Grid Modernization Plan

Annual Report

Calendar Year 2023

D.P.U 24-40

July 1, 2024, Submitted to:
Massachusetts Department of Public Utilities

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I. Introduction

On May 10, 2018, the DPU (Department of Public Utilities) issued a decision (the "Order") approving in part the grid modernization plan (GMP) for Massachusetts Electric Company and Nantucket Electric Company, each d/b/a National Grid ("National Grid" or "Company"), Fitchburg Gas and Electric Light Company d/b/a Unitil ("Unitil"), and NSTAR Electric Company d/b/a Eversource Energy ("Eversource"), together the "Electric Distribution Companies" (EDCs), in dockets DPU. 15-120, 15-121 and 15-122. In the Order, the Department pre-authorized grid-facing investments over three years (2018-2020) for National Grid, Eversource, and Unitil, respectively, and adopted a three-year (2018-2020) regulatory review construct for preauthorized Grid Modernization investments. Order at 106-115. The Order provided that the Companies would submit GMPs every three years, which would be addressed in separate proceedings, and that the Companies must submit Grid Modernization Term Reports at the end of each three-year term, which document performance during the term. Id. at 111-112.

The Order also provided that the Companies must submit "Grid Modernization Annual Reports" to document performance during the applicable year and that these would be docketed for informational purposes only, but the Department may formally investigate a company's performance during the term of the plan if the Department determines this is warranted. Id. These Grid Modernization Annual Reports are due on April 1 of the year following the first and second plan years. Id. at 114. In DPU 15-120-D/15-121-2/15-122-D (May 12, 2020), the Department extended the first grid modernization plan investment term through the calendar year 2021, and the deadline for the first Grid Modernization Term Report was April 1, 2022. On July 1, 2021, the Companies filed their respective 2022-2025 GMPs consistent with the Department's directives in Grid Modernization – Phase II, DPU. 20-69-A (May 21, 2021). The Department docketed these matters as DPU 21-80 (Eversource), DPU. 21-81 (National Grid), and DPU 21-82 (Unitil), respectively.

As part of their 2022-2025 GMPs, the Companies jointly proposed revisions to their existing statewide Volt VAR Optimization (VVO) performance metrics approved by the Department in DPU 15-120, DPU. 15-121, and DPU. 15-122 (see DPU 21-80, Exh. ES-JAS-2, at 145 & Att. A; DPU 21-81, Exhs. NG-GMP-1, at 11; NG-GMP2 (Rev. 2) at 84; NG-GMP-4; DPU 21- 82, Exhs. Unitil-KES-1, at 22-24; Unitil-GMP at 109 & Att. A). Additionally, Eversource submitted two Eversource-specific metric proposals applicable to its previously deployed technology investments. Specifically, Eversource proposed: (1) to delete its existing Eversource-specific advanced load flow performance metric (see DPU 21-80, Exh. ES-JAS-2, Att. A at 23- 24); and (2) a new Eversource-specific metric associated with its power quality monitoring investment (see DPU 21-80, Exh. ES-JAS-2, at 146-147).

On September 1, 2021, the Department bifurcated its investigation of the 2022-2025 GMPs into two separate, parallel tracks. DPU 21-80/DPU. 21-81/DPU. 21-82, Procedural Notice at 2 (September 1, 2021). The Department designated Track 1 to review proposed investments identified as having been previously deployed and preauthorized grid modernization investments and technologies under the Companies' 2018-2021 GMPs ("Continuing Investments") and Track 2 to review proposed investments identified as new grid modernization investments and those investments proposed as part of each Company's advanced metering infrastructure implementation plan. DPU 21-80/DPU. 21-81/DPU. 21-82, Procedural Notice at 2 (September 1, 2021). On December 30, 2021, the Department issued an Interim Order in DPU. 21-80/DPU. 21-81/DPU. 21-82, authorizing the Companies to continue their respective GMPs and implement Track 1 investment categories that are consistent with the investment categories previously preauthorized for the 2018-2021 GMPs, until the Department issued its final Track 1 decision. Order on Interim Continuation of Grid Modernization Programs and Revised Grid Modernization Factor Tariffs, DPU. 21-80/DPU. 21-81/DPU. 21-82, at 6-7 (2021) ("Interim Continuation Order"). The Department noted that these investments would be subject to a further prudence review at the end of the 2022-2025 GMPs' term. The Interim Continuation Order should not be construed as preauthorization of any proposed Track 1 investment category or as a modification of the Companies' burden to demonstrate that proposed Track 1 investments meet the Department's preauthorization eligibility standards. Id. at 7.

On October 7, 2022, the Department issued its Track 1 order in DPU. 21-80, DPU. 21-81, and DPU. 21-82 approving, with modifications, the Companies' Continuing Investments proposals. DPU 21-80-A/D.P.U. 21-81-A/D.P.U. 21-82-A, at 114-115 (2022) ("Track 1 Order"). As part of its Track 1 Order, the Department made certain findings regarding the Companies' proposed revisions to the existing statewide VVO performance metrics and the Eversource-specific proposals. Specifically, the Department found the proposed revisions to the VVO performance metrics reasonable and approved the revisions, apart from the VVO energy and greenhouse gas (GHG) impact performance metric. Track 1 Order at 102. The Department required the Companies to update the GHG emissions factors to be consistent with those used in the current 2022-2024 Three-Year Energy Efficiency Plans. Id. at 102-103. Further, the Department: (1) rejected Eversource's proposal to delete its existing company-specific advanced load flow performance metric; and (2) approved Eversource's power quality monitoring performance metric. Id. at 104. The Department also directed National Grid to develop a company-specific performance metric within 90 days of the date of the Track 1 Order for its smart capacitor investment for consideration during a compliance phase of the DPU. 21-81-A proceeding. Id. at 87-88, 104. Lastly, the Department required the Companies to make certain non-substantive edits to the existing statewide performance metrics. Id. at 102-103.

On, November 30, 2022, the DPU issued its Track 2 Order and preauthorized $35.4 million for grid-facing investments as follows:

1. $ 1.9 million for an investigative study in the Distributed Energy Resource Management System (DERMS) category.

2. $ 15.7 million for DERMS implementation.

3. $ 7.0 million for advanced short-term load forecasting capabilities.

4. $ 6.2 million for an active resource integration (ARI) investment demonstration project.

5. $ 0.2 million to evaluate local export power control in the demonstration category.

6. $ 4.4 million for program management and third-party measurement and verification.

DPU 21-80-B/21-81-B/21-82-B, at 175. The Department allowed the Company to continue to be able to recover these costs on an accelerated basis through a separate grid modernization factor. The approved budget is a cap, though the Company can shift spending among these categories; any spending over the cap may be recovered in a base distribution rate case. Id. at 175-176.

On January 25, 2023, the Department of Public Utilities ("Department") requested comment on the form and content of the annual reports for grid modernization investments made by the Electric Distribution Companies under their approved 2022-2025 grid modernization plans. DPU 23-30, Hearing Officer Memorandum at 2-3 (January 25, 2023) ("Request for Comments"). The Department included a proposed narrative outline and data reporting template with its request. Request for Comments, Atts. A & B.

On February 15, 2023, NSTAR Electric, National Grid, Unitil, the Massachusetts Department of Energy Resources, and the Cape Light Compact JPE ("Compact") each submitted comments. On March 2, 2023, the EDCs jointly submitted reply comments ("Joint Reply Comments"), and the Compact submitted reply comments. On March 16, 2023, the Department issued a memorandum on the Grid Modernization Annual Reports that (1) identified revisions, as applicable, to the proposed narrative outline and data reporting template included in the Request for Comments; and (2) established the form and content of the annual report filings by the EDCs for their CY 2022 grid modernization plan investments. The Department additionally adopted templates to be completed and included with the term reports. On March 30, 2023, the EDCs jointly submitted a motion for an extension of time to file their respective 2022 Grid Modernization Plan Annual Reports, which was granted by the Department. On April 24, 2023, the EDCs separately filed their 2022 Grid Modernization Annual Reports.

On January 27, 2023, the Department issued a memorandum in D.P.U. 21-80, D.P.U. 21-81, and D.P.U. 21-82 that (1) sought comments on a number of issues related to performance metrics for continuing and new grid-facing investments; (2) requested performance metric proposals for customer-facing investments; (3) requested performance metric proposals related to low-income and environmental justice community (EJC) customers for both grid-facing and customer-facing grid modernization investments; and (4) established submission deadlines for comments, proposals, and reply comments. On May 3, 2023, the EDCs filed joint comments and a proposed metric for grid-facing investments. On June 28-29 the Department held technical sessions on metrics. On November 9, 2023, the Department issued a Hearing Officer Memorandum directing the EDCs to file: (1) for Department review and approval, a revised performance metrics proposal; (2) for Department consideration, a proposed annual data reporting template; and (3) for informational purposes, an evaluation plan for the Companies' second term grid modernization investments. On December 12, 2023, the EDCs filed revised Grid Modernization performance metrics and a revised reporting template including:

1. Addition of low-income/environmental justice metrics: Tabs 10a, 10b, and 10c;

2. Removal of reliability columns: removed in Tabs 3b, 3c, and 3d;

3. Removal of electric vehicle columns on feeder status tabs, Tabs 3b, 3c, and 3d;

4. Removal VVO columns on feeder status tabs: removed from Tabs 3b, 3c, and 3d.

On February 1, 2024, the Department approved the revised Grid Modernization performance metrics.

On January 10, 2024, the Department issued a memorandum in D.P.U. 21-80/21-81/21-82 instructing the EDCs to submit for Department consideration revisions to the annual and term report filing deadlines in their respective grid modernization factor tariffs to July 1 to provide sufficient time to include finalized costs in the annual report filings. On January 12, 2024, National Grid submitted a revised Grid Modernization Factor Provision, M.D.P.U. No. 1539, with the requested revisions, which the Department approved on January 22, 2024.

On April 3, 2024, the Department issued a revised Grid Modernization Annual Report Outline and reporting template in D.P.U. 24-40 for this filing. This is National Grid's second Grid Modernization Annual Report for its CY2022-2025 GMP. It contains the narrative documenting the Company's performance on its Grid Modernization Plan from January 1, 2023, through December 31, 2023 ("Report") and is accompanied by the templates the Department has approved.

Key elements of the Department's Track 1 and Track 2 Orders approving in part the GMPs, include:

1. Grid-Facing Investments: The Department approved National Grid's proposed grid-facing investments and preauthorized $336 million in spending for these investments over four years from January 1, 2022, through December 31, 2025. The Department held that these investments may be treated as incremental to current investments if the proposed investment's primary purpose is accelerating progress in achieving the grid modernization objectives.

2. Customer-Facing Investments: The Department approved National Grid's proposed customer-facing investments and preauthorized $391.1 million in spending for these investments through 2027 for AMI electric meters, communications network, AMI (Advanced Metering Infrastructure) back-office infrastructure head-end system, and meter data management system, enterprise integration enhancements, cybersecurity, and project management.

3. Cost Recovery: The Department continued the short-term targeted cost recovery mechanism, the Grid Modernization Factor, for pre-authorized grid modernization investment.

The Department preauthorized the following categories of grid-facing investments for a combined four-year budget of $336.2 million: monitoring and control ($4.1 million), VVO ($76.4 million), Advanced Distribution Automation (ADA)/Fault Location, Isolation and Service Restoration (FLISR) ($37.7 million), Advanced Distribution Management System (ADMS) ($61.0 million), Information Technology (IT)/Operational Technology (OT) ($18.8 million), communications ($102.8 million), DERMS ($24.6 million), demonstration projects ($6.4 million), and program management and third-party measurement and verification ($4.4 million) for the 2022-2025 Grid Modernization Plan term. The preauthorized investment categories incorporated the following investments:

- VVO: The VVO technology flattens a feeder's voltage profile by utilizing intelligently controlled capacitors and regulators on the feeder, which minimizes system losses. Then, the source voltage at the substation is remotely lowered to provide energy savings for customers and the distribution grid.

- FLISR: The Company is deploying FLISR equipment designed to reduce the impact of interruptions on the distribution system by installing automated switches along the feeder's main line and tie points. This allows a fault to be automatically isolated into a sub-section of the feeder and isolates uninvolved sub-sections that are resupplied via automated tie points, significantly reducing impacted customers and outage durations.

- Feeder Monitors: Feeder Monitors are a cost-effective method of measuring current, voltage, and real and reactive power that can be deployed on feeders for which the

Company otherwise does not have sufficient visibility. This will allow the distribution system to fill an information and awareness gap, leading to efficient operation and maintenance, planning, storm recovery, and lower costs to all the Company's customers by optimizing system performance.

- IT/OT: These investments build a technology foundation as the infrastructure cornerstone for delivering the capabilities of the proposed grid modernization investments, including VVO, FLISR, feeder monitors, ADMS/Supervisory Control and Data Acquisition (DSCADA), DERMS, demonstration projects, and integrating Distributed Generation (DG). Comprehensive data management, integration services, cyber security, and data analytical functions are core components of this investment area.

- Communications: These investments provide a reliable, cost-effective two-way communications capability to end devices, including grid automation controls, field sensors, and substations, while ensuring the network meets all technical requirements for the devices and systems deployed. These requirements include availability, latency, bandwidth, security, and other performance considerations. These investments provide the capabilities to plan, design, manage, maintain, and troubleshoot the communications network. The infrastructure includes additional backhaul networks, substation fiber installations, a multi-tiered field-based wireless communication network, and radios for devices without embedded communications.

- ADMS/SCADA: The Company's ADMS investment is an integrated grouping of hardware and software necessary for Distribution Control Center operations to provide greater visibility, situational awareness, and optimization of the electric distribution grid, resulting in improved outage response and increased efficiencies through automating and digitalizing multiple control center processes. ADMS is being developed to continue safe and reliable operations under growing system complexities such as dynamic load profiles from increasing levels of customer DER adoption. ADMS is a critical platform for the integration and operational management of DERs as their impact on grid performance grows.

- DERMS: The DERMS Platform is a group of individual products managed by the Company that works cohesively to actively track, plan, manage, and control DER interconnected on circuits below 100 kV through monitoring and control either directly or via an aggregator. The DERMS Platform will improve the reliability, resiliency, efficiency, and overall performance of the electric distribution system in a DER-centric world. Common DERMS Platform use cases include interconnection of DERs, DER registration, DER program enrollment, long-term DER planning, operational DER planning, DER operations, and DER settlement.

- Demonstration Projects: The Company has two demonstration projects to test new tools to facilitate the interconnection of DG in certain areas of the Company's electric distribution system that are approaching saturation. (1) ARI explores the ability to interconnect up to 15 MW of actively managed solar PV DG projects through a flexible interconnection service, avoiding the need for a new supply cable by limiting output from the solar PV DG projects during periods of high generation and low load. This technology and testing will provide learnings supporting the DERMS investigation and subsequent implementation as the demonstration project progresses. (2) Local Export Power Control (LEPC) explores using a Power Control System to allow a behind-the-meter solar and storage project with net zero thermal impact to interconnect and operate without costly system upgrades.

- Project Management / Measurement and Verification – Program management and Measurement and Verification (M&V) are used to manage and measure the GMP delivery effectively. Program Management investment funds the Company's project management office to manage overall portfolio delivery. M&V investment is used for evaluation activities by Guidehouse, the Program evaluation consultant for all EDCs, to provide a uniform statewide approach for ensuring that benefits are both maximized and achieved with greater certainty.

A. Progress Toward Grid Modernization Objectives

The Department's Grid Modernization objectives are as follows:

- Optimize system performance by attaining optimal levels of grid visibility, command and control, and self-healing,
- Optimize system demand by facilitating consumer price responsiveness,
- Interconnect and integrate distributed energy resources.

The Company's second Grid Modernization Plan includes a range of investments and initiatives to modernize the distribution system and deliver customer benefits, including energy supply savings, decreased outage duration, fewer customers impacted by outages, and improved system operations and planning. The preauthorized and new investments will provide additional functionality necessary to increase Distributed Energy Resources (DER) integration capacity.

In 2023, the Company made considerable progress in FLISR deployments. The Company installed 18 FLISR schemes, including 88 reclosers, across 36 feeders, spanning 25 substations, thereby increasing FLISR saturation in the Commonwealth and decreasing outage frequency and duration

for customers. Additionally, the Company initiated the design and construction activities for 30 additional FLISR schemes. By year's end, 42 FLISR schemes, including first-term deployments, were initiated. FLISR schemes delivered 30 successful FLISR service restoration operations in 2023 resulting in a 17% improvement in outage duration and 16% improvement in outage frequency for customers on FLISR-enabled feeders. At the end of 2023, FLISR covered approximately 13% of the Company's Massachusetts customers. While FLISR penetration is still relatively low, the FLISR restorations led to an overall improvement of 2% for system-level outage duration and frequency.

By deploying feeder monitors on feeders that lack telemetry or have sub-optimal telemetry, the Monitoring and Control investment has increased system visibility for the operations control center and electric system planners, who use this information to help optimize the control and design of the electric system. In 2023, the Company deployed 43 feeder monitors, bringing the total deployment levels to 208 feeder monitors, including first-term deployments.

The Company continued its VVO technology deployment, which helps optimize system demand and reduce customer energy usage with feeder monitors and centralized control of advanced capacitors and regulators. The additional operational data collected by automated capacitors and regulators and displayed in the ADMS will support the improved distribution system management, which will assist in integrating distributed resources. Maintaining proper voltage via intelligent centralized control will also improve feeder voltage performance, allowing for more DERs. In 2023, the Company completed construction on 13 feeders and three substations as part of the VVO deployment. The Company installed 122 individual units, consisting of 104 feeder-level units and 18 substation units, bringing the total number of substations with VVO to 14, including installations from the first term. The VVO program also initiated 14 additional substations for engineering in 2023 and construction in 2024/2025. Additionally, the Company upgraded 16 previously installed VVO circuits with head-end feeder monitors to improve VVO performance.

The Company continues advancing a portfolio of telecommunications and Information Technology/Operational Technology (IT/OT) solutions to build a technology foundation and infrastructure cornerstone for delivering the capabilities of the grid modernization investments, including VVO, FLISR, feeder monitors, ADMS/DSCADA, DERMS, and demonstration projects. As a component of the strategy, National Grid identified short-term and long-term plans for building the enabling capabilities, platforms, and communications necessary to achieve visibility, control, and operation of these investments. In 2023, the Company made progress in implementing important telecommunications and IT/OT projects as part of the Grid Modernization Plan. Significant milestones were achieved, including successful negotiations for the 700 MHz

spectrum license for the Field Area Network (FAN), the creation of workflows in the Telecommunications Operations Management System (TOMS), and the successful implementation of the Multiprotocol Label Switching-Transport Profile (MPLS-TP) nodes for Data Multiplexer (DMX), Synchronized Optical Network (SONET) replacement, and Digital Signal Zero (DS0) leased circuit replacement. Additionally, efforts to modernize communication links between key and critical sites were continued. Regarding IT/OT, significant advancements were made in the Data Management Platform, Enterprise Integration, and Cybersecurity Services.

The Company has progressed in developing and implementing the ADMS/DSCADA platform, which supports all three Grid Modernization objectives; this includes advancing efforts to perform data model updates, data clean-up, and validation of the connected model within the Geographic Information System (GIS) to support ADMS requirements. In 2023, the Company completed the outage management functionality, switching all outage management functionality from the legacy Outage Management System (OMS) to the ADMS system. The Company also completed the Power Out Reporting Tool (PORT) for ADMS.

The Company's investment in DERMS and demonstration projects in Track 2 will significantly contribute towards achieving the Department's objectives. The two demonstration projects, ARI and Local Power Export Control will facilitate the interconnection of Distributed Generation (DG) in areas of the Company's electric distribution system nearing saturation. These investments in DERMS will work alongside existing grid modernization investments such as IT/OT, Distribution Supervisory Control and Data Acquisition (SCADA), ADMS, VVO, and the Data Management Platform to support all three of the Department's grid modernization objectives.

B. Summary of Grid Modernization Deployment (Actual v. Planned)

In 2023, the Company progressed investments across all the approved Track 1 and Track 2 investments. Below is a summary of the key highlights with the supporting details in each investment Category within Section III.

VVO: The VVO program has successfully constructed 13 feeders within three substations. In addition, the program has initiated engineering for 14 more substations, which will be constructed in 2024/2025, including Field Street, Marlboro 311, N. Dracut 78, N. Haverhill 48, Chartley Pond 8, W. Andover 8, Pinehurst 92, Swansea, Newbury 60, N. Weymouth 6, N. Chelmsford, Wilbraham 507, W. Hampden 139, and Rocky Hill 336. Moreover, the Company has installed 122 individual units, consisting of 104 feeder-level units and 18 substation units.

Additionally, the Company has retroactively installed sixteen head-of-circuit feeder monitors to improve VVO performance.

FLISR: The Company installed 18 FLISR schemes, including 88 reclosers, across 36 feeders spanning 25 substations and initiated the design and construction activities for 30 schemes.

Feeder Monitors: The Company installed 43 feeder monitors.

ADMS: The Company continues to progress with key activities:

- The critical accomplishment for ADMS in 2023 was delivering outage management functionality. The Company switched all outage management functionality from the end-of-life legacy OMS to the ADMS. Additionally, the Company has created the PORT to replace the outdated and obsolete ABB FocalPoint application. This in-house solution serves as the analytics and reporting window for OMS, used by employees throughout the Company in their storm roles to respond to major events, optimize outage response, and relay outage information to the communities National Grid serves throughout the Commonwealth.
- By the end of 2023, the Company increased the number of ADMS-ready feeders to 715, where load flow calculations can be performed manually and automatically (server load flow).
- The Company progressed GIS validation of the core technology and architecture during 2023. The exercise aimed to verify spatial data's accuracy, completeness, and reliability within the ADMS system.
- The Company made significant progress on the Mobile Outage Dispatch system deployment, including initiating bi-directional communication with the ADMS system.

Communications: The Company continued progressing essential telecommunications projects initiated as part of the GMP. The Company reached several significant milestones in various areas, including successfully negotiating the 700 MHz spectrum license for the FAN with the expected transfer of the licenses to occur in 2024. In preparation for the 2024 spectrum license transfer, implementation teams have completed the initial network design for the FAN. Regarding the DMX SONET replacement project, the Company installed 25 MPLS-TP nodes across 17 locations. Regarding DS0/leased line replacement, the Company completed surveys at 95 implementation sites and received equipment for the initial 20 sites. Additionally, construction has been completed at two sites. New workflows have been implemented in the TOMS to enhance the traditional work order process. One of these workflows involves creating circuit work orders in the TOMS, which initiates a work order to

track scheduling, dispatching, and closure. The Company's Integrated Network Operations Center (INOC) implementation team merged a Network Management System (NMS) with the existing telecom network infrastructure and configuration. This NMS centralized platform helps track and analyze grid devices and provides predictive analytics and real-time network surveillance abilities.

IT/OT: Enterprise integration teams implemented platform scaling of digital products for ADMS and TOMS. The ADMS integrations enabled outage management through an integration platform, reducing technical debt and enhancing scalability, reliability, logging, monitoring, alerting, and disaster recovery. For cybersecurity implementations, the Company completed the Privileged Access Management (PAM) tool, which manages, tracks, and enhances privileged accounts' security across the critical network infrastructure environment. In the data management workstream, the Company has made progress in building a centralized data platform and advancing the 'One System One Model' electric data management strategy to create an interoperable data platform for Grid Modernization. The focus for 2023 was on improving data quality, prioritizing a single data source, and ensuring ease of use, automation, and interoperability.

The Company provided the required format for the annual reporting of the system-level deployment and spending information in the annual report. The baseline plan summary was provided in Tab 5.b. Spending - 2023 Report in the attached DPU Annual Report Template. The Company has provided the summary of planned versus actual deployment of devices and spending as of December 31, 2023, in Tab 5.b. Spending - 2023 Report in the attached DPU Annual Report Template. Refer to columns F - P.

C. Summary of Spending (Actual v. Planned)

The Department has approved a budget of up to $336.2 million for incremental spending on grid-facing investments during the period 2022-2025. The primary purpose of these investments must be to accelerate progress in achieving grid modernization objectives. These investments must either involve new types of technology or represent an increase in the level of investment a company proposes relative to its current investment practices. Operation and Maintenance (O&M) expenses must be incremental to the representative level of the costs recovered through rates and solely attributable to preauthorized grid modernization expenses.

The Company filed documentation for its incremental capital additions and O&M costs for its GMP in the plan year 2023 in Docket D.P.U. 24-36. The plan year 2023 spending included costs

for ADA, ADMS, Feeder Monitors, VVO, IT/OT, Communications, DERMS, Advanced Short Term Load Forecasting, ARI, Program Management, and M&V. The capital investments for the ADMS, Communications, and IT/OT categories contain certain investments to be deployed across Massachusetts and New York. The shared investment will be allocated using National Grid's standard allocation factors, and the costs presented in the DPU Annual Report Template are the amounts estimated to be allocated to Massachusetts based on the allocation factors in effect as of April 1, 2023.

The Company provided the required format for the annual reporting of the system-level deployment and spending information. The baseline plan summary is provided in Tab 5. b. Spending - 2023 Report in the attached DPU Annual Report Template.

Below is a table summarizing the Company's spending through 2023 and forecasted spending for the remainder of the term:

$ millions

Major Cost Category	Preauthorized Budget Cap	Spend to Date (CY22 - CY23)	Forecast Spend (CY24 - CY25)	Total Spend Forecast (CY22 - CY25)
Monitoring and Control	$ 4.1	$ 3.2	$ 1.5	$ 4.7
VVO	76.4	19.1	49.3	68.4
ADA/FLISR	37.7	28.1	14.8	42.9
ADMS	61.0	47.2	23.0	70.2
IT/OT	18.8	11.7	4.3	16.0
Communications	102.8	20.9	77.9	98.8
Subtotal Track 1	300.8	130.2	170.8	301.0
Track 2	35.4	2.5	30.5	33.0
	$ 336.2	$ 132.7	$ 201.3	$ 334.0

II. Program Implementation Overview

A. Organizational Changes to Support Program Implementation

The Grid Modernization Execution (GME) team oversees the implementation of approved grid modernization investments. This includes managing the portfolio, designing business processes, defining requirements, developing solution architecture, managing change, coordinating testing and vendor technical implementation, and monitoring performance. In 2023, the GME team continued to build on the capabilities established in the first term to carry out the investments approved in the 2022-2025 Grid Modernization Plan.

Through September 2023, a cross-functional Steering Committee provided guidance and oversight for the GMP implementation process. This committee included representatives from Engineering Asset Management and Planning, Information Technology, Electric Control Centers, Electric Operations, Regulatory, Finance, and Budgeting. The Steering Committee oversees the budget and implementation of GMP investments, facilitates appropriate functional support and staffing, and champions program activities.

In October 2023, the Company reorganized its electric business, moving deployment-focused Grid Modernization execution resources to the Program Management organization and moving Program oversight resources to the newly established Massachusetts Electric Regulatory Delivery organization, which is responsible for ensuring Grid Modernization investments comply with all relevant Department Orders. This organization hosts regular Grid Modernization Regulatory Review meetings with leaders responsible for investment delivery to ensure all projects are executed within allowance, review progress against plan, and make decisions on programmatic risks and issues.

The Company also held monthly GME Status Meetings as a performance monitoring and measurement activity. These meetings aimed to identify project risks, performance issues, and cross-project dependencies. Project managers responsible for delivering Grid Modernization investments provided updates, which could be escalated to the Steering Committee or Regulatory Review Meeting for informational purposes or critical decisions.

The Company used established business frameworks and practices, as well as the capabilities, processes, procedures, departments, and personnel to support the delivery of the GMP. This approach promotes early adoption and consistency across the enterprise, allowing the organization to deliver, scale, and sustain the GMP portfolio. A matrix approach involves a

combination of internal and contracted operational personnel, including line workers, technicians, IT developers, and engineers.

The Company provides training as efficiently and cost-effectively as possible by integrating necessary changes into ongoing refresher training and existing curriculums whenever feasible. Training took place at centralized training facilities or Company field offices, depending on the location most suitable for delivering the training.

The Company has 40 positions dedicated to delivering the Grid Modernization program across various departments, including GME, ADMS, and Grid Modernization Information Technology. The staffing includes a mix of existing Company employees (non-incremental) and new hires (incremental) to fill specific roles. Additional contractors are hired as needed. Employees from other departments partially support grid modernization tasks, although they do not necessarily charge their time to grid modernization accounting. Examples of these employees/groups include those involved in capital planning, finance support, regulatory support, legal support, and higher-level management.

Additional contractors and National Grid full-time employees supported the grid modernization initiatives by providing program management, change management, engineering services, construction, and analytical/systems support. In addition, the Company continued to identify and deploy process improvements and implement effective change management as part of the GMP.

B. Cost and Performance Tracking Measures Adopted

The Company has developed protocols and measures for identifying and tracking incremental capital and O&M expenses. Cost centers were set up within the Company's reporting hierarchy for Grid Modernization to precisely track program costs associated with the Grid Modernization organizations and Program costs. The Company has grid modernization-specific work orders to distinguish the preauthorized grid modernization investments within its accounting system. Costs associated with program implementation are tracked using unique funding projects and work orders for capital, as well as internal orders for O&M. Capital is classified as either direct (operating company) or benefitting multiple companies (service company). O&M work that benefits one jurisdiction is directly charged to specific grid modernization orders/accounting for that jurisdiction. Work that benefits more than one jurisdiction is charged to orders that allocate the costs based on predetermined allocators. The charges are reviewed monthly for verification, and any charges deemed unrelated to the eligible grid modernization investments are reclassified according to the appropriate organization. Incremental labor is captured, and all labor charged

to Grid Modernization O&M accounting is reviewed at the end of each plan year. All capital costs, including labor, are considered incremental. For O&M labor costs, the Company follows the guidelines set forth by the Department's order on incremental O&M to determine which labor is incremental. D.P.U. 15-120-E/15-121-E/15-122-E (September 7, 2022) ("Incremental O&M Order").

The Department's Incremental O&M Order provides that the Companies must demonstrate that all O&M expenses proposed for recovery through the Grid Modernization Factor are (1) incremental to the representative level of O&M expenses recovered through rates and (2) solely attributable to preauthorized grid modernization expenses. Id. at 26.

This overarching two-prong test has been applied to all O&M expenses sought for recovery, including the two broad categories of (a) internal O&M labor expenses; and (b) third-party/contractor costs.

The Company, through its Regulatory Delivery organization, effectively manages cost and performance tracking and controls. This demonstrates the Company's robust capabilities in overseeing and ensuring the efficiency of grid modernization investments.

The Company, recognizing the need to maintain grid modernization investments separate from other capital investments, has taken significant steps to ensure process efficiencies and alignment with core controls. Leveraging its existing sanctioning and approval process for capital and IT investments, the Company has extended this process to grid modernization investments. This strategic move not only ensures alignment with core controls but also enhances the visibility of grid modernization investments, enabling proper prioritization.

The Company has adopted and provided performance metrics described later in this Report. The EDCs have also supported and progressed the Evaluation Plan.

The adopted cost and performance tracking measures allowed for greater clarity and visibility of GMP-related investments, which allowed for the collection and management of the investments for cost recovery tracking and annual reporting.

C. Project Approval Process and How it is Separate from Standard Capital Investments

The Company meticulously oversees the program cost tracking mechanisms, ensuring precision in cost data and reporting on portfolio performance. This involves aligning cost tracking within the overall financial process and the established program cost tracking process. The reporting combines both financial and operational metrics of the GMP portfolio. Operational work order details are formally tracked using this reporting. Work order details, including work order description, service center, costs, and work order status, are pulled into the reports from various systems. Data is organized by project and by the GMP-specific lines of business discussed above in the GMP Cost Tracking section. Any identified inconsistencies are promptly addressed and corrected.

As a further review of the data, monthly status meetings are held with project managers. The summarized GMP data and detailed data from the tracking mechanism are shared and analyzed during this meeting. The Grid Modernization project managers also report on progress made in their respective areas of responsibility. The monthly meetings provide a recurring opportunity and platform to discuss issues related to or potentially impacting the GMP.

In addition to the formal tracking reports and monthly meetings, the Company recognizes the significant role of informal processes in implementing the GMP. Different departments, such as Distribution Planning, Design, Scheduling, Engineering, Procurement, and Investment Planning regularly communicate with each other to ensure the successful implementation of the GMP. The departments collaborate, using their expertise to meet the performance expectations of the GMP portfolio. Stakeholders in these departments also have their own tracking systems, which are periodically compared with the official GMP source documents maintained by the Regulatory Delivery team.

III. Implementation System Level Narrative by Investment Category

(1) Volt Var Optimization

VVO deployments are designed to minimize system losses while reducing customer demand and energy use. VVO reduces the head of feeder voltage, flattens the voltage profile, and maintains circuit power factors near unity. VVO targets reducing the circuit output to a lower acceptable voltage of 117 volts. Doing this lowers the overall circuit voltage to an optimal level while keeping customers fully operational. This voltage leveling helps to minimize circuit demand and energy consumption. By actively managing capacitor banks, VVO optimizes power factor, improving the efficiency of power delivery. The load profiles are expected to change drastically and unpredictably with higher penetration of variable DG (such as solar) and emerging load technologies (such as electric vehicles (EV) chargers). By actively managing voltage levels and power factors, VVO enables optimal load balancing capabilities to accommodate increasingly variable supply and demand dynamics.

a. Description of Work Completed

Throughout 2023, the Company made significant strides in VVO deployments. The Company completed construction on 13 feeders and three substations. The Company also initiated 14 additional substations (Field Street, Marlboro 311, N. Dracut 78, N. Haverhill 48, Chartley Pond 8, W. Andover 8, Pinehurst 92, Swansea, Newbury 60, N. Weymouth 6, N. Chelmsford, Wilbraham 507, W. Hampden 139, Rocky Hill 336) for engineering in 2023, and plans to begin construction in 2024/2025.

The Company installed a total of 122 individual units, including 104 feeder-level units and 18 substation units. The Company has proposed system enhancements to the vendor and has retroactively installed head of circuit monitors at sixteen sites.

Below is a table of VVO equipment installed in 2023:

VVO – Capacitor Banks	VVO – Line Sensors	VVO – Line Regulators	VVO – Station Regulators	VVO – LTC Controls
72	26	6	15	3

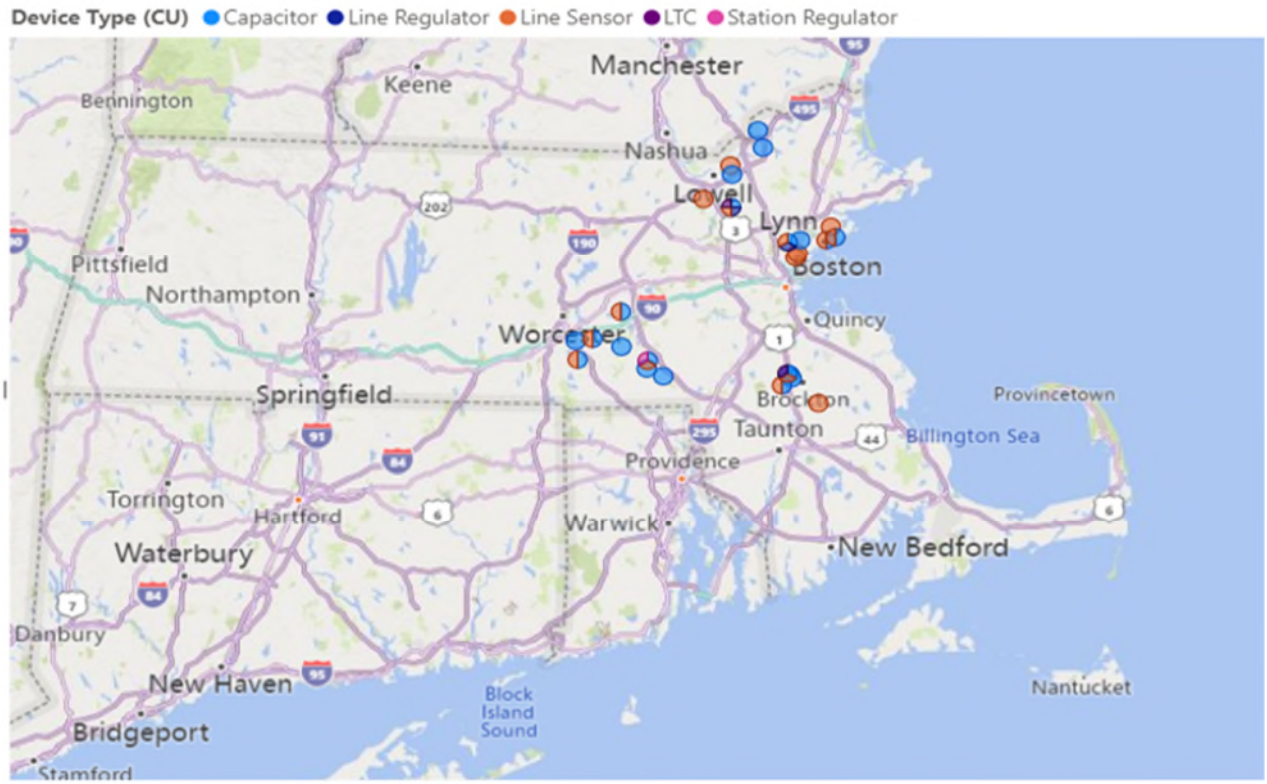


Fig. 1 VVO device installation map, 2023

b. Lessons Learned, Challenges, and Successes

The Company has taken steps to address the performance issues with VVO schemes, which were reported as a challenge in 2022. The VAR settings have been corrected with guidance from the VVO software vendor. The parameters will be updated in all Massachusetts circuits, and the results will be monitored to assess the impact of the new settings. The Company decided to halt further license procurement from the vendor, UtiliData, starting from March 28, 2023. Instead, the Company plans to have the ADMS manage all VVO circuits.

Regarding plans for the data and system management supporting VVO in the ADMS, the Company commenced collaboration with Hitachi to configure the VVO/CVR module within the ADMS application. The currently deployed equipment provides immediate benefits by offering insights into circuit performance and enabling localized optimization of power profiles. Additional circuits may be added depending on the resolution of the configuration issues with the existing

vendor. Improving performance and accuracy with a full view of data from VVO remains a crucial objective for the Company, and significant progress has been made in integrating VVO with the ADMS, with plans for full VVO integration expected in 2025.

The Company has diversified its vendor relationships and pre-ordered materials using anticipated quantities to ensure a steady supply of devices like capacitors, regulators, feeder monitors, and LTC controls. This approach mitigates potential production issues with individual vendors and leverages existing contracts for timely line and station regulator delivery. Improved vendor oversight has been achieved through regular cadenced meetings to ensure efficient processing of purchase orders. Improving the material procurement process by setting up primary and secondary vendors for crucial equipment such as capacitor banks and line post sensors has led to a significant reduction in the lead time for station regulators from 80 to 26 weeks.

The Company tests all smart devices before field installation, increasing productivity. This process for VVO significantly reduces the cycle time for programming devices. Similar efficiency gains have been observed in platforms with a decentralized office commissioning process, thanks to improved coordination within the Grid Modernization portfolio.

c. Actual v. Planned Implementation and Spending

Tab 5b Spending – 2023 Report in the attached Department Annual Report Template provides the deviation in the implementation and spending. Refer to columns F - P, rows 13 - 16.

d. Performance on Implementation

VVO equipment optimizes voltage management and helps minimize reactive power flow for an efficient distribution grid. By actively managing voltage levels, VVO may facilitate higher penetration levels of DERs, such as solar photovoltaic systems.

e. Description of Benefits Realized as the Result of Implementation

Implementing VVO leads to many benefits across the distribution system. These include improved feeder power factor, reduced losses, and enhanced energy efficiency. Flatter voltage profiles ensure more stable voltage levels, reducing stress on equipment. Once enabled, VVO reduces peak demand and energy consumption by customers, translating into lower bills and

decreased greenhouse gas emissions associated with energy consumption. Improved feeder voltage performance and system awareness provide invaluable insights for daily operations and long-term planning processes. VVO has proven to be a valuable technology, delivering tangible benefits that positively impact customers and the distribution network.

f. Description of Capability Improvement by Capability/Status Category

Fourteen substations have VVO technology installed, including installation from the first term. The Company continues to adjust VVO to maximize benefits. After completing each location's final site acceptance testing, measurement and verification protocols were initiated for the substations. After installation and field commissioning, the VVO equipment provided improved voltage and load visibility to distribution control center operators.

g. Key Milestones

Milestones achieved in the period were the feeder aspects of design and construction and the associated circuits at one substation, in Swampscott. Engineering was completed at three substations: Millbury, Dighton, and Northboro Rd. In addition, six substations entered the Measurement & Verification phase.

h. Updated Projections for Remainder of the Term

The Company has 32 substations (126 circuits) in the design or construction phase. By the end of the term, 48 substations, consisting of 219 feeders, are scheduled to have VVO installations completed, including installations from the first term.

Feeder-Level Narrative

a. Highlights of Feeder-level Implementation

The table below lists the substations and feeders where VVO has been installed in 2023:

Substation Name	Feeder ID
Billerica	14-70L5
	14-70L6
Depot Street	05-335W1
	05-335W2
	05-335W3
	05-335W4
	05-335W5
	05-335W9
E. Bridgewater	07-797W23
East Dracut	14-75L1
	14-75L2
	14-75L3
East Methuen	14-74L3
	14-74L5
Easton	07-92W44
Maplewood	12-16W1
	12-16W4
	12-16W5
	12-16W8
Melrose	12-25W3
	12-25W4
Millbury	01-304W1
	01-304W2

	01-304W3
	01-304W4
	01-304W5
	01-304W6
Parkview	07-94W40
	07-94W41
	07-94W42
	07-94W43
	07-94W44
Swampscott	12-22W1
	12-22W2
	12-22W3
W. Salem	12-29W6
Westboro	05-312W1
	05-312W2
	05-312W4
	05-312W5

b. Feeder-level Lessons Learned, Challenges, and Successes

For more detail on feeder-level lessons learned, challenges, and successes, see section b.

(2) Advanced Distribution Automation

FLISR uses an ADA program to minimize the impact of outages on customers. The program uses sectionalizing protection equipment and automated switches along the feeder's main line and tie points to automate and coordinate outage response. The sensors along the feeder collect data to identify and isolate faults in a sub-section of the feeder. The unaffected sub-sections are supplied via automated tie points, significantly reducing outage durations for affected customers.

a. Description of Work Completed

In 2023, the Company made significant progress in FLISR deployments. The Company installed 18 FLISR schemes, including 88 reclosers, across 36 feeders spanning 25 substations. These implementations substantially increased FLISR saturation in the Commonwealth, improving customer reliability. Additionally, the Company initiated the design and construction activities for 30 schemes in 2023.

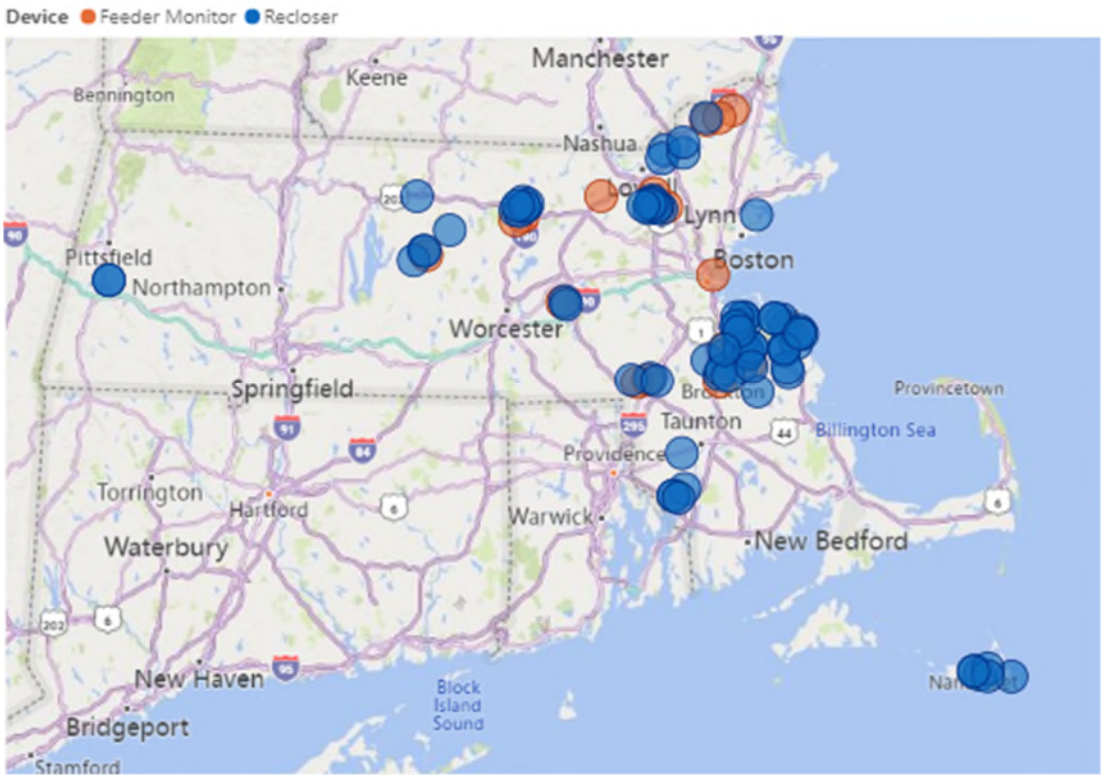


Fig. 2 FLISR device installation map, 2023

b. Lessons Learned, Challenges, and Successes

While 20 FLISR schemes were scoped and designed for the reporting year, permitting and construction complexities presented challenges to implementing some schemes. However, to expedite project delivery, the Company achieved significant process improvements in 2023 by centralizing dedicated teams focusing on FLISR deployment. Supporting these implementation teams were outside resources including securing commitments from appropriate resources to conduct field commissioning of devices. The Company onboarded contractors to perform some of the scoping and design to accelerate FLISR project delivery, supplementing internal resources.

During the field commissioning process, the Company discovered incorrect voltage readings on the G&W Viper S model reclosers. This required the equipment vendor to inspect the units to determine the issue. They found that the recloser's grounding bolt, assembled at the vendor's factory, needed to be torqued to specifications. Due to this faulty assembly, the units needed replacement, which presented unforeseen cost and time expenditures. The vendor fixed the reclosers that the Company had taken down from the poles and verified that all other reclosers were assembled correctly and functioning to specifications.

To avoid deployment delays experienced in years prior, implementation teams fast-tracked the permitting process, establishing a direct line of communication with internal permitting teams and the Massachusetts Department of Transportation (DOT), facilitating the clearance of many construction permits. Notably, the Company successfully processed 86 permits throughout the year, comprising 42 environmental permits, 23 DOT permits, and 21 town petitions, demonstrating substantial progress and efficiency in their operations.

The Company achieved several successes through proactive planning and strategic partnerships. A project scheduling tracker was introduced in 2023. In leveraging the project tracker, detailed Business Intelligence reports were generated and shared in regular meetings, facilitating improved oversight and accountability. These reports have been instrumental in identifying and addressing any delays in the work, enhancing overall workflow.

Orders for essential equipment such as reclosers and feeder monitors, were placed well in advance to accommodate long lead times, ensuring timely project execution. Additionally, reclosers were strategically office commissioned and stored near an implementation site to enable swift response to project demands. The project team diversified its vendor base by sourcing reclosers from multiple vendors to mitigate risks. Improved procurement and vendor management initiatives collectively contributed to efficiency in meeting timelines and material needs.

Successes:

The 42 active FLISR schemes, inclusive of first term deployment, delivered 30 successful FLISR service restoration operations in 2023.

- FLISR operations automatically restored over 37,000 customers in 2023.
- On December 18th, seven FLISR operations occurred during a major storm event, the most to have happened in one day.
- DA33 launched on January 20, 2023, and completed its first successful operation two weeks later.
- One FLISR scheme had 5 operations in 2023, and 10 operations since its implementation on December 16, 2021.

Feeder-level examples and analysis will be illustrated in ADA case studies in the 2023 evaluation report compiled by Guidehouse, which will be filed in June 2024.

c. Actual v. Planned Implementation and Spending

Tab 5b Spending – 2023 Report in the attached Department Annual Report Template provides the deviation in the implementation and spending. Refer to columns F - P, rows 10 - 12.

d. Performance on Implementation

During 2023, the Company deployed 18 FLISR schemes, covering 36 feeders encompassing 27 substations. The total number of FLISR schemes completed is now 42. As FLISR schemes cover more customers throughout the state, outage durations have been reduced in those areas where FLISR is active on the network.

e. Description of Benefits Realized as the Result of Implementation

The Company directly measures the reliability benefits from FLISR by analyzing the restoration details of FLISR operations to estimate avoided customer minutes interrupted and reduction in outage frequency. This method of calculation avoids some sources of uncertainty of using a statistical comparison to historical reliability data, such as the year-to-year variability of storms,

vegetation management cycles, and other reliability drivers independent of grid modernization investments.

In 2023, FLISR operated 30 times, resulting in a 17% improvement in outage duration and a 16% improvement in outage frequency for customers on FLISR-enabled feeders for reportable outages. At the end of 2023, FLISR covered approximately 13% of the Company's Massachusetts customers. While FLISR penetration is still relatively low, the FLISR restorations led to an overall improvement of 2% for system-level outage duration and frequency for reportable outages for the Massachusetts Electric Company service area.

In 2023, FLISR performed exceptionally well during major storm events, with ten out of the 30 FLISR operations occurring during major events. These events are excluded from reliability reporting. Customers on FLISR-enabled feeders experienced an 11% improvement in outage duration and a 9% reduction in outage frequency during major events in 2023. During a major storm event on December 18, 2023, featuring heavy winds and rain, FLISR operated seven times restoring thousands of customers. The Company does not always expect FLISR to restore customers during major storm events since these events are dynamic and outage patterns can vary. For instance, the Company has observed instances of FLISR being unable to operate during major events due to both connected feeders in the scheme experiencing mainline faults, restricting FLISR's ability to resupply customers.

FLISR restorations during major events have additional unquantified reliability benefits: automatically operating switches that would have needed to be manually operated without FLISR allows crews to focus on resolving other outages and leads to improved outcomes for all customers, not just those covered by FLISR.

The Company expects even more significant performance improvements as FLISR coverage expands statewide.

f. Description of Capability Improvement by Capability/Status Category

Improved distribution system management is supported by operational data collected from automated switches. Voltage and current data from six internal voltage sensors are collected on both the load side and source side of the reclosers. The voltage and current data at reclosers provide improved visibility of the distribution system, allowing for more granular and accurate distribution analysis modeling, including interconnection studies analysis.

Feeder ties and reconductoring implemented through FLISR allow for enhanced remote switching opportunities from the control center for both emergency and planned work.

g. Key Milestones

The Company deployed 18 FLISR schemes in 2023, bringing the total number of FLISR schemes completed since 2019 to 42 schemes, spanning 83 feeders and 61 substations.

h. Updated Projections for Remainder of the Term

The updated projections for FLISR installations in 2024 and 2025 indicate considerable progress and expansion. The Company anticipates implementing 36 schemes in 2024. In 2025, the Company plans to continue investing in FLISR through base rates but does not anticipate implementing FLISR schemes funded through grid modernization allowances. This forward-looking approach underscores a commitment to enhancing grid resilience and efficiency by deploying FLISR technology to address operational challenges and improve system reliability in the coming years.

Feeder-Level Narrative

a. Highlights of Feeder-Level Implementation

FLISR technologies have been installed on the following feeders during 2023:

Substation Name	Feeder ID
Ames	07-911W13
Barre	09-604W1
	09-604W4
Billerica	14-70L5
Candle St	04-101L2
	04-101L4

	04-101L5
	04-101L8
Chestnut Hill 702	09-702W1
Crocker Pond	05-3424W1
Dighton	05-19W73
E. Bridgewater	07-797W24
East Dracut	14-75L4
	14-75L6
East Holbrook	07-2W1
	07-2W2
East Main Street	05-314W2
	05-314W3
East Weymouth	07-9W1
Harrison Blvd	07-75W1
Holbrook	07-10W1
Lenox Depot	09-1103W1
	09-1103W2
Litchfield St	01-207W2
Mid-Weymouth	07-12W1
	07-12W4
North Abington	07-99W32
	07-99W63
North Andover Jct.71	14-71L1
North Weymouth	07-6W1
	07-6W2

Norwell	07-96W41
	07-96W43
Parkview	07-94W40
Pinehurst	14-92L3
	14-92L6
Plymouth St	07-93W40
Prospect St.	01-219W2
	01-219W4
	01-219W5
Railyard	12-49W2
Scituate	07-915W36
	07-915W37
	07-915W82
South Billerica	14-18L1
	14-18L2
	14-18L3
South Wrentham	05-3422W4
Stoughton	07-913W47
Swansea Sub	05-11W84
Water St	07-910W51
	07-910W52
Water Street	14-31L1
West Newbury	14-47L1
Westford	14-57L2
Westminster	01-602W2

Whittier	14-76L1
	14-76L3
Winthrop	12-22W5

b. Feeder-Level Lessons Learned, Challenges, and Successes

For more detail on feeder-level lessons learned, challenges, and successes, see section b.

(3) Monitoring and Control

The Feeder Monitor program's main objective is to acquire visibility at the feeder heads for feeders where the Company does not have visibility in its Energy Management System (EMS). The Feeder Monitor program's secondary objective is to be used as a tool for system planners to gain visibility along the feeders. Feeder Monitor deployment is leveraged for step-down transformers distributed across the system. These transformers step down primary distribution voltages, such as 13.8KV to 4KV to serve local loads. These system designs are challenging to support operationally, and monitoring them will significantly help electric planning, as they are often points of congestion on the electric system due to their inherent current limitations.

The Company currently has over 1,100 distribution feeder circuits in Massachusetts. However, due to the historic lack of feeder data, there remain gaps in the Company's situational awareness. Installing feeder monitors fills this awareness gap, assisting in more efficient operation and maintenance, planning, and storm recovery.

a. Description of Work Completed

In 2023, the Company progressed in implementing Feeder Monitors, with 43 installations. By comparison, in 2022, implementation teams installed nine units. This represents a significant increase in the number of deployments compared to the previous year. The head-end mainline feeder monitors were specifically deployed to upgrade feeders that previously lacked sensing capabilities.

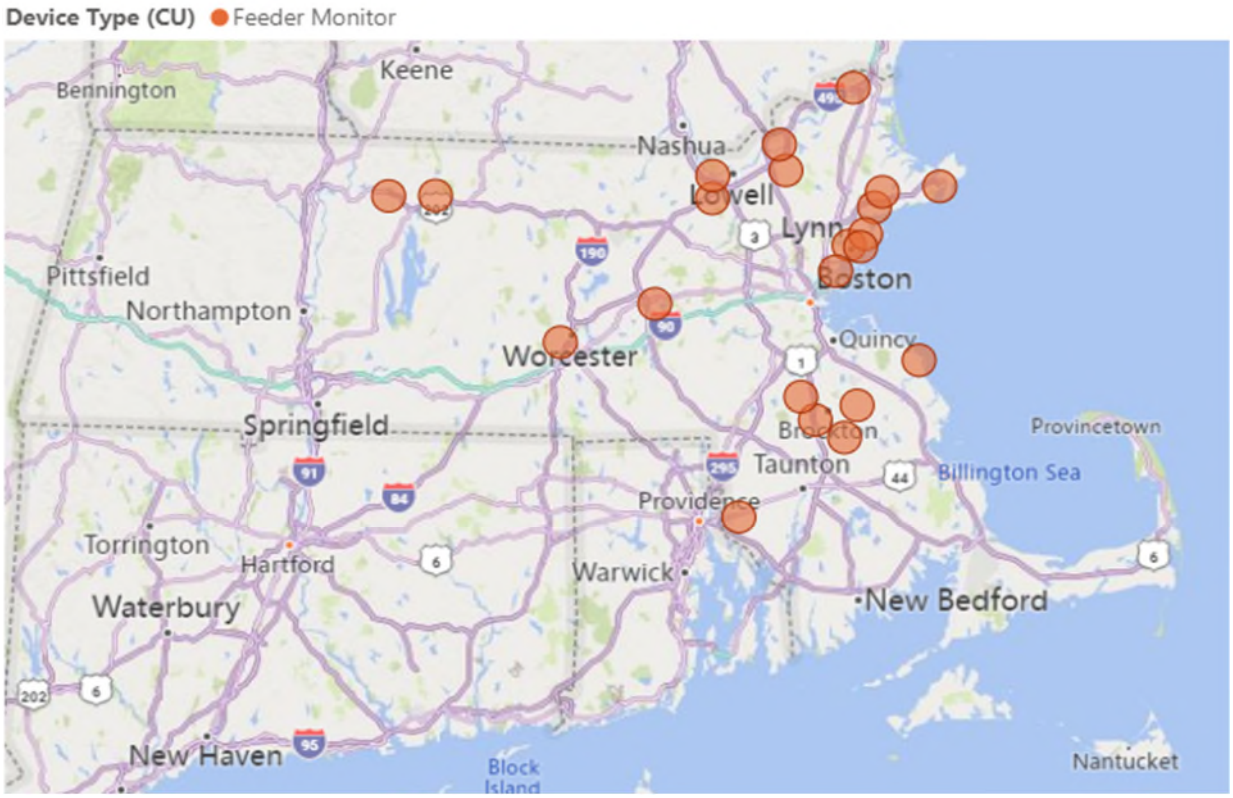


Fig. 3 Feeder Monitor device installation map, 2023

Installing feeder monitors provides increased visibility regarding line loading, resulting in more data for identifying voltage issues, allowing for early alerts, and improving response times.

b. Lessons Learned, Challenges, and Successes

The Company installed more monitoring and control installations this year than in the past. In doing so, implementation teams faced several challenges. The high demand for line construction resources created prioritization conflicts, which had the potential to delay feeder monitor installations. The Company managed to mitigate potential delays by leveraging external contractors. This strategy resulted in a significant increase in deployments.

The Company achieved successes through improved resource allocation and project prioritization, which has proven crucial for meeting, and exceeding, installation targets.

Leveraging the project tracker, the team generated detailed reports shared in regular meetings, facilitating better oversight and accountability. These reports have been instrumental in identifying and addressing any delays or stagnation in the work, enhancing overall efficiency. Notably, the tracker's implementation has significantly reduced feeder monitor installation delays, contributing to the acceleration of project completion.

During the previous term, implementation teams installed clip-on sensors, which the manufacturer has since discontinued. The Company's standards team approved another manufacturer's clip-on style feeder monitor sensor this year, and teams began the design process for a limited deployment of these sensors. If successful, these sensors will enable installations in previously inaccessible locations, opening new options for monitoring and control.

A review of the end-to-end process was conducted to improve future implementations. To ensure the installation location is suitable, an enhanced engineering and constructability review was conducted. The review aimed to verify that the pole is not double or triple-circuited, has enough space to accommodate the sensors, and is safe for the installation crew to work on.

Procurement process improvements included prioritizing proactive equipment management were implemented. Upon completion of preliminary engineering, the team worked with the Inventory Management team to expedite the creation of purchase orders, mitigating previous long lead times team to expedite the creation of purchase orders, mitigating previous long lead-times and supply chain shortages.

Feeder-level examples and analysis will be presented in M&C case studies in the 2023 evaluation report compiled by Guidehouse, which will be filed in June 2024.

c. Actual v. Planned Implementation and Spending

Tab 5b Spending – 2023 Report in the attached Department Annual Report Template provides the deviation in the implementation and spending. Refer to columns F - P, row 9.

d. Performance on Implementation

In 2023, 43 feeder monitor systems were installed. These installations enable increased visibility for the Distribution Control Center and Engineering teams. As a result, they have better access to data that aids in understanding line loading and voltage issues.

e. Description of Benefits Realized as the Result of Implementation

Monitoring and control devices improve visibility into load demand, enabling substations to report and collect data, and integrate with the ADMS without costly station overhauls. Feeder Monitors also assist the operations control center (through the ADMS integration with real-time information) in performing system reconfiguration following contingencies and during peak loading periods. Feeder Monitors, in combination with other grid modernization investments, enable the Company to ensure voltage and loading compliance year-round across the distribution system, particularly in areas of the distribution system with high levels of DER penetration, which are necessary for safe and reliable electric service. The Company's electric planning group will benefit directly from the historical logging of data, which will assist in designing systems solutions. This will lead to a more efficiently planned system, using direct time interval feeder data, instead of annual and peak usage data as is done currently.

f. Description of Capability Improvement by Capability/Status Category

In 2023, the Company implemented 43 feeder monitor installations.

g. Key Milestones

The Company completed 43 Monitoring and Control systems installations in 2023, marking a significant milestone.

h. Updated Projections for Remainder of the Term

As of December 2023, feeder monitors have been installed at 208 locations including the 155 first term installations, with 24 additional locations planned for feeder monitors to be completed by the end of 2024. The final 11 locations will be completed in 2025.

The initial deployment plan was to set up telemetry at 197 selected locations to provide data for feeders that lacked it. Out of the original 197 locations, the Company has already installed feeder monitors at 140. As the original feeder plan was developed, more locations were identified and added to address the need for telemetry or to provide feeder readings for the upcoming ADMS go-live.

Feeder-Level Narrative

a. Highlights of Feeder-level Implementation

Feeder monitors were installed on the following feeders in 2023:

Substation Name	Feeder ID
Andover	14-3J42
	14-3J43
	14-3J44
Belmont	07-98W48
Boulevard	14-77L1
	14-77L2
	14-77L3
Chestnut Hill	09-702W2
Concord Road	14-24L2
	14-24L3
E. Beverly	12-51L2
	12-51T1
	12-51T2
E. Bridgewater	07-797W24
Hillside	14-66L1
	14-66L2
Lawrence Street	14-53J3
Marlboro	05-311W1
	05-311W3
	05-311W4
	05-311W5
N. Beverly	12-18L2

Plymouth St	07-93W42
Rehoboth	05-3J2
Revere Beach	12-35J3
Salem Boston St.	12-3J4
Scituate	07-17J1
South Marlboro	05-310W4
	05-310W5
	05-310W6
Stoughton	07-913W43
	07-913W47
	07-913W69
Swampscott	12-22W1
	12-22W2
W. Salem	12-29W3
Webster St.	01-6W2
Wendell Depot	09-705W1
West Chelmsford	14-73L2

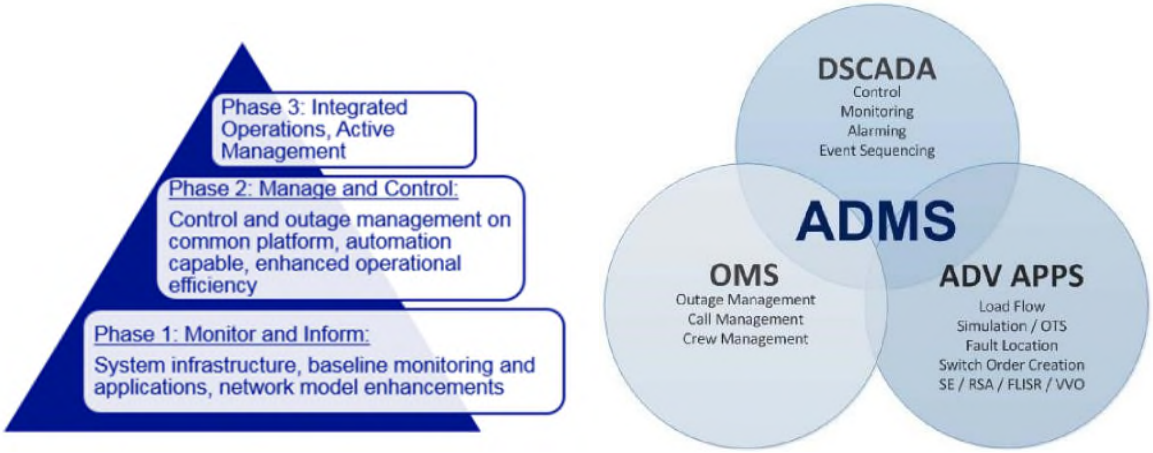
b. Feeder-Level Lessons Learned, Challenges, and Successes

For more detail on feeder-level lessons learned, challenges, and successes, see section b.

(4) Advanced Distribution Management System, Distribution SCADA

The Company is harnessing the power of the ADMS to revamp the oversight of the electric grid. The ADMS has three main modules: a Distribution SCADA (Supervisory Control and Data Acquisition), an OMS, and a Distribution Management System (DMS). This system is crucial for futureproofing the grid. These modules operate on a common platform that centralizes data, improves efficiency, and digitizes operational processes, paving the way for a more streamlined and effective distribution management.

The ADMS implementation is progressing in a phased approach. The Company first implemented DMS applications and then upgraded its existing OMS production system into a common OMS/DMS platform and network model. The next step is to implement a DSCADA (distribution-only SCADA) system, separate from the existing SCADA system that will remain for transmission-only SCADA. This phased approach ensures a systematic and efficient implementation of the ADMS.



Planned Phases of the ADMS implementation include:

Phase 1: Monitor and Inform (placed in service May 2021)

- Define requirements and design ADMS's infrastructure and network.
- Data expansion, population, and centralization in ADMS for required functionality test and verify baseline application functionality.

- Implement the monitor and inform functionality via baseline DMS applications, load flow, restoration switching analysis, simulation mode, and experimental fault location analysis.

Phase 2: Manage and Control

- Upgrade and refresh OMS, incorporating functionality into standard system and network model with DMS applications sharing data to improve outage visibility and response, expanded analytics and reporting. (in-service in 2023)
- Build DSCADA to support, manage, and control functionality for distribution devices. Minimum Viable Product (MVP) planned for 2024, full capabilities scheduled for 2025)
- Interface with Advanced Metering Infrastructure (AMI) and mobile dispatch functions. (MVP planned 2024)
- Initial testing and implementation of more advanced automation-capable applications, such as VVO/CVR and FLISR. (Planned for 2024)
- ADMS components (i.e., DSCADA, OMS, DMS apps) are available utilizing a single platform. (DMS/OMS in 2023, DSCADA in 2025)

Phase 3: Integrated Operations, Active Management (planned in-service by 2025)

- Fully integrated system automation centralizing VVO/CVR and FLISR applications.
- Move towards active network management, leveraging distributed resources and interfacing system data, allowing real-time DER control guided by short-term load forecast and economic dispatch (by integrating with proposed DERMS-related investments).
- Publishing an "as-operated" system model to the Enterprise Integration Platform or future data lake.
- Protection & Arc Flash Application: ADMS-based Protection & Arc Flash application maintains safe and reliable service with increasing levels of customer DER adoption. This application would automatically check if protective devices can clear all faults anywhere on the feeder. The vendor has not developed this work, which is currently a road map item. The Company expects this may not be complete by the end of the term without significant vendor support.

a. Description of Work Completed

In 2023, the Company achieved a significant milestone in the ADMS Phase 2 by delivering outage management functionality in a standard system with Phase 1 DMS applications. This involved a complex cutover from the legacy OMS, migrating all outage management capabilities and interfacing data into the ADMS. The Company upgraded the ADMS platform (release 10.3.34 Rev F) before the OMS went live. The Company conducted comprehensive testing, including system acceptance testing, user acceptance testing, performance testing, and security penetration testing, ensuring a smooth transition to the new system.

Transferring all historical outage data and device tag information into ADMS was critical as part of the OMS cutover. Historical outage information can benefit operators. Information such as events, duration, affected areas, customer impact, and restoration efforts can help operators make informed decisions to improve outage response and restoration efforts. This structured approach to outage data management enhances the effectiveness of outage management processes within the ADMS platform.

The new ADMS system is integrated with a central data repository in the corporate network, which provides access to outage data for other applications that benefit from leveraging this data. The extended outage analytics capabilities developed as part of the PORT product (described below) leveraged this data.

Additionally, the Company implemented a separate interface with Snowflake's data warehouse software to import engineering data to support DMS functionality. This interface imports critical data, such as device settings for capacitors, regulators, reclosers, and generators, into ADMS. Implementing this interface has replaced manual data entry efforts engineers had previously undertaken as part of feeder readiness efforts.

The ADMS environment has 715 feeders where load flow calculations can be performed manually and automatically (server load flow); this represents the cumulative number of distribution feeders with SCADA connectivity. A list of feeders that became "ADMS ready" in 2023 is included in the Department Data Reporting Template on Tab 1b. Incremental Deployment 2023.

Several supporting projects are essential to allow the Company to leverage the ADMS capabilities fully. These projects, described further in this section, are:

1. Mobile outage dispatch.
2. Remote terminal unit separation / SCADA separation.
3. Distribution Process Information (PI) historian.
4. Geographic Information System (GIS) data enhancements.

Outage analytics and reporting, PORT: The Company has created PORT to replace the outdated ABB FocalPoint application. This in-house solution uses the capabilities of the enterprise data platform. It serves as the analytics and reporting window for OMS, used by employees throughout the Company in their storm roles to respond to significant events, optimize outage response, and relay outage information to the communities National Grid serves throughout the Commonwealth. PORT offers more user-friendly dashboards and improved storm situational awareness, which helps to enhance storm support, response, and communication.

The vision for this initiative is to address how to replace the vendor-deprecated FocalPoint reporting system with these capabilities:

- Business-hardened platform for uptime during heavy use
- Reporting separated from the core OMS system
- Enhanced dashboards with customizable reporting
- Modern internet browser enabled
- Leverage enterprise-wide approved data management tools
- Mobile enabled

The PORT product was developed and released, leveraging the agile development approach. This allowed the MVP releases to ensure quality, ease of use, and scalability. The Company delivered the full version of the PORT product in late 2023. Work continues to expand and enhance PORT's functionality.

Distribution Process Information (D-PI) Historian: The D-PI Historian software, with its efficient data collection, storage, analysis, and visualization capabilities, is a reliable tool for managing process data related to distribution operations. It captures data from various sources within the distribution network, such as sensors, meters, and control systems, and stores it in a centralized database. This data can include information about voltage levels, current flows, equipment status, alarms, and other operational parameters, ensuring a comprehensive view of the distribution network's performance.

The PI Historian product records all SCADA data received by the ADMS from distribution feeders and substations. This product complements ADMS by allowing direct data access to the operator through an ADMS console under secure conditions. D-PI is only accessible by ADMS consoles, thus ensuring its continuous, as-designed performance, especially when FLISR and VVO centralized automation technologies go live. Additionally, non-OT-related data queries will not affect D-PI, ensuring uninterrupted performance.

By harnessing the power of D-PI Historian, the Company can significantly enhance the ADMS's performance. This tool lets the Company spot trends and anomalies, streamline operations, and make informed data-based decisions to boost reliability, efficiency, and safety.

Considerable progress was made on the ADMS D-PI Historian project in 2023. The scope and specifications for the D-PI project were identified, outlining the objectives and requirements for implementation. As part of the ADMS-SCADA project, a comprehensive implementation plan was developed for the D-PI Historian project. This plan was seamlessly integrated into the overall project timeline, ensuring that the implementation of the D-PI was synchronized with other components of the ADMS. This project plan integration enhanced efficiency and alignment across the project, demonstrating the crucial role of the D-PI Historian in the overall system.

b. Lessons Learned, Challenges, and Successes

The Company encountered a significant challenge when implementing the telecom system upgrades required for ADMS. The Wide Area Network (WAN) required telecom connections to extend to all the control rooms and data centers; implementing these connections was a formidable challenge. The ADMS system requires a low latency, high bandwidth, and resilient telecommunications system. Deploying the components of this system required complex construction plans, special permits, asbestos remediation, and fixing broken conduits. Attending to these challenges and unforeseen construction requirements needed more time than expected. However, the Company navigated these delays and complexities without delaying the project delivery.

The Company's implementation of ADMS Phase 1 was a significant success in executing grid modernization plans to improve the distribution system's operation. Phase 1 was completed after progressing through development and production stages. Comprehensive business training, readiness acceptance, and a successful cutover were completed, and the system is now operational. ADMS Phase 1 can monitor and provide information on the system's state. This release marks a significant milestone in the progression of ADMS implementation.

The release of ADMS Phase 2, which includes outage management functionality, has been successfully completed and implemented. All vendors involved in the ADMS program are on board, and contracts are in place. Multiple primary hardware and software systems have been installed in Company data centers. ADMS capabilities can be customized to meet specific use cases based on geographic area, network topology, build type (underground versus overhead, network versus radial), type of weather events, DER penetration, and other variables. During the Phase 2 build, the Company agilely performed minor releases to deliver new features, expanded application coverage, and software enhancements for the present production DMS applications.

Work was done to ensure crew information can synchronize between ADMS/OMS and mobile outage dispatch application to allow for ease of expansion.

As work was done to develop the outage analytics for PORT, the focus was placed on resiliency to ensure that the application could meet uptime and support requirements. In addition, expanded performance testing was required to allow scripted tests to mimic actual user load and qualify the application's performance throughout numerous test cycles. During this work, the infrastructure was upsized to sustain the rapid increase in user load during storm events.

c. Actual v. Planned Implementation and Spending

Tab 5b Spending – 2023 Report in the attached Department Annual Report Template provides the deviation in the implementation and spending. Refer to columns F through P, rows 17 through 21.

d. Performance on Implementation

ADMS establishes new ways of operating the distribution network given rapidly changing load patterns driven by high penetration of DER on the network. The focus is two parts: (1) build new capabilities to contend with the changing grid landscape, and (2) maintain or increase reliability and grid resiliency. As ADMS Phase 2 moves into production, the Company will see changes to baseline outage processes due to system centralization that will create new efficiencies in operating the grid.

Phase 2 ADMS deployment was focused on a significant release of an OMS upgrade, which puts the critical functionality of trouble and outage dispatching on the same system and network model as the Phase 1 ADMS applications. Future work will complete this by integrating SCADA

data into the OMS functionality. Centralizing the OMS into ADMS will allow cross-system data sharing from primary grid telemetered devices and future AMI integrations. This provides more timely and comprehensive information at the start of an outage, allowing for more accurate analysis and response, and at the end of the outage, to better utilize resources and improve reporting accuracy.

e. Description of Benefits Realized as the Result of Implementation

ADMS is an improvement over prior processes that relied on operators to use historical information and manual calculations. ADMS centralizes and automates distribution grid functions such as VVO and FLISR.

System Enhancements:

- Configuring and programming GIS to accommodate new asset types and equipment, including adding expanded equipment attributes and characteristics, has been completed.
- Configure and program GIS to facilitate the capture of more significant data and modeling granularity for underground distribution networks.
- Develop substation objects to support operations and planning processes that have been completed.
- The development of additional tools and the improvement of existing toolsets used to manage data quality and processes in GIS have been completed.

Data Enhancements:

- Analyze and enhance existing data, including network connectivity, configuration, and attribute-level values.
- Identify and populate additional attributes and new asset types, including network connectivity, configuration, and attribute-level values.
- Ensure the total population of DER interconnections in GIS and populate customer equipment attributes.
- Analyze, enhance, and populate additional assets to extend further the underground distribution network and secondary distribution models and functionality.

- Populate enhanced substation models aligned with use in operational and planning processes.
- Completed the interface from the Advanced System for Process Engineering (ASPEN) to Snowflake and completed the design work for the Snowflake to ADMS interface.
- GIS improvements and data hardening.

Process Review and Improvement:

- The partial post capability was completed and implemented to improve data accuracy and reduce design-to-post cycle time. This process is under constant review and iterative improvement to ensure optimal usage.
- Additional supporting processes are under review to ensure fit for Phase 2 (control capability).

f. Description of Capability Improvement by Capability/Status Category

DMS capability improvements:

- Centralizing the outage management system into ADMS will allow cross-system data sharing from primary grid telemetered devices and future AMI integrations. This provides more timely and comprehensive information at the start of an outage, allowing for more accurate analysis and response, and at the end of the outage, to better utilize resources and improve reporting accuracy.
- During the Phase 2 build, the Company agilely performed minor releases to deliver new features, expanded application coverage, and quarterly software enhancements for the present production DMS applications.

PORT capability improvements:

- Addresses existing FocalPoint technical debt and outdated software and infrastructure.
- Separate reporting of data from core OMS functions to minimize performance impact.
- Improved software quality control measures ensure less re-work and higher quality software releases.

- Cybersecurity standards are applied to prevent unauthenticated users from accessing corporate data.
- Engaging business intelligence data visualizations provides better situational awareness and analytics for identifying and resolving electric outages.
- PORT is implementing an intuitive user interface to facilitate navigation and ensure transparent data reporting for users of the online web application.
- Using detailed data validation, the PORT product will provide accurate and timely data to end users.

g. Key Milestones

- The successful cutover of the new OMS.
- All infrastructure supporting the legacy OMS application was retired.
- ADMS replaced the following legacy systems during 2023: Windows 7 consoles, Windows 2008 and 2012 servers, RHEL 6 servers, Oracle 11 databases, Checkpoint firewalls, Cisco switches, and F5 load balancers.
- Integrations between ADMS and corporate applications were delivered using MuleSoft application programming interfaces (APIs). MuleSoft replaces the Oracle Java CAPS middleware used for integrations with legacy OMS.
- A new Microsoft Remote Desktop Services infrastructure provides corporate access to ADMS for storm support. This replaces the use of Citrix applications for storm user access.
- The ADMS platform was upgraded to release 10.3.34 Rev F before OMS went live. The Company conducted Site Acceptable Testing (SAT) User Acceptance Testing (UAT), performance, and security penetration testing before the OMS go-live date.
- As part of the old OMS system cutover, implementation teams transferred all historical outage data and device tag information into ADMS.
- The Company implemented an interface with Snowflake's data warehouse software to support DMS functionality.
- The ADMS environment has 715 feeders where load flow calculations can be performed manually and automatically (server load flow); cumulatively, this represents 97% of all distribution feeders that have SCADA connectivity.
- The Company delivered the completed PORT digital product in late 2023.

- As part of the ADMS-SCADA project, a comprehensive implementation plan was developed for the D-PI Historian project.
- D-PI data pre-migration activities.
- D-PI design and ordering equipment.

h. Updated Projections for the Remainder of the Term

During the remainder of the term, the Company plans to finish the DSCADA control capability and implement ADMS Phase 3 concepts, expanding automation and active network management.

ADMS Geographic Information System

GIS informs the ADMS to enhance capabilities that expand and improve the data necessary to maintain network models for advanced applications. GIS enhances the ability to manage, operate, and optimize the distribution network by providing spatial intelligence, asset management integration, network analysis, and support for field operations. GIS is essential for the Company to integrate grid modernization devices because it provides the following:

- Spatial intelligence.
- Asset management capabilities.
- Network planning tools.
- Data integration.

The GIS Phase 2 project's primary goals are to upgrade the GIS technology, improve data management practices, enhance substation modeling capabilities, and enable interoperability with third-party analytics tools. Phase 2 GIS will focus on improving the quality, completeness, and efficiency of GIS data management processes, ensuring that the platform remains a reliable and valuable tool for operations, planning, and decision-making.

a. Description of Work Completed

The Company progressed GIS validation of the core technology and architecture during 2023. The exercise aimed to verify spatial data's accuracy, completeness, and reliability within the system. The validation exercise demonstrated that GIS successfully ingests and stores geospatial data using the Feature Manipulation Engine (FME), a powerful data integration platform employed for geospatial data in a data warehouse environment, Snowflake. The FME effectively facilitates data movement, transformation, and loading processes. Using FME to ingest, transform, and store geospatial data enables the Company to leverage its spatial data assets for analytics, visualization, and decision-making purposes.

Deployment teams mapped Smallworld to the FME. This mapping implementation is a comprehensive solution for managing complex spatial data and network infrastructure. The Smallworld software suite provides robust tools for storing, organizing, and managing spatial data in a centralized database. This integration allows seamless data exchange and workflow automation across multiple departments and business processes supporting grid modernization goals.

Validation testing also proved that Magik Scripts, used in the context of Smallworld GIS, can customize and extend the functionality of Smallworld GIS applications. Magik Scripts streamlines operations reduces manual effort and improves efficiency by automating routine tasks, notifications, and data processing steps. Teams evaluated knowledge dependencies for their capabilities, compatibility with Magik code, and suitability for downstream system functionality, aligning with GIS functionality.

Additionally, implementation teams developed the Network State Engine (NSE), hosted in Azure, for validation, which collects, processes, and analyzes data to ensure reliability, performance, and security. The NSE has been validated to generate explicit spatial topology relationships.

b. Lessons Learned, Challenges, and Successes

Implementation teams discovered that the NSE generates incremental updates with different keys than what the Smallworld Magik-based extracts for ADMS generated, resulting in an inability to apply NSE extracts to the ADMS case study in a lower environment, using incremental updates. The approach to remediate the challenge is to use a lookup reference dataset in NSE that helps to use the identical IDs generated via Magik extracts at the time of transition. This approach has yet to be fully vetted due to the team's focus on high-priority deliverables. This will only be fully

vetted once a complete data set is imported into ADMS during the NSE MVP phase. Also, the incremental updates process must be validated at multiple levels (single object, single feeder, multiple feeders in a region, and a large 500 feeder load set). There is a risk that too many transactions will slow down incremental updates and make it unworkable on the ADMS system. If a bulk load of the Network model into ADMS is required, the system's downtime must be minimized; less than an hour is usually the business threshold for an outage.

c. Actual v. Planned Implementation and Spending

Tab 5b Spending – 2023 Report in the attached Department Annual Report Template provides the deviation in the implementation and spending. Refer to columns F - P, rows 17 - 21.

d. Performance on Implementation

The validation process for GIS data is crucial in maintaining data integrity and trust within the Company's GIS system. By identifying discrepancies and ensuring accuracy, these exercises ensure that GIS data meets industry standards and best practices, mitigating risks associated with decision-making. Accurate GIS data is vital for informed decision-making in infrastructure development, outage response, and device management. Through validation exercises, the Company ensures that its GIS data remains reliable and suitable for supporting critical decision-making processes across various domains.

e. Description of Benefits Realized as the Result of Implementation

By leveraging GIS as part of the grid modernization efforts, the Company can improve operational efficiency, enhance grid reliability, and deliver better customer service.

Specifically, using FME to ingest, transform, and store geospatial data in Snowflake enables the Company to leverage its spatial data assets for analytics, visualization, and decision-making purposes within the Snowflake data warehouse environment.

f. Description of Capability Improvement by Capability/Status Category

GIS provides spatial intelligence by allowing the Company to visualize, analyze, and understand its electrical grid infrastructure's physical layout and characteristics. By having a clear spatial understanding of its assets, the Company can make more informed decisions about grid planning, operations, and maintenance.

GIS provides geospatial data to ADMS which enables the Company to quickly identify, locate, and respond to outages and disturbances on the grid. Teams use ADMS to visualize outage patterns, assess severity, prioritize restoration efforts, and communicate outage information to customers and stakeholders.

ADMS is a central platform for integrating, analyzing, and visualizing diverse data sources relevant to grid modernization efforts, including spatial, network, operational, customer, and environmental data. By integrating data from disparate sources into ADMS, the Company can comprehensively understand grid operations, identify opportunities for efficiency improvements, and make data-driven decisions to support grid modernization goals.

g. Key Milestones

Milestones of the NSE validation phase:

- Ingest and store geospatial data in the cloud data warehouse (Snowflake) using FME and Spatial Business Systems Plug-In.
- Built the NSE in Azure.
- Generated and stored network trace results, connecting the model with business rules for downstream systems for the validation scope boundary.
- Extract the connected model and process the downstream system in ADMS and Cybernetica Measurement, the software module used for analysis and simulation in the ADMS environment.
- Demonstrate that ArcGISPro successfully connects with Snowflake and successfully displays features with geospatial information.
- Demonstrate NSE can generate explicit spatial topology relationships.
- FME version compatibility between Smallworld and Snowflake.

- Mapping Smallworld to NSE database through FME transformation without employing plug-ins.
- Magik Script conversions and validation.

h. Updated Projections for the Remainder of the Term

The Company plans to perform data extraction and transform and load activities for GIS Smallworld data to NSE, supporting full and incremental sync. Additionally, the Company intends to enable NSE capabilities around tracing and connected models for various networks, and support integration to ADMS & CYME, along with reporting capabilities.

As part of a different workstream, the Company intends to enhance the existing construction view in GIS Smallworld and deliver planned layer data from Smallworld to ADMS to enable faster commissioning of new objects that support FLISR and VVO efforts in ADMS. A future goal is to perform a validation followed by implementation for extracting construction view data into NSE and performing trace and provision extracts from NSE to ADMS.

The Company intends to draw schematics of substation equipment in GIS Smallworld and perform extracts for ADMS to support VVO within ADMS. In the future, the Company plans to implement the extraction of substation equipment data from Smallworld into NSE, perform trace, and provide connected model extracts to ADMS to support VVO-enabled substations.

ADMS Outage Management System- Mobile Outage Dispatch

The Company handles 31,000+ outages and trouble calls annually. Mobile Outage Dispatch (MOD) is an outage management tool for outage dispatch and information tracking. MOD enhances and digitizes operational processes around outage dispatching, enabling crews to visualize and update outage information directly via mobile clients to the centralized ADMS/OMS. MOD increases insights into field conditions, digitizes incident details while on location, and provides estimated restoration times digitally rather than calling that information into the centralized dispatch locations. Using MOD, field crews can update details concerning their actual time of arrival; the crews will receive near-real-time updates directly on their devices to enable situational awareness in the field and reduce field-to-control center process steps.

a. Description of Work Completed

During 2023, the MOD system deployment team made significant progress, including initiating bi-directional communication with the ADMS/OMS system. This enabled seamless communication and data exchange between the MOD and ADMS infrastructure.

Using an agile, iterative deployment approach for MOD, teams initially completed the MVP for the bi-directional communication functionality for "blue sky" events. The team finished the MVP's integration testing between ADMS/OMS and MOD. Breaking the solution into modular components enables the team to build, test, learn, and adjust quickly to meet requirements.

The Company completed the bi-directional communication enhancement for MOD to ensure rapid information dissemination to both ADMS/OMS and MOD systems for optimal performance. Implementing publish/subscribe bi-directional communications in the mobile outage application enables real-time communication and data exchange between different application components, ensuring that information is disseminated swiftly and efficiently.

Implementing bi-directional communications facilitates quicker response times to outage events, enhancing operational efficiency. Additionally, bi-directional communications allow for scalability, enabling the application to handle more data and users without sacrificing performance. By supporting bi-directional communication, field personnel can receive updates and send status reports seamlessly, improving coordination and decision-making during outage restoration efforts. This deployment enhances the efficiency and effectiveness of outage response and management.

Additionally, teams completed a comprehensive assessment of data structures to guarantee seamless reception and processing of existing data by the ADMS/OMS, ensuring smooth data integration and operational functionality. By late 2023, the MOD system was fully integrated with the ADMS/OMS, marking a significant milestone in improving the Company's outage management response.

b. Lessons Learned, Challenges, and Successes

Integration with the new ADMS/OMS was successfully tested. Bi-directional communication functionality was deployed to the production environment, and an electric overhead crew in Leominster, MA, completed it. Furthermore, performance enhancements for bi-directional

communications were successfully implemented, ensuring swift information exchange between systems.

Implementation teams faced some challenges during the migration process from the former OMS system to the new ADMS/OMS system, which resulted in delays in the transition. Teams also encountered difficulties in synchronizing the crew data between MOD and the new ADMS/OMS system, causing synchronization issues that required immediate resolution.

c. Actual v. Planned Implementation and Spending

Tab 5b Spending – 2023 Report in the attached Department Annual Report Template provides the deviation in the implementation and spending. Refer to columns F - P, rows 17 - 21.

d. Performance on Implementation

MOD is currently in development. This initial release offers foundational features for a MVP solution. New features will continue to be built and deployed throughout the remainder of the term.

e. Description of Benefits Realized as the Result of Implementation

Leveraging technology is crucial for meeting service quality objectives, mitigating outage impacts from extreme weather, and bolstering resilience amidst climate change challenges. MOD enhances operational efficiency and customer satisfaction by enabling quicker responses to outage events. Field personnel gain access to real-time, comprehensive information, facilitating more efficient work practices.

f. Description of Capability Improvement by Capability/Status Category

MOD enables the dispatch of outage jobs and trouble calls in real-time via mobile devices. Field personnel gain access to up-to-date information, facilitating a more coordinated outage

response. Efficiencies are gained from crews inputting more up-to-date information from on-site in the field.

g. Key Milestones

Initiated bi-directional communication between ADMS/OMS and MOD in March 2023.

h. Updated Projections for the Remainder of the Term

For the remainder of the term, the Company will work on improving the MOD system by taking full advantage of the capabilities of the new ADMS/OMS infrastructure. Implementation teams will focus on refining the communication protocols to improve services to customers.

Remote Terminal Unit Separation/Dual Porting

The Company uses Remote Terminal Units (RTU) to monitor and control various network processes. These RTUs are connected to the SCADA system, which collects data from the RTU and provides control commands.

RTU separation and dual porting involve configuring the RTU to transmit its data simultaneously to two SCADA systems, allowing redundancy, monitoring, and controlling the RTU by multiple systems. By implementing a dual interface, the RTU can effectively transmit its data to two separate SCADA systems, ensuring continuous monitoring and control of the network while the Company implements and cuts over to the new DSCADA system. Dual porting allows the Company to gradually bring data into the new DSCADA system in a controlled manner while not losing the control functionality in the existing system. This will enable efficiency and learnings to occur as part of the DSCADA project and avoid needing a “big bang” type of cutover.

In addition, this configuration allows for flexibility in the choice of communication protocols, enabling the RTU to communicate with diverse SCADA systems and adapt to varying network requirements. The dual porting of the RTU data not only enhances the security and robustness of the overall system but also offers scalability for accommodating future expansion and integration with different control systems.

a. Description of Work Completed

In 2023, the Company completed RTU make-ready work at seven substations: Billerica, Burtt Road, North Dracut, West Andover, Woodchuck Hill, Plymouth Street, and West Salem. This work will ensure that the newly implemented RTU separation/dual porting system aligns with the enhanced communication infrastructure.

Substations were prioritized for RTU implementation when they had shared transmission and distribution assets. After receiving input from telecom engineering, asset management, and the control center, the stations were prioritized, and a work plan was developed. Implementation teams considered each station's specifications, resulting in scopes ranging from installing new communication lines in some substations to managing increased bandwidth in other locations and upgrading RTU and telecom equipment.

Enhancing the communication system, especially in large geographical areas, complements the newly implemented RTU separation and dual porting system—including Grid Modernization investment such as remote-control server microwave communication network equipment and remote telemetry units.

b. Lessons Learned, Challenges, and Successes

Implementation teams encountered challenges when working with a new telecom shelter product, including designing unique specifications for each location and considering various deployment factors. For example, at two locations, teams encountered a need for space within some of the substation's existing control houses; the team needed to engineer, design, build, and install a telecom shelter.

Drawing from past experiences and anticipating potential materials delays, teams circumvented potential scheduling delays in construction by initiating early procurement of standard materials.

Having a consistent project team and maintaining team involvement throughout the initiative is essential for effectively carrying over lessons learned from project to project. This also presents an opportunity to improve the design and execution processes.

c. Actual v. Planned Implementation and Spending

Tab 5.b. Spending – 2023 Report in the attached Department Annual Report Template provides the deviation in the implementation and spending. Refer to columns F - P, rows 17 - 21.

d. Performance on Implementation

In 2023, the Company completed RTU make-ready work at seven substations. Additionally, implementation teams preordered construction materials, including routers, fiber, power supply units, and innerduct protective conduit housing.

e. Description of Benefits Realized as the Result of Implementation

RTU/dual porting-enhanced communications clearly separate assets and allow for more efficient and effective operation of existing distribution assets. They also allow future monitoring and system enhancements to be effectively tied back to the future SCADA system. Dual porting provides a foundational platform for DSCADA supporting Grid Modernization projects.

When realized, a fully integrated ADMS with a DMS/DSCADA system benefits include:

- Reliability Improvement – Improvement in reliability performance.
- Operational Efficiency – Reduced drive time and trips related to faults and outage restoration.
- Thermal Performance – Deferring system upgrades due to increased grid flexibility to respond to seasonal and contingency events.
- Customer Satisfaction – Customer satisfaction is improved due to the expected reduction in momentary and extended interruptions.
- Improved flexibility and cost-effectiveness.

f. Description of Capability Improvement by Capability/Status Category

This investment will separate the combined transmission and distribution SCADA system into separate transmission SCADA and DSCADA systems. Dual porting is an industry-accepted

approach and is NERC-compliant. RTU separation and dual porting improve flexibility and are the most cost-effective foundational platforms for DERMS expansion and integration.

g. Key Milestones

The Company completed RTU make-ready work at seven substations. Additional milestones include preordering targeted items to prevent delays in planned construction windows. Equipment and materials include DX940 routers (the DX940 configurable router is purpose-built to withstand extreme temperatures in harsh environments), smooth wall innerduct, AC and DC panels, and all-dielectric self-supporting fiber. Due to supply chain issues, these previously off-the-shelf items now require advanced procurement.

h. Updated Projections for the Remainder of the Term

RTU implementation is planned for approximately 57 sites for the remainder of the term.

(5) Information/Operational Technologies

Cybersecurity

Cybersecurity is vital for the safety, efficiency, and resilience of the Company's grid. As new technologies such as smart grid devices and telecommunications upgrades are implemented, preparation and vigilance are required to address potential threats.

Cybersecurity measures are incorporated throughout the project lifecycle, including vendor acquisition and solution delivery, to ensure sustained security performance as business and technical operations evolve. Where cybersecurity capabilities are absent, teams identify and deploy services required to reduce risk appropriately in alignment with risk factors. Investment in cybersecurity for core capabilities remains a strategic priority for grid modernization.

a. Description of Work Completed

For cybersecurity implementations in 2023, the Company completed the Privileged Access Management tool, which manages, tracks, and enhances privileged accounts' security across the critical network infrastructure environment. For the cybersecurity aspects of the ADMS PAM buildout, a risk assessment for data transfer was completed to test DSCADA and FLISR capabilities.

The cybersecurity implementation teams also completed the MVP security architecture for the telecommunications network MPLS-TP (DMX Replacement) deployments to mitigate potential risks and vulnerabilities associated with transporting critical data services over the network.

b. Lessons Learned, Challenges and Successes

In previous years, teams experienced challenges due to workflow disruptions caused by the heating and storm season. In 2023, the Company prioritized implementing cybersecurity measures for the Systematic Tracking of Restoration and Management Services (STORMS) component of the OMS in ADMS as an urgent measure before the heating season.

Security engagement and integration into the grid modernization program have succeeded. Anticipating security participation in solution design has successfully built better solutions and avoided project delays. Security is now an integrated aspect of all grid modernization deployments. Leveraging security services and tools improved project implementation efficiency by identifying risks and applying controls.

c. Actual v. Planned Implementation and Spending

Tab 5b Spending – 2023 Report in the attached Department Annual Report Template provides the deviation in the implementation and spending. Refer to columns F - P, rows 24- 26.

d. Performance on Implementation

The implementation proceeded as planned. The Company developed a PAM tool to manage privileged accounts and enhance network infrastructure security. As part of the ADMS PAM cybersecurity measures, a risk assessment was conducted for the DSCADA and FLISR data transfer capabilities.

e. Description of Benefits Realized as the Result of Implementation

Cybersecurity is becoming increasingly important as more intelligent devices are interconnected and data volumes increase on the grid. Maintaining confidentiality, ensuring data integrity, and improving resiliency to leverage this information for more efficient operations and better decision-making is becoming increasingly essential. The cyber-attack surface is also growing, making these measures even more crucial.

Measures are in place to ensure safe and reliable grid operations, including capabilities that prevent, detect, and respond to cybersecurity threats. From the end user's perspective, enforcing least-privilege access and activity monitoring can avoid data loss and identify malicious activity. Access is monitored and analyzed to detect and flag malicious user activity, enabling risk mitigation actions. Network traffic is monitored in real-time to detect abnormal network traffic, devices, or endpoints and establish a baseline for traffic during grid operations so that the Company can detect and appropriately address abnormal activity. The Cybersecurity Operations

Center is critical in central activity monitoring and combines detection, analysis, and response during a cybersecurity incident.

f. Description of Capability Improvement by Capability/Status Category

Cybersecurity services are fundamental capabilities that reduce the security risk of deploying modern grid devices, systems, and applications.

Cybersecurity capability improvements include:

- Cybersecurity protocols protect critical network infrastructure from cyber threats, including improving network visibility, optimizing firewall rules, developing integrated network architecture, and creating phishing campaign technology.
- Platform security safeguards workstations, laptops, mobile devices, tablets, servers, and infrastructure by implementing encryption, secure configuration, continuous protection through file integrity and configuration monitoring, application safe-listing, and configuration standards.
- Identity and access management focuses on managing individual identities and their authentication, authorization, and privileges/permissions within or across system and enterprise boundaries to increase security and productivity.
- Vulnerability management focuses on proactive threat management and reactive response capabilities. This service will analyze logs and monitor applications and systems for abuse/misuse, provide intelligence around cyber threats, scan internal and external systems for vulnerabilities and compliance, analyze and support security patching, and enable a 24x7 response capability.
- Security orchestration automation and response defend against unauthorized, malicious activity in real-time. This requires employing people, technology, and processes. The Company's Security Operations Center is organized to prevent and report on cybersecurity risks and detect, analyze, and respond to incidents.
- Data protection focuses on protecting data from accidental or intentional but unauthorized modification, destruction, or disclosure using data protection solutions and other safeguards to maintain confidentiality and integrity.
- Commercial and third-party risk focuses on providing software, hardware, and procedural methods to protect applications from external threats. Third-party risk embeds itself

within the software development process to protect applications vulnerable to multiple threats.

- Awareness and training reduce the risk of human error resulting in a security breach by ensuring users know information security policies, threats, concerns, responsibilities, and liabilities. This includes developing phishing campaign technology to prevent phishing events.

g. Key Milestones

For the Data Management functions, the solution's security architecture requirements have been identified. A third party slated to deliver a solution has been engaged, and a risk assessment has been completed. SailPoint integration and various other integrations with GIS, such as Maximo, were architected and achieved when working with GIS.

For ADMS integration, the Company completed the PAM buildout and the data transfer risk assessment to Hitachi to test DSCADA and FLISR capabilities. Implementation teams identified a remote access solution for the STORMS component pending pen testing.

For grid modernization applications: GIS, TOMS, MuleSoft, and ADMS Critical Network Infrastructure, the Company deployed Identity Access Management (including SailPoint).

For grid modernization enterprise applications: TOMS, GIS, VVO, and MuleSoft, the Company deployed PAM.

The MVP solution is complete for the telecommunications MPLS-TP (SONET-DMX Replacement) security architecture.

h. Updated Projections for the Remainder of the Term

For the remainder of the term, the Company plans to deploy the RSA Prime Self-Service Portal and activate multi-factor authentication for the ADMS System for Total Operational Readiness Monitoring (STORMS) users and control operations support.

Securicon will conduct a security review of the ADMS network equipment in Worcester. Cybersecurity teams will perform penetration testing on various DSCADA platform features, such

as D-PI connection, Data Acquisition, and Inter-Control Center Communications Protocol systems. Additionally, the DSCADA backup site in Worcester will undergo penetration testing.

Data Management

The Company progressed the "One System One Model" electric data management strategy to build an interoperable data platform. The Snowflake Data Platform offers the Company a cloud-native solution for managing its data infrastructure, enabling it to unlock the full potential of its data assets while reducing complexity, costs, and time to insight. The centralized data repository has automated data pipelines, positioning it for seamless integration into product teams' workflows. This consolidation enhances operational efficiency and is critical to achieving grid modernization goals; building this technology foundation delivers the capabilities of the grid modernization investments, including VVO, FLISR, feeder monitors, ADMS including SCADA, and integrated DERs.

a. Description of Work Completed

Throughout 2023, the Company progressed in building out the centralized data platform, prioritizing improving data quality and emphasizing the importance of a single data source, ease of use, automation, and interoperability. This strategy lays the foundation for reliable and accessible data that aligns with business operations and facilitates informed decision-making.

The Company completed the following data management implementations in 2023:

- The Company improved data management for its telecommunications assets in TOMS. Using the Snowflake database, daily data loads for tracking telecom nodes, communication circuits, and telecom work orders for maintenance and capital projects were automated. This information was then made available in TOMS.
- The Company extracted and loaded geospatial data for Environmental Justice Communities (EJC) into the Snowflake database, ensuring accessibility for analysis. This data is refreshed weekly and consolidated into a single table within Snowflake. This linkage enables the inclusion of EJC information in reports, aligning with regulatory goals.

- Data from the comprehensive GIS server platform for managing, sharing, and analyzing spatial data, ArcGIS, was loaded into Snowflake to enrich asset data products with precise asset locations, meeting grid inspection requirements.
- The PI Historian data was loaded into Snowflake. The data loading process was automated for incremental hourly refresh. The data quality was reviewed, and any necessary corrections were made before reloading to meet analytic needs, such as short-term forecasting and grid modernization reports.
- Weather data from 34 stations on the National Weather Service website was loaded in Snowflake and profiled using Continuous Data Quality (CDQ), an Informatica Cloud Data Quality Tool, scanned, and loaded to the Informatica Enterprise Data Catalog for metadata management. This data informs grid modernization projects, such as operations, load forecasting, damage prediction, reliability analysis, and planning.

b. Lessons Learned, Challenges, and Successes

Analyzing substantial amounts of data quality profiling results in the Informatica CDQ tool was cumbersome and time-consuming. The Company's Electric Data Management group designed a solution to extract the profiling result from the Informatica CDQ repository using REST API. The solution involved loading the data into Snowflake to analyze the data quality metrics more efficiently using Power Business Intelligence (BI) analytics.

Ingestion of bulk data from a cloud-based application such as Oracle P6 into a centralized electric data platform has been a challenge; it was limited by existing mechanisms such as MuleSoft middleware or file transfer through GO Anywhere Managed File Transfer (MFT) or applying Change Data Capture using Qlik. The Company performed a proof-of-concept series of tests on leveraging the enterprise tool Matillion for bulk ingestion and identified its Application Programming Interfaces (API) Query component feature to connect to the Oracle Cloud source system to pull the data into the electric data platform. This solution proved most efficient for bulk data ingestion, scheduling data refresh, enabling data accessibility, and addressing near real-time reporting requirements.

Electric data contains sensitive information such as Personal Identifying Information (PII) and Critical Electric Infrastructure Information (CEII) that must be governed and managed securely. Working with internal Cybersecurity groups, the Company added CEII data in Snowflake and extended the Role Based Access Control (RBAC) to include the CEII Role to ensure access to CEII data is handled through the Company's RBAC policy.

The Company advanced the foundation for building electric data lineage to give the electric business a holistic view of the asset lifecycle using Informatica AXON as a single point of access for data discovery. The Company also established a technical framework integrating electric metadata and data relationships from the data catalog (in Informatica EDC).

The Company leveraged secure data in Snowflake to build BI dashboards and reports to enable grid modernization project managers and engineers to track project activities from inception to closure. The following grid modernization reports were developed:

- DER SF CASE Report: This report analyzes the DER permits and connections pipeline.
- SDE CSS CUSTOMER Report: This report calculates the percentage of each rate class by substation.
- FEEDER METRICS Report: This report provides details about feeder characteristics such as feeder type, system voltage, feeder capacity rating, feeder length, and customer count.
- CRITICAL CUSTOMERS BY FEEDER Report: This report determines how many critical customers (Hospitals, Care Facilities, Police/Fire) are in a particular location (city, feeder, substation).
- National Grid SEARCH CALLS MAINTENANCE (OMS Symptoms) Report: This report lists outage incidents reported for a specific period.
- CIRCUIT LEVEL PROGRESS Report: This report provides quick access to work order progress and status updates.
- STORMSVVO Report: This report provides the work request hours and cost information for the VVO Program.
- FLISR Work Request Tracking Report: This report tracks the work request status for the FLISR Program.

The Company leveraged geospatial network data, customer data, and the Massachusetts Environmental Justice map loaded into the Snowflake database to determine the overlap between Grid Modernization investments and customers residing in EJCs. This output populates the EJC reporting in the report Appendix, Tab 10.

c. Actual v. Planned Implementation and Spending

Tab 5b Spending – 2023 Report in the attached Department Annual Report Template provides the deviation in the implementation and spending. Refer to columns F - P, rows 24-26.

d. Performance on Implementation

The Company advanced electric data product models to streamline business processes and enhance comprehension of critical data elements. These models bridge the gap between operational needs and data insights, fostering a more agile and responsive organizational environment.

Additionally, reporting and dashboard capabilities have been bolstered through an access control mechanism, leveraging consolidated data views from multiple source systems housed within the centralized repository. This approach ensures data security while enabling comprehensive analysis and reporting across the organization. The Company has improved access to data using the digital data warehouse, where electric domain source data is consolidated and made easily accessible for consumption.

e. Description of Benefits Realized as the Result of Implementation

The primary benefit of Electric Data Management is realized through centralizing, profiling, and providing secure access to a singular, trusted enterprise data warehouse. Data is classified, managed, and secured to meet the Company's security requirements while providing data insights across grid modernization projects.

f. Description of Capability Improvement by Capability/Status Category

Creating interoperable data asset products in Snowflake establishes a single source of data. Introducing data-as-a-service capabilities empowers users with self-service access to data, reducing reliance on IT support and improving operational efficiencies. Data management democratizes electric data knowledge, enabling grid modernization teams to efficiently inform, engage with, and interpret data for project implementation.

The Company also built interoperable electric data products (Datamart) that curate data by business functions so that electric data can be trusted and easily consumed, reducing data delivery time and effort for digital and analytical products.

The Company leveraged trusted and secured data in Snowflake (Grid Data Ops) to build Power BI dashboards and reports, enabling informed decision-making by grid modernization project managers.

g. Key Milestones

- EJC information, service point to premises/customer reports, and customer counts by rate class have been deployed in Snowflake.
- The Massachusetts Grid Mod P6 schedule dashboard was updated. (P6 are project schedules used by FLISR and VVO implementation teams for project planning, resources, and activities, like construction).
- TOMS data is available in Snowflake, with 46 data tables developed. Data is centralized in TOMS for all Company telecom locations with internet, phone, or radio connections to track nodes, communication circuits, and work orders.
- Improved data quality for ASPEN and eliminated existing manual data feed by automating the ASPEN data load from Snowflake to ADMS.
- Historical PI Historian data loaded in Snowflake and refreshed hourly.
- Weather data was loaded hourly from 34 stations into Snowflake.
- Extended the RBAC for CEII data in Snowflake and Power BI to ensure that CEII data access is secure.

h. Updated Projections for the Remainder of the Term

The Company plans to continue to build interoperable electric data products that standardize core electric operations sub-processes. Advancing data management for ADMS consumption as part of ADMS Phase 3 is a primary objective.

Projections include the following data management implementations:

- Associate PI measurement data from PI Asset Framework loaded in Snowflake to the corresponding GIS asset IDs (“PI Tags”). Associate PI Tags related to the substation, feeder, recloser, distributed generation, regulators, transformers, and capacitors with GIS IDs so that the PI measurement values can be linked to geolocation data, network topology data, and other asset attributes.
- Load raw PI tag measurement values from the PI data archive in PI Historian for data quality analysis and forecasting model inputs.
- Replace the manually extracted data for ADMS with an automated weekly data feed from Snowflake to a blob storage for ADMS consumption.

- Develop and enhance reports to fulfill operational requirements and meet compliance and regulatory reporting needs.
- Update the weekly data feed from Snowflake to ADMS to reflect the new electric grid device configuration model changes in ASPEN RDB.
- Centralize MV90 fed into Itron Enterprise Edition in Snowflake to enable ADMS to estimate load flow for commercial and industrial customers.
- Centralize Computer-Aided Design drawings so that the engineers can access them (unstructured images) and combine them for geospatial analysis, enabling ADMS to estimate load flow with a higher level of accuracy.
- Build a secured and unified repository of financial data from Powerplan and SAP data to track Purchase Orders, inventory data, actuals spent on contractors, and materials for grid modernization project tracking.

Enterprise Integration Services

A fundamental component of grid modernization is an integration architectural framework that acts as a foundation for delivering the capabilities of the grid modernization investments, including VVO, FLISR, Feeder Monitors, TOMS, GIS, and ADMS/DSCADA. The Company aims to streamline and automate these investments' business processes by implementing robust integration architecture. The Company selected MuleSoft as the middleware to move data between systems, automate and manage business processes, transfer files between entities, and enable real-time and batch data integration. By leveraging MuleSoft technology, the Company is rearchitecting its digital infrastructure from legacy systems, proprietary platforms, and custom integration code to allow data interchange through standard methods such as REST Web Services, APIs, and event-driven architecture. By connecting applications, data, and devices with an API-led approach, the Company is gaining exceptional business agility.

a. Description of Work Completed

In 2023, the Company implemented a platform scaling of digital products for ADMS and TOMS. The ADMS integrations enabled outage management through a modern integration platform, reducing technical debt and enhancing scalability, reliability, logging, monitoring, alerting, and

disaster recovery. For TOMS integrations, equipment, site, and circuit data for GIS were integrated into the TOMS using the Snowflake platform.

ADMS Integrations:

- Developed APIs for various functionalities, including trouble calls, send-to-dispatch, weather data, Automatic Vehicle Location System, outage notes, and outage central, enabling seamless communication and interaction between software components.
- Completed comprehensive, integrated system testing to ensure seamless interface interaction and functionality.
- Conducted User Acceptance Testing to validate that the integrated system meets user requirements and expectations.
- Conducted performance testing to ensure the system performs optimally under various load conditions and can handle expected user traffic.
- Deployed the integrated system into the production environment, making it accessible for users and ready for operational use.
- Automated Data Transfer from the ASPEN database to ADMS: Enabled computerized data transfer from the ASPEN database to the ADMS through batch processing, ensuring timely and accurate data synchronization between the two systems.
- Enabled ADMS with automated synchronization of search Pole and Street Intersection data from the GIS, ensuring that ADMS has up-to-date and accurate spatial data for efficient operations.

The Company also completed several integrations for the TOMS. These deployments enhance TOMS capabilities by integrating critical data sources, streamlining workflows, and automating data transfer processes, improving operational efficiency, accuracy, and decision-making in telecommunications operations.

TOMS Integrations:

- Integrated GIS data, including equipment, sites, and circuit information, are integrated into TOMS via the Snowflake platform. This integration ensures that GIS updates are seamlessly transferred to TOMS every week. The integration resulted in a significant 75% improvement in process time, enhancing efficiency and accuracy in managing telecommunications infrastructure data within TOMS.

- Provided end-to-end systems integration between TOMS and the STORMS database for work orders and workflow management. This integration streamlines workflow management by enabling seamless data exchange and collaboration between the two systems. It enhances visibility, coordination, and decision-making across the telecommunications operation workflow.
- Enabled automated data transfer from multiple sources, including 4RF, Vistanet, SAP Fleet, and TXCare, to TOMS. By automating data transfer from these systems, TOMS receives timely and accurate updates on equipment, fleet management, and other relevant information, improving data integrity and operational efficiency. This integration reduces manual effort, minimizes errors, and ensures that TOMS has up-to-date information from various sources to support telecommunications operations effectively.

b. Lessons Learned, Challenges, and Successes

The Company incorporated lessons from past implementations, emphasizing the importance of thorough connectivity testing, proactive engagement with support teams, and timely resolution of issues to ensure a successful deployment and smooth transition to production. For example, performing thorough connectivity testing between assets like the MQ server and the integration platform is crucial before going live; this ensures that there are no connectivity issues, and that data can flow seamlessly between systems during the transition to production.

Similarly, it has proved essential to conduct connectivity testing between the source and target systems before the go-live phase. This testing helps identify and resolve any connectivity or data transfer issues between systems, ensuring a smooth transition to production.

The successful implementation of an integration-ready platform for ADMS has allowed the Company to scale its digital products, like OnMyWay, and centralize grid automation, resulting in increased efficiency and reliability for its customers.

c. Actual v. Planned Implementation and Spending

Tab 5b Spending – 2023 Report in the attached Department Annual Report Template provides the deviation in the implementation and spending. Refer to columns F - P, rows 24-26.

d. Performance on Implementation

Planned integrations were completed, as needed, for all grid modernization investments on the required timeline. All the interfaces were delivered as designed and without any production issues.

e. Description of Benefits Realized as the Result of Implementation

Beyond establishing a foundational infrastructure for grid modernization platforms, Enterprise Integration initiatives offer many benefits to ensure seamless, secure, and scalable operations across the digital service landscape:

- They foster agile business processes and information orchestration across diverse systems, encompassing various integration scenarios.
- They promote a model-driven service approach, emphasizing reusability and high availability of services.
- The project facilitates a secure gateway, enabling the integration of external cloud services or third-party offerings while maintaining robust security measures beyond the Company network.
- They enhance user productivity by optimizing service utilization, leveraging appropriate protocols, and adhering to integration standards, such as lightweight APIs for mobile and web consumption.
- They ensure end-to-end traceability, audit capabilities, and operational efficiency through comprehensive traceability, alerting mechanisms, and audit trails, facilitating informed decision-making and streamlined operations.

f. Description of Capability Improvement by Capability/Status Category

The Company delivered an integration-ready platform for ADMS to enable future integrations with grid modernization investment and provide a platform to scale digital products like OnMyWay. Capability improvements include centralizing grid automation and realizing new efficiencies.

g. Key Milestones

The Company achieved the following enterprise integration milestones:

- Delivered approximately ten new integration flows for Mobile Outage Dispatch on the middleware platform, MuleSoft.
- Deployed ADMS-related interfaces, including trouble calls from CSS to ADMS, dispatch from ADMS to CSS, and weather data interface from National Weather Service to ADMS.
- MFT and API MuleSoft + Azure service platform enhancements/upgrades.
- MuleSoft and GoAnyWhere implementation.
- Optimized and migrated 16 integration flows and approximately 30 plus APIs for ADMS Phase 2 on MuleSoft/MFT to provide higher performance and security.
- Delivered approximately ten new integration flows (approximately 24 APIs) for TOMS on MuleSoft.
- Delivered approximately ten new integration flows for PORT (replacement of Focal Point) on MuleSoft.
- Unit testing for ADMS Phase 2A integration flows for TOMS, Mobile Outage Dispatch, and PORT.
- System integration testing for integration flows for ADMS Phase 2, TOMS, Mobile Outage Dispatch, and PORT.
- UAT for integration flows for ADMS Phase 2, TOMS, Mobile Outage Dispatch, and PORT.
- Performance/Penetration testing for integration flows for ADMS Phase 2, TOMS, Mobile Outage Dispatch, and PORT.
- Transition/Deployment for ADMS Phase 2 integration flows, TOMS, Mobile Outage Dispatch, and PORT.
- Deployed Search Pole and Street intersection-related batch interfaces from GIS to ADMS.
- ASPEN DB-related batch interfaces were deployed from Snowflake to ADMS.
- Deployed work order interface for TOMS to STORMS database.
- Snowflake was deployed to the TOMS interface for GIS data.
- Deployed Vistanet and 4RF related Batch interface from NMS to TOMS.
- Deployed SAP Fleet related Batch interface from SAP to TOMS, TX Care from OTN to TOMS

h. Updated Projections for the Remainder of the Term

Enterprise Integration projects for ADMS Phases 2 and 3 and telecommunications implementations are planned.

(6) Communications

The main goal of Operational Telecommunications is to establish a reliable and cost-effective communication system for end devices, such as field sensors, grid automation controls, and substations. Ensuring the telecommunications network meets all technical requirements, including availability, latency, fidelity, bandwidth, security, and other essential network performance areas, is a primary objective in Operational Telecommunications implementations. Additional objectives include equipping the INOC with the necessary tools to manage, maintain, and troubleshoot the communication network efficiently.

In 2023, the Company continued to progress essential telecommunications projects initiated as part of the GMP. The Company achieved significant milestones across various fronts, including successful negotiations for the 700 MHz spectrum license for the FAN, the creation of workflows in the TOMS, and the successful implementation of the MPLS-TP nodes for DMX SONET replacement and DS0 leased circuit replacement. Additionally, the Company initiated efforts to modernize communication links between key and critical sites.

Implementing communications and networking projects emphasizes the delivery of a suite of services that ensures efficient information transfer, telecom traffic prioritization, and quality of service. As a central support hub, the INOC utilized dashboards and improved ticketing solutions for streamlined monitoring, managing, and maintaining the integrated telecommunications network services and infrastructure.

Key and Critical Communications

Modernizing the existing microwave paths is crucial to ensuring communication between Key and Critical sites. The plans to move the Rhode Island Backup Control Center (BCC" to the new Worcester, MA BCC necessitate this modernization to support future bandwidth requirements. The Company's existing microwave radios are end-of-life and incompatible with the MPLS-TP nodes selected for DMX SONET replacement for the WAN.

The Company's choice of the Aviat product line for this new system is significant. It provides over twice the current bandwidth, up to 380Mbps, a substantial increase. This new microwave path will enable the retirement of the legacy path and support future Grid Modernization and Land Mobile Radio (LMR) applications.

The two microwave paths include five separate locations. The first path consists of the hops between Asnebumskit Shelter to Sligo Hill and Sligo Hill to Northboro Control Center. The second path consists of the hop between the Brockton Shelter and the West Bridgewater Shelter.

a. Description of Work Completed

The contract with the selected vendor, Aviat, was executed at the close of 2022, and the formal project kickoff was held in January 2023. In February, the Company finished installing the Aviat Frequency Assurance Software (FAS) interference monitoring system at the Northboro Control Center. This system monitors, detects, and tracks interference and performs trend analysis of the communications network over time, isolating problematic links before resulting impacts or potential outages occur within the network.

To initiate the design phase, the engineering team visited all five site locations to perform site and path surveys. The site surveys were required to document the existing tower data, waveguide mounting, shelter floorplan, overhead trays, rack space, available power, grounding, and demarcation of existing equipment. The Company uses path surveys and frequency coordination to finalize the design of each path and make any necessary changes to antenna centerlines, antenna sizes and types (standard vs. high performance vs. ultra-high performance), radio configurations, and frequency bands.

For the Asnebumskit to Sligo Hill to Northboro path, the existing microwave system was installed in 2010 and carries critical operational communications. The legacy microwave radios are end-of-life and incompatible with the OTN XTran MPLS-TP nodes deployed for the WAN. The Aviat product line has optical ethernet interfaces for connectivity to the MPLS-TP nodes. This new system will provide over twice the current bandwidth, up to 380Mb.

Construction on the Asnebumskit Shelter to Sligo Hill and Sligo Hill to Northboro Control Center paths started in late November 2023. The new 48VDC power supply was installed at Sligo Hill and completed in December 2023.

The existing antenna on the rooftop of the Northboro Control Center required a new pipe-mount design to meet the required path design criteria. An engineering design of the mount was completed in August 2023, and a structural analysis and fabrication are expected to be finished in 2024.

The existing wireless microwave radios are incompatible with the MPLS-TP nodes for the Brockton Shelter to West Bridgewater Shelter path. To support future Grid Modernization and LMR applications, the Aviat system will increase bandwidth to 180Mb.

The Brockton Shelter to West Bridgewater Shelter path requires the installation of new antennas and waveguides on the towers. A structural analysis was conducted on both towers to ensure they could handle the extra load; the study showed that both towers and foundations had sufficient capacity for the specified load.

Construction on the Brockton Shelter to West Bridgewater path began in late 2023. The antenna and waveguide feed lines were installed on the Brockton Shelter tower, and construction was completed in December.

b. Lessons Learned, Challenges, and Successes

The implementation team encountered a challenge when the installation of the antenna feedhorn for the West Bridgewater tower had to be postponed due to damage. A replacement had to be ordered, leading to a delay in the tower's construction until 2024.

The Company encountered a challenge when the path survey at Northboro Control Center revealed that multiple trees interfered with the planned path to Sligo Hill, and the minimum 99.999% availability would not be achieved. Tree cutting was required to correct the minimum availability issue. The proximity of some of the trees to wetlands necessitated a tree survey. The survey results determined that some trees were in the 100-foot buffer associated with Solomon Pond adjacent to the Northboro Control Center. The Company decided that the work qualified as a minor activity in the buffer zone and, by employing best management practices to protect the pond from impacts, it was deemed exempt from permitting. The Company notified the Northboro Conservation Commission of the work, which provided concurrence and approval in October 2023. The tree-cutting work was initiated and completed in 2023.

A significant achievement was the completion of path and site surveys for all Key and Critical locations. This milestone allowed the installation of antenna, waveguide, and radio equipment at the Brockton Shelter. The Northboro Control Center antenna rooftop pipe-mount design was also finalized, marking a successful step toward the project's completion.

c. Actual v. Planned Implementation and Spending

Tab 5b Spending – 2023 Report in the attached Department Annual Report Template provides the deviation in the implementation and spending. Refer to columns F - P, rows 22-23.

d. Performance on Implementation

The implementation of the new microwave path will not only replace the outdated pathway but also facilitate future developments in Grid Modernization and LMR applications. The updated pathway, equipped with optical ethernet interfaces, will allow connectivity to the MPLS-TP nodes deployed for the DMX SONET replacement project. This updated pathway will provide more than double the current bandwidth, up to 380Mb, ensuring a robust and efficient communication network for the future.

e. Description of Benefits Realized as the Result of Implementation

These deployments are part of the communications investments that provide the capabilities to plan, design, manage, maintain, and troubleshoot the communications network. The new Aviat radios have increased bandwidth and can interface with the MPLS-TP nodes via an Ethernet connection. This new system will provide over twice the current bandwidth, up to 380Mb.

Additionally, the Field Activation System (FAS) interference monitoring system can monitor, detect, and track interference on the network. It can also perform trend analysis over time and isolate problematic links before any resulting impacts or potential outages occur within the network.

f. Description of Capability Improvement by Capability/Status Category

A new microwave path will be established between the National Grid Brockton office and the National Grid wireless LMR site in West Bridgewater. This new microwave path will enable the legacy path to be retired and support future Grid Modernization and LMR applications.

The FAFS system monitors, detects, and tracks interference and performs trend analysis of the network over time, isolating problematic links before resulting impacts or potential outages occur within the network.

g. Key Milestones

The team achieved several significant accomplishments, including completing path and site surveys for all Key and Critical locations. This paved the way for installing antenna, waveguide, and radio equipment at the Brockton Shelter. Additionally, construction was completed on the Brockton to West Bridgewater path.

h. Updated Projections for the Remainder of the Term

The following upgrades and installations are planned for Key and Critical Communications sites: upgrading the DC plant and radio equipment and performing structural analysis of the pipe mount at the Northborough Control Center. Additionally, a new pipe mount must be fabricated and installed, and the existing antenna needs to be relocated and realigned back to Sligo Hill. At Sligo Hill, the existing antenna needs to be aligned back to the Northboro Control Center, and the radio equipment needs to be upgraded to face the Asnebumskit Shelter. Finally, a radio equipment upgrade is required at Asnebumskit Shelter.

Digital Multiplexing Synchronized Optical Network Replacement

The Company's WAN telecommunications infrastructure traditionally utilizes SONET devices. SONET-based equipment is being discontinued, no longer supported, and requires updating. The Company's Nokia DMX SONET system provides a redundant core network architecture linking critical substations and corporate facilities utilizing:

- Private (Company-owned) fiber.
- Additional fiber leased from third parties.
- Microwave links.

The proposed DMX replacement solution has scalable functionality integral to the network access, edge, and core next-generation telecommunications network architecture. Network technology has been identified as a modernized solution compared to the legacy DMX SONET equipment. The replacement MPLS-TP technology and equipment will deliver true network convergence by providing higher bandwidth and enhanced operability. The MPLS-TP network equipment will expand the WAN and future-proof the backhaul for multiple technologies supporting grid modernization.

a. Description of Work Completed

In 2023, the Company installed 25 MPLS-TP nodes across 17 locations. Spare fibers are required to connect the MPLS-TP equipment in parallel to the existing DMX SONET equipment to provide connectivity between sites. Splicing nine fiber paths was completed, delivering connectivity on 172.6 miles of fiber between sites. After the splicing work, characterization of the fiber was conducted. This testing confirmed that the fiber meets the requirements to carry traffic by validating insertion loss, optical return loss, and chromatic and polarization mode dispersions. Upon acceptance of the fiber, the Company completed connections from the MPLS-TP nodes to the fiber termination locations.

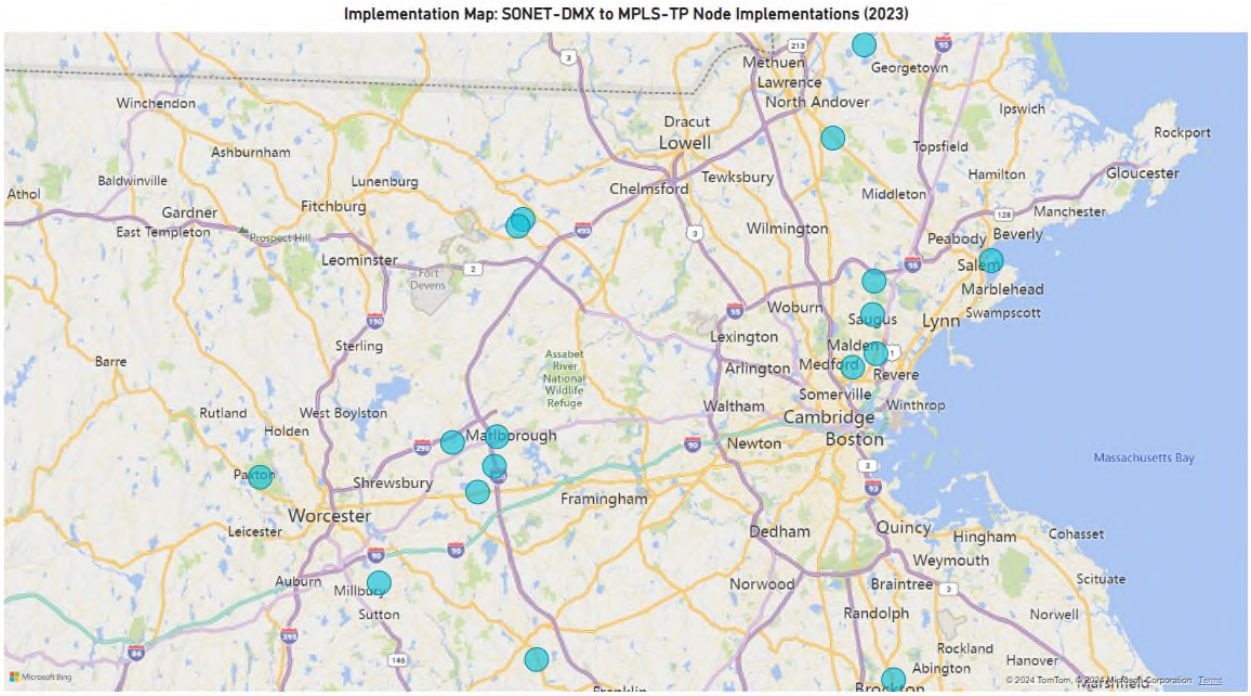


Fig. 4, SONET-DMX to MPLS-TP node implementation map, 2023

Additionally, the Company implemented a required photonics solution. There are areas within the Company's telecommunications network with fiber capacity constraints due to data aggregation onto a limited amount of fiber strands as the data passes from control rooms, through midpoints, to the furthest connections on the network. Some of these connections within the network will require amplification due to the distance between locations. Photonics equipment is necessary to solve the fiber capacity and distance issues; the photonics solution will be used along with the MPLS-TP nodes.

The Company conducted field demonstrations with two vendors for the photonics solution RFP. After careful evaluation, SM Optics was selected as the preferred vendor. Before deployment, Securicon conducted security penetration testing. Once complete, the SM Optics photonic equipment was installed and tested for path connectivity.

An RFP was issued to source replacement network timing/synchronization equipment for the MPLS-TP node deployment. The current equipment is reaching its functional end-of-life, and the MPLS-TP network being deployed alongside the SONET network has additional requirements that

the current timing equipment cannot meet. Based on the vendor responses, the team will select the final vendor to replace the network timing/synchronization equipment in 2024.

The team completed Issued for Construction (IFC) drawings for eleven sites. After receiving the IFC drawings, the equipment bill of materials was sent out for pricing quotes, and orders were placed. The initial materials order is expected to arrive in early 2024.

After finalizing the network design, the team issued purchase orders for 37 MPLS-TP nodes. Factory Acceptance Testing (FAT) was successfully executed and documented. The nodes were shipped and staged at the warehouse until deployment to the field in 2024.

The Company progressed the infrastructure and an MVP of the element management system, TXCare, in the production environment. This software manages the new OpTel backbone network. With the implementation of TXCare, operations teams can now automate circuit provisioning and eliminate the current complex, manual, and error-prone process. This integration of TXCare is a critical foundational technology enabling OpTel to expand its services more effectively.

b. Lessons Learned, Challenges, and Successes

The implementation team encountered challenges with long lead times for specific equipment, particularly the DC breaker panels and their associated breakers. The procurement process for these components proved to be more time-consuming than anticipated, causing delays in the overall timeline. Additionally, the team faced complications in evaluating the synchronization and clocking equipment RFP, as the required scrutiny exceeded the initial estimates. These challenges underscored the complexity of the implementation process and necessitated strategic adjustments to ensure the successful execution of the project.

From previous experience with procurement challenges, the team created a process to track material deliveries for construction effectively. A Millbury Lab campus building was retrofitted and designated as a warehouse facility to organize and stage equipment for DMX replacement installations. The telecommunications group installed new shelving and wire spool racks. The team allocated rack space for each of the seventeen sites, and as the material was received and inventoried, it was staged accordingly.

c. Actual v. Planned Implementation and Spending

Tab 5b Spending – 2023 Report in the attached Department Annual Report Template provides the deviation in the implementation and spending. Refer to columns F - P, rows 22-23.

d. Performance on Implementation

In 2023, the Company installed 25 MPLS-TP nodes across 17 locations. Nine fiber paths were spliced, delivering connectivity on 172.6 miles of fiber between sites.

e. Description of Benefits Realized as the Result of Implementation

To reliably transport network information from the increasing number of sensors and grid management devices deployed on the grid, a replacement for the end-of-life Nokia DMX SONET equipment is required. Transitioning from SONET to MPLS-TP is integral to the Company's next-generation network architecture. Deploying MPLS-TP across the telecom networks will achieve higher bandwidth, scalable functionality, and improved security and reliability.

f. Description of Capability Improvement by Capability/Status Category

The improvements realized through this investment allow for expanded network capacity, security, and reliability. Replacing DMX SONET with MPLS-TP-enabled equipment facilitates expanded network capacity for integrating an increasing quantity of intelligent grid devices and distributed energy resources.

g. Key Milestones

The team accomplished several significant milestones during the reporting period. The Company has installed 25 MPLS-TP nodes across 17 sites. Moreover, the network designs for 31 additional sites are in progress, and purchase orders for 37 MPLS-TP nodes to be installed at these sites have been issued. All 37 nodes have undergone FAT, and the testing results have been documented; these 37 nodes have been received and inventoried at the Company's lab facility.

The Photonics equipment underwent security penetration testing, and the first path between Brockton and Malden was installed in the field. Surveys were conducted for 31 additional sites, and splicing was completed for nine fiber paths, providing connectivity across 172.6 miles of fiber between sites.

h. Updated Projections for the Remainder of the Term

The Company plans the following projections for the DMX-SONET replacement project:

- Finalizing the implementation phase.
- Thoroughly testing the system.
- Preparing for the transition to full operational status.

The network site will be accepted before traffic is migrated from the legacy DMX SONET equipment to the MPLS-TP nodes. The project team expects to deliver a robust, state-of-the-art DMX SONET replacement system that meets the GMP goals and exceeds expectations.

Digital Signal Zero/Leased Circuit Replacement

The DS0 Leased Circuit Replacement project is an essential modernization to the Company's substation network architecture. The initiative ensures network reliability and prevents obsolescence using the latest circuit architecture. The project goals include using updated, dedicated circuits with guaranteed signal speeds.

The DS0 replacement project dovetails with the DMX replacement project. The SONET devices, currently sunsetted across the networks, are designed to accommodate DS0 circuits. As the network architecture transitions from SONET to MPLS-TP equipment, data packets are utilized instead of telephone protocols, such as those used by DS0.

The DS0 project will also prepare the telecommunications circuits for the private network. By replacing all the DS0 circuits, the Company will cost-effectively expand capacity, enhance reliability, and future-proof the network.

a. Description of Work Completed

The DS0 project made significant progress in 2023, achieving several key milestones. The team has completed private and third-party fiber surveys and designs, ensuring the efficient implementation of the project. Pole inspections and make-ready activities continued through 2023, facilitating preparations for modernized communications installations. The team completed final orders for circuit replacement equipment in 2023. In addition, construction has been completed at two sites, ensuring an efficient transition to fiber communications infrastructure.

Implementation process:

- Site Surveys: To replace the DS0 circuits, each substation or radio station must be surveyed on-site. During the survey, design engineers examine, measure, record, and document deployment sites. The detailed documentation, pictures, and 3D video of the location's interior and exterior are preparation for installation.
- Scope Design Document: Based on the site survey, the design engineering partner creates a detailed design outlining the work options and networking materials required to replace the DS0 circuit for each site. The scope is reviewed across multiple departments, and the most viable option is agreed upon.
- Engineering Design and Drawings: Based on the agreed-upon scope of work, the design engineering partner creates the engineering drawings in accordance with National Grid standards, depicting every item and detail required for the build. The drawings are reviewed across multiple departments for validation of work, and materials and comments are incorporated into final construction drawings.

The Company will assess the additional 50-100 sites Verizon has marked for discontinued service and create a design and implementation plan for each site.

b. Lessons Learned, Challenges, and Successes

Navigating through the project deployment has posed some challenges. Long lead times on materials presented a hurdle, demanding careful planning and coordination to ensure timely procurement. Delays stemming from complex designs impacted the construction timeline, emphasizing the need for streamlined communication and a proactive approach to problem-solving. Despite these challenges, the project team adapted strategies to overcome obstacles and successfully keep the project on track.

The successes achieved in the project include completing the first 95 site surveys. The team has also made significant design progress, with 75 percent completion. Furthermore, the completion and issuance of the first set of construction drawings for review indicate progress in the project. Site construction has already commenced on 38 sites, and the first site commissioning has been completed. In terms of materials and equipment, most of the required equipment has been ordered, and 80 percent of the materials have been received. The team has also established weekly cadence project review meetings with team members, facilitating improved communication and coordination.

c. Actual v. Planned Implementation and Spending

Tab 5b. spending – 2023 Report in the attached Department Annual Report Template provides the deviation in the implementation and spending. Refer to columns F - P, rows 22- 23.

d. Performance on Implementation

Two DS0 sites were completed in 2023, with 14 sites in the network construction stage and four in the civil construction stage. Twenty sites are planned for build-out in 2024.

e. Description of Benefits Realized as the Result of Implementation

The primary driver of the DS0/leased circuit replacement is the obsolescence of current DS0 circuits by the leased carrier, Verizon. Replacing low-bandwidth DS0 circuit technology with higher capacity fiber-ready circuits allows for increased system flexibility, enabling the effective management and integration of outage response technology, EV charging infrastructure, electricity storage units, and distributed energy management systems. By replacing DS0 circuit technology, the communications network can accommodate expanding data requirements, improve reliability, and integrate network device data and sensor measurements into the network. In addition to these benefits, the locations where new circuits are private rather than leased will reduce the network operational expenses over time.

f. Description of Capability Improvement by Capability/Status Category

The improvements realized through this investment allow for expanded network capacity, security, and reliability. Upgrading DS0 circuits to MPLS-TP-enabled equipment facilitates expanded network capacity for integrating intelligent grid devices and distributed energy resources.

g. Key Milestones

The project has achieved several significant milestones. Surveys have been completed at 95 sites, which has laid the groundwork for implementation. Materials have been received for the initial 20 sites. Additionally, construction has been completed at two sites.

h. Updated Projections for the Remainder of the Term

In 2023, Verizon announced that it would cease supporting DS0 circuits. As DS0 replacement efforts progress for 95 sites, the Company has identified 20 sites for circuit replacement in 2024 and 40 sites for 2025. The team will undertake site surveying, engineering, design, and deployment for subsequent sites until all planned DS0 circuits are updated.

Integrated Network Operations Center

The INOC ensures proper operation and performance of the communications infrastructure supporting multiple grid modernization devices over a hybrid network. The INOC is a central location where network administrators manage, control, troubleshoot, and monitor communications networks. The overall function is to maintain optimal network performance across various platforms, mediums, networks, network segments, devices, and communications channels. The INOC enables proper monitoring, provisioning, and configuring of grid modernization investments, eliminating the risks of a point-to-point system in an increasingly complex electric grid.

a. Description of Work Completed

In 2023, one of the main objectives for the INOC implementation team was to merge an NMS with the Company's existing telecom network infrastructure and configuration. This NMS centralized platform helps track and analyze grid devices and provides predictive analytics and real-time network surveillance abilities.

The INOC team built detailed dashboards for remote radio monitoring. Radio monitoring allows for real-time surveillance of FLISR and VVO radios, enabling telecom network operators to continuously monitor the systems' performance and review field incidents to detect anomalies, signal disruptions, and equipment issues.

The Company also enhanced the ticketing and event management processes with the dedicated dashboard, providing insights into key performance indicators, updates on the ticketing systems, and a detailed breakdown of the fault code and cause code values, network status, and incident reports.

b. Lessons Learned, Challenges, and Successes

Due to the immature functional capabilities of newly deployed dashboards and telecom network response tools, teams have faced challenges in automating and streamlining processes for faster response times and minimizing or eliminating outages. A plan has been devised with telecom network and network outage response teams to enhance the capabilities and utilization of the dashboard.

The Company achieved notable successes, including implementing the NMS, which resulted in the migration of approximately 5,500 radios into the NMS. Implementing a redesigned and enhanced Field Device Activation Request (FDAR) demonstrates a successful effort to provide more finely defined and granular services. The Company continues to progress on its commitment to effective communication network management and operational improvements.

c. Actual v. Planned Implementation and Spending

Tab 5b Spending – 2023 Report in the attached Department Annual Report Template provides the deviation in the implementation and spending. Refer to columns F - P, rows 22-23.

d. Performance on Implementation

Performance improvements include complete visibility and performance insights for grid infrastructure radios, communications networks, databases, and applications to detect issues and reduce the time to resolution.

e. Description of Benefits Realized as the Result of Implementation

Deploying advanced toolsets owned and managed by the Company gives support teams better access to current configurations and issues as they occur, improving the ability to plan and strategize network improvements and reducing incident counts. Utilizing robust datasets for analytics and proactive support measures over time is essential; this will help reduce overall incidents and outage durations/impacts and even wholly avoid outages.

The NMS implementation improved the mean time between failures for critical systems through predictive analytics and proactive maintenance. Radio uptime has shown measurable improvement. Dashboard improvements facilitate informed decision-making and proactive issue resolution.

f. Description of Capability Improvement by Capability/Status Category

The implemented capability improvements represent a significant enhancement, establishing a centralized platform to monitor and undertake corrective actions across the telecommunications network. These capabilities encompass fault management, ensuring prompt identification and resolution of issues, configuration management for seamless system adjustments, and administration management for efficient administrative control. Performance management features enable monitoring and optimizing system performance, while security management enhances overall system protection. The platform is also equipped for comprehensive system integration, fostering seamless interoperability. Additionally, the integration of Power-BI dashboard solutions enhances data visualization and reporting. Streamlined operations are achieved through automation and data analytics, resulting in a holistic and advanced telecom network monitoring and management system.

g. Key Milestones

In 2023, the INOC group achieved significant milestones, including successfully integrating approximately 5,500 radios into the NMS. Additionally, the group implemented a new design and enhancements to the FDAR, facilitating a more granular definition of services. Introducing a dedicated dashboard enabled enhanced ticketing and event management processes. This dashboard provides real-time insights into key performance indicators, updates on ticketing systems, and a detailed breakdown of fault and cause code values, network status, and incident reports.

h. Updated Projections for the Remainder of the Term

The Company plans to continue working on enhancing the FDAR granular service. The focus will be on improving service levels, outages, and automated service restoration prioritization. These efforts aim to provide improved visibility and management of radio devices, further demonstrating the Company's commitment to continuous improvement and effective communication network management.

Field Area Network

The FAN is a crucial telecommunications component. It serves as the 'last mile' communication link to the end devices, with field-installed grid controls acting as the endpoints on this network layer. The FAN seamlessly integrates remote sensors, advanced capacitor controls, line voltage regulators, state-of-the-art reclosers, circuit breakers, and DER devices with the Distribution Control Center ADMS, making it a vital part of our operations.

a. Description of Work Completed

Following a meticulous evaluation of various vendors' wireless hardware solutions supporting the 700 MHz A block spectrum across Massachusetts, and an in-depth analysis of network planning tools, license procurement processes, software, and radio site design, the Company procured the licenses for 700 MHz spectrum for the entire state of Massachusetts. This decision

was more cost-effective than purchasing only the communities where the Company operates and is expected to result in a higher quality service due to reduced interference.

The Company has made considerable progress in the FAN project. The Company entered negotiations with the 700 MHz spectrum vendor and expects the transfer of the licenses to occur in 2024. In preparation for this, implementation groups have already completed the initial network design for the 700 MHz spectrum, keeping the Company on track for a successful project implementation.

b. Lessons Learned, Challenges, and Successes

The FAN spectrum license negotiations were a success, and the Company is on track to complete the transfer of the spectrum licenses in early 2024. The selection of the preferred radio supplier was delayed until 2024, with an RFP expected to be issued in early 2024.

c. Actual v. Planned Implementation and Spending

Tab 5b Spending – 2023 Report in the attached Department Annual Report Template provides the deviation in the implementation and spending. Refer to columns F - P, rows 22- 23.

d. Performance on Implementation

The FAN project is in the design and procurement phase.

e. Description of Benefits Realized as the Result of Implementation

Investing in the FAN deployment is a strategic move that will yield significant benefits. The FAN will help avoid long-term costs associated with commercial cellular fees, leading to substantial savings over time. Implementing the FAN will also enable the Company to benefit from traffic prioritization, including outage response data in areas with FLISR deployment, enhancing operational efficiency and service quality.

f. Description of Capability Improvement by Capability/Status Category

Third-party communications services do not prioritize the Company's communications over other cellular traffic. Deploying FAN will lower third-party fees while improving operational control of the grid. This is particularly beneficial as technologies such as FLISR and VVO are increasingly deployed on the network.

g. Key Milestones

In pursuit of advancing wireless capabilities, the Company achieved critical milestones in reviewing and selecting equipment vendors for wireless hardware solutions supporting the 700 MHz frequency band. Concurrently, commercial and technical discussions progressed with the owners of the 700 MHz spectrum, marking significant strides in advancing the FAN deployment. The initiation of radio network design involved a thorough evaluation using two prominent network planning tools within the wireless industry. Upon procurement of the selected design software, the Company completed a detailed radio site design.

h. Updated Projections for the Remainder of the Term

The plan for the remainder of the term is to improve the telecom network design to meet the specific requirements, considering factors such as interference mitigation and reliability. After that, the Company will start deploying the infrastructure, including base stations, access points, and supporting hardware.

Integrating the FAN with existing telecommunications infrastructure is crucial to ensure seamless interoperability with other telecom networks and systems. The FAN must be thoroughly tested to validate its performance, coverage, and reliability. Any issues or challenges arising during testing must be identified and addressed to ensure the network meets specified standards and requirements. Additionally, robust security measures must be implemented to protect the FAN from potential cyber threats and unauthorized access.

Telecommunications Operations Management System

The TOMS software is designed to assist with planning, designing, deploying, and maintaining telecom networks. The aim is to provide enhanced capabilities and cost efficiencies and increase network operator's ability to manage and troubleshoot the growing communications network. The TOMS software offers failure diagnostics and calculations with a comprehensive view of circuit connections across the network. It also includes work order management capabilities that facilitate maintenance, troubleshooting, mapping, and streamlining telecom network design.

a. Description of Work Completed

Throughout 2023, the Company made considerable progress on implementations and system improvements to the TOMS. New workflows have been implemented in the TOMS to enhance the traditional work order process and address issues related to damage or "failure" work. One of these workflows involves creating circuit work orders in the TOMS, which initiates a work order to track scheduling, dispatching, and closure. This workflow provides a foundation for an efficient and robust solution in future telecommunications network development.

The Company developed a new workflow in TOMS for ordering a new leased telecom circuit. These are called Other Lease Line Operations (OLO) circuits within the TOMS application. This workflow consists of tasks that will capture the required data from the user for the OLO circuits and an automated task that will use the data to create the OLO circuit objects in TOMS. The transition to an automated task will be handled by a new TOMS message broker feature that will monitor specified triggers in the order module and notify external systems of the event execution.

Another workflow implementation in the TOMS was for preventative maintenance reports to replicate what is currently generated from the CASCADE database. The Operations Team uses this data to dispatch resources to sites for preventive maintenance on various equipment. Examples include generator start-ups, testing generator transfer switches, annual battery load testing, validating annual compliance on password changes for RTUs, tower inspections, Federal Communications Commission tower light inspections, microwave checks, room inspections, transducer calibrations, and meter tests.

Each workflow implementation followed a similar process of design and development, followed by internal testing, demonstrating the functionality to the business, providing step-by-step procedural documentation, formal UAT, and installation to the production environment.

The Company has completed site surveys for telecom equipment at 212 substations and office facilities to update or populate the data in the TOMS. These surveys involved mapping the floor plans, telecom equipment racks, cables, and fiber connectivity and taking photos of the sites' interiors and exteriors.

TOMS deployment groups also focused on developing additional business reports, refreshing data, patching systems, and integrating with multiple NMS applications and back-office systems.

b. Lessons Learned, Challenges, and Successes

Throughout the implementation phases in 2023, the Company encountered unforeseen complexities, particularly in integrating work order automation with STORMS and SAP systems. These challenges surpassed initial estimates, requiring additional vendor support for the intricate development and testing of the STORMS interface. Despite these hurdles, the deployment team successfully navigated these challenges, ensuring the seamless integration of delivery workflow support for damage failures.

The Company successfully integrated three NMSs, streamlining complex processes within the telecommunications landscape and overcoming obstacles to deliver innovative solutions for improved operational efficiency.

c. Actual v. Planned Implementation and Spending

Tab 5b Spending – 2023 Report in the attached Department Annual Report Template provides the deviation in the implementation and spending. Refer to columns F - P, rows 22-23.

d. Performance on Implementation

Implementations enhanced the TOMS performance through:

- Integrating the OTN/Belden NMS for MPLS-TP network node management.
- Implementing workflow automation in the TOMS system, improving work order efficiency.
- Data migration for the Circuit Database and CASCADE was completed, streamlining database efficiency.
- Ensuring continuous business user adoption to maximize system utilization.
- Developing and updating workflows for OLO circuit design, delivering improved workflow.
- Updating TOMS configuration to support end-to-end design of DS0 circuits, contributing to a more comprehensive and efficient system.

e. Description of Benefits Realized as the Result of Implementation

Implementing a unified, integrated application that encompasses all network information from the circuit level and beyond can provide several benefits for enhanced telecom network configuration and data quality. By automating workflows and data transfer and ensuring seamless integration with other corporate systems, operations can be streamlined, and efficiencies can be realized. Furthermore, generating and tracking work orders supports the management of network changes while enabling remote configuration and deployment of logical connections across the telecom network.

f. Description of Capability Improvement by Capability/Status Category

The damage failure workflow implementation in the TOMS improves and enhances the traditional work order process used by Operations to address this type of work. With the TOMS workflow, a work order is created in TOMS, which triggers a work order to be issued in the STORMS application to track the order's scheduling, dispatching, and closing. The following business capabilities are now provided via the new TOMS workflow:

- Cataloging damage failure projects.
- Capture changes to asset data resulting from damage failure projects.
- Reminder notifications to document project completion.

- Switch from an O&M Work Order to a damage failure order and cancel the O&M order in STORMS once the damage failure work is completed.

g. Key Milestones

The Company achieved significant milestones by implementing Leased Circuit Work Orders and reporting enhancements. A key initiative involved automating the circuit creation processes, a strategic move aimed at streamlining operations and enhancing overall efficiency. This approach was extended to private circuit work orders and reporting functionalities, where workflows were created to improve and optimize productivity. Additionally, the Company successfully delivered production releases for three NMS – GE Vistanet, and 4RF Aprisa.

h. Updated Projections for the Remainder of the Term

The project implementation plan involves completing the remaining functionality in upcoming application releases to ensure comprehensive coverage. The Company will conduct end-to-end UAT to validate the functionality and identify potential issues. At the same time, field survey work will continue to validate and add to telecom data, ensuring accuracy and completeness. Additionally, efforts will persist in promoting business adoption through ongoing training initiatives and onsite use case execution. This integrated approach aims to guarantee thorough and successful project implementation.

(7) Distribution Energy Resource Management System

Distribution Energy Resource Management System Investigation

The DERMS Investigation project is a parallel effort to inform and advise on the Company's DERMS implementation project. It validates customer value and the feasibility of implementing specific DER management capabilities, leading to a more cost-effective deployment of an enterprise-wide DERMS and DERMS Platform that build upon the foundation of the Company's ADMS project.

In its 2022-2025 Grid Modernization Plan, the Company highlighted the following tasks that are the focus areas of its DERMS Investigation:

- Identify DERMS business needs and capabilities for DERMS Platform and application products on the Company's DERMS roadmap.
- Assess any changes needed to the Company's overall DERMS Platform roadmap to address newly identified capability gaps.
- Identify any interim MVPs that can be implemented in an agile deployment approach and may build on previously proposed demonstration projects.
- Assess existing and new IT/OT infrastructure and define overall DERMS Platform architecture to address dependencies with other enterprise solutions.
- Develop detailed DERMS Platform IT diagrams.
- Align the Company's Data Management framework with all the products under the DERMS Platform.
- Define integration needs between various products within the DERMS Platform to achieve desired DER management capabilities.
- Define cybersecurity and physical security requirements and considerations, including protocols, governance, and compliance for the DERMS Platform.
- Identify roles, responsibilities, resource requirements, and training required for Company users and departments.
- Develop a detailed Benefit-Cost Analysis of DERMS focused on business and customer value.

- Conduct vendor interviews, market research, and a Request for Information to inform the Company's investigation efforts.
- Develop an RFP if there is a need to procure vendor solutions to implement specific DER management capabilities.

a. Description of Work Completed

In 2023, the Company focused on identifying DERMS business needs and customer use cases. The Company's DERMS vision centered around two customer use cases, which are discussed in detail in the Company's Electric Sector Modernization Plan[1]. Flexible Interconnections uses DERMS technology to enhance the Company's ability to utilize the system's hosting capacity to reduce interconnection cost and time.

In addition, the Company presented its vision to utilize DERs for Grid Services. Through this vision, the Company will accelerate pathways to procure and manage DERs flexibly to help address distribution system constraints, provide reliability, and defer and/or avoid network investments as non-wire alternatives (NWAs), including via the continued development of a market platform to manage programs for DERs to provide services to the distribution network.

The Company plans to use MVPs to test and validate DERMS use cases. As part of this vision, the Company launched an ARI pilot of Energy Storage (ES) to test the use case of offering Flexible Interconnections for ES customers. In the Company's Grid Modernization Annual Report for 2022, the Company discussed review of the distributed generation interconnection queue in preparation for providing its customers with ARI. The review revealed a high volume of ES applications. Stakeholder feedback from forums such as the Technical Standards Review Group and Energy Storage Interconnection Review Group has indicated an interest in exploring solutions to alleviate interconnection challenges associated with ES. As a result, the Company expanded its vendor selection efforts to choose vendors capable of delivering Grid Edge Control technology to solar, energy storage, and facilities that include both solar and ES.

As part of the investigation, the Company performed a solar/ES gap analysis that showed that incorporating software features into Grid Edge Control technology will not significantly impact the ARI project's cost or schedule. The developer community interested in the pilot will cover the deployment costs of flexible interconnection of ES.

[1] The Company's Electric Sector Modernization Plan was filed on January 29, 2024 in docket D.P.U. 24-11.

b. Lessons Learned, Challenges, and Successes

The industry has matured in managing and controlling ES. As part of the investigation gap analysis, the Company found that the vendor selected for the ARI solar demonstration pilot offered the ability to control ES assets in the same package.

During exploratory meetings with customers interested in the ES pilot, the customers shared that the ES developer communities often bid in the wholesale market one day in advance and that there are significant penalties for underperforming and not responding.

They shared that a forecast sent 24-36 hours in advance will help them avoid such penalties. The need for ES owners to plan their charging and discharging times one day in advance has highlighted the importance of the Company providing a Dispatch Request Signal to asset owners. This signal would indicate the best times for charging and discharging the batteries and will be piloted in a future state.

The Company launched a pilot program for ES developers interested in integrating ARI. Three facilities have been approved to proceed with this pilot program. The developer community interested in the pilot will cover the deployment costs of flexible interconnection of ES.

c. Actual v. Planned Implementation and Spending

Tab 5b Spending – 2023 Report in the attached Department Annual Report Template provides the deviation in the implementation and spending. Refer to columns F - P, rows 27-31.

d. Performance on Implementation

Implementation of the DERMS Investigation is progressing according to the plan.

e. Description of Benefits Realized as the Result of Implementation

Optimal operation and management of DER through the deployment of a DERMS Platform can result in numerous customer benefits, such as: (1) avoiding or deferring system upgrades to

integrate DER into the grid via optimal dispatch of DER; (2) operationalizing DER to provide grid services that can further increase the value of DER to all stakeholders; and (3) offering innovative programs that interact with customer DER. Some of these benefits can be realized through use cases such as more significant deployment of NWAs, integration of DER into VVO, and improved DER coordination with ISO-NE.

Conducting due diligence to determine DERMS's most valuable and optimal deployment is essential to ensure customer funding is effectively spent before making any significant DERMS investments. The output from this investigation will be a fully specified DERMS investment and implementation plan.

f. Description of Capability Improvement by Capability/Status Category

The DERMS investigation will inform the planning and process for DERMS implementation. Capability improvements will be achieved through the DERMS implementation investment.

g. Key Milestones

- A pilot program was established for ES developers interested in integrating ARI for DG interconnections.
- Three facilities have been approved to proceed with this pilot program. The developer community interested in the pilot will cover the deployment costs of flexible interconnection of ES.
- The Company performed a solar/ES gap analysis that showed that incorporating software features into Grid Edge Control technology will not significantly impact the ARI project's cost or schedule.

h. Updated Projections for the Remainder of the Term

In Calendar years 2024 and 2025, the Company will focus on the critical remaining areas highlighted in the 2022-2025 Grid Modernization Plan to support the delivery of its DERMS platform:

- Assessment of existing and new IT/OT infrastructure and definition of overall DERMS Platform architecture to address dependencies with other enterprise solutions. This step is essential for integrating the Company's DERMS solutions with existing infrastructure.

- Development of detailed DERMS Platform IT diagrams.
- Alignment of the Company's Data Management framework with all the products under the DERMS Platform.
- Definition of integration needs between various products within the DERMS Platform to achieve desired DER management capabilities.
- Definition of cybersecurity and physical security requirements and considerations, including protocols, governance, and compliance for the DERMS Platform.
- Identify roles, responsibilities, resource requirements, and training required for Company users and departments.
- Execution of vendor interviews, market research, and RFI to inform the Company's investigation efforts.
- Development of a RFP if there is a need to procure vendor solutions to implement specific DER management capabilities.

Distribution Energy Resource Management System Implementation

The DERMS Implementation is a strategic initiative designed to accelerate the interconnection of DERs and leverage DERs to provide grid services. The first wave of capabilities, which include grid edge control, economic dispatch engine, and market platform, are crucial for this initiative.

As discussed in the Company's 2022-2025 Grid Modernization Plan, DERMS Implementation will be based on MVPs, resulting from the Company's DERMS Investigation and the Company's demonstration projects.

For example, the Company's ARI demonstration project focused on DER management of utility-scale distributed PV facilities and will serve as the MVP for the DERMS Platform's Centralized DER Dispatch Engine and Grid Edge Control products. Through the Company's proposed DERMS Implementation investment for these products, plans are in place to further scale out the MVPs from the demonstration project so that the application of these products can expand to broader use cases (for example, load relief support) and DER types (for example, energy storage) and later coupled with an awareness of an as-operated network model and load flow capabilities being delivered through the Company's ADMS. The Company plans to implement the DERMS system after the successful completion of the MVP. This will allow the Company to validate its capabilities. The current schedule is to begin DERMS Implementation after the MVP is validated.

The following provides an overview of the MVP status of the first wave of DERMS capabilities:

- Grid Edge Control communicates and sends dispatch commands securely to DER facilities.
- Under the Company's ARI Demonstration, the Company conducted a competitive solicitation process to compare multiple vendors against standard requirements. The aim was to identify a vendor that would provide the most suitable Grid Edge Control capabilities for the Company's solar and energy storage pilots. The selected vendor demonstrated its ability to provide an integrated package for Grid Edge Control, including a dispatch engine for local constraint analysis. Moreover, the vendor's record of successful implementations and projects, such as the Company's flexible interconnection program, was a key factor in the selection process. This vendor selection is a significant step towards successfully implementing the DERMS, as it ensures that the Grid Edge Control can communicate with DER facilities securely and reliably.
- The Centralized Economic Dispatch Engine (CEDE) analyzes available DER to determine the most suitable dispatch event, considering multiple customer DER, grid constraints, and economic factors. The Company's current MVP, developed in ARI, can make grid-edge dispatch decisions without communicating with the ADMS, a form of decentralized dispatch.
- The MVP also includes capabilities that allow distribution system operators to supervise the ARI dispatch operation and override it in case of unexpected behavior.
- Validation work for the Market Platform is expected to begin in 2024.
- The Company held multiple DERMS vendor interviews in 2023 to understand the status of the industry; validation and project kick-off are scheduled for 2024.

a. Description of Work Completed

Work on DERMS Implementation is scheduled to begin in 2024.

b. Lessons Learned, Challenges, and Successes

No lessons learned have been documented yet.

c. Actual v. Planned Implementation and Spending

Tab 5b Spending – 2023 Report in the attached Department Annual Report Template provides the deviation in the implementation and spending. Refer to columns F - P, rows 27-31.

d. Performance on Implementation

DERMS implementation will build on the deployments in the Company's ARI pilots. Testing at the Company's sites along with testing at customer DER facilities allows the Company to validate key operational assumption of the Company's DERMS. Through these pilots, the Company can evaluate how to scale each DER management capabilities of its DERMS.

e. Description of Benefits Realized as the Result of Implementation

Enhanced DER management capabilities through the implementation of the Company's DERMS platform will likely result in numerous customer benefits, such as: (1) avoiding or deferring system upgrades to integrate DER into the grid via optimal dispatch of DER; (2) increased utilization of both existing and future system infrastructure; (3) operationalizing DER to provide grid services that can further increase the value of DER to all stakeholders and (4) offering innovative programs that interact with customer DER.

f. Description of Capability Improvement by Capability/Status Category

The agile approach for the Company's DERMS implementation will allow the Company to validate its DERMS capabilities through testing conducted during the ARI pilots. This will allow the Company to scale ARI into a fully-fledged flexible interconnections program for solar and ES as the Company scales its Grid Edge Control capability. Implementing the CEDE will allow customer DER to provide distribution reliability and resiliency services to the electric grid.

g. Key Milestones

The launch of ARI pilots offers a critical milestone in the Company's DERMS implementation as it will allow the Company to gain critical insights regarding its DERMS capabilities implementation.

h. Updated Projections for the Remainder of the Term

Through the remainder of the term, the Company anticipates completing the following for DERMS Implementation:

- Refine the MVP for Grid Edge Control to respond to dispatch commands from CEDE based on feedback from pilots and findings during implementation.
- Explore cost-effective options for Grid Edge Control to support projects' economic viability.
- Develop a detailed MVP procurement, design, and implementation plan for CEDE and the market platform.
- Implement and test the MVP and enhancements to Grid Edge Control, CEDE, and market platform.
- Transition to full-scale product deployment and evolving the product features over time through customer feedback, market dynamics, and technological advancement in DER and DER management solutions.

Advanced Short Term Load Forecasting

Advanced Short-Term Load Forecasting (ASTLF) uses advanced algorithms and data analysis techniques to predict electricity demand over a short period, usually from a few hours to several days in advance. Historical load data, weather patterns, and other relevant factors are analyzed to develop predictive models that accurately forecast future electricity consumption. These forecasts are crucial for the Company to plan resource allocation, ensure grid reliability and utilize distributed generation through DERMS.

a. Description of Work Completed

The Company has developed a platform to support its Short-term Load Forecasting (STLF) efforts. The STLF platform supports analyzing, modeling, and managing the developed models throughout their lifecycles. The platform is a Software as a Service (SaaS) tool, enabling the Company to scale as datasets grow and become more complex.

Central to the development of the STLF solution is the role of the Company's data scientists. Their expertise is instrumental in model training, a process that involves training machines to recognize patterns through algorithms and statistical models. This training enables the Company's computer systems to learn and adapt without requiring constant human interactions. Model training was the most significant effort the Company focused on in 2023 and is likely to be a continued effort in 2024.

Model training began by selecting a few substations with distinct characteristics. These characteristics include industrial versus residential areas or high versus low solar penetration. Next, the Company's engineers initiated a process called data scrubbing. This process requires the engineer to sift through the data collected from devices like feeder monitors, covering months and years. Data scrubbing aims to identify anomalies such as loss of communication or incorrect polarities.

Additionally, the Company's data scientists worked on creating statistical models, initiating the supervised learning process to help the computer system detect relationships in the collected data. One example of such a relationship is the correlation between temperature and load for residential feeders.

b. Lessons Learned, Challenges, and Successes

Implementing STLF is not without its challenges. One of the most significant is the continuous feeding of quality data to the models without manual intervention. This task requires vigilance and expertise, as multiple sources can cause data quality issues. Process-related data issues are discovered and addressed during the data scrubbing process. As the models begin to pull data regularly, the model may encounter abnormal data caused by loss of communication or device failure. The machine learning model will need to be trained to deal with such issues, and this requires complex algorithms to inform the model training process.

Another model learning challenge is dealing with abnormal circuit configurations. In this case, the model must be made aware that the distribution system operator has intentionally made changes to the system that it was trained on, and this often requires continuous supervision of the models.

Forecast delivery to the end user is also essential to short-term forecasting. Delivering the forecast requires discussion with stakeholders to identify ways to provide the models to the end customers. The end customers can be internal or external; an example of an internal customer is the team responsible for the Company's ADMS, while an example of an external customer is the energy storage developer community. These conversations focus on how the forecast will be shared and its characteristics.

The Company completed the development of its data analytics platform for STLF in 2023.

c. Actual v. Planned Implementation and Spending

Tab 5b Spending – 2023 Report in the attached Department Annual Report Template provides the deviation in the implementation and spending. Refer to columns F - P, rows 27-31.

d. Performance on Implementation

This investment category is still in the developmental phase and has yet to show performance on deployment.

e. Description of Benefits Realized as the Result of Implementation

Expected benefits include improved DER experience and operation by using more accurate short-term load forecasts as input into distribution system security analysis and feasibility assessment of DER schedules.

f. Description of Capability Improvement by Capability/Status Category

The data analytics platform and the algorithms developed in 2023 are the steppingstones for the Company's vision to develop short-term forecasts, which will be an essential element for optimizing the operation of DERs on the distribution system. Over the coming years, the Company will continue to scale the platform, build on the developed algorithms, and develop and train new algorithms.

g. Key Milestones

The key project milestones in 2023 were:

- Selection of a data analytics platform for STLF in 2023.
- Advancing the development of a SaaS platform to support its ASTLF efforts.
- The Company's data scientists developed statistical models to help the computer system detect relationships in the collected data through supervised learning.

h. Updated Projections for the Remainder of the Term

The primary tasks that the Company will focus on in 2024 and 2025 are:

- Model training/algorithm: The Company will continue to progress its work on model development and machine learning training as this is the most pivotal part of forecast development.
- Addressing data clean-up challenges: With the rapid growth of smart devices in the electric grid, two-way data flow is growing exponentially. Data growth is likely to increase significantly. The Company will work to address the challenge by automating parts of the data scrubbing process. Manual data scrubbing is also expected to continue during this period.
- Developing forecast delivery solutions: The Company will work with internal and external stakeholders to develop methods for delivering the forecast to the end user as needed.
- Platform scaling: The platform will continue to scale as needed during model development.

(8) Demonstration Projects

Active Resource Integration Demonstration

The Company's ARI demonstration is a key element of National Grid's strategy to enable an affordable clean energy transition. It seeks to deploy system automation strategies to leverage available system capacity better while maintaining a safe and reliable electric grid. Under the ARI demonstration, DER facilities will be interconnected in traditionally constrained sections of the distribution network. Technological solutions deployed as part of the program will monitor the thermal conditions of the grid in real-time and initiate automated commands to a customer's DER facility to adjust operating conditions as needed to avoid exceeding certain grid constraints. This technology allows DER to utilize the distribution network when it has the capacity and to limit operation when there is insufficient capacity, thereby enhancing the overall efficiency and reliability of our energy systems.

The ARI demonstration marks the initial stage of the Company's ability to provide various adaptable interconnection solutions to its customers. These solutions will go beyond solar energy to ES, EVs, and other types of distributed DERs that may impact the grid in the future.

a. Description of Work Completed

To support the deployment of ARI, the Company executed multiple critical tasks to deliver ARI. First, after a series of stakeholder and user interviews, the Company was able to develop the technical requirements essential for the demonstration.

Second, the team performed a gap analysis to identify the incremental functionality needed to allow ARI to support ES-related use cases. After careful evaluation, the Company was able to onboard a vendor that could deliver both solar and ES within the same product line. This vendor selection process was a crucial step in ensuring the success of the ARI project, as it allowed the Company to find a partner with the right capabilities and expertise to meet the project's needs.

The successful onboarding of the vendor/partner for ARI in Massachusetts marked a crucial step in project delivery. After that, the Company began the meticulous design and confirmation of the equipment selection process to help begin the deployment processes.

In September 2023, the Company launched its ARI solar pilot initiative, a key milestone in the ARI project. This initiative allowed the Commonwealth's solar developers to apply and engage with ARI technology. The Company actively engaged with several solar developer applicants to support those interested in applying for the demonstration. In total, 43 solar projects (of approximately 23.5 MW) were submitted for consideration for the demonstration project, revealing a high level of interest and potential for ARI to integrate solar resources.

Finally, the Company developed a plan to test the first iteration of the solution at a Company facility to help expedite actual DER facility deployment and avoid DER downtime for troubleshooting.

b. Lessons Learned, Challenges, and Successes

A key lesson learned from the ARI deployment was the importance of aligning contracts with the asset's lifetime. This was identified as a preference among developers, as it provides partnership stability and longevity. This insight will inform our future contract and partnership strategies, ensuring the Company meets the needs and expectations of our stakeholders.

A series of successes were achieved for the ARI initiative. First, the successful onboarding of the vendor for ARI marked a pivotal step forward in enhancing operational efficiency and effectiveness.

Second, the successful launch of the pilot initiative created a stepping-stone for the Company's vision to deliver flexible solutions to its customers.

c. Actual v. Planned Implementation and Spending

Tab 5b Spending – 2023 Report in the attached Department Annual Report Template provides the deviation in the implementation and spending. Refer to columns F - P, rows 27-31.

d. Performance on Implementation

- The Company launched the ARI pilot to allow the developer community to apply for the demonstration of ARI at their local facility.

- The communication and infrastructure requirements to link Company assets to customer DER facilities have been defined.
- An MVP unit has been planned to undergo testing at a Company facility.

e. Description of Benefits Realized as the Result of Implementation

The Company anticipates that DER customer facilities enrolled in the ARI pilot will benefit through reduced interconnection cost and time. Learnings from ARI deployment will allow for increased utilization of both existing and future system infrastructure, which will help enable clean energy deployments in the Commonwealth.

f. Description of Capability Improvement by Capability/Status Category

The MVP unit procured and designed to deploy ARI will allow the Company to validate DERMS capabilities essential for flexible interconnection offerings. At a later stage of the project, the work will allow the Company to scale ARI into a fully-fledged flexible interconnections program for solar, ES, and EVs.

g. Key Milestones

The key milestone achieved in 2023 were:

- Completed the requirements definition work, product design, and vendor selection process.
- Launched Active Resource Solar pilot webpage to engage with developers interested in the program and its benefits.

h. Updated Projections for the Remainder of the Term

The Company will begin testing ARI functionality at its facilities in the remaining years of the Grid Modernization Plan term.

After successfully deploying solar-only ARI functionality at a Company facility, the Company plans to explore integrating additional functionalities. This may include investigating BESS dual operating envelope for co-located assets, testing smart/advanced inverter functions, integrating the ADMS system, and incorporating short-term forecasting to support load flow analysis.

The Company will finalize the selection of solar facilities available for the pilot. This includes parallel work outside of solely ARI functionality, such as formalizing interconnection process steps for flexible assets in addition to the standard process.

The Company also plans to begin testing at customer facilities.

Local Export Power Control

Local Export Power Control (LEPC) aims to address the challenges customers face with behind the meter (BTM) DG interconnection requests, particularly customers experiencing a growth in load and generation. The demonstration project empowers the customer to manage the facility's DER operation to avoid impacting the distribution network, reducing the cost and time to interconnect.

The Company is collaborating with the town of Orange, MA, to demonstrate that a customer can effectively manage the local assets within the facility to minimize the impact of the additional power generation. This can be achieved by selecting the appropriate equipment and carefully choosing the facility's operational parameters.

a. Description of Work Completed

The underlying theory behind the project is that a Power Control System (PCS), when locally installed at a customer site, can limit AC electric current at a Point of Reference (PoR) to a defined maximum by adjusting the operating setting of a DER. This innovative approach, where the PCS can be a standalone device or integrated into the DER inverter system, is a key aspect of the project. The current measurement point installed at the PoR may be located internally within the equipment or an external device approved by the Company. Additional protective devices and relaying may be required, which will be determined through the associated System Impact Study.

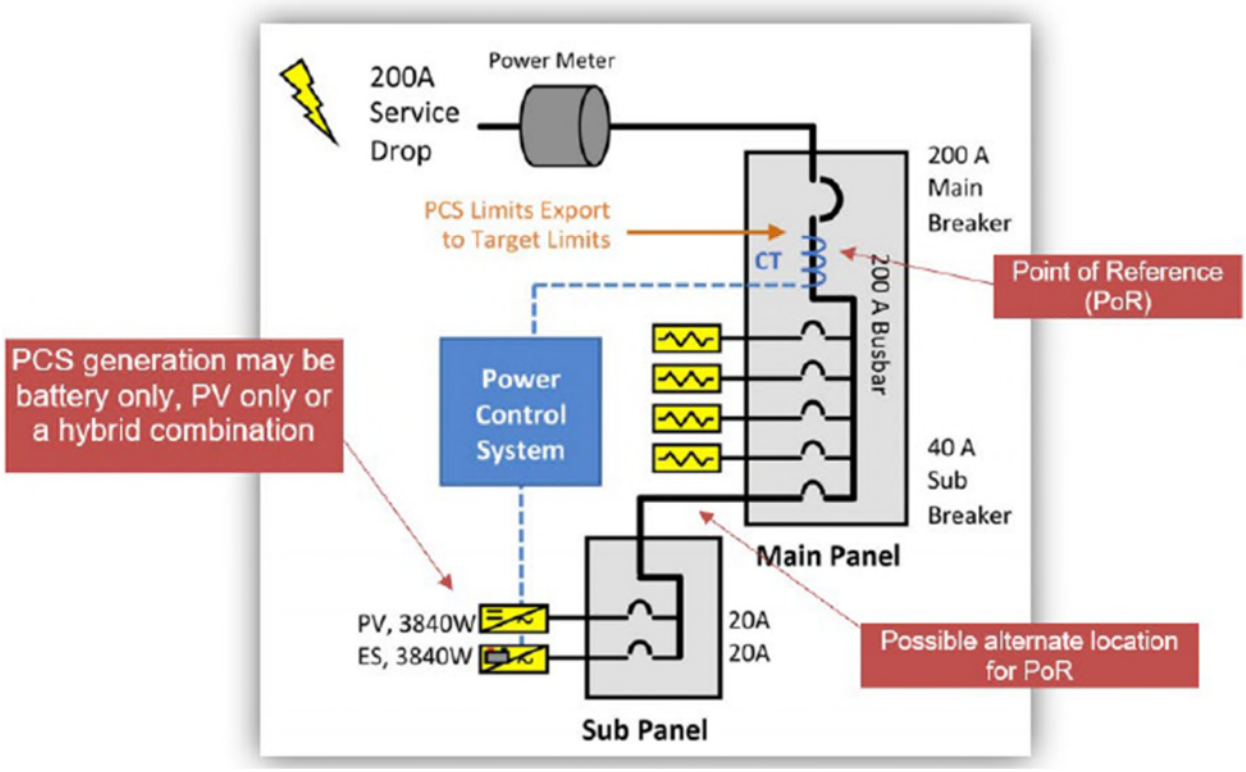


Fig. 5 Power Control System Illustrative Example (courtesy of the Electric Power Research Institute)

In 2023, the Company worked closely with the customer to design a solution to help a school in Orange, MA manage its load and generation profile. By adding a PCS, battery, and additional metering, the customer proposed a design that oversees the school's DER operation without creating a thermal impact on the electric system.

Working with the Company's engineers, the customer's design also included a proposal for two relays that would help reduce the risk to the electric distribution system should the LEPC not function as expected. The first relay is installed to prevent the facility from pushing excessive generation onto the electric grid. The second relay is designed to protect the system from the additional load caused by the integration of the battery.

The Company's subject matter experts in DER management have confirmed that the customer's design can be transitioned to the interconnection study phase. The Company is confident that the town of Orange will be ready for solution testing in late 2024 or early 2025.

b. Lessons Learned, Challenges, and Successes

When the Company filed its 2022-2025 Grid Modernization Plan in 2021, the pilot plan was based on a solution intended to be an off-the-shelf solution such that a PCS would come in an integrated package with an ES system, photovoltaic inverters, and metering to be tested together.

As the pilot developed, the customer's chosen developer struggled to find an off-the-shelf solution because readily available products on the market were found to limit the size of such installations to approximately 30kW typically. Instead, the developer proposed using a custom-programmed PCS and installing protection relaying to avoid risk to the distribution system.

Given that the Company believes that allowing a variety of solutions is in the best interest of its customer base, the Company accepted the proposal. One impact of the decision is that the school will require new engineering analyses beyond those needed for a typical DG interconnection impact study.

The Town of Orange, MA, the Company's partner on the project, faced multiple challenges that delayed facility development. The Town Administrator, its developers, and the Company's LEPC team worked closely to address these challenges, which led to the project's continued progression.

At the time of filing the Company's 2022-2025 GMP, the Company expected the technology to be limited to operating PV and ES combined. As the industry became aware of the pilot, the Company had discussions with approximately five other BTM project developers interested in testing alternative solutions and technologies to be controlled by a PCS.

Based on the industry's interest, the Company chose to launch a pilot (beyond the demonstration in this filing at the expense of interested participants) for other developers in early spring of 2024. Through the pilot, the Company believes that it can offer customers applying to add BTM DG to a flexible load profile option to manage the operational profile of the facility to create solutions that negate the thermal impact of the incremental generation to help reduce interconnection cost and time. The customer will be responsible for assuring operations and compliance, and the Company may take any action to monitor compliance and address any non-compliance.

c. Actual v. Planned Implementation and Spending

Tab 5b Spending – 2023 Report in the attached Department Annual Report Template provides the deviation in the implementation and spending. Refer to columns F - P, rows 27-31.

d. Performance on Implementation

A deployment will be carried out in partnership with the Town of Orange at a local school as part of the LEPC project. The Company's partner did not implement or deploy any LEPC project in 2023. Any further deployments must be funded by developers interested in piloting outside the approved grid modernization demonstration.

e. Description of Benefits Realized as the Result of Implementation

The project aims to lower interconnection costs and time for BTM DER developers in areas with distribution system constraints.

f. Description of Capability Improvement by Capability/Status Category

The Company aims to develop robust tools and processes to allow developers of BTM DER to flexibly interconnect with the distribution system.

g. Key Milestones

The customer design and solution were accepted.

h. Updated Projections for the Remainder of the Term

The Company plans to perform an interconnection study to identify the PCS's safe operational limits. The Town of Orange will then deploy the solution and receive authorization to interconnect. The Company will create a test plan to evaluate the solution's performance. Then, the Company will begin testing and monitoring the solution at the local facility.

(9) Measurement, Verification & Support

Measurement and Verification

a. Description of Work Completed

In the Order, at 204, the Department determined that it is appropriate to establish a formal evaluation process, including an evaluation plan and evaluation studies, for the Companies' preauthorized grid modernization plan investments. To the extent possible, the evaluation plan will provide a uniform statewide approach and standards to study the deployment of the preauthorized grid modernization investments to ensure that benefits are maximized and achieved with greater certainty and that future investments are more effective.

For the 2018-2021 term, as part of the evaluation process, the Companies, in consultation with DOER, selected Guidehouse (formerly Navigant Consulting) as the evaluation consultant to conduct studies on appropriate topics related to deploying the preauthorized investments.

The Companies continue to work with Guidehouse as evaluation consultants for the current term. On November 11, 2023, the Department published a memo ordering the EDCs to file revised evaluation reports in D.P.U. 21-80/21-81/21-82. On February 7, 2024, Guidehouse filed an updated evaluation plan outline to address the items in the memo. The 2023 evaluation report will incorporate the components outlined in the updated evaluation plan and is expected on June 28, 2024. The data-gathering process to support the 2023 evaluation report commenced in early 2024.

b. Lessons Learned, Challenges, and Successes

The lessons learned in the M&V process cover 2018-2022 and are documented in the Evaluation Consultant Recommendations section. Some examples of these lessons include the importance of stakeholder engagement in the evaluation process and the need for clear and consistent data collection methods.

c. Actual v. Planned Implementation and Spending

Tab 5b spending – 2023 Report in the attached Department Annual Report Template provides the deviation in the implementation and spending. Refer to columns F - P, rows 27-31.

d. Performance on Implementation

Evaluation reports and the underlying data-gathering process have been delivered on time. They are complete and comprehensive.

e. Description of Benefits Realized as the Result of Implementation

Benefits are recorded at the project level. M&V helps to quantify those benefits.

f. Description of Capability Improvement by Capability/Status Category

While the M&V process does not directly lead to capability improvements, it does help measure investment performance and inform corrective actions if needed.

g. Key Milestones

The Massachusetts Grid Modernization Program Evaluation Report is filed annually.

h. Updated Projections for the Remainder of the Term

Guidehouse is expected to deliver evaluation reports for 2023, 2024, and 2025. The 2025 evaluation report will incur program costs in 2026.

Project Management

The Company established a new GME organization in August 2018. This organization played a crucial role in driving the delivery of grid modernization investment areas approved in the 2018-2021 term and continued to do so in the 2022-2025 term. The GME organization serves as a project management office, overseeing the overall delivery of services and ensuring the successful execution of the grid modernization projects.

In October 2023, the Company reorganized its electric business moving deployment-focused GME resources to the Program Management organization and moving Program oversight resources to the newly established Massachusetts Electric Regulatory Delivery organization, which is responsible for ensuring Grid Modernization investments comply with all relevant Department Orders. This organization hosts regular Grid Modernization Regulatory Review meetings with leaders responsible for investment delivery to ensure all projects are executed within allowance, review progress against plan, and make decisions on programmatic risks and issues.

The Company also held monthly Grid Modernization Execution Status Meetings as a performance monitoring and measurement activity. These meetings aimed to identify project risks, performance issues, and cross-project dependencies. Project managers responsible for delivering Grid Modernization investments provided updates, which could be escalated to the Steering Committee or Regulatory Review Meeting for informational purposes or critical decisions.

a. Description of Work Completed

In 2023, the GME organization and Regulatory Delivery organization continued progressing and monitoring approved Grid Modernization investments, working to deliver Track 1 and Track 2 investments.

b. Lessons Learned, Challenges, and Successes

Lessons learned, challenges, and successes are recorded at the project level.

c. Actual v. Planned Implementation and Spending

Tab 5b Spending – 2023 Report in the attached Department Annual Report Template provides the deviation in the implementation and spending. Refer to columns F - P, rows 32-33.

d. Performance on Implementation

The GME organization and now the Regulatory Delivery organization continue to fulfill their functions.

e. Description of Benefits Realized as the Result of Implementation

Benefits are recorded at the project level.

f. Description of Capability Improvement by Capability/Status Category

Capability improvements are recorded at the project level.

g. Key Milestones

Milestones are recorded at the project level.

h. Updated Projections for the Remainder of the Term

The Company plans to continue activities associated with this category for the remainder of the term.

IV. Performance Metrics

A. Description and Update on each Performance Metric

The Department stamp-approved the revised Performance Metrics on February 1, 2024, in dockets D.P.U. 21-80/21-81/21-82, which the Company reports on in this Section. The Department also ordered the EDCs to develop a formal evaluation process, including an evaluation plan and evaluation studies, to review their preauthorized GMP investments and progress toward meeting the Department's grid modernization objectives. Order, at 204-205. Guidehouse (formerly Navigant Consulting, Inc.) is completing the evaluation to ensure a uniform statewide approach and to facilitate coordination and comparability across the EDCs.

The data supporting the performance metrics have been provided to the Guidehouse evaluation team by the Company. Results of the Monitoring and Control, Distribution Automation, VVO, and ADMS investment areas are expected to be filed by Guidehouse at the end of June 2024.

2.1 VOLT VAR OPTIMIZATION AND CONSERVATION VOLTAGE REDUCTION BASELINE – At the end of 2023, the Company had 14 substations and 75 feeders equipped with VVO technology. Baseline calculations for feeders equipped with VVO in 2023 are in process and will be published by Guidehouse in the 2023 Massachusetts Grid Modernization Program Evaluation Report at the end of June 2024.

2.2 VOLT VAR OPTIMIZATION (VVO) ENERGY SAVINGS – At the end of 2023 the Company had a total of 14 substations and 75 feeders equipped with VVO technology. Energy savings calculations for feeders equipped with VVO in 2023 are in process and will be published by Guidehouse in the 2023 Massachusetts Grid Modernization Program Evaluation Report at the end of June 2024.

2.3 VVO PEAK LOAD IMPACT – At the end of 2023, the Company had a total of 14 substations and 75 feeders equipped with the VVO technology. Peak load impact calculations for feeders equipped with VVO in 2023 are in process and will be published by Guidehouse in the 2023 Massachusetts Grid Modernization Program Evaluation Report at the end of June 2024.

2.4 VVO – DISTRIBUTION LOSSES WITHOUT ADVANCED METERING FUNCTIONALITY (BASELINE) - At the end of 2023, the Company had a total of 14 substations and 75 feeders equipped with the VVO technology. Calculation of reduction in losses for feeders equipped with VVO in 2023 is in process and will be published by Guidehouse in the 2023 Massachusetts Grid Modernization Program Evaluation Report at the end of June 2024.

2.5 VVO POWER FACTOR – At the end of 2023 the Company had a total of 14 substations and 75 feeders equipped with the VVO technology. Calculation of improvement in power factor for feeders equipped with VVO in 2023 are in process and will be published by Guidehouse in the 2023 Massachusetts Grid Modernization Program Evaluation Report at the end of June 2024.

2.6 VVO ESTIMATED VVO/CVR ENERGY AND GREEHHOUSE GAS IMPACT – At the end of 2023 the Company had a total of 14 substations and 75 feeders equipped with the VVO technology. GHG impact calculations for feeders equipped with VVO in 2023 are in process and will be published by Guidehouse in the 2023 Massachusetts Grid Modernization Program Evaluation Report at the end of June 2024.

2.7 INCREASE IN SUBSTATIONS WITH DISTRIBUTION MANAGEMENT SYSTEM POWER FLOW AND CONTROL CAPABILITIES – The Company has enabled DMS power flow capability for over 157 feeders in 2023. National Grid's ADMS model functions differently than how this metric was intended to measure completeness. The ADMS uses telemetered data from field devices paired with the ADMS electric network model to run an operational load flow on enabled feeders (715 at the end of calendar year 2023), allowing the users to view load flow results on the real-time electric network model or run a load flow in simulation mode to study future switched grid reconfigurations to ensure no voltage or thermal violations and that grid configuration is optimal. Presently, automatic load flow is not run continuously. All feeders enabled for ADMS load flow are qualified and tested before transitioning to operational use. The engineering team performs a series of screenings, including data checks on device limits and ratings, line ratings, peak load and light load qualification, comparison of ADMS load flow outputs and solar/DER outputs to telemetered field data, and verification of no abnormal voltage or thermal violations while feeders are in normal state. The Company provides the summary of feeders enabled as of December 31, 2023, in Tab 7. DMS Power Flow in the attached Department Annual Report Template.

2.8 CONTROL FUNCTIONS IMPLEMENTED BY CIRCUIT (VVO, AUTO RECONFIGURATION) - The Company has not enabled DMS control functions during 2023.

2.9 NUMBERS OF CUSTOMERS THAT BENEFIT FROM GMP FUNDED DISTRIBUTION AUTOMATION DEVICES - The Company has enabled 83 feeders representing 42 ADA schemes from 2019 through 2023. Refer to the Department Annual Report Template at 3b. Feeder Status-2023 column DA for the list of installed ADA devices by feeder.

2.10 VVO RELATED VOLTAGE COMPLAINTS PERFORMANCE METRIC AND BASELINE - The Company does not have an automated system to track voltage complaints instead reviewing incidents from the Company’s OMS system to identify voltage complaints.

2.10 VVO RELATED VOLTAGE COMPLAINTS PERFORMANCE METRIC AND BASELINE - The Company does not have an automated system to track voltage complaints; instead, reviewing incidents from the Company's OMS system to identify voltage complaints. The current OMS system was installed at the end of upgraded with VVO technology. Additional filters were applied to the results to better understand the reason behind the reported incident to be linked to a possible complaint in voltage. Filters were applied to exclude results as follows:

a. Remove blank caller comments due to lack of description of incident.

b. Remove the address "1234 Trouble St" as this is a placeholder address and not connected to the premise of incident.

c. Remove underground facilities from the transformer list.

d. Remove results associated with motor vehicle incidents, fire, trees, storms, and other results that would not have been caused by blue sky activity.

From the reduced results of customer-reported voltage complaints incidents, focus was given to incidents such as Voltage, Dim, Flickering, and Voltage Recorder Monitor. The Company is working towards process improvements and system enhancements to enable better details of customer voltage complaints that may be related to VVO voltage optimization.

Below is a table of summarizing the change in voltage complaints from baseline for substations equipped with VVO:

VVO Substation	Sum of Baseline Average (2016 & 2017)	Sum of # of Volt Complaints 2023 Results	Sum of Change in # of volt complaints (baseline minus 2023)
Billerica	42	35	7
Depot St.	28	26	2
Dighton	19	13	6
E. Bridgewater	30	44	-14
East Dracut	18	21	-3

East Methuen	31	23	8
Easton	22	36	-14
Maplewood	26	54	-28
Melrose	17	24	-7
Millbury	39	36	3
Northboro Rd	3	1	2
Parkview	13	19	-6
Stoughton	28	41	-13
Swampscott	19	19	0
West Salem	19	47	-28
Westboro	13	21	-8
Grand Total	**367**	**460**	**-93**

2.11 DERMS SOFTWARE- Implementation of DERMS software is scheduled to begin in 2024.

2.12 THE NUMBER OF EJ AND LI CUSTOMERS, RESPECTIVELY, IMPACTED BY THE COMPANIES' DISCRETE INVESTMENTS

Note: the numbers reported for this metric reflect Term 1 and Term 2 deployments.

1. Number of EJ and LI customers impacted by discrete grid modernization investments deployed by circuit.

There were 293 circuits with grid modernization investments deployed by the end of 2023. On those circuits, there were 219,518 residential customers residing within Environmental Justice Communities and 60,567 customers receiving a low-income rate. Please see Tab 10a. 2023 EJ & LI of the Appendix for circuit-level details.

2. Percentage of EJ and LI customers impacted by discrete grid modernization investments deployed by circuit.

The Company has a total of 590,375 residential customers residing within an Environmental Justice Community and 219,518 of those have been impacted by discrete grid modernization investments, representing 37%. The Company has a total of 160,235 customers receiving a low-income rate and 60,567 have been impacted by discrete grid modernization investments, representing 38%. Overall, out of the Company's total 1,358,966 customers across all customer classes, 468,560 customers have been impacted by discrete grid modernization investments, representing 34%. Feeder-level details are reported on Tab 10 a. 2023 EJ & LI of the Appendix.

3. The number of impacted LI customers who reside in an EJ population location impacted by discrete grid modernization investments deployed by circuit.

There are 38,357 customers receiving a low-income rate, residing within an Environmental Justice Community, and receiving service from a circuit with a grid modernization investment deployed.

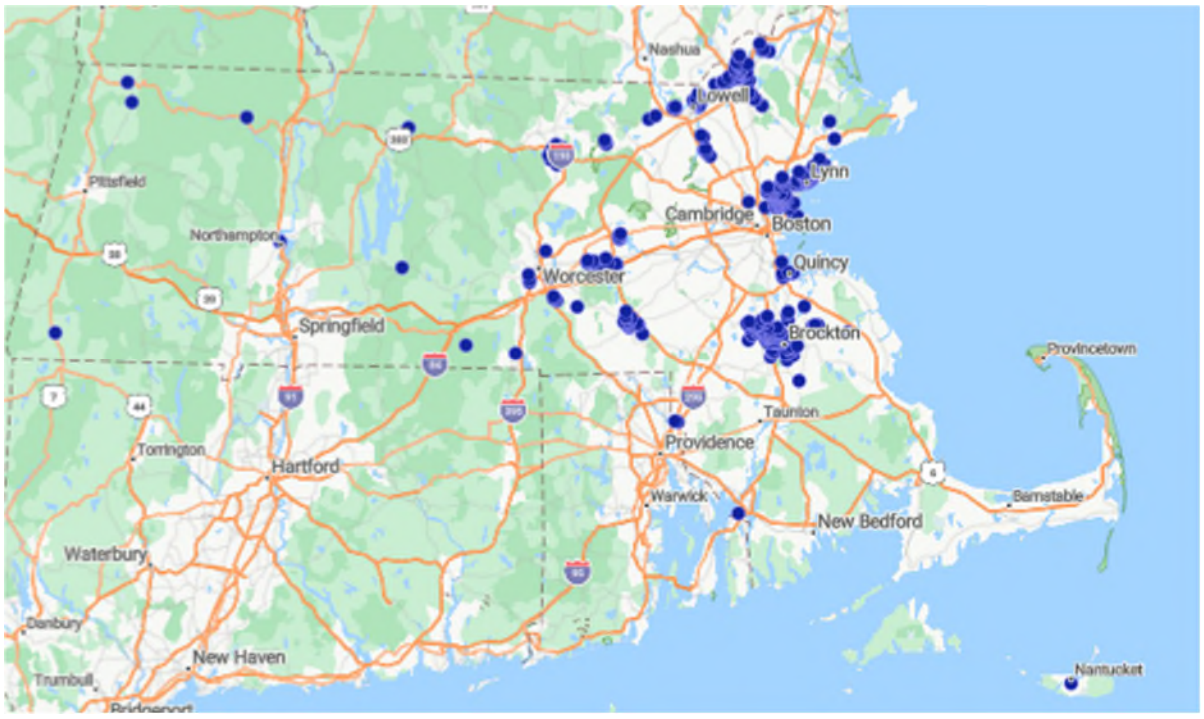


Fig. 6 map of grid modernization investments that have been deployed on circuits that traverse an Environmental Justice Community.

App.C.1.0 NATIONAL GRID RELIABILITY-RELATED COMPANY-SPECIFIC - This metric is designed to measure the impact of ADA investments on the CMI for main line interruptions. The Company has enabled feeders representing ADA schemes from 2019 through 2023. There were mainline events that caused operations of the ADA during the 2023 plan year. Please refer to Tab 3b Feeder Status – 2023 Columns DE and DF in the attached Department Annual Report Template for details.

App.C.2.0 NATIONAL GRID REPLACING FIXED CAPACITORS WITH ADVANCED DISTRIBUTION MANAGEMENT SYSTEM CONTROLLED SMART CAPACITORS – This metric is designed to demonstrate that the operation of smart capacitors through an ADMS will result in fewer voltage violations than traditional fixed capacitors, especially on circuits with high DG penetration, thereby helping to mitigate the impact of DG on voltage.

The Company will not report on this metric until after Phase 3 of the ADMS system is deployed and operational, and smart capacitors are installed and integrated with the ADMS. The Company anticipates this will happen at the end of the calendar year 2025.

B. Lessons Learned, Challenges and Successes

Lessons learned, challenges, and successes are detailed within each of the core investment area narratives within Section III. A.

V. Evaluation Consultant Recommendations

The Department's March 16, 2023, Memorandum in D.P.U. 23-30 added this reporting section, which includes narratives and explanations on the implementation of consultant recommendations from both the 2018-2021 term (for continuing investments) and the 2022-2025 term. Please refer to the Attachment "Guidehouse Evaluation Recommendations CY2023".

For each recommendation below, the following questions are addressed in each response as defined in the Annual Report Outline:

A. Assessment of the evaluation consultant's recommendations during both the 2018-2021 term (for continuing investments) and the 2022-2025 term.

B. Explanation of whether and how the company considered each recommendation during 2022-2025 investment plan development and implementation.

C. Implementation status of each recommendation.

Glossary of Terms, Abbreviations, and Acronyms

AC – Alternating Current

ADA – Advanced Distribution Automation

ADMS - Advanced Distribution Management System

AMI – Advanced Metering Infrastructure

API – Application Programming Interface

ARI – Active Resource Integration

ASPEN – Advanced System for Process Engineering

ASTLF – Advanced Short-Term Load Forecasting

BCC – Back-up Control Center

BI – Business Intelligence

BTM – Behind the Meter

CDQ – Continuous Data Quality

CEDE – Centralized Economic Dispatch Engine

CEII – Critical Electric Infrastructure Information

CMI – Customer Minutes of Interruption

CVR – Conservation Voltage Reduction

CY – Calendar Year

DER - Distributed Energy Resources

DERMS - Distributed Energy Resource Management System

DERs – Distributed Energy Resources

DG – Distributed Generation

DF – Damage Failure

DMS - Document Management System

DMX - Data Multiplexer

DOT – Department of Transportation

D-PI – Distribution Process Information

DPU – Department of Public Utilities

DSCADA – Supervisory Control and Data Acquisition

DS0 - Digital Signal Zero

EDC - Electric Distribution Companies

EJC - Environmental Justice Community

EMS – Energy Management System

ES – Energy Storage

EV – Electric Vehicle

FAN - Field Area Network

FAS – Field Activation System

FAT - Factory Acceptance Test-

FDAR - Field Device Activation Request

FLISR – Fault Location, Isolation, and Service Restoration

FME - Feature Manipulation Engine

GHG - Greenhouse Gasses

GIS - Geospatial Information Systems

GME – Grid Modernization Execution

GMP - Grid Modernization Plan

HES - Head-end System

IFC - Issued for Construction

INOC – Integrated Network Operations Center

IT - Information Technology

LEPC – Local Export Power Control

LMR – Land Mobile Radio

LTC - Load Tap Changer

MFT - Managed File Transfer

MOD – Mobile Outage Dispatch

MPLS-TP - Multiprotocol Label Switching-Transport Profile

M&V – Measurement and Verification

MVP - Minimum Viable Product

NMS – Network Management System

NSE - Network Security Environment

NWA- Non-wire Alternatives

OLO - Other Lease Line Operations

OMS – Outage Management System

OT - Operational Technologies

PAM - Privileged Access Management

PI - Process Information

PII - Personal Identifying Information

PORT - Power Out Reporting Tool

RBAC - Role Based Access Control

RFI - Request for Information

RFP – Request for Proposal

RTU – Remote Terminal Unit

SAT - Site Acceptable Testing

SCADA - Supervisory Control and Data Acquisition

SONET – Synchronized Optical Network

STLF - Short Term Load Forecasting

STORMS - Systematic Tracking of Restoration and Management Services

TOMS - Telecom Operations Management System

TP - Transfer Protocol

UAT - User Acceptance Testing

VVO - Volt VAR Optimization-

WAN - Wide Area Network