Grid Modernization Plan
Annual Report
Calendar Year 2022

D.P.U 23-30

April 24, 2023

Submitted to:
Massachusetts Department of Public Utilities

I. Introduction

On May 10, 2018, the Department of Public Utilities (the "Department") issued a decision (the "Order") approving in part the grid modernization plans ("GMPs") 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" or "EDCs"), in dockets D.P.U. 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 D.P.U. 15-120-D/15-121-2/15-122-D (May 12, 2020), the Department extended the first grid modernization plan investment term through calendar year 2021 and extended the deadline for the first Grid Modernization Term Report to April 1, 2022. On July 1, 2021, the Companies each filed their respective 2022-2025 GMPs consistent with the Department's directives in Grid Modernization – Phase II, D.P.U. 20-69-A (May 21, 2021). The Department docketed these matters as D.P.U. 21-80 (Eversource), D.P.U. 21-81 (National Grid), and D.P.U. 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 D.P.U. 15-120, D.P.U. 15-121, and D.P.U. 15-122 (see D.P.U. 21-80, Exh. ES-JAS-2, at 145 & Att. A; D.P.U. 21-81, Exhs. NG-GMP-1, at 11; NG-GMP2 (Rev. 2) at 84; NG-GMP-4; D.P.U. 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 D.P.U. 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 D.P.U. 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. D.P.U. 21-80/ D.P.U. 21-81/D.P.U. 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/or 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. D.P.U. 21-80/D.P.U. 21-81/D.P.U. 21-82, Procedural Notice at 2 (September 1, 2021). On December 30, 2021, the Department issued an Interim Order in D.P.U. 21-80/D.P.U. 21-81/D.P.U. 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, D.P.U. 21-80/D.P.U. 21-81/D.P.U. 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 and 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 for. Id. at 7.

On October 7, 2022, the Department issued its Track 1 order in D.P.U. 21-80, D.P.U. 21-81, and D.P.U. 21-82 approving, with modifications, the Companies' Continuing Investments proposals. D.P.U. 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, as well as the Eversource-specific proposals. Specifically, the Department found the proposed revisions to the VVO performance metrics were 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 D.P.U. 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. Consistent with the Department's Track 1 Order, the Companies have made the required edits below

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 investment demonstration project; (5) $0.2 million to evaluate local export power control in the demonstration category; and (6) $4.4 million for

program management and third-party measurement and verification. 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

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 NSTAR Electric Company d/b/a Eversource Energy ("NSTAR Electric"), Massachusetts Electric Company and Nantucket Electric Company d/b/a National Grid ("National Grid"), and Fitchburg Gas and Electric Light Company d/b/a Unitil ("Unitil") (together, "Companies"; individually, "company") pursuant to their approved 2022-2025 grid modernization plans. Grid Modernization Annual Reports, D.P.U. 23-30, Hearing Officer Memorandum at 2-3 (January 25, 2023) ("Request for Comments"). The Department included with its request a proposed narrative outline and data reporting template. Request for Comments, Atts. A & B. Additionally, the Department assigned docket number D.P.U. 23-30 for the Companies' calendar year ("CY") 2022 grid modernization annual report filings. Request for Comments at 2.

On February 15, 2023, NSTAR Electric, National Grid, Unitil, the Massachusetts Department of Energy Resources ("DOER"), and the Cape Light Compact JPE ("Compact") each submitted comments. On March 2, 2023, the Companies 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) identifies revisions, as applicable, to the proposed narrative outline and data reporting template included in the Request for Comments; and (2) establishes the form and content of the annual report filings by the Companies for their CY 2022 grid modernization plan investments. The Department additionally has adopted templates to be completed and included with the term reports.

This filing is National Grid's first Grid Modernization Annual Report for its CY2022-2025 GMP, which contains the narrative documenting the Company's performance on its Grid Modernization Plan for the time period January 1, 2022, through December 31, 2022 ("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 a "primary purpose" of the proposed investment is to accelerate 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, Advanced Metering Infrastructure ("AMI") back-office infrastructure head-end system (HES) and meter data management system (MDMS), CIS enhancements, cyber security, and project management.

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

In the Track 2 Order, at 305, the Department will not require an annual report for Customer-Facing Investments since the Department will conduct annual reviews of the customer-facing investments through annual prudency reviews on NSTAR Electric and National Grid's AMIF cost recovery filings.

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 ADA/FLISR ($37.7 million), ADMS ($61.0 million), IT/OT ($18.8 million), communications ($102.8 million), DERMS ($24.6 million), demonstration projects ($6.4 million), 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 the voltage profile of a feeder by utilizing intelligent controlled capacitors and regulators on the feeder which serves to minimize system losses, followed by remotely lowering the source voltage at the substation to provide energy savings for customers and the distribution grid.
- ADA/FLISR – The Company is deploying ADA equipment designed to accomplish Fault Location, Isolation and Service Restoration ("FLISR"). FLISR reduces the impact of interruptions on the distribution system through the installation of automated switches along the main line and tie points of a feeder. This allows a fault to be automatically isolated into a sub-section of the feeder and isolates uninvolved sub-sections that is resupplied via automated tie points, which significantly reduces both 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 which will lead to efficient operation and maintenance, planning, and storm recovery, and result in 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 CVR/VVO, ADA, feeder monitors, ADMS/DSCADA, DERMS, demonstration projects and integrating distributed generation ("DG"). Comprehensive data management, integration services, cyber security and data analytical functions are core components for 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 consists of 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 currently being progressed 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 work together in a cohesive fashion 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: National Grid 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) Active Resource Integration ("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 thereof will provide learnings in support of the DERMS investigation and subsequent implementation as the demonstration project progresses. (2) Local Export Power Control explores the use of a Power Control System to allow a behind-the-meter solar and storage project with net zero thermal impact to interconnect and operate without the need for costly system upgrades.
- Project Management / M&V – Program management and M&V are used to effectively manage and measure delivery of the GMP. 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; and
- Interconnect and integrate distributed energy resources.

The Company's second GMP contained a comprehensive suite of investments and initiatives that continue to modernize the Company's distribution system and deliver significant customer benefits, including energy supply savings, reduced outage duration, reduced numbers of customers impacted by outages, and improved system operations and system planning. The continuation of preauthorized investments, as well as new investments, will provide enhanced and new functionality necessary to enable increased DER integration capacity.

With respect to optimizing system performance, the Company expanded its deployment of feeder monitors and ADA. In 2022, the Company deployed 10 feeder monitors and 8 FLISR schemes, which when combined with deployment over the First Term bringing total deployment levels to 165 feeder monitors and 24 FLISR schemes. By deploying feeder monitors on feeders that lack telemetry or have sub-optimal telemetry, this investment has increased system visibility for the operations control center and electric system planners, who will use this information to help optimize the control and design of the electric system. At the end of 2022 FLISR covered approximately 8% of National Grid's Massachusetts customers. These investments are delivering reliability improvements both in terms of reduced outage frequency and outage duration. In 2022, the Company experienced 17 successful FLISR operations, delivering an average reduction of 23% in outage frequency and outage duration for customers on FLISR enabled feeders.

The Company continued its deployment of VVO technology, which helps to 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 ADMS, should support the improved management of the distribution system which will assist in the integration of distributed resources. Actively maintaining proper voltage via intelligent centralized control will also improve feeder voltage performance, allowing for more DERs. In 2022, three VVO-enabled substations were put in service, adding to the four from the first Grid Modernization Term.

National Grid is advancing a portfolio of telecommunications and IT/OT solutions to build a technology foundation and infrastructure cornerstone for delivering the capabilities of the grid modernization investments, including CVR/VVO, ADA, 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. In the telecommunications program in 2022, the Company advanced plans for developing and enhancing its Wide Area Network and Field Area Networks. Additionally, major milestones were achieved in the INOC and TOMS investments, delivering new capabilities to monitor and plan, respectively, the telecommunications network. In IT/OT, significant advancements were made on the Data Management Platform, Comprehensive Integration Services, and Cyber Security Services.

The Company has progressed in the development and implementation of the ADMS/DSCADA platform, which supports all three Grid Modernization objectives. This includes progression of efforts to perform data model updates, data clean up and validation of the connected model within GIS to support ADMS requirements. In 2022, the Company completed the data cleansing effort for the ADMS electric distribution feeder and advanced Phase 2 work for ADMS.

Finally, the Track 2 investments in DERMS and demonstration projects will help advance all three of the Departments objectives in future years. The two demonstration projects, Active Resource Integration and Local Power Export Control will facilitate the interconnection of DG in certain areas of the Company's electric distribution system that are approaching saturation. Investments in DERMS will work hand in hand with existing grid modernization investments such as line sensors, IT/OT, DSCADA, ADMS, VVO, and Data Management Platform to support the Department's grid modernization objectives to optimize system performance by attaining optimal levels of grid visibility, command and control, and self-healing, optimize system demand by facilitating consumer price responsiveness, and interconnect and integrate DER.

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

In 2022 the Company progressed investments across all the approved Track 1 categories. Due to the timing of the Track 2 Order, the Company was unable to progress Track 2 investments in 2022. Below is a summary of the key highlights with the supporting details contained in each investment Category within Section III.

VVO – In 2022, VVO work was completed on three substations consisting of 17 feeders that have subsequently entered M&V: East Dracut, West Salem, and Easton. Work was progressed at the Melrose and Westboro substations and the 10 associated feeders. VVO work was initiated on five substations and 27 associated feeders: Billerica, Depot St, Parkview, Swampscott, and Millbury. Five additional substations were identified to be initiated in 2023: Dighton, Field St, Marlborough, Pinehurst, and Wilbraham.

ADA – In 2022 the Company completed eight FLISR schemes representing 27 reclosers, 16 feeders and 14 substations. The design and construction activities for an additional 17 schemes were initiated in 2022.

FM – In 2022, the Company successfully deployed 10 feeder monitors out of the initially planned 32 as part of the FM program. Presently, the program has 16 locations ready for construction scheduling, 21 locations are in the process of obtaining required permits, and an additional 36 locations are in the design phase.

ADMS – The company continues to progress key activities. In 2022, the Data Enhancement team working in Massachusetts completed the data cleansing effort for the ADMS electric distribution feeders. ADMS engineering staff significantly progressed our ADMS ready feeder count and continued to add new features to the ADMS solution, such as adding a pole search feature. Utilizing the ADMS solution, our operations were able to increase the amount of solar generation output during abnormal grid configurations. The OMS portion of the ADMS project completed Conceptual Solution Architecture, Logical Technical Model, and Physical Technical model as well as obtained Sanctioning Approval. System building progressed at National Grid sites and Factory Acceptance Testing was completed. Preliminary design work for the DSCADA module has started.

Communications – The Company selected a Multiprotocol Label Switching - Transport Profile ("MPLS-TP") vendor for the Wide Area Network ("WAN") and negotiations and contracting were completed. As part of ongoing work, completion of security penetration testing of the MPLS-TP nodes and network management system software ("NMS") which allows engineers to manage the independent components across the network, was concluded with no critical findings. The Company completed the installation of the NMS back-up and training servers and software loading. The initial phase of site surveys was completed and thirteen of seventeen construction drawing packages were completed. The Company successfully completed factory acceptance testing ("FAT") for the first order of the MPLS-TP nodes and delivery was received at the Company's lab facility, and also accepted delivery of MPLS-TP nodes which were installed and configured at the Company's lab facility to be used for testing and training. In September 2022, the Unified Technology Operations Center (UTOC) (formerly known as INOC – Integrated Network Operations Center) Minimum Viable Product (MVP) was launched to support Remote Radios (RRD) at the temporary space while the permanent space is being built. Ticketing Solutions and alert systems (for issue tracking in the Service Now System) have been built to monitor and identify the outages with the remote radios.

IT/OT – The company continued to build its middleware platform Mulesoft to move data between systems, automate and manage business processes, transfer files between entities and enable real-time and batch integration of data. In 2022, multiple environments to support development, test and production have been provisioned, and integration work in support of the TOMS Phase 2 and the ADMS Phase 2 projects is completed. In the data management workstream, the Company

progressed a "One System One Model" electric data management strategy to build an interoperable data platform for Grid Modernization. The capabilities delivered in data management are:

- Delivered a centralized data repository with automated data pipelines ready for product teams' usage improving performance operations
- Security-approved and controlled data platform to store sensitive data (classified as – Internal use only, confidential, or strictly confidential)
- Improved data quality focused on a single source of truth, ease of use, automation, and interoperability
- Built electric data product models to align with business operations process and improve the understanding of critical data elements
- Developed reporting and dashboard capabilities using access control mechanism that leverage consolidated data views across multiple source systems from a centralized repository
- Enabled data as-a-service capabilities (data is available to meet business user needs with little or no support from the IT team improving operational efficiencies)

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.a. Spending - 2022 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, 2022, in Tab 5.a. Spending - 2022 Report in the attached DPU Annual Report Template. Refer to columns D-L.

C. Summary of Spending (Actual v. Planned)

The Department approved a budget of up to $336.2 million in incremental spending for grid-facing investments over four years. The investments' primary purpose must be to accelerate progress in achieving grid modernization objectives and they must be either (1) new types of technology or (2) an increase in the level of investment a company proposes relative to its current investment practices.[1] Incremental O&M expenses must be (1) incremental to the representative level of expenses recovered through rates, and (2) solely attributable to preauthorized grid modernization expenses.[2]

The Company filed its documentation for its incremental Capital and O&M costs for its GMP in the plan year 2022 in Docket D.P.U. 23-28. The plan year 2022 spending included costs for ADA, ADMS, Feeder Monitors, VVO, IT/OT, Communications and Program Management and M&V.

The capital investments for the ADMS, Communications, and IT/OT categories contain certain investments that are to be deployed across Massachusetts and New York. The shared investment

[1] Order at 221-222.
[2] Id.

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, 2022.

The Company provided the required format for the annual reporting of the system-level deployment and spending information. The baseline plan summary was provided in Tab 5.a. Spending - 2022 Report in the attached DPU Annual Report Template.

The Company progressed the preauthorized investments from the first term during the beginning of 2022 based upon the DPU Order on Interim Continuation of Grid Modernization Programs and Revised Grid Modernization Factor Tariffs, dated December 30, 2021. Specifically, National Grid may continue its grid modernization program and implement proposed Track 1 investment categories that are consistent with investment categories previously preauthorized in its 2018-2021 Grid Modernization Plan. The balance of the investments was initiated upon the final Track 1 Order received on October 7, 2022 and the Track 2 Order received on November 30, 2022. As a result, the Company had a slightly slower than planned progression of the 2022 planned investments for the CY2022 Plan period.

II. Program Implementation Overview

A. Organizational Changes to Support Program Implementation

The Grid Modernization Execution Team (GME) manages the overall delivery of Department-approved grid modernization investments, including portfolio management and reporting, business process design and requirements definition, solution architecture, requirements management, change management, testing management, training and transfer planning, deployment operations, vendor technical implementation coordination, and performance monitoring and reporting. In 2022, the GME built on the capabilities established over the first Term to execute on the investments approved in the 2022-2025 Grid Modernization Plan.

Throughout 2022, a cross-functional Steering Committee provided guidance and oversight of the GMP implementation process. It includes representation from Engineering Asset Management and Planning, Information Technology, Electric Control Centers, Electric Operations, Regulatory, Finance and Budgeting. The Steering Committee provides oversight for the budget and implementation of the GMP investments, facilitates appropriate functional support and staffing, and champions program activities.

The Company also continued with monthly Grid Modernization Execution Status Meetings as a performance monitoring and measuring activity to identify project risks, performance, and cross-project dependencies. Project managers delivering Grid Modernization investments provide updates, which may be escalated to the Steering Committee for informational purposes or for key decisions.

The Company has organized delivery of the core grid modernization investments, initiatives, and capabilities into the following areas listed below:

- Physical Infrastructure
- Advanced Distribution Management System
- Grid and Network Communications
- Program and Change Management
- IT-enabling platforms

The Company incorporated existing business frameworks and practices and leveraged the existing capabilities, processes, procedures, departments, and personnel to support the delivery of the GMP. This approach promotes early adoption and consistency across the enterprise with the ability to engage and enable the organization to deliver and ultimately scale and sustain the GMP portfolio. Using a matrix approach leverages a combination of internal and contracted operational personnel, such as line workers, technicians, IT developers, and engineers.

The Company delivered training in the most efficient and cost-effective manner possible by incorporating necessary changes into ongoing refresher training and existing curriculums where possible. Training was held either at centralized training facilities or at Company field offices, operating locations, depending on which location made the most sense for delivery of training.

Additional contractors and National Grid FTEs supported the grid modernization initiatives by providing services including 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.

The Company has 50 positions focused on delivery of the Grid Modernization program across several organizations including Grid Modernization Execution, ADMS and Grid Modernization Information Technology. The staffing is comprised of a mix of existing NG employees (non-incremental) and new hires (incremental) to fill specific roles. Contractors also fill roles as needed. There are also a number of other organizations that have employees working partially to support grid modernization tasks, but they do not necessarily charge their time to grid modernization accounting. Examples of employees/groups working partially include but are not limited to capital planning, finance support, regulatory support, legal support, and higher level management.

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 specifically 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, and 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 on a monthly basis for verification and any charges that are deemed unrelated to the eligible grid modernization investments are reclassified to the appropriate organization. Incremental labor is captured, and a review of all labor charged to Grid Mod O&M accounting is completed 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.

The Department's Order provides that the Companies must demonstrate that all O&M expenses proposed for recovery through the GMF are: (1) incremental to the representative level of O&M

expenses recovered through rates; and (2) solely attributable to preauthorized grid modernization expenses.

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 manages cost and performance tracking and controls through the Grid Modernization Execution organization.

The Company has adopted and provided performance metrics described later in this Report. The EDCs have also supported and progressed the Evaluation Plan, which will be formally filed in July 2023.

The Company recognizes the requirement to maintain grid modernization investments separate from other capital investments. The Company also sought to maintain process efficiencies and alignment with core controls for progressing project approvals. The Company leveraged its existing sanctioning and approval process for capital and IT investments and applied this process to grid modernization investments as well. This ensures alignment with core controls and visibility of grid modernization investments for proper prioritization.

The adopted cost and performance tracking measures allowed for greater clarity and visibility of GMP related investments which allowed for 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 implemented program cost tracking mechanisms to report on portfolio performance and ensure the accuracy of the cost data. This included aligning cost tracking within the overall financial process as well as the established program cost tracking process described above. This required managing the cost tracking across both a fiscal and calendar year reporting process. The Company reviews and assesses the reported cost data through the work order process to track GMP portfolio operational performance and analyze GMP work order activity.

The reporting combines both financial and operational metrics of the GMP portfolio. Operational work order details are formally tracked using this reporting. Work order detail, including but not limited to, 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 Accounting Process section. Any identified inconsistencies are addressed and corrected in a timely manner.

As a further review of the data, monthly meetings are held with project managers. The summarized GMP data, as well as detailed data from the tracking mechanism, is shared and analyzed during this meeting. In addition, the Grid Modernization Portfolio Manager shares additional information

related to the program, such as program risks, issues, and progress towards internally established targets. The Grid Modernization Project Managers also report on progress made for their respective areas of responsibility. The monthly meetings provide a recurring opportunity and platform to discuss any issues related to or potentially impacting the GMP.

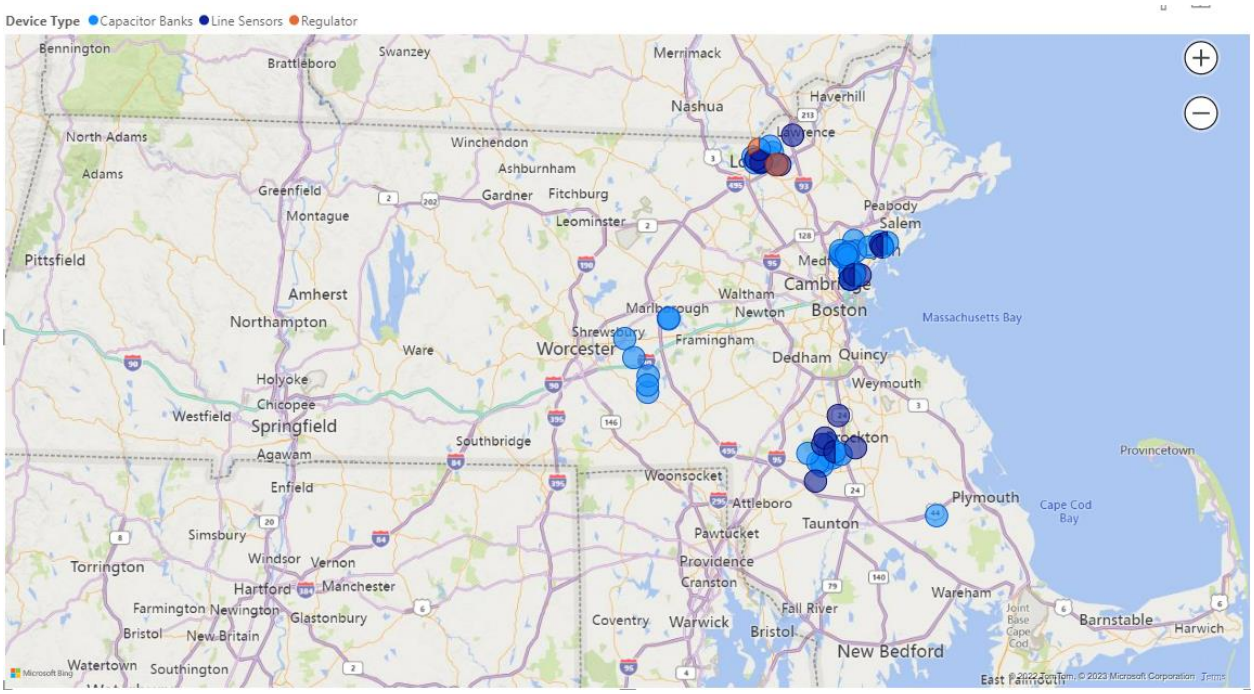
Informal processes also exist outside of the formal tracking reports and weekly meetings. Distribution Planning, Design, Scheduling, Engineering, Procurement, Corporate Performance Management, and other functional groups across the Company are in constant communication regarding all aspects of Company business, including the implementation of the GMP. Representatives of these various departments work cross functionally and collaboratively to meet GMP portfolio performance expectations. Stakeholders within these various departments also maintain their own tracking mechanisms, which are cross checked periodically to the formal GMP source document maintained by the Grid Modernization Program team.

III. Implementation System Level Narrative by Investment Category

(1) System Level Narrative -Volt Var Optimization (VVO)

Volt/VAR Optimization (VVO) connects and monitors voltage and *reactive power (*VAR*)* control field devices, enabling system-wide visibility and providing customers with the most efficient power delivery. VVO manages the voltage levels and reactive power (VARs), reducing system losses and improving capacity during peak demand. VVO activates continuous monitoring of voltage levels and seamless adjustment to changing demand. Success with the VVO initiative will enable increased system control, lowering feeder voltages, and benefits customers by reducing customer demand and energy use resulting in lower customer energy bills.

Installed VVO Devices



a. Description of work completed

In 2022, VVO work was completed on three substations consisting of 17 feeders that have subsequently entered M&V: East Dracut, West Salem, and Easton. Work was progressed at the Melrose and Westboro substations and the 10 associated feeders. VVO work was initiated on five substations and 27 associated feeders: Billerica, Depot St, Parkview, Swampscott, and Millbury. Two additional substations were identified to be initiated in 2023: Dighton, and Northborough.

The VVO deployment for Massachusetts was initiated in the first quarter of 2019 with the selection of substations and feeders to be upgraded with the new technology. Since the initial three substations with 20 feeders were selected in 2019, an additional three substations with 19 feeders in 2020, three substations with 15 feeders in 2021 and three substations with 27 Feeders in 2022 were selected for VVO upgrades. The Company has been making continual progress on the deployments. The table below provides details of the equipment deployments in support of the VVO investments during 2022.

Progress of Equipment Installation to support VVO Investment:

Work initiated in 2020 & 2021						
Substation	Year Work Completed	# Feeders	Cap Banks	Regulators	Feeder Monitors	Substation Bus
East Dracut	2022	6	19	6	8	2
West Salem	2022	6	23	3	7	2
Easton	2022	5	19	3	5	1
Melrose	2023*	5	24	9	8	5
Westboro	2023*	5	17	3	7	5
	Total:	27	102	24	35	15

Work initiated in 2022						
Substation	Year Work Completed	# Feeders	Cap Banks	Regulators	Feeder Monitors	Substation Bus
Billerica	2023*	7	22	3	12	2
Depot St	2023*	6	40	3	7	6
Parkview	2023*	5	7	0	5	1
Swampscott	2024*	3	12	3	3	2
Millbury	2024*	6	26	6	6	6
	Total:	27	107	15	33	17

* Planned completion year

The VVO implementation process involves several stages and multiple departments throughout the Company, as follows:

- Design and Work Request preparation: Distribution Planning and Asset Management, Distribution Design, Substation Engineering and Design departments
- Material Ordering and Preparation: Material Planners, Material Handlers, Resource Coordinators ("RC"), Protection and Telecom Operations ("PTO"), Operation & Maintenance ("O&M"), Distribution Controls & Integration ("DC&I"), Critical Network Infrastructure
- Installation: RC, PTO, O&M, Overhead Crews, DC&I, Distribution Control Center ("DCC")
- Commissioning: PTO, O&M, Overhead Crews, DC&I, DCC

Now that the Company is in the fourth year of VVO deployments, many of the departments are familiar with the technology. For those who are new to VVO, there is continued support through online and face-to-face training. The Grid Modernization Execution team is responsible for administering the training and tracking the progress of the work through commissioning. Measurement & Verification ("M&V") support is provided by Guidehouse, the Grid Modernization Evaluation Consultant.

Implementation over the prior term:

- Distribution Planning refinement of the selection process to pick the highest priority feeders that will result in expedient deployment and best efficiency performance.
- Building a pipeline of equipment (Capacitors, Regulators, Advanced Controls, Sensors) to ensure a continuous flow of devices from supplier to meet project deployment schedule.
- Delivered a central location for VVO device locations and their associated control settings.
- Developed device office commissioning, which led to more efficient field commissioning efforts.
- Installed, configured, and commissioned the server that runs the VVO software.
- Continued streamlining the overall process, from design to commissioning, reducing end-to-end duration of the deployment.
- Developed formal training modules for Engineering, Design and Construction.
- Refined process for equipment procurement pipeline (capacitors, regulators, feeder monitors and advanced controls) to ensure a continuous flow of devices from supplier to meet project schedule.

Implementation in 2022:

- Completed all device installations for 17 feeders.

- Completed substation VVO upgrades for three substations (Easton, Melrose and Westborough)
- Stoughton Substation underwent final M&V testing and transitioned to normal operations.
- Continued the process initiative to establish day two ownership and monitoring of FLISR, LVM & VVO assets that are placed in service. The Unified Technology Operations Center (UTOC) was formed to provide continuous technology supervision, monitoring, and management of any connected technology that provides value to customers and the company. VVO and FLISR will be included in future phase expansions as the new department matures.
- VVO projects were initiated for Billerica, Depot St, Parkview, Swampscott, and Millbury.
- Identified two additional projects to be initiated early in 2023, Dighton and Northboro.
- Grid Mod Execution collaborated with Distribution Planning to create high-level equipment demands for future projects. This allowed procurement to order long lead time equipment from vendors before full project development.
- Identified opportunity to engage incremental resources to construct the Billerica VVO Line work starting in January 2023 with expected completion March 2023.

b. Lessons learned/challenges and successes

Lessons Learned:

- Held meetings with relevant teams to forecast workload and plan resources for efficient project progression and scheduling.
- Shared best practices and lessons learned from one substation to another to improve and streamline the process.
- Established a workflow system with defined status points to track equipment progress through the office commissioning process, increasing visibility and clarity for the operations team. Enhanced training documentation to provide a more comprehensive understanding and rationale for the VVO investment, resulting in increased engagement and productivity in project meetings among field personnel.

Challenges:

- Identified a challenge in material planning and management processes that limited visibility of material availability and location. This challenge is being addressed for future programs.
- After commissioning a VVO system and entering the M&V stage, it is necessary for it to continuously run for several months to produce optimal data for analysis. However, some field devices may become damaged or inoperable and require repair to maintain optimal VVO system performance. The company's previous process for addressing Smart Device

repairs was not efficient, leading to some devices being offline for extended periods. Recognizing this issue, the company formed a team to examine a new "2nd Day Support" process for all new Grid Modernization equipment.

- Resolved server issues with VVO control software vendor central server in Massachusetts by replacing it with the backup training server to prevent intermittent events that caused the server to go offline.
- Two incidents with the installation of line post sensors, in April 2021 and May 2022 created a pause on the installation of this equipment. Retraining and review was needed with Operations crews prior to resuming installations.
- National Grid performed a review of VVO scheme performance, as reported in DPU 22-41 AG 1-5. During the review, several system flaws were identified, including issues with the Capacitor Switching Order, VAR Settings, and Undesirable Capacitor Exclusions. See below for discussion.

National Grid has taken action to address VVO scheme performance. The switching order has been corrected on all Massachusetts circuits by October 27th, 2022, which led to flatter voltage profiles along the length of VVO feeders. The VAR Settings were corrected with the help of guidance received from the VVO software vendor on January 17, 2023. The parameters will be updated in all Massachusetts circuits, and the results will be monitored to determine if the new settings yield improvements.

Regarding the Undesirable Capacitor Exclusions, National Grid has observed that all capacitors on a circuit have become unavailable several times on multiple feeders. The company is working with the VVO software vendor to troubleshoot the issue and find a solution. This issue has impacted the savings from reduced losses by optimizing capacitor states and voltage reductions.

National Grid has decided to pause further procurement of feeder licenses effective March 28, 2023, until solutions to the remaining performance issues are implemented. The company is committed to finding solutions and resuming further deployment as soon as possible. In the meantime, National Grid will focus on deployments of equipment in anticipation of a solution, either through improvements to the VVO control software or a transition of VVO control to ADMS.

In light of the ongoing challenges with the VVO control software and corrective actions taken in late 2022, National Grid has initiated additional M&V for all VVO circuits to observe the impact of corrective actions and calculate an accurate performance baseline. If additional corrective actions are taken, additional M&V may be necessary. The baseline M&V process involves day On / Off testing, alternating between VVO on and VVO off on subsequent days. Customers are still receiving VVO benefits during this period when VVO is engaged. Additional details of the M&V process are available in the annual evaluation reports published by Guidehouse.

Successes:

- Implemented a streamlined process for Office Commissioning, leading to a more efficient workflow and a decrease in downstream errors.
- Created a Material Planning process that accurately forecasts and orders long-lead time equipment, preventing material shortages.
- Developed and made available an on-demand training module titled "Introduction to VVO" for any company personnel interested in learning about the technology and its advantages.
- Several VVO implementations overlap with FLISR. The information from FLISR field devices is integrated with the VVO system so that the two technologies can work together on the same feeder. When the FLISR system is activated, VVO automatically detects this and temporarily disables it until the feeder returns to its normal state. This was successfully demonstrated on the Stoughton feeders on November 4, 2021.
- Standardized the VVO scope document for Distribution Planning, providing Distribution Design and DC&I standard engineering scopes to create construction plans and VVO schemes.

c. Actual v. planned implementation and spending

Tab 5.a Spending – 2022 Report in the attached Department Annual Report Template provides the deviation in the implementation and spending. Refer to columns D-L, rows 20 through 23.

d. Performance on implementation/deployment

National Grid continues to collaborate with the VVO software vendor, UtiliData, and its internal planning and engineering teams to review the underlying factors and drivers of the lower performance of VVO systems. As seen in Guidehouse's 2021 EDC Evaluation Reports for VVO in DPU 22-41 on p. 105, when the VVO/CVR system functions optimally, it yields tangible benefits, with voltage exhibiting the desired behavior and remaining low when VVO is engaged. National Grid has made substantial progress in addressing some of the misconfiguration issues in current VVO programs and is partnering with industry partners to resolve application errors.

The deployment of VVO equipment optimizes voltage management and helps to minimize reactive power flow for an efficient distribution grid. By deploying assets to lower and even out the energy profile, reducing reactive power allows for Conservation Voltage Reduction (CVR), which reduces system losses, peak demand, or energy consumption. National Grid continues to work closely with UtiliData to find solutions for the outlined issues, and at the same time, is pushing forward with the deployment of ADMS. Ultimately, all VVO circuits will be managed by the ADMS system.

e. Description of benefits realized as the result of implementation

After the system is fully operational, the expected benefits of the deployment of VVO include:

- Improved feeder power factor
- Flatter voltage profiles
- Reduced feeder losses
- Reduced peak demand and reduced energy consumption by customers, resulting in lower customer bills
- Reduction in greenhouse gas ("GHG") emissions embedded in energy consumption by customers
- Improved management of the distribution system which will assist in the integration of DERs
- Improved fault location
- Improve feeder voltage performance
- Improved system awareness into the daily operations and planning processes

f. Description of capability improvement by capability/status category

Nine substations across 55 feeders have VVO technology commissioned and enabled. As they have been deployed, the VVO system optimized energy usage based on system needs and loads. Upon completing final site acceptance testing for each location, measurement and verification protocols for substations were initiated. Additionally, even before they were fully operational, all equipment deployed for VVO (once installed and field commissioned) provided the ancillary benefits of providing visibility and data to the distribution control center operators.

g. Key Milestones

Substation	Engineering Complete	Construction Complete	In Service	Start M&V
East Methuen	Jul-2019	Jan-2021	Feb-2021	Mar-2021
Maplewood	Jul-2019	Dec-2021	Dec-2021	Dec-2021
Stoughton	Jul-2019	Jul-2020	Jul-2020	Dec-2020
East Dracut	Sep-2020	Nov-2022	Dec-2022	Dec-2022
West Salem	Sep-2020	Apr-2022	May-2022	Jun-2022

East Bridgewater	Sep-2020	Jul-2021	Jul-2021	Jul-2021
Melrose	Dec-2022	Apr-2023	Jun-2023	Jul-2023
Westboro	Oct-2022	Mar-2023	Apr-2023	Jun-2023
Easton	Mar-2022	Oct-2022	Nov-2022	Dec-2022
Billerica	Dec - 2022	Apr-2023	Jun-2023	Jul-2023
Depot St	Feb-2023	Aug-2023	Sep-2023	Oct-2023
Parkview	Feb-2023	Jul-2023	Aug-2023	Sep-2023

Milestone completed

h. Updated Projections for remainder of the four-year term

Milestone	CY23	CY24	CY25
Feeder count	44	56	56

The VVO program is scheduled to be implemented on 44 feeders in 2023, followed by an additional 56 feeders in 2024 and 2025.

Feeder Level Narrative

a. Highlights of feeder level implementation

Below is a list of all the feeders and substations that had VVO implemented on them in CY22

Substation	Feeder

Westboro	05-312W1
Westboro	05-312W2
Westboro	05-312W3
Westboro	05-312W4
Easton	07-92W43
Easton	07-92W44
Easton	07-92W54
Easton	07-92W78
Easton	07-92W79
Maplewood	12-16W4
Maplewood	12-16W7
Maplewood	12-16W8
Melrose	12-25W1
Melrose	12-25W2
Melrose	12-25W5
W. Salem	12-29W1
W. Salem	12-29W3
W. Salem	12-29W4
W. Salem	12-29W5
East Dracut	14-75L1
East Dracut	14-75L2
East Dracut	14-75L3
East Dracut	14-75L5
East Dracut	14-75L6

b. Feeder level lessons learned/challenges and successes

The Feeder Level lessons learned/challenges and successes are described in VVO Section (1) b.

Smart Capacitors

The deployment of Smart Capacitors is contingent on the completion of the Company's ADMS Phase 3: Integrated Operations, Active Management, which is expected to be in service in December 2025.

As described in the Company's response to DPU. 6-5 in docket D.P.U 21–81-part C. "The Company has no near-term plans to replace or add more smart capacitors on the distribution grid to address system performance concerns resulting from the aggregation of DER.". Hence the Company plans to deploy Smart Capacitors in January 2026.

a. Description of work completed

The Company did not perform any implementation or deployment of the smart capacitors program in 2022.

b. Lessons learned/challenges and successes

The Company did not perform any implementation or deployment on its smart capacitors program in 2022, so no lessons learned/challenges and successes were identified.

c. Actual v. planned implementation and spending

The Company did not perform any implementation or deployment on its smart capacitors program in 2022, so no actual v/ planned implementation rationales were identified.

d. Performance on implementation/deployment

The Company did not perform any implementation or deployment on its smart capacitors program in 2022, so no performance on implementation or deployment was identified.

e. Description of benefits realized as the result of implementation

The Company did not perform any implementation or deployment of its smart capacitors program in 2022, so no benefits were identified.

f. Description of capability improvement by capability/status category

The Company did not perform any implementation or deployment on its smart capacitors program in 2022, so no capability improvement by capability/status were identified.

g. Key milestones

The Company did not perform any implementation or deployment on its smart capacitors program in 2022, so no key milestones were identified.

h. Updated Projections for remainder of the four-year term

The Company's ADMS phase 3 "Integrated Operations, Active Management" is expected to be in service in December 2025.

Feeder Level Narrative

a. Highlights of feeder level implementation

The Company did not perform any implementation or deployment on its smart capacitors program in 2022, so no highlights of feeder level implementation were identified.

b. Feeder level lessons learned/challenges and successes

The Company did not perform any implementation or deployment on its smart capacitors program in 2022, so no feeder level lessons learned/challenges and successes were identified.

(2) System Level Narrative -Advanced Distribution Automation

ADA is a FLISR-based advanced distribution automation program that minimizes the customer impact of outages. ADA employs sectionalizing protection equipment, installing automated switches along the feeder's main line and tie points, to automate and coordinate outage response. Data from sensors along the feeder is used to identify and isolate faults in a sub-section of the feeder. The uninvolved sub-sections are resupplied via automated tie points, significantly reducing outage durations for impacted customers.

Previously, the Company had communications capabilities with some of the reclosers on the distribution system but needed to coordinate their operation during faults beyond their local protective control. The ADA scheme replaces manual tie points between adjacent feeders to provide for downstream restoration. It also integrates enhanced telecommunications and additional management on existing protective switches and adds switch locations as necessary to optimize system reliability.

a. Description of work completed

Over the first GMP from 2018-2021 the Company deployed 16 FLISR/ADA schemes covering 31 feeders. Building on that foundation, in 2022, the Company deployed eight FLISR/ADA schemes covering 16 feeders. The FLISR/ADA program has achieved several milestones on the journey to a more modern grid as it moves toward the definitive goal of automated and reliable service restoration infrastructure. The first round of deployment for the FLISR program focused on minimizing complexities while delivering customer benefits. With that intention in mind, the candidates selected for the FLISR schemes avoided feeders with moderate to high amounts of DERs or pre-existing field devices. Other factors considered when determining areas of implementation included but were not limited to: feeder metric data; poor, problem, and worst performing feeders; transformer metric data; feeder length; and the number of customers served. The second round of deployment added slightly more complexities with more reclosers per scheme and one scheme with DERs.

Implementation in 2022:

- Completed sanctioning for 2022.
- Documentation of all key processes with updated check sheets and job aids.
- Engineering analysis of candidate feeders through evaluation of poor-performing circuits and various metrics.
- Streamlined the overall process, from planning and designing to commissioning and implementation to reduce end-to-end duration of deployment.
- Evaluated and optimized the overall deployment process mentioned in the bullet above through the life cycle of the program.

- Developed, updated and improved end-to-end FLISR deployment process map while also developing detailed sub-process maps.
- Verification of good signal for field device communications with telecom surveys.
- Proactive procurement orders with Inventory Management (reclosers, control boxes, radios, feeder monitors) to get ahead of long lead times, pandemic shortages, and to meet project schedules.
- Completed design for all field work and issued work requests for 34 feeders.
- Initiated design for planned schemes for the upcoming calendar year 2023.
- Successfully implemented a QA/QC process for advanced control device settings for FLISR and initiated implementation of said process.
- Documented 17 FLISR events and recorded the associated performance metrics.
- Collected lessons learned throughout the process to make improvements in planning, engineering, design, procurement, scheduling and implementation.
- Implemented 8 FLISR schemes that went live and are currently active. This is in addition to the two FLISR schemes that went live in 2020 and the 14 FLISR schemes that went live in 2021, for a total of 24 live FLISR schemes at the end of 2022.
- Developed plans to accelerate the implementation of FLISR schemes in 2023. This involved developing a streamlined end-to-end process map, addressing bottlenecks, analyzing financials, requesting a budget, assessing the need for additional resources, communicating with internal and external stakeholders, ordering materials from vendors, and scoping feeders.

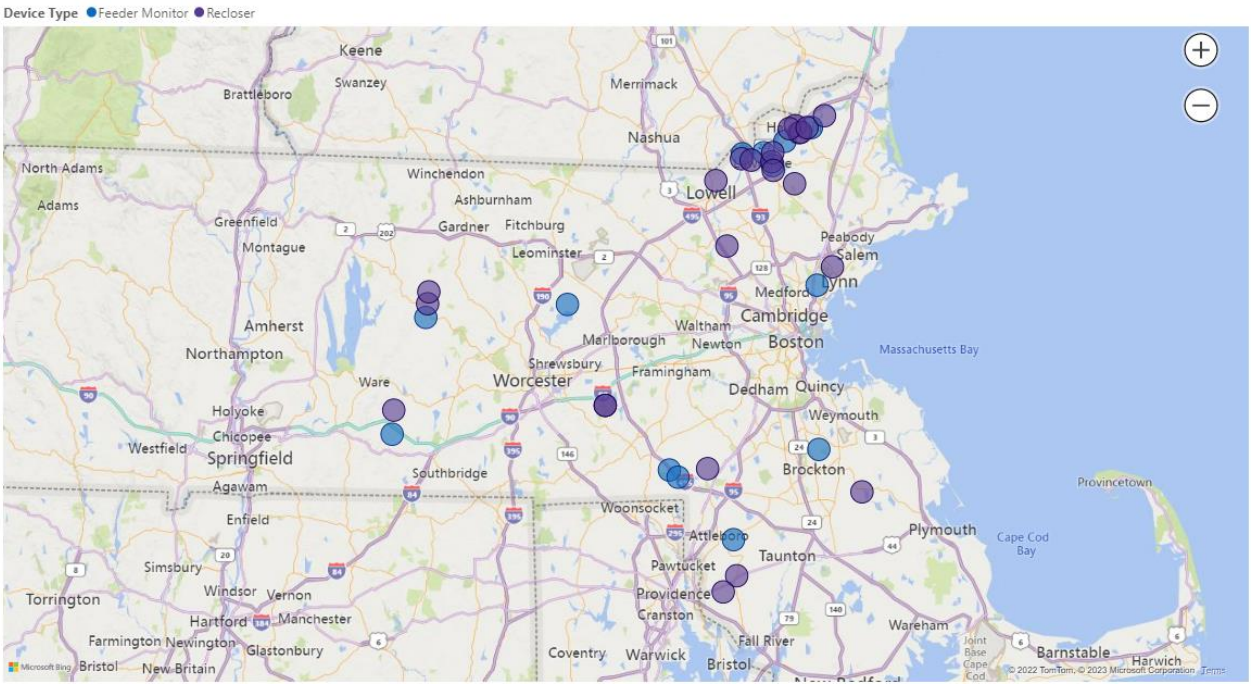
Detail of the FLISR/ADA schemes completed in 2022.

District	Substations with (Feeder)	Commission Date	Reclosers	Feeder Monitors
BSS	Franklin (341W1) & Beaver Pond (344W5)	2/24/2022	6	2
BSN	E. Methuen (74L4) & Ward Hill (43L4)	3/17/2022	3	2
BSS	Water St (910W25) & Philips Ln (95W3)	3/21/2022	2	1
BSN	Water St (31L2) & N. Haverhill (48L2)	3/25/2022	5	2
BSN	Quinn (24W1 & 24W2)	3/29/2022	3	2
BSN	W. Methuen (63L1) & E. Dracut (75L3)	5/17/2022	3	1

BSW	Little Rest Rd (516L2 & 516L3)	8/3/2022	2	1
BSS	Mink St (7L4) & Chartley Pond (8L4)	10/13/2022	3	1
Total			27	12

The devices installed in 2022 are plotted on the following map.

Reclosers are shown in purple and feeder monitors are shown in blue.



b. Lessons Learned/Challenges and Successes

Throughout 2022, the commissioning of feeders faced a variety of challenges. Although the process was established and streamlined from previous and active implementation of other FLISR schemes, progress was delayed due to the ongoing scheduling conflicts, crew resourcing issues, and various weather events. Once the reclosers for each FLISR scheme were installed, the Control Center operators were able to work with the engineering teams to seamlessly test and confirm functionality of the FLISR technology. With the challenges previously mentioned, the success of deploying 8 FLISR schemes also came with several lessons learned.

The Company enabled 16 feeders representing 8 FLISR/ADA schemes from January 1, 2022, to December 31, 2022, and has collected lessons learned throughout the process.

Lessons Learned:

- The importance of ensuring the communications network required to support grid devices is installed, tested and enabled to provide an efficient deployment and commissioning of distribution automation.
- The need for dedicated contacts to work and communicate with throughout key milestones within the end-to-end process.
- Using a hybrid grid communications strategy where a combination of cellular, 700Mhz and other solutions can coexist to provide options for connecting to devices when circumstances require it.
- The significance of communication among stakeholders regarding candidate feeder selection to avoid problematic areas of implementation. Suggestions and open discussion help highlight the roadblocks that are not otherwise known.
- The need to ensure that zone logic and automation capabilities are programmable within the data concentrator (Orion LX) so that the scheme can successfully be commissioned once the installation is complete to mitigate problems on the back end.
- The need to verify stable communications of field devices and take proactive measures for telecom signal verification once recloser locations were scoped.
- Prioritization of inventory management by placing proactive material/equipment orders to align the long lead times into the project plans and to avoid delays once installations are ready to mobilize. This is particularly important during a period where the supply chain is facing several challenges between staffing, transportation, materials and manufacturing.
- The importance and need to have multiple vendors for the various field devices being implemented to avoid equipment shortages in the current supply chain market.
- The importance of staying engaged and aware of other recloser program inventory needs and construction schedules within the Company. Communication and transparency are the main drivers to avoiding any inventory and construction bottlenecks.
- Proactive process mapping and anticipation of testing requirements allowed for commissioning to be executed seamlessly for the FLISR schemes that have gone live.
- The significance of utilizing DG facilities that are already live to incorporate into FLISR schemes to avoid scheduling delays of DERs that are in the process of interconnection. Effective project management is crucial to ensure the successful implementation of FLISR schemes alongside other programs and priorities within the company.
- There were a few challenges in the design phase where incorrect funding and scopes with missing field devices were found. This was mitigated by meeting with the Design team to clarify the program needs and hosting a bi-weekly call while working through the incomplete work requests. The FLISR team also learned how to initiate work requests in National Grid's database without having to reach out to Design, which helped speed up the process and ensure proper funding. This is a continued effort throughout the design process and for future implementation of upcoming FLISR plans.

- In addition to initiating work requests, the FLISR team learned how to perform several other tasks that would otherwise involve reaching out to other teams and sometimes waiting long periods of time for the task to get done. These include pulling reliability data, transferring funds from work requests with incorrect funding to the FLISR funding project number, and tracking the status of reclosers through an additional device tracker resource. These led to a smoother, more streamlined way of working for the FLISR project.
- Design challenges were also improved with a refreshed implementation plan from the beginning of the process to ensure correct funding, tracking and overall progression of each work request.
- The challenge and importance of keeping an updated list of crew resources throughout the jurisdiction that have been impacted by the ongoing COVID-19 pandemic.
- The continuation of building on the success, challenges, and lessons learned from FLISR deployment from the first GMP term and 2022. With this knowledge, the project team was able to proactively prepare for future commissioning and kick off a strong start to 2023.

Challenges:

The Company faced a variety of challenges on the path to commissioning and implementing FLISR in 2022. The Company initially planned for 16 FLISR schemes to go live by the end of 2022, but due to external challenges, some of those plans were delayed.

- During 2022, efforts to commission 32 feeders on 16 FLISR schemes were delayed due to resource constraints with limited availability crew members in various work locations.
- Supply chain procurement delays resulted in materials lead time and vendor procurement delays that impacted the ability to schedule work throughout the calendar year.
- There were delays for building the new settings template file to incorporate alternative settings that are required when a tie recloser is closed in upon FLISR automation. Internal prioritization of materials management and incorporation of materials delayed installations. The Company progressed procurement of Orion LX servers for the program which will serve as the FLISR automation platform until ADMS is implemented.
- The frequency of severe weather event limited crew availability and delayed construction schedules.
- Work requests created for each recloser, or feeder monitor of a FLISR scheme, and progression levels can vary individually. For example, if there was a three recloser FLISR scheme, there were three separate work requests and three timelines. Each work request faced challenges when it came to construction, as one work request may have environmental issues, and another could involve permitting or digging. These challenges were mitigated through manual tracking for each work request and forecasting when a FLISR scheme could go live per its installation specifications. Additional efforts to streamline this challenge included grouping installations into FLISR scheme bundles and

keeping communication between scheduling and operations consistent to ensure schemes were able to progress as smoothly and efficiently as possible.

Successes:

- Eight FLISR schemes were successfully deployed in 2022.
- Recognizing the need for increased engagement with the resource coordination and planning teams to ensure that FLISR schemes are implemented more efficiently, the team meets bi-weekly with the resource coordinators to monitor and advance priority work requests on a scheme-by-scheme basis. These meetings have been highly successful in creating a synergistic process for future FLISR implementation.
- 17 successful FLISR events occurred in 2022. Fourteen of these events involved FLISR restoring power to a significant portion (25% or more) of the customers initially impacted by the outage in less than one minute.

c. Actual v. planned implementation and spending

Tab 5.a. Spending – 2022 Report in the attached Department Annual Report Template provides the deviation in the implementation and spending. Refer to columns D-L, rows 14-17.

d. Performance on implementation/deployment

While eight FLISR schemes were successfully deployed in 2022, due to resource constraints and delays in both the office and field commissioning process, the Company fell short of its 16 scheme FLISR goal in 2022. However, the Grid Modernization team aims to complete the remaining schemes in early 2023.

e. Description of benefits realized as the result of implementation

The benefit of having 24 live FLISR schemes is that 17 successful FLISR events occurred in 2022. Fourteen of these events involved FLISR restoring power to a significant portion (25% or more) of the customers initially impacted by the outage in less than one minute. Some of the more notable FLISR events include the Beaver Pond (344W5) event on October 12, 2022, in which 3,048 of the 3,112 customers initially affected (98%) were restored within 52 seconds, and the East Bridgewater (797W19) event on February 2, 2022, in which 2,399 of the 2,536 customers initially affected (95%) were restored in 42 seconds. The chart below summarizes the reliability information from all 17 of these events.

Note that three of the numbers in the "Total # of Customers Impacted from Fault" column have asterisks next to them. This is because these faults happened on a sub-transmission or transmission level, so multiple feeders were impacted. This table only includes the number of customers on the FLISR-specific feeder, to reflect the total number of customers who could potentially benefit from

the existing FLISR scheme. For example, on April 10, 2022, the Chartley Pond 2276 sub-transmission circuit breaker locked out and both the 8L3 and 8L4 feeders lost power. The total outage included 5,302 customers, but only 2,640 of the customers were on the 8L3 feeder with FLISR. FLISR was able to restore power to 750 of these customers in 48 seconds.

Another detail to notice in the chart below is that three of the 17 events had zero customers restored by FLISR. Although no customers were impacted by FLISR in these cases, they are still considered successful operations. The Water St (910W25) event on April 29, 2022, included a tree limb falling and causing a fault near the tie recloser that connects the 910W25 feeder to the 95W3 feeder. Due to the location of the fault, FLISR acted correctly and did not transfer any customers. In both the Melrose (25W4) event on August 7, 2022, and the Water St (31L2) event on December 23, 2022, FLISR performed a load check and determined that closing the tie point recloser would cause a load that would exceed the ratings of the connected substations.

Overall, these 17 events collectively saved the Company over 2.3 million customer minutes of outage time.

FLISR Events in 2022

Event Date	Feeder	Total # of Customers Impacted from Fault	Customers Restored	Method of Restoration	Time to Restore	Major Event? Y/N
2/2/2022	East Bridgewater (797W19)	2536	2399	FLISR	42 seconds	N
			137	Field Restore	44 min	
3/7/2022	North Beverly (18L2)	1626	899	FLISR	19 seconds	N
			727	Field Restore	6 hr, 8 min	
3/13/2022	North Beverly (18L2)	1592	899	FLISR	28 seconds	N
			693	Field Restore	4 hr, 38 min	
4/10/2022	Chatley Pond (8L3)	2640*	750	FLISR	48 seconds	N
			1890	Field Restore	1 hr, 8 min	

4/13/2022	West Quincy (3W3)	2101*	529	FLISR	36 seconds	N
			1572	Remote Switching	2 min	
4/29/2022	Water St (910W25)	1476	0	FLISR	N/A	N
			1476	Field Restore	32 min	
5/23/2022	Hoover St (21L1)	2941*	937	FLISR	35 seconds	N
			2004	Field Restore	18 min	
7/2/2022	Franklin (341W1)	3049	2266	FLISR	11 seconds	N
			783	Field Restore	5 hr, 16 min	
7/25/2022	North Beverly (18L2)	1636	909	FLISR	15 seconds	N
			727	Field Restore	1 hr, 13 min	
7/30/2022	Water St (910W25)	2818	1343	FLISR	<1 min	N
			1475	Field Restore	2 hr, 29 min	
8/7/2022	Melrose (25W4)	4708	0	FLISR	N/A	N
			4708	Field Restore	3 hr, 43 min	
9/23/2022	North Beverly (18L2)	1640	912	FLISR	34 seconds	N
			728	Field Restore	4 hr, 39 min	
10/12/2022	Beaver Pond (344W5)	3112	3048	FLISR	52 seconds	N
			64	Field Restore	1 hr, 31 min	
11/8/2022	East Beverly (51L3)	2115	1090	FLISR	25 seconds	N
			1025	Field Restore	1 hr, 28 min	

11/26/2022	Mink St (7L4)	2674	1754	FLISR	38 seconds	N
			920	Field Restore	5 hr, 23 min	
12/23/2022	Water St (31L2)	3978*	0	FLISR	N/A	Y
			3978	Field Restore	9 min	
12/28/2022	East Dracut (75L3)	2359	1222	FLISR	9 seconds	N
			1137	Field Restore	3 hr, 57 min	

FLISR Benefit Calculation Approach

Beginning in 2022, the GME team began directly calculating the reliability impact of FLISR by analyzing the restoration details of FLISR operations to estimate avoided customer minutes interrupted and reduction in outage frequency (if FLISR restored customers in under a minute, which is the threshold for an interruption to be included in reliability reporting). While the direct calculation method of reliability improvement involves assumptions, it 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.

To calculate the improvement in outage frequency the Company counts all customers who were restored in under 1 minute and calculates a feeder-level impact and system-level impact. The 2022 results, excluding major events, are presented in the table below:

Customers Restored in <1 minute by FLISR	Total customers interrupted on FLISR-enabled feeders (excluding major events, pro-rated*)	Total customers served by FLISR-enabled feeders	SAIFI for FLISR-enabled feeders	SAIFI for FLISR-enabled feeders if FLISR had not operated	Feeder-level SAIFI improvement due to FLISR (excluding major events)
19,081	64,870	113,419	0.57	0.74	23%

*For feeders with 2022 FLISR deployment customers interrupted on FLISR-enabled feeders is pro-rated to the month when FLISR was deployed

To calculate the improvement in outage duration, the Company calculates the duration impact of FLISR for customers outside of the faulted zone that were restored by FLISR, assuming that these FLISR-restored customers would have been restored through manual switching by a field crew if FLISR were not installed. To estimate this duration, the Company examines the outage notes to determine the timestamp of the first field restoration step and assumes that crews would have started manual switching at this time if FLISR had not been installed. An additional 30 minutes of crew efficiency to arrive at the fault is assumed since:

- FLISR isolates faults to sub-zones along a feeder which can be communicated to field crews that need to locate the fault, shortening feeder drive down times and
- FLISR automatically opens / closes pole-top reclosers that would have otherwise needed to be switched by field crews, saving crew time.

Additionally, the Company assumes FLISR reduces the outage duration for customers within the faulted zone by 30 minutes. Based on the efficiencies above, the field crew can begin repairs 30 minutes sooner than they would have if FLISR was not active. The event-level and feeder-level results are presented in the tables below:

Event Date	Feeder	Cust. outside of faulted zone restored by FLISR	Cust. inside of faulted zone, restored via field crews	Duration from FLISR operation until first field restore step	Assumed Crew Efficiency	CMI reduction - outside faulted zone	CMI reduction - inside faulted zone
2/2/2022	East Bridgewater (797W19)	2,399	137	44	30	177,526	4,110
3/7/2022	North Beverly (18L2)	899	727	100	30	116,870	21,810
3/13/2022	North Beverly (18L2)	899	693	134	30	147,436	20,790
4/10/2022	Chartley Pond (8L3)	750	1,890	22	30	39,000	56,700
4/13/2022	West Quincy (3W3)	529	1,572	2	0*	1,058	-
4/29/2022	Water St (910W25)	0	1,476	NA	NA	0	0

5/23/2022	Hoover St (21L1)	937**	2,004	18	30	44,976**	60,120**
7/2/2022	Franklin (341W1)	2,266	783	58	30	199,408	23,490
7/25/2022	North Beverly (18L2)	909	727	74	30	94,536	21,810
7/30/2022	Water St (910W25)	1,342	1,476	128	30	212,036	44,280
8/7/2022	Melrose (25W4)	-	4,708	NA	NA	0	0
8/13/2022	Quinn (12-24W1)	1,062	470	10	0***	10,620	-
9/23/2022	North Beverly (18L2)	912	728	48	30	71,136	21,840
10/12/2022	Beaver Pond (344W5)	3,048	64	91	30	368,808	1,920
11/8/2022	East Beverly (51L3)	1,090	1,025	88	30	128,620	30,750
11/26/2022	Mink St (7L4)	1,754	920	98	30	224,512	27,600
12/23/2022	Water St (31L2)	0	3978	NA	NA	0	0
12/28/2022	East Dracut (75L3)	1,222	1,137	107	30	167,414	34,110
					Totals	2,003,956	369,330

*The 4/13/2022 FLISR event on West Quincy W3W was caused due to animal contact on a substation transformer and all customers not initially restored by FLISR were restored within 2 minutes via remote SCADA switching done within the control center, negating the need for a field restoration.

**The 5/23/2022 FLISR event was caused by a transmission outage, which is not reportable and therefore these numbers are excluded from the SAIFI and CMI improvement calculations within this section. However, customers benefited from FLISR in this situation and therefore the event is included for informational purposes.

***The 8/13/2022 FLISR event was triggered intentionally from the control center. Repairs were needed along the 24W1 feeder due to damage caused by a motor vehicle accident. FLISR was used to quickly isolate the repair area. This was not included in the FLISR events in 2022 table above as it was intentionally triggered, but it is assumed to have had a reliability benefit over manual switching and therefore included here.

Total 2022 CMI reduction due to FLISR	Total 2022 CMI on FLISR-enabled feeders (pro-rated, excluding major events)	Feeder-level CMI improvement due to FLISR (excluding major events)
2,268,190	7,544,516	23%

Overall in 2022, FLISR is estimated to have reduced feeder-level outage frequency by 23% and feeder-level outage duration by 23%.

Discussion of uncertainties:

Event-level benefit analysis has inherent uncertainty since it is impossible to know exactly what would have happened if FLISR was not installed. For crew efficiency, assuming 30 minutes may in some instances underestimate efficiency if a crew needs to perform a feeder drive-down and switching when the fault is located near the end of the feeder. However, in some instances 30 minutes may overestimate crew efficiency if the fault location is known from a downed wires report or is located very close to the substation. If no crew efficiency is assumed, feeder-level CMI improvement would be 16%. There would be no impact on feeder-level outage frequency.

Other factors that could impact estimates:

- While the vast majority of FLISR reclosers are installed at new locations on a feeder, there are some occasions where FLISR reclosers are replacing a switch with some level of automation. In theory, this switch could potentially have been operated remotely from the control center to partially restore customers outside of the faulted zone, which would reduce the assumed duration impact of FLISR.

f. Description of capability improvement by capability/status category

In addition to the FLISR events described above, the benefits of FLISR include:

- Optimizing system performance – National Grid anticipates a reduction in CMI on the individual feeders targeted for the ADA deployment. This projected reduction is based on historical analysis of actual past performance in the Pilot, as well as calculated anticipated reductions from historic outages. In 2022, the Company observed a 24% reduction in CMI on FLISR-enabled feeders. While the Company observed a reduction in outage frequency in 2022 due to FLISR restoring customers in less than one minute, the Company cannot guarantee that FLISR will always operate in under one minute.

- Optimizing system demand – The additional operational data collected by the automated switches will support the improved management of the distribution system, assisting in demand optimization. This operational data includes voltage and current on both the load side and source side of the reclosers, via the six internal voltage sensors. Additionally, the feeder monitors placed outside the substations provide useful data.
- Interconnecting and integrating distributed energy resources – the additional operational data collected by the automated switches- will support the improved management of the distribution system, assisting in the interconnection of DG and potential integration of DERs as a tool to operate the system. The additional voltage and current data at reclosers provide improved visibility of the distribution system. The enhanced visibility from voltage and current data allows for more granular and accurate distribution analysis modeling, including interconnection studies analysis.

g. Key Milestones

The Company has installed and commissioned eight FLISR schemes from January to December 2022, totaling 24 FLISR schemes from the start of the program to the end of 2022. This translates to 38 substations and 47 feeders covered by FLISR at the end of 2022. The Company is forecasting completion of the remaining schemes originally planned for 2022 in addition to a new group of schemes for calendar year 2023. Additionally, key accomplishments from the Company plans were as follows:

- The Company designed 17 FLISR/ADA Schemes on 34 feeders.
- The Company procured all the field devices necessary for the 17 FLISR/ADA schemes, including but not limited to reclosers, feeder monitors, and radios.
- The Company procured server equipment for the Northborough Control Center which allowed for the testing of the ADA schemes and to verify the proposed logic was functional.
- The Company verified stable signal strength for field device locations through telecom field surveys.
- The Company completed all designs required for the program to prepare for recloser settings installation.
- The Company implemented and tested alternative settings for tie point reclosers and incorporated the necessary updates to documentation.
- The Company anticipated and prepared for final commissioning that allowed for 8 ADA schemes to go-live.
- The Company scoped out one additional FLISR/ADA scheme on two feeders, to be completed in 2023.
- The Company compiled a list of lessons learned to optimize future implementation.

h. Updated Projections for remainder of the four-year term

In 2023, the Company aims to complete 14 carryover schemes from 2022 while implementing the "FLISR Acceleration" program to ramp up the pace of scheme deployment. This accelerated plan involves completing an additional 37 FLISR/ADA schemes between 2023-2024, encompassing 270 reclosers and 70 feeder monitors across 74 feeders (final equipment counts subject to change until the scope is finalized).

The table below summarizes the estimated number of feeders and schemes estimated to be implemented over the next three years. Note that the Company usually plans on a fiscal year basis, so these numbers are adjusted to reflect the calendar year schedule. These are high-level estimates and are subject to change.

The Company plans to accelerate the FLISR rollout compared to previous years and has performed significant planning and preparation for FLISR acceleration. The four-year plan is to start the accelerated implementation in the South Shore in 2023, then move to the Merrimack Valley, and continue a regional approach until over 91% of Massachusetts customers have outage coverage from FLISR. This is a long-term aspiration, extending beyond the timeframe of the GMP.

Planned FLISR Implementation

	Calendar Year		
	2023	2024	2025
# of feeders	80	60	70
# of schemes	40	30	35

Identified Schemes Planned for Commission in 2023

District	Substations with (Feeder)	Reclosers	Feeder Monitors
BSN	W. Salem (29W2) & Railyard (49W2)	5	2
BSN	W. Newbury (47L1) & Whittier (76L1)	7	2
BSN	Dale St (55L1) & N. Andover (71L1)	5	2
BSS	East Main St (314W2 & 314W3)	5	2
BSW	Barre (604W1) & Athol (702W1)	4	2

BSW	Barre (604W1 & 604W4)	5*	1
BSW	Barre (604W4) & Westminster (602W2)	4	1
BSS	E. Bridgewater (797W24) & Mill St (912W74)	5	1
BSN	Water St (31L1) & Whittier (76L3)	4	2
BSS	S. Wrentham (3422W4) & Crocker Pond (3424W1)	4	2
BSN	S. Billerica (18L1) & Pinehurst (92L6)	3	2
BSN	S. Billerica (18L2) & Pinehurst (92L3)	4	2
BSN	S. Billerica (18L3) & Billerica (70L5)	4	2
BSS	Candle St (101L2 & 101L8)	4	0
BSS	Candle St (101L4 & 101L5)	4	0
		66	23

** This recloser is a repeat – it is used on both the Barre (604W1) & Athol (702W1) scheme and the Barre (604W1 & 604W4) scheme, and therefore does not count towards the total.*

Of the 66 reclosers and 23 feeder monitors listed above, 28 reclosers and five feeder monitors are completed. Fourteen schemes remain in progress, and implementation is under way for the devices associated with those schemes.

Feeder Level Narrative

a. Highlights of feeder level implementation

Eight FLISR schemes went live in 2022, totaling 16 feeders. For a list of the specific feeders that were commissioned, refer to the table in section a.

b. Feeder level lessons learned/challenges and successes

Section A (2) b above summarizes the overall lessons learned, challenges and successes from 2022. In addition to those already listed, there were a few feeder-specific challenges and successes in 2022:

Feeder-Specific Challenges:

- The Dale St (55L1) & North Andover (71L1) FLISR scheme required 2,000 ft of reconductoring and some environmental work. This took longer than expected, and ultimately delayed the commissioning of the scheme. Going forward, the team will account for more time needed to reconductor.
- The West Newbury (47L1) & Whittier (76L1) scheme had 3 DG reclosers integrated into its design. The DG reclosers progressed at a much slower rate than the Grid Mod reclosers, which caused delays in commissioning the scheme. The team ended up developing a workaround that will allow the scheme to be commissioned before these 3 DG reclosers are completed. The scheme is scheduled to go live in early 2023, and when the DG reclosers are completed the FLISR logic will be adjusted to include them.
- The Water St (31L1) & Whittier (76L3) scheme ended up needing a relay replacement in the Whittier substation before the scheme could be commissioned. The relay work was projected to take a few months to complete, but the scheme needed to be commissioned sooner. The team found a workaround, where the scheme could be commissioned by placing the first recloser outside of the Whittier substation in sectionalizing mode. Once the relay work is completed, the FLISR logic will be adjusted accordingly.

Feeder-Specific Successes:

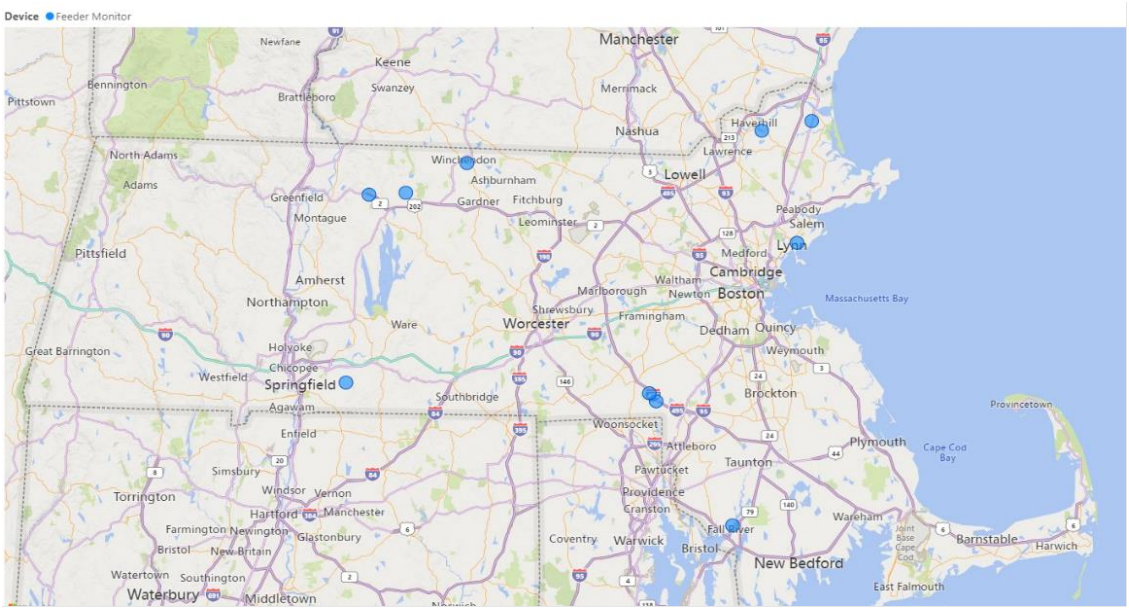
- The Mink St (7L4) feeder was a worst performing circuit. The team knew that FLISR would be able to greatly improve the reliability of the circuit and prioritized a scheme between the 7L4 and 8L4 feeders. With a quick turnaround, the scheme was commissioned in October 2022, and saved the Company from a large outage in November 2022.
- In 2022, the Company saw 17 successful FLISR operations from the 22 total FLISR schemes in Massachusetts. This saved the Company an estimated 2.4 million customer minutes of outage time.

(3) System Level Narrative - Monitoring and Control

Feeder monitor devices provide interval power monitoring on feeders where the Company does not currently have this information. Feeder monitors create visibility for the control centers, and the data collected informs engineering planning and asset management assessments.

National Grid has over 1,100 distribution feeder circuits in Massachusetts. This lack of historical and live interval data represents a gap in National Grid's situational awareness. While the electric system of the past has been operated and maintained without this data, having this data available in the future is vital to enabling the modern electric grid, which has increased reliability requirements and proliferation of DERs. Installing feeder monitors fills this awareness gap and assists in more efficient operation and maintenance, planning, and storm recovery, furthering the Department's objectives for grid modernization.

Installed M&C Devices



a. Description of work completed

Monitoring and Control had continued success in 2022 with the commissioning of 10 feeder monitors, which when combined with 155 installed in the first term, brings the total to 165 feeder monitors installed by December of 2022. The Company has reviewed its population of feeders, focusing on overhead feeders in National Grid's distribution system which lack sensing

capabilities. As extensive upgrades are made to substations and circuits, National Grid is deploying head-end mainline feeder monitors, which are used to capture real-time voltage, current and power data. The operations control center uses this information, as well as electric system planners, to help optimize the control and design of the electric system. The Company has undertaken a planning assessment to prioritize the deployment of feeder monitors through the four-year grid modernization plan term.

Implementation over prior term:

- Preliminary engineering was completed in order to access and choose the highest areas of impact for feeder monitoring to be installed. These areas were typically categorized as feeders with large customer counts but low historical data.
- Design surveyed and checked the locations given by preliminary engineering. Design takes these locations and design each project in accordance with National Grid standards.
- Both Telecom Operations ("Telecom Ops") and Distribution Control and Integration completed cellular strength testing for all locations to determine if more advanced designing was needed or the location had to be changed.
- Materials were procured and pipelines were established to ensure that consistent delivery times were communicated and maintained.
- Telecom Ops in conjunction with Grid Modernization Execution and Engineering created an office commissioning step to ensure that all communication equipment was operational before field deployment.
- Continuously improved overhead operational work habits through tracked lessons learned as well as bulletin updates to ensure current standards were being met.
- Determined new locations for installations at midline of the feeder and on feeders highly impacted by COVID-19 load shifting and added them to the scope of work.

Implementation in 2022:

- Monitoring and Control had continued success in 2022 with the commissioning of 10 feeder monitors.
- Sanctioning was completed for the project and the scope of the project was clearly laid out.
- Compounded prior historical data and data collected from the feeder monitor to make informed engineering decisions. These decisions included substation LTC rebalancing to better serve customers to avoid projected overloads through load balancing instead of reconductoring.
- Improved and streamlined the Feeder Monitoring Process map to ensure that critical tasks were not being held up and all responsibilities and expectations were clearly understood by each department.
- Organized and carried out biweekly meetings with all the project critical players in order to continuously align the goals of the project.

- Created strong lasting communication with material vendors in order to create a reliable material pipeline.
- Feeder monitors have been used to ensure that feeder integrity is not compromised during major storm events. In the event of a widespread outage, feeder monitors are checked to ensure that the feeder is still in service and has not been knocked out at the substation. This benefits outage response emergency crews by narrowing down potential outage areas and ensuring that crews are being used in the most efficient and impactful way.

b. Lessons Learned/Challenges and Successes

Lessons Learned:

- Assembly of the mounting brackets for the control box should be attached to the box in-house.
- The commissioning process needed to be updated and shared with the control room in order to allow for a smooth commissioning process between the distribution control center and the Overhead Crews.
- Sensor cables should be phase-labeled, and the phase diagram of the feeder should be given ahead of time to Overhead in order to increase the efficiency of device installation.
- Trained Overhead Crews to attach sensors to crossarms on the ground and then use two trucks to lift them if the crossarm was being replaced as a work method for increasing efficiency.
- In order to simplify the process for grounding and tampering of the control box in the field, hardware installation steps were added to the office commissioning phase. With this being addressed in office, it helps reduce the additional work required for field installations
- Material was being shipped with other non-Grid Modernization assets causing confusion on material location and the loss of material and time to track down missing material. To rectify this, material was labeled and placed on individual pallets and receiving engineers were notified of all material arrival dates.
- LineWatch Sensor training was updated to include technical troubleshooting techniques to avoid issues in the implementation of technology in the field.
- Meetings with vendors ahead of material issues and constant communication about expectations lead to more visibility on supply problems as well as expectation setting for the supply chain of the project.
- Adding new vendors for Lindsey Sensor alternatives in December of 2022 to increase diversity of stock has helped resolved material shortage issues with the Lindsey Sensors.
- Added dedicated resources to the scoping, sanctioning, and designing to streamline project start and engineering phases of calendar years.

- Added option to package work for external contractors and COC construction groups in order to avoid work priority issues with existing FLISR and VVO work.

Challenges:

- Due to the global supply chain shortage of semiconductors, material ship times increased significantly causing delays in the construction timeline.
- In the beginning of the construction phase, Lindsey sensor material shortage due to vendor miscommunication on the vendors side led to delays in material ordering and the construction timeline.
- Due to a material polymer issue during an installation causing a Lindsey sensor to fail, the company experienced a work stoppage period specific to Lindsey Sensor installations. The work stoppage ended after a thorough incident report and investigation into reasons for the failure and new guidelines on handling the Lindsey Sensors pre- installation were released.
- Scoping and sanctioning was delayed until mid-2022 due to Engineering resource constraints, causing a major delay in the design, construction, and commissioning milestones.
- Prioritizing customer work, FLISR, and VVO projects contributed to the discrepancy in the Company's Feeder Monitors goals; stakeholders prioritized each project in the planned construction schedule.

Successes:

- Successfully increased the intake of feeder data across the Commonwealth by installing 165 Feeder Monitor devices. The data gathered has already led to important grid modernization improvements through detection of load imbalance.
- Successfully completed training with Overhead Crews and Telecom Ops for new Feeder Monitor equipment that is expected to be used next year in the field.
- Contributed to the National Grid GIS map by adding 165 data points and providing historic feeder data to the Distribution Planning and Asset Management team which has actively aided in their planning of new equipment installations and initiatives.
- During storm outages, feeder data from installed sensors has aided in determining if feeders were impacted, replacing the need for crews to check head of line feeder integrity, and allowing more targeted dispatch of repair crews and damage assessment employees.
- The Company added locations to supplement the ongoing ADMS investment; telemetry on specific feeders has allowed further advancement in ADMS capabilities.
- New vendors added much needed diversity to the procurement area leading to shorter lead times and alternate vendor options in the case of shortages.

c. Actual v. planned implementation and spending

Tab 5.a Spending – 2022 Report in the attached Department Annual Report Template provides the deviation in the implementation and spending. Refer to columns D-L, row 13.

d. Performance on implementation/deployment

Ten feeder monitors were successfully deployed in 2022, due to resource constraints caused by competition with Customer work, VVO Deployment, and FLISR, the company fell short of its goal of 32. The remaining 22 planned locations will be rolled into 2023 for completion.

e. Description of benefits realized as the result of implementation

From 2019 through 2021, 155 feeder monitors were installed with an additional ten feeder monitors installed in 2022**.** All sensors are reporting data back correctly and completing their designated function, increasing visibility of real-time demand. With the completion of preliminary engineering cellular surveys, there have been no issues with the data collection functionality of the feeder monitors. All data is tracked and can be accessed using internal PI Historian software.

Benefits Details:

- During the winter storm event on October 17, 2019, the feeder monitors saved time in the technical assessment of the 910W2 feeder in Hanover, Massachusetts. During the emergency outage planning engineers responded to customer calls reporting outages centered around the Water Street 910 Substation Area. Before dispatching damage assessors, planning engineers utilized PI Historian software to verify that there was no major impact to the feeder from the substation level.
- On the Swansea 11W83 feeder, feeder monitors informed a load-balancing solution to a projected overload. Prior to the installation of the feeder monitors, only single-phase loading information was available so there was limited visibility of the load imbalance issue. The initial resolution for the projected overload would have included reconductoring a significant section, and through the additional data and visibility the projected overload pursued a lower cost approach of load balancing.
- In the East Bradford area of the 65L3 feeder, East Bradford Ski was reporting electrical voltage issues. By leveraging the data of the feeder monitors at the station, it was able to be deduced that low LTC settings was the root cause. Original settings showed the voltage at the substation would be allowed to go as low as 96% of nominal with it going no higher than 101%. After using the monitor as a reference and consulting operations able to adjust the LTC raising the nominal up to around 99% during its low dips and as high as 103%.

f. Description of capability improvement by capability/status category

With the 165 completed installations, visibility on the loading of lines has increased to the Distribution Control Center and Distribution Planning and Engineering teams. This has improved the visibility and data available for understanding line loading and voltage issues and serves as an early alert to outages to enable faster identification and improved response times.

g. Key milestones

Calendar Year	Scope Complete	Design Complete	Construction Complete	Commission Complete	Go Live
CY22	6/1/2022	9/1/2022	12/31/2022	12/31/2022	12/31/2022
CY23	12/31/2022	3/31/2023	11/15/2023	11/15/2023	12/11/2023
CY24	12/31/2023	3/31/2024	11/15/2024	11/16/2025	12/11/2024
CY25	12/31/2024	3/31/2025	11/15/2025	11/17/2025	12/11/2025

h. Updated Projections for remainder of the four-year term

Milestone	CY22	CY23	CY24	CY25
Feeders Monitor Installs per year	10	32	32	32

Feeder Level Narrative

a. Highlights of feeder level implementation

Feeder Monitors installed on the head-end in 2022:

Substation	Feeder
East Bradford 65	14-65L1
Beaver Pond 344	05-344W5
East Winchendon 612	01-612W3
Wilbraham 507	09-507L3

Wendell Depot 705	09-705W1
Newbury 34	14-34M1
Riverside 12	05-17J1
Union St 348	05-348W8
Chestnut Hill 702	09-702W2
Swampscott 22	12-22W1

b. Feeder level lessons learned/challenges and successes

The Feeder Level lessons learned/challenges and success are captured in section b), above.

(4) System Level Narrative - Communications

In 2022, the Company progressed implementation of all proposed IT/OT projects; the Field Area Network (FAN), the Telecommunications Operations Management System (TOMS), DMX/Sonet replacement, DS0 leased circuit replacement and providing communications between Key & Critical sites.

- Communications and Networking- A set of communication services that transfer information with the correct prioritization and quality of service to the appropriate destination.
- Integrated Network Operations Center/ Unified Technology Operations Center (INOC /UTOC) - INOC/UTOC actively monitors, manages, and maintains the integrated set of telecommunications network services and infrastructure, and provides a single point of contact for support and operations through a ticketing solution, and real-time monitoring of the Grid Mod devices. UTOC is also working with the field organizations to facilitate the integration of radio devices.

Communications and Networking:

Communication between Company systems and devices in the field are essential to the overall success of the GMP. The communications requirements from all parts of the GMP drive the design of the network. The main drivers for the telecommunications network plan are:

- Provide a reliable, cost-effective two-way communications capability to end devices including grid automation controls, field sensors and substations.
- Ensure the network meets all technical requirements for the devices and systems deployed. These requirements include availability, latency, bandwidth, security, and other network performance considerations.
- Provide Network Operations with the capability to manage, maintain and troubleshoot the communications network.
- Enable new grid technologies as they become available and future-proof the network as much as practical.

The telecommunications network comprises two main elements: Field Area Network (FAN) and Wide Area Network (WAN). The FAN provides “last mile” communications to the end devices where field-installed grid controls are the endpoints on this network layer. The WAN provides the backbone and ties the end devices to major field communications nodes and ultimately the ADMS and back-end data systems. Substations and other Company facilities make up the major nodes of the WAN that are comprised of both leased and private circuits. At the beginning of 2020, the Company revisited the priorities and needs for the Communications and IT/OT investment area. Specifically, it decided to defer significant investments in private fiber expansion for the initial plan period and focus on further developing the FAN and WAN solutions.

a. Description of Work Completed

In 2022, the Company progressed implementation of all proposed Communications and Information/Operational Technologies, including the FAN, the Telecommunications Operations Management System (TOMS), DMX SONET Replacement, and DS0/Leased Circuit Replacement, as detailed below.

Field Area Network (FAN)

Implementation in prior term:

In 2018, the Company leveraged that strategic assessment to identify specific network elements such as the wireless FAN that were critical for modernization in connecting a multitude of forecasted field control devices and sensors. During 2019, the Company commissioned wireless coverage and channel reuse studies for both the 700 MHz and 900 MHz frequency bands and evaluated other available bands and technologies associated with different spectrum options. Results provided initial baseline costs for the acquisition of 700 MHZ and 900 MHz spectrum and the ability to model implementation costs based on a radio site count that provided coverage across the service territory.

Implementation in 2022:

In 2022, the Company reviewed equipment vendors' wireless hardware solutions supporting these two frequency bands and began initial field testing, transmitting off a rooftop in the City of Worcester. Commercial and technical discussions have also progressed with the owners of the 700 MHz and 900 MHz spectrum. Radio network design began with the evaluation of two network planning tools popular in the wireless industry. Following procurement of the design software, detailed radio site design will take place.

To leverage some of the investment and work already completed within the network communications area of the utility industry, the Company has maintained monthly working groups with other joint utilities both nationwide and regionally to share lessons learned and collaborate on the various types of network technology that has been evaluated and implemented. In further developing multi-utility collaboration, engineers supporting GMP attended and represented the Company on technical panels at national conventions, conferences, and roundtables including DistribuTECH and Utilities Technology Council (UTC) where the focus of the discussions centered on wireless communications.

Telecommunications Operations Management System (TOMS)

Implementation in prior term:

Development and implementation of the TOMS network tool started in 2019 with the Company issuing a Request for Proposal (RFP) for software that will enable the planning, design, deployment, and maintenance of telecom networks. The tool will deliver greater capabilities and cost efficiencies over the longer term as well as provide network operations groups with increased capability to manage, maintain and troubleshoot the growing communications network. TOMS provides single point of failure diagnostics and calculations, with an end-to-end network view of circuit connections. It also provides work order management capabilities to facilitate maintenance, troubleshooting and reserving resources, as well as streamlining circuit design inclusive of mapping and fault analysis.

Vendor demonstrations on the execution of test scripts were completed and final evaluations and vendor selection were completed in 2020. A contract and scope of work was signed and the design phase for the software was initiated with a two-phase approach. Phase 1, to provide minimum viable product (MVP) capabilities, was completed in December 2021 and supports efforts to progress field surveys for baselining and validating the data during 2022. Phase 2, which will deliver the balance of the planned product functionality through interfaces and integrations to back-office applications, is projected to be completed in 2023.

The MVP objectives that were achieved included the implementation of the core software modules on the Company infrastructure for multiple environments for development, testing, quality assurance, and production. With the software environments available, telecommunications equipment data from various source systems was collated, cleansed, and then loaded for subsequent testing to ensure data was ingested and presented correctly within the application.

TOMS application administration was completed to establish initial user groups and associated permissions for the requisite user community. Existing fiber data, such as Optical Ground Wire (OPGW) and All-Dielectric Self-Supporting (ADSS), was also initiated from the Company's GIS platform to enable fiber network mapping capabilities. As proof of concept, a single ring for the data multiplexer (DMX) Synchronous Optical Network (SONET) WAN was modeled, including the circuit layers between sites. A Document Management System was also implemented which provides users the ability to store and open files within the application through connectivity to a dedicated SharePoint site. Once the MVP development work was completed, User Acceptance Testing (UAT) was successfully executed to validate that business requirements were met. Official MVP go-live for the production environment and service transition to the IT support organization was achieved in December 2021.

Implementation in 2022:

During 2022, development was completed for multiple interfaces to various Network Management Systems (NMS) / Element Management Systems, providing automated functionality to capture changes to existing and newly deployed communications equipment. This allows for the TOMS application to import new equipment installations, equipment card changes, port assignments,. and reduces the amount of time required to manually perform this within the application. In addition, multiple integrations were completed to Company back-office applications to support work order automation and bidirectional data flows to mapping applications, specific to communications equipment.

DMX SONET

Implementation in prior term:

In 2019, the Company performed a current-state assessment of the WAN and determined that the existing DMX SONET equipment has reached end-of-life and will not handle the future growth to support the needs for Grid Modernization. The 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, and microwave links. The Company engaged with a third-party consultancy in December 2019 to deliver a market research report to identify vendors with available technologies, product maturity, and utility experience. Based upon these efforts, the Company issued an RFP in March 2020 for the replacement of the DMX SONET backbone equipment. This new network equipment will enable the expansion of the WAN and future-proof the backhaul for multiple technologies in support of grid modernization. Based upon the vendor responses to the RFP, scoring was completed, and three vendors were down selected to participate in testing of each solution against a comprehensive set of test cases. An initial round of testing was performed in December 2020 and additional testing was completed in February 2021. Upon completion of the testing and an evaluation of the results, a final vendor selection was made in March 2021 and formal negotiations and contracting started. The contract with the vendor was formally executed in March 2022.

Implementation in 2022:

The Company completed an evaluation of the existing DMX SONET network to determine initial site locations for the new MPLS-TP nodes to minimize risks to the network and avoid sites transporting communications for neighboring utilities. An existing ring of seventeen sites was selected and site surveys began in May 2022 to document existing communications racks, available rack space, available power, and spare fiber pairs. The surveys were completed in July 2022 and site-specific design scope documents for the new MPLS-TP equipment were completed. Leveraging the design scope documents, engineering construction drawings were prepared.

Through December 2022, thirteen of the seventeen construction drawing packages were completed. The remaining four drawing packages are planned for completion in 2023.

For the sites selected, twenty-five MPLS-TP nodes were ordered in September 2022 and manufacturing was completed in November 2022. Prior to vendor shipment of the equipment, the Company completed Factory Acceptance Testing (FAT) in November 2022. Upon completion of the FAT, the vendor shipped the equipment, and delivery was received in December 2022.

To facilitate testing and training, the Company acquired six MPLS-TP nodes which were installed and configured at the Company's lab facility. Security penetration testing of the nodes and associated Network Management System (NMS) software was conducted in June 2022. The NMS primary and backup production server locations were determined, and installation of the NMS back-up server and software loading was completed in August 2022. The training server was installed, and software loading was completed in November 2022. The remaining primary server installation is planned for February 2023.

The Company recognizes that with new technologies, construction standards will need to be developed for the expansion of the fiber network. In support of this effort, significant progress has been made in developing a standard for entry of fiber circuits into substations. Field surveys were performed on recently installed OPGW fiber to document splice locations and the work remaining to complete fiber circuit termination to substations for WAN expansion.

Key & Critical

Implementation in 2022:

In support of providing communications between Key & Critical sites, the Company determined that multiple existing microwave paths need to be modernized to transport critical operational communications between the Local Control Center (LCC) and the Backup Control Center (BCC). The BCC is being moved to the Worcester facility and the microwave system requires modernization to support future bandwidth requirements between the LCC and BCC. The existing NEC microwave radios are end-of-life and are not compatible with the OTN XTran MPLS TP product that is being implemented for the WAN. The Aviat IRU600 product line has been selected and this new system will provide over twice the current bandwidth up to 380Mbps.

A new microwave path will be established between the National Grid Brockton office and the National Grid wireless land mobile radio (LMR) site located in West Bridgewater. This new microwave path will enable the legacy path to be retired and will support future Grid Mod and LMR applications.

DS0/Leased Circuit Replacement

Operational telecommunications remain foundational elements to grid modernization activities as these provide the media over which the devices interface to be functional. Upgrade of analog communication circuits is consistent with the Company's goal of improving reliability across the system. Private, dedicated circuits that provide time certainty in signal speeds are necessary to ensure the reliability and security of the electric grid. A private network solution to replace leased communications avoids the uncertainty of third-party service.

Implementation in 2022:

The Company has been notified by its carriers that they intend to discontinue support for some of their copper-based circuits over the next several years, specifically the DS-0 circuits. These circuits will be replaced with hybrid private /public fiber which will also serve as the primary backhaul and communication path for all NG-US operational equipment, including Tiers 1, 2 & 3.

b. Lessons Learned, Challenges and Successes

Lessons Learned:

FAN: A major driver in the cost of deploying the FAN is spectrum, both in acquiring it and its implications on build cost that is proportional to site count. Site count is highly dependent on frequency given that lower frequencies transmit much further thereby providing more coverage with fewer sites. This relationship significantly limits spectrum options to frequency bands below 1 GHz. Through the commission of studies and spectrum evaluation, the Company has also validated that the cost of spectrum is population-driven over county-based geographies, creating large cost differentials for metropolitan areas versus rural. In counties where Eversource serves much of the population, the cost of deploying the FAN is more costly per endpoint device. In these partially serviced counties as well as very rural areas that have low forecasted device density, commercial cellular solutions will continue to be implemented to maintain a reasonable cost-benefit balance across the State between private and commercial network connectivity.

TOMS: The TOMS solution has multiple environments that require data refreshes to keep the environments synchronized. As the user population continues to increase, and is performing work in multiple environments, the Company needs to be more structured on notifications to the user community on the scheduling of the data refresh. There have been instances of data being overwritten during a refresh because certain users were unaware of the schedule and data was not previously imported to the higher environments.

DMX Replacement: Supply chain issues have had impacts on material delivery and impacted the schedule for make-ready work at sites. To minimize the impacts, the Company is evaluating multiple vendors for supplier diversity and accounting for longer lead times in deployment schedules.

Successes:

FAN

- The Company has begun developing cost models for available spectrum and narrowband technologies to evaluate the cost-effectiveness of private FAN investments in support of the GMP and other operational business needs such as the replacement of analog or Digital Signal 0 (DS0) circuits used for tele-protection or substation RTUs.
- A multi-year lease of 700 MHz spectrum was executed in support of field testing.
- Installation and preliminary testing of 700 MHz base station equipment on a roof top in Worcester, MA to evaluate coverage and network performance across multiple vendors. Five endpoint radios extending up to 3-4 miles from the radio site were also installed on utility poles in 2022 as part of the testing.

TOMS

- Completed interfaces to two legacy Element Management Systems to allow for an automated process for equipment changes in the field.
- Migrated circuit data from legacy database and loaded OPGW and ADSS data from the Company's GIS platform.
- Developed a work order workflow to support the physical site survey process for the capture of equipment, power, and fiber data and steps for loading into the TOMS application.
- Created NERC CIP reports for the Company's Operation teams to maintain and service required equipment.
- Functionality was developed for importing and exporting geographical map shape files.
- Completed development on work order automation and scheduling.

DMX

- The initial field surveys have identified locations for future work to be completed for WAN expansion which will be supported through the standards and processes that are in progress.
- The knowledge gained through the market research report and the initial evaluation of available DMX SONET replacement technologies has allowed the Company to make a more informed selection of future-proof WAN designs.
- In support of the DMX SONET replacement project, the Company down-selected to three vendors that offer either Multi-protocol Label Switching - Transport Profile ("MPLS-TP") or IP Multi-protocol Label Switching ("IP/MPLS") solutions. These solutions underwent operational and security testing in a third-party vendor's lab to evaluate the ability to meet the requirements and capabilities to support the future growth of the WAN.

- The Company selected an MPLS-TP vendor for the WAN and negotiations and contracting were completed.
- Completed security penetration testing of the MPLS-TP nodes and NMS software with no critical findings.
- Completed the installation of the NMS back-up and training servers and software loading.
- Initial phase of site surveys completed and the thirteen of seventeen construction drawing packages completed.
- Successfully completed FAT for the first order of the MPLS-TP nodes and delivery received at the Company's lab facility.

Accepted delivery of MPLS-TP nodes which were installed and configured at the Company's lab facility to be used

DS0 Leased Circuit Replacement

- The Company has begun design work at several locations.
- Initial field surveys have been planned for future work to be completed.

c. Actual v. Planned Implementation and Spending

Tab 5a Spending – 2022 Report in the attached Department Annual Report Template provides the deviation in the implementation and spending. Refer to columns D-L, rows 31.

d. Performance on implementation/deployment

For TOMS, the Company has continued to develop and release new functionality per the release plan and full deployment expected in 2023. To develop the skillset of the user community, training is being delivered through online classes and recorded modules and user adoption is ongoing.

e. Description of Benefits Realized as the Result of Implementation

Until FAN deployment, the Company has continued to install cellular communications for the devices commissioned to date.

The current network planning, capacity and management business processes are highly manual, supported by various number of tools such as spreadsheets, drawings, and stand-alone databases. The TOMS MVP phase delivers a mature application to realize the following benefits:

- Improving data quality with a single, integrated application for all network information to the circuit level
- Automating circuit design, including mapping and fault analysis

- Automating data transfer with integration across other corporate systems
- Generating and tracking work orders for network changes
- Remotely configure and deploy logical connections across the telecom network
- Remotely manage and push software updates to equipment
- Detect, locate, and isolate communications and connectivity failures in the telecom network

f. Description of Capability Improvement by Capability/Status Category

The path to deliver the greatest customer benefits through WAN and FAN investments will occur over the long term in gradually expanding privatization of these two network elements, which will provide increased control, availability, and security of the communications network. However, in the near term, the Company recognized that the use of public cellular will provide some customer benefits until final WAN/FAN solutions are delivered.

The TOMS MVP release was successfully deployed in December 2021 to allow the business to start field survey activities. Data migration was completed for equipment license data, Cascade, GIS, and Circuit Data (Eastern and Western Fiber Rings). Over 700 unique equipment models have been created and loaded into the TOMS application. Consistent naming conventions are used for sites, equipment, and circuit definitions.

g. Key Milestones

Milestone	Target Date	Completed Date
Substation fiber termination using developed WAN construction standards	December 2020	
WAN nodes FAT – first phase	November 2022	November 2022
Install WAN nodes – first phase	August 2023	
Field surveys for WAN expansion – second phase	May 2023	
WAN security penetration testing	August 2022	August 2022
FAN equipment vendor testing	July 2023	
FAN preliminary statewide network design	June 2023	
FAN final network design – South Shore and Merrimack Valley	November 2023	
TOMS MVP Release	October 2021	December 2021
TOMS Final Release	May 2023	

Milestone	Target Date	Completed Date
Key & Critical Sites – first phase nodes installed	April 2023	

h. Updated Projections for remainder of the four-year term

FAN

1. Procure and transfer ownership of spectrum license.
2. Select preferred radio supplier.
3. Complete final statewide design and initial build for South Shore and Merrimack Valley
    a. 8 and 12 radio sites respectively in FY2024 and FY2025
    b. 2 and 3 backhaul sites respectively in FY2024 and FY2025

TOMS

- Complete remaining interface and integration work
- Execute end-to-end UAT
- Continue field survey work to validate and augment telecom data
- Facilitate business adoption through training and targeted use case development

DMX Replacement

- Complete the implementation of the primary NMS server and associated access for operating, monitoring, and maintaining the system
- Continue the same engineering, design, and deployment process for subsequent phases until all existing Nokia DMX nodes are replaced
- Migrate all circuits from the Nokia DMX nodes to the OTN XTran nodes and decommission the Nokia nodes

DS0

- Continue site surveying, engineering, design, and deployment process for subsequent phases until all existing DS0 circuits are modernized

Integrated Network Operations Center (INOC) (renamed Unified Technology Operations Center in 2022)

The Unified Technology Operations Center (UTOC) (formerly known as INOC – Integrated Network Operations Center) ensures proper operation and performance of the communication infrastructure supporting multiple GMP business services over a hybrid network. The UTOC is a central location where network administrators manage, control, troubleshoot, and monitor one or

more networks. The overall function is to maintain optimal network performance across various platforms, mediums, networks, network segments, devices, and communications channels.

The UTOC monitors the health and behavior of all data and communications of the grid using an Operation Support System ("OSS") and provides a first level of incident response. Computer-based tools create alarms when anomalous activity, performance issues, or system failures are detected. UTOC 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.

- Manage, monitor, and report on the Network performance of SLA's (Service Level Agreement) against negotiated thresholds.
- Monitor and manage the availability of the LAN, WAN and Wi-Fi, including wired and wireless communications, to ensure availability requirements are met. Networks are prioritized based on the criticality of the services they support.
- Monitor and manage the capacity of Network communications, including wired and wireless communications, to ensure performance to service requirements.
- Monitor and coordinate any changes to the system; ensuring all changes are communicated and have rollback and testing times.
- Monitor and report on total round-trip time of application or network latency between endpoints. Characterize and drive remediation of incidents that could lead to, or have caused, a loss of service, as defined by the SLAs.
- NMS (Network Management System) Integration with ticketing System to monitor the resources and real-time monitoring.

a. Description of work completed

In 2022, the Company launched UTOC MVP (Minimum Viable Product) to support Remote Radios (RRD) / AMI (Advanced Metering Infrastructure). To monitor and identify outages with remote radios, the Company initiated the build-out of a ticketing solution and alert system for issue tracking in the Service Now system. Developing UTOC brings together in a centralized location network operation staff who provide 24X7 supervision, monitoring, and management, and take corrective actions for all telecommunications network equipment including wireless devices, radios, servers, switches, databases, firewalls, devices, and related external services. It provides a "single pane of glass" top-down view for support and operations through a cross-functional set of people, processes, and technologies.

Implementation over the prior term:

In 2020, the Company initiated a review and assessment effort for the UTOC investment area. The Company issued an RFP on October 29, 2020, seeking consulting services to support the development of a framework and approach for progressing a UTOC effort, including the

following: an assessment of the people, process and technology aspects, a service level basis for SLA and Operation-Level Agreements and an overall investment and business case structure.

In October 2021, the Ideation and Validation phase was initiated to progress the framework and assessment outcomes and identify and document existing and proposed state of network operation management functions for Grid Modernization investments. The project identified and prioritized core foundational capabilities for an UTOC platform and developed a roadmap with clear vision for UTOC rollout.

b. Lessons Learned, Challenges and Successes

Lessons Learned

- A visit was made to tour Portland General Electric's state-of-the-art Integrated Operations Center (IOC) in Tualatin, OR to learn more about their facility which was in the final stages of construction.
    - Runbook – As - Is processes have been captured via workshops and the improvements have been made via To-Be Design changes. MVP ticketing solutions implemented in production to support the new process changes.

Successes

- The Company developed a communications strategy to shape the foundational communications network supporting all existing and future communications requirements.
- The UTOC will allow the Company the capability to provide real time supervision and control of all telecommunications equipment infrastructure supporting future grid modernization initiatives.

Challenges

- The Company is in the process of planning discussions with other utilities that have deployed similar integrated NOCs (Network Operations Center) to document their lessons learned, challenges, and recommendations.

c. Actual v. planned implementation and spending

Implementation	Planned	Actual	Comments

UTOC Processes – Discovery and requirement for As-Is and To-Be for RRD and AMI	Q1'22	Q1'22	Runbooks and the As-Is/To-Be documents have been approved.
UTOC Ops Staffing – UTOC Eng management, Tier-1 and Tier-2 staffing for MVP	Q2'22	Q2'22	All the open req's have been fulfilled and UTOC
UTOC Support Model Setup and processes	Q2'22	Q2'22	UTOC Support Model has been defined and approved by the Management team.
Onboarding process for the ServiceNow tool for the UTOC	Q2'22	Q2'22	ServiceNow tool onboarding has been completed
Remote Radios for FLISR, VVO has been onboarded for MVP	Q2'22	Q2'22	RRD Devices Go-Live
To receive the 4 x test border routers information from the AMI team so these can be used for testing and to receive the 5 x MVP Production border routers ready for go live.	Q2'22	Q2'22	Test and Production Border routers has been installed and ready for Go-Live
UTOC OPS Facilities – MVP Temporary phase	Q2'22	Q2'22	UTOC team has moved to temporary space at 300 Erie Blvd W, Syracuse, NY 13202 for the MVP phase
End to End ticketing flow implementation in ServiceNow for UTOC, RRD, AMI and Network Monitoring for Day 1.	Q2'22	Q2'22	MVP Ticketing System Go-Live
UTOC Home dashboard and reporting requirements for Day 1.	Q3'22	Q3'22	UTOC Dashboard Go-Live
Day-90 Additional Enhancement and Improvements on the ticketing system for RRD and AMI	Q3'22	Q3'22	Day-90 Enhancement Go-Live
AMI/RRD: To understand and document/refine SolarWinds capability for AMI/RRD to accurately determine and	Q4'22	Q4'22	UTOC Engineering team has completed baseline and threshold setup for RRD/AMI.

monitor the devices that require maintenance.			

d. Performance on implementation/deployment

Proactive end to end observability and performance insights across infrastructure, network, databases, and applications for rapid issue resolution, anomaly detection and to reduce meantime to resolution (MTTR).

e. Description of Benefits Realized as the Result of Implementation

The key benefit of the UTOC is that it provides a centralized location for the network operations staff to provide 24x7 real-time monitoring, management and the ability to take corrective actions. Network administrators use Network Management Software to maintain the quality of services of all end-to-end connections in a network per individual service level agreements. Mature applications are available in the telecommunications industry. When integrated with network elements, planning/design systems, cyber security systems, and business processes significantly improve the efficiency and effectiveness of managing the network and cyber security functions. UTOC team works with engineering and field operations to assess and act on open issues quickly and effectively.

These capabilities provide the following benefits:

- Bringing systems into an insourced model allows teams that rely on those services and projects to receive an increased level of customer service.
- By implementing toolsets owned and managed by the Company, support teams will have greater access to current configurations and issues as they occur. This results in improved ability to plan and strategize improvements to the network that reduce incident counts.
- Implementing advanced toolsets and utilizing strong datasets for analytics and proactive support measures should be deployed over time, reducing overall incidents, outage durations/impact, and avoiding some outages completely.
- Through implementing a combined support model, lessons learned can be shared across multiple organizations, and processes and toolsets will be identified that can benefit multiple groups at once, and in turn lead to more standardization and efficiencies between processes and toolsets.
- Creating a successful combined support model with clearly defined tools and processes integrates new solutions into the existing models leading to quicker time-to-market and deployment.

f. Description of Capability Improvement by Capability/Status Category

As part of the UTOC project, the following high-level capabilities will be enabled as a centralized platform to monitor and take corrective actions:

- Fault Management
- Configuration Management
- Administration Management
- Performance Management
- Security Management
- System Integration
- Power-BI Dashboard solutions

g. Key Milestones

Milestone	Target Date	Completed Date
Substation fiber termination using developed WAN construction standards	December 2020	
Field surveys for WAN expansion	December 2020	
FAN equipment vendor testing	July 2021	
FAN preliminary network design	August 2021	
UTOC MVP Launch	September 2022	September 2022
Permanent Space	March 2023	TBD

h. Updated Projections for remainder of the four-year term

With the additional growth and expedited of services with FLISR, VVO and re-closure. Next-Gen technology and devices will be incorporated into UTOC Solution Design for Real-Time Operational Monitoring.

Projections for implementation in 2023:

Develop the capability to raise tickets based on SolarWinds alerts within SNOW.	Q1’23	Q1’23	End to End Ticketing functionality has been implemented.
UTOC Permanent Facility Construction and Move-in	Q1’23	TBD	Expected move-in date is Q1’23

(5) System Level Narrative - Information/Operational Technologies (IT/OT)

The Company prioritized specific IT investments to deliver efficiencies and benefits to projects in progress.

- Cyber Security Services - Investments will ensure that Cyber Security capabilities that exist at National Grid today are applied and integrated to support Grid Modernization and where Cyber Security capabilities are absent, identify and deploy services required to reduce risk to an appropriate level, in alignment with risk appetite.
- Electric Data Management & Enterprise Analytics - The "big data" analyzing the data from grid modernization investments, combined with existing and third-party data sources, providing valuable insight into the current state as well as predictive and prescriptive analysis
- Enterprise Architecture - An enterprise architecture approach mitigates stranded costs typically experienced in "one-off" siloed solutions and minimizes the expense, configuration, and management complexity that individual built-to-purpose applications often experience.
- Enterprise Integration Platform & Comprehensive Integration Services (CIS) - The integration services to enable the exchange of information between systems, services and devices.

Cyber Security Services

Cyber security is critical to the safety, efficiency, and resiliency of National Grid's distribution grid. As new technologies, such as smart grid technologies, are deployed, preparation and vigilance are required to meet potential cyber threats.

National Grid will ensure the incorporation of formalized security practices and engagement across project lifecycle activities, such as vendor acquisition and solution delivery, to support sustained security performance as business and technical operations evolve. The program will ensure that Cyber Security capabilities at National Grid today are applied and integrated to support Grid Modernization. Where Cyber Security capabilities are absent, identify and deploy services required to reduce risk appropriately in alignment with risk factors.

a. Description of work completed

In 2022, the focus has been to ensure that cyber security services are integrated with grid modernization applications. Specifically, identity and access management and privileged access management were expanded to cover grid modernization to mitigate risks related to access control and insider threats.

Implementation in prior term:

In January 2020, the Company began an analysis of the business capabilities required to achieve Grid Modernization goals. These business capabilities were assessed against cyber security threat families to determine how cyber security threats could potentially hinder different capabilities.

The threat families include:

- Malware
- Social Engineering
- Supply chain
- Denial of Service
- Data Breach
- Integrity Violation
- Exploitation of Access Controls
- Web Attacks
- Insider Threat

Based on the cyber security threats and the impact these threats have on Grid Modernization goals, cyber security improvement opportunities were defined and mapped to National Grid's taxonomy of existing and planned services.

Further discovery activities were undertaken to define a cyber security improvement plan. This included stakeholder engagement with key stakeholders across Cyber Security, IT, OT, CNI and the Business to understand how cyber security capabilities would integrate with and leverage existing security capabilities, incorporating improvement opportunities and expected evolution.

To date, the cyber security services that have been identified as critical to the security and success of Grid Modernization have been incorporated into each workstream. The Cyber Security team continues to be a key stakeholder in all Grid Modernization workstreams, and cyber security requirements are incorporated into the planning, design, development and implementation processes of each workstream.

b. Lessons Learned/Challenges and Successes

Lessons Learned:

- Cyber security is a critical focus at National Grid and substantial improvements have been made to ensure the security of all company environments. The pace in which improvements have been made company-wide has outpaced the plans developed in the early stages of the Grid Modernization strategy. This has resulted in a reduction of dedicated, stand-alone cyber security capabilities needed and the ability to leverage

foundational capabilities already in existence and extend them to Grid Modernization applications and environments.

Challenges:

- It is important to ensure that as cyber security threats and malicious actor tactics evolve, so does the internal cyber security strategy, approach and capability development. The cyber security threat landscape continues to evolve with threats becoming more numerous and persistent, with malicious actor tactics changing to increase the chance of a successful cyber-attack. To address this challenge, the Company engages with government entities and private sector partners to keep informed about changes to the threat environment in real time.

- By integrating these capabilities in the existing networks, systems, and touchpoints that are capable of exchanging information seamlessly, the older proprietary and often manual methods of securing utility services will give way to more open, automated and networked solutions. The benefits of this increased connectivity depend upon robust security services and implementations that are necessary to minimize disruption of vital services and provide increased reliability, manageability, and survivability of the electric grid and customer services.

Successes:

- Recognizing the unique challenges of grid modernization is imperative for deploying a secure and reliable solution. This program seeks to review and revise existing processes to ensure they meet Grid Modernization requirements and objectives.
- The cyber security team is successfully embedded into each Grid Modernization workstream to understand the unique requirements each workstream has from a capability perspective. This has enabled a "secure-by-design" approach and ensures that security continues to remain at the forefront.
- Cost efficiencies in securing Grid Modernization environments has been realized due to the pace of deployment of foundation cyber security capabilities. Had foundational capabilities been absent, dedicated stand-alone capabilities would have been implemented to meet specific Grid Modernization needs.

c. Actual v. planned implementation and spending

The Company implemented Identity and Access Management (IAM) and Privileged Access Management PAM) for several Grid Mod applications as planned. Funds were approved for $5.63M with a forecast to complete of $5.7M. The overage was due to supply chain hardware delays.

d. Performance on implementation/deployment

Implementation went in accordance with the plan with minor delays. However, PAM will be completed for ADMS Disaster Recovery environment this year.

e. Description of benefits realized as the result of implementation

The importance of cyber security is increasing as more intelligent devices are interconnected, volumes of data increase along with an ever-growing cyber-attack surface. The need to maintain confidentiality, ensure data integrity, and improve resiliency is increasingly important to leverage this information to drive more efficient operations and improve decision making.

Measures are in place to ensure safe and reliable grid operations including capabilities that enable the prevention, detection, and response to cyber-security threats. From the perspective of the end user, enforcement of least-privilege access and monitoring of activity is a means to prevent data loss and to identify malicious activity. Access is closely monitored and analyzed to ensure that malicious user activity is detected and flagged so that necessary actions can be taken. Network traffic is monitored in real time to detect any abnormal network traffic, devices, or endpoints and to establish a baseline for traffic during grid operations so that any abnormal activity can be detected and appropriately addressed. The Cyber security Operations Center plays a critical role in the central monitoring of activity and brings together detection, analysis, and response in the event of a cyber-security incident.

f. Description of capability improvement by capability/status category

Cyber Security services currently exist at National Grid as foundational capabilities and will be enhanced and integrated with the Grid Mod applications to mitigate Cyber Security risk associated with these new systems.

Cyber Security capabilities:

- Network Security focuses on the critical network infrastructure required to protect against cyber threats and will include the design of network visibility capabilities, design of optimized firewall rules, design of integrated network architecture and the development of phishing campaign technology focused on Grid Mod scenarios.
- Platform Security focuses on the protection of workstations, laptops, mobile devices, tablets, servers and infrastructure through the application of encryption, secure configuration and continuously protected operation through file integrity and configuration monitoring, application whitelisting and configuration standards definition.
- Identity and Access Management focuses on providing the management of individual identities, and their authentication, authorization, and privileges/permissions within or

across system and enterprise boundaries, with the goal of increasing 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 both internal and external systems for vulnerabilities and compliance, analyze and support security patching, and enable a 24x7 response capability.
- Security Orchestration Automation and Response focuses on providing vital line of defense against unauthorized, malicious activity in real time. This requires employing the people, technology, and processes. The Company's Security Operations Center is organized to prevent, report on cyber security risks and to detect, analyze and respond to incidents.
- Data Protection focuses on providing the protection of data from accidental or intentional but unauthorized modification, destruction or disclosure using data protection solutions and other safeguards to ensure that confidentiality and integrity is maintained.
- Commercial & Third-Party Risk focuses on providing software, hardware, and procedural methods to protect applications from external threats. This domain embeds within the software development process to protect the various applications that might be vulnerable to a wide variety of threats.
- Awareness and Training focuses on reducing the risk of a human error resulting in security breach by ensuring that users are aware of information security policies, threats, and concerns as well as their responsibilities and liabilities. This includes the development of phishing campaign technology focused on Grid Mod scenarios.

g. Key milestones

The Cyber Security services and capabilities categorized in the previous section have been integrated into the Grid Modernization workstreams and the appropriate measures have been put in place to mitigate the cyber security risks identified prior to go-live. These milestones have been embedded into the delivery timelines within each workstream to ensure security requirements are met before any service is live.

h. Updated Projections for remainder of the four-year term

The Cyber Security services and capabilities categorized in the previous section will continue to be embedded into each Grid Modernization workstream as part of the planning, design, development, and implementation phases of each initiative. The services and capabilities projected in the next four years are continuously assessed to ensure that emerging cyber security threats are addressed. The assessments are based on the latest threat intelligence information available from government and private sector partnerships.

Electric Data Management & Enterprise Analytics

Driven by technological advancements, climate change, and regulatory expectations, National Grid leverages digital transformation to optimize business agility, business processes, and intelligent insight across customer experience and asset life cycle. These transformations are critical to realizing grid modernization objectives.

The Company's digital transformation roadmap addresses the increased data volume, complexity, and interconnectivity essential to becoming an electric transmission and distribution grid that manages power from varied real-time distributed energy resources. Enterprise Analytics is a foundational systems architectural framework that can deliver "any data, any service, anytime." Building this technology foundation delivers the capabilities of the proposed grid modernization investments, including VVO/CVR, ADA, feeder monitors, ADMS including SCADA, and integrated DER.

With intense focus on grid modernization data and dependencies on accurate, consistent and reliable data, the Company is addressing the ability to manage incoming data from sensor deployment, connected devices and other grid modernization investments. The company is evolving from a semi-centralized data approach to a fully centralized data management capability with an overall electric data model. These investments enable advanced technologies, like artificial intelligence or advanced analytics, that require that the data be fit-for-purpose.

National Grid's Data Models represent BMS-based data quality assurance practices to plan, maintain, and secure a holistic view of the grid operations processes from a data-centric perspective. Each Data Model depicts a mission-critical view of the electric energy delivery process based on its data. Data Models ensure that any data in the repository is aligned with dynamic and operations processes so that resulting analytics results are sustainable as a "fundamental component of grid modernization." Analytics thrive because of the data model's flexible and reasonable depiction of actual business process.

The Electric Data Platform (EDP):

- Achieves data interoperability to access and exchange data consistently from multiple sources to strategic operational targets
- Liberates data from difficult to access systems and data sources
- Creates the One Model – holistic, fully integrated source of the key electric data
- Establishes greater data governance and management capabilities to build trust and confidence in electric data quality

- Democratizes data knowledge to enable the organization's ability deliver digital transformation products
- Enhances reporting, analytics, and data operations capabilities to enable data driven decision making
- Evolves and extends as business and technology evolves

a. Description of work completed

In 2022, work was completed on a centralized Electric Asset and Location Data resource, transitioning from 19 siloed systems to a singular Electric Data Platform (Snowflake). The new platform established a "One System, One Model" electric data management strategy to build an interoperable data platform for Grid Modernization. The Electric Data Platform (EDP) leverages company software and toolsets to:

- Build a centralized electric data repository
- Build confidence in electric data quality
- Create a holistic and trusted view of the electric data
- Establish the highest level of data governance
- Generate a single, consolidated source of data for reporting, analytics, and operations

Implementation in prior term:

In 2019, a data management planning and strategy team identified a framework and roadmap for implementing a Grid Modernization data management platform. From this exercise, several data management use cases were identified based on the Grid Modernization Business Capability Model.

In 2020, the data management project team assessed the current state of governance and data management, after which the team analyzed business use cases. The project scope aligned with data management and governance best practices. The project received full sanction in 2021 to complete development and implementation using the enterprise toolsets. The Company completed the software deployment and associated licenses for Enterprise Analytics Phase 1, focused on developing a centralized electric distribution data repository to support grid modernization.

b. Lessons Learned, Challenges and Successes

Lessons Learned:

- Profiling large amounts of data in Informatica CDQ was cumbersome and a time-consuming process. This was replaced by a team designed cloud data profiling custom solution using Rest API to automate the scheduling of column profiling in CDQ.
- Ingestion of bulk data from a cloud-based application such as Oracle P6 into a centralized Electric data platform have been a challenge and with limited scope, by using existing mechanisms such as MuleSoft middleware, or file transfer through GO Anywhere MFT, or applying Change Data Capture (CDC) using Qlik. Electric data has sensitive information that must be governed and managed in a secure manner.

Challenges:

- Performance issues while loading some of the high-volume distribution tables from Storms. The data took more than a day to load into Snowflake, which caused delays in providing the latest dataset for downstream consumption AMI and Electric Data Asset (EDA) teams and impacted business reporting.
- Similar issues were encountered during data load from Oracle Primavera P6 using RESTful API into Snowflake.
- Performance issues were encountered in the Power BI reports. Measures taken to successfully optimize the performance were:
    a. Reduced the number of filters used in the dashboard
    b. Provided different dashboards instead of showing all the objects in one dashboard/Page
    c. Implemented Row level Security
    d. Removed the unused columns from the Power BI Data model
    e. Moved time consuming calculations/Custom columns to Snowflake

Successes:

- Team performed a POC leveraging the enterprise ETL tool Matillion and identified its API Query component feature to connect to Oracle Cloud source system to pull the data into the Electric Data Platform. This solution proved to be most efficient for bulk data ingestion, schedule data refresh, enable data accessibility, and address near real time reporting requirements. This framework can be leveraged by other NG teams to pull data from Oracle Cloud (P6, Unifier).
- Implemented data classification to identify confidential and non-confidential data
- Leveraged Snowflake's Role-Based Access Control (RBAC) mechanism to identify required roles to drive data visibility and accessibility
- Defined User Roles for confidential (PII & CEII) and non-confidential data and implemented the roles using Active Directory (AD) groups
- Masked confidential data in enterprise data platform to prevent unauthorized usage and reporting.
- Extended the Role-Based Access Control (RBAC) for data visualization in Power BI

- Leveraged Single Sign on (SSO) between Power BI and Snowflake to enable secured data access

c. Actual v. planned implementation and spending

Implementation	Planned	Actual	Comments
Centralize Electric Data in Snowflake			
Centralize Electric Asset and Location Data from 19 siloed systems in National Grid's Electric Data Platform (Snowflake) • Cascade • GIS SDE • GIS SW/ADW • Inspection • Storms • Computapole • Powerplan (T only) • IDS • CYME • MITS • ACIS • ITOA • Aspen • Feedpro • Gridforce • Splicelog • DPAM • IMAP (Hosting Capacity) • VIPER	September 2022	September 2022	The initial data load completed for 19 systems, which includes 920 tables
Centralize Project Schedule from Oracle P6 in Snowflake	December 2022	December 2022	Loaded 19 tables from Oracle P6 cloud to EDM Snowflake which includes project, activity, and resource information
Build Electric Data Quality, Models, Data Glossary and Data Catalog			
Data Quality (19 systems)	September 2022	September 2022	Column profiled 920 tables corresponding to 19 source systems using Informatica Cloud Data Quality (CDQ)

Data Quality (P6)	December 2022	December 2022	Column profiled 19 P6 tables which includes project, activity, and resource information using Informatica Cloud Data Quality (CDQ)
Data Models • Asset • Systems • Work Management • Outage • Reliability • Location • DER • Energy Source and Load • Inspection and Maintenance (I&M) • Connectivity • Material Management • Products & Services • Finance • Electric Telecom	September 2022	September 2022	14 Electric Domain logical models have been created along with 6 Electric Asset Sub Domain logical models
Build Data Glossary and Catalogue: 1. Scan metadata information using Informatica Enterprise Data Catalogue (EDC) 2. Build a repository of Electric Business Glossary Terms using Informatica Axon	December 2022	December 2022	• Scanned metadata for 939 tables across 20 systems • Built a repository of 300 Electric Business Glossary Terms
Build Reporting Dashboard			
Build Grid Mod Reports (5 reports) 1. NGSEARCHCALLSMAINNET 2. DER SF CASE 3. SDE_CSS_CUSTOMER_NE 4. FEEDER METRICS 5. CRITICAL CUSTOMERS BY FEEDER	December 2022	December 2022	5 Grid Mod Dashboards have been completed in Enterprise Power BI
Build Inspection and Maintenance (I&M) Reports (4 reports) • I&M Detailed Report • Red/Green/Blue Tracking Report • Switch Report • Work Hours Report	December 2022	December 2022	4 I&M Dashboard have been built in Enterprise Power BI

Build Electric Data Products			
Electric Data Asset Products (6 products) – Customer Point of connection 1. Devices 2. Distributed Energy Resources 3. Linear Electric Assets 4. Network Electric Reliability 5. Reactive Power Management	December 2022	December 2022	6 Electric data products have been built

Program Spending

The Electric Data Management Program is tracking the projected spend. The Actuals are within 10% of the projection.

d. Performance on implementation/deployment

In 2022, the Company implemented four I&M dashboards, built in Enterprise Power BI, built five Grid Mod reports for feeder metrics; DER SF Case, Side CSS Customer NE, Critical Customers by Feeder, NG Search all. Additionally, they initiated data load for 19 systems, which included 920 tables.

Improved data processes:

1. Replaced the full data refresh approach with an incremental load approach to extract and load only data that has been newly added, updated or deleted.

2. Data that could not be loaded incrementally are handled by fine-tuning the data ingestion framework built using Snowflake & Matillion.

3. Used novel approaches such as splitting the data loads of multiple batches to run them concurrently. EDM's future roadmap is to convert all full load processes into incremental batches and schedule them to refresh data. Measures taken to successfully optimize the performance were:

    - Reduced the number of filters used in the dashboard
    - Provided different dashboards instead of showing all the objects in one dashboard/Page
    - Implemented Row level Security
    - Removed the unused columns from the Power BI Data model
    - Moved time consuming calculations/Custom columns to Snowflake

e. Description of Benefits Realized as the Result of Implementation

Established a “One System One Model” electric data management strategy to build an interoperable data platform for Grid Modernization. The Benefits of the Phase 2 work are listed below:

- Trusted and interoperable data from multiple sources is accessible in a central platform for insights and analytics to aid decision making.
- Accurate and reliable data delivers seamless exchange of information for operational efficiencies.
- Data modeling and metadata literacy facilitates data discovery, accessibility, and traceability that improves operational efficiencies.
- Electric data assets products provide a holistic view of business operations, management, and analytics.
- Established the foundation for predictive analytics and forecasting models for outage management, load flows, load forecasting and emerging distribution network functions.

f. Description of Capability Improvement by Capability/Status Category

- Delivered a centralized data repository with automated data pipelines ready for product teams' usage improving performance operations
- Security-approved and controlled data platform to store sensitive data (classified as – Internal use only, confidential, or strictly confidential)
- Improved data quality focused on a single source of truth, ease of use, automation, and interoperability
- Built electric data product models to align with business operations process and improve the understanding of critical data elements
- Developed reporting and dashboard capabilities using access control mechanism that leverage consolidated data views across multiple source systems from a centralized repository
- Enabled data as-a-service capabilities (data is available to meet business user needs with little or no support from the IT team improving operational efficiencies)
- Enabling edge computing, AI/ML and Digital Twin capabilities improving operational efficiencies to meet electric market demands

g. Key Milestones

- Established technical foundation by building an interoperable data repository with asset and location data from multiple sources leveraging Grid stack (Snowflake + Matillion) and extended data sources to include additional T&D operations lifecycle data to provide a trusted single point of integration for data consumption
- Implemented role-based access (RBAC) in Snowflake to secure and manage data access
- Leveraged Informatica Data Quality toolset to generate column profiling on datasets and created data quality scorecards to ensure data is trusted and can be used by digital and transformational programs, and regulatory reporting

- Established data governance framework and logical models in ER/Studio, developed industry standard business glossary content to promote business data literacy and support searchable and traceable metadata
- Built Electric Data Product physical data models to define a holistic data view and relationships of the electric network, assets, and operations
- Delivered multiple reports and dashboards (using Power BI) for I&M and Grid Mod to automate operational reporting and meet compliance requirements

h. Updated Projections for remainder of the four-year term

Data Platform

- Add data in the Platform from the digital products- VMO, FNOW, OMW
- Widen data access & roles into business
- Develop & Rollout training

Data Governance

(1) Demonstrate Axon tool & data scorecards to stakeholders
(2) Agree plan to implement data management roles closer to data creation/use (using Axon)
(3) Continue to work on Data Quality
(4) Electric Data Asset Gaps - Close gaps using business rules, at source changes, manual efforts

Data Improvement & Process Change

- DER – Salesforce\Salesforce Misalignment
- Finish Substation to GIS Matching
- Finish PP Major Location to Circuit\Sub\Asset
- PI Historian Tag to Asset Completion – from Corp PI deploy
- Stretch: EMS to Substation to Circuit Matching
- Stretch: Tx Circuit Naming in CNI

Next Gen BI

Reporting & Analytics

- Asset 360 - Easy, integrated insight to Asset-Condition-Work-Finance Data
- Process Metrics Scorecard & Opex Efficiency Analytics
- Remaining Grid Mod Reporting Use Cases & Asset Data Warehouse Replace\Retire
- Complete I & M reporting dashboard
- Create Dashboard for Project Management Team leveraging P6 and Unifier data

Electric Data Products

- Complete and deploy the remaining EDA products

Enterprise Architecture

Enterprise Architecture work stream provides business and technical foundation which are required to be adopted across all the investments. This will ensure required consistency across all the initiatives and significant decisions are made keeping focus on business priorities. This approach mitigates stranded costs typically experienced in "one-off" siloed solutions, and minimizes the expense, configuration and management complexity that individual built-to-purpose applications often experience.

a. Description of work completed

The below Enterprise Architecture activities are completed for Grid Mod Projects like ADMS - OMS, TOMS, GIS, PORT and other investments in 2022, and will continue to provide architecture support for any upcoming projects / releases in the coming years.

- Applied Enterprise Standards and Best Practices within Grid Mod and Electric Domains
- Drove Technology, Product, Platforms Reuse as appropriate
- Ensured proposed Architecture and Designs adhering to Security Requirements and Controls and leverage appropriate Security product frameworks and capabilities
- Applied Data Architecture Frameworks and Standards
- Ensured proposed Designs leverage Infrastructure and Platforms capabilities to support Secure, Reliable and Resilient Hosting and Deployment
- Assessed the Current-State Grid Mod Architecture and Technology Optimization Options
- Develops Future-State Domain Architecture for respective Grid Mod MVPs and releases.
- Development of Conceptual, Logical and Physical Solution Architecture Designs
- On-going Architecture Governance and Solution Design Authority practices
- Ensure the Proposed Product Designs support Design to Operate Principles
- Drive key Architectural decisions for the Grid Mod investments based on organization objectives and security principles.

From the ADMS perspective, overall solution validation and definition for DSCADA and FLISR was completed. This involves identification of various technical components involved in the architecture for DSCADA and supported FLISR functionality, validating various solution options for all the technical components to meet expected customer benefits. Also, architecture team involved with vendor SMEs to define approach for one line conversion from EMS. The team also worked on completing high level roadmaps. There are several data needs from various corporate applications which are identified and analyzed for operational efficiency to meet control based advanced applications needs.

b. Lessons learned/challenges and successes

Lessons Learned:

- Focused more on long lead hardware items and finalized the design and procurement while the other aspect of the design is still under progress to shorten the critical path of the project.
- Connectivity between ADMS (DSCADA) and EMS (SCADA) for MVP needs to be re-assessed to ensure both functionality and security

Challenges:

- Minor issues and gaps identified in the One-Line conversion tool to migrate Displays from EMS to ADMS. Working with vendor teams to perform a POC and trying to fix those gaps for a successful migration to ADMS mitigating long duration manual work.

Successes:

- Applied more of agile principles on the architecture and design which could enable us to achieve incremental delivery.
- EMS to DSCADA database migration approach and its impact to fully migrated operational data from EMS will be evaluated through a proof of concept (POC).

c. Actual v. planned implementation and spending

The plan vs actual spending and milestones will be covered as part of the respective Grid Mod investments.

d. Performance on implementation/deployment

The performance of the Grid Mod implementations where Enterprise Architecture support is provided will be covered under their respective investments.

e. Description of benefits realized as the result of implementation

The benefits of the Grid Mod implementation from Enterprise Architecture support are provided under their respective investments.

f. Description of capability improvement by capability/status category

The capabilities improvement for the respective investments are addressed under relevant sections.

g. Key milestones

Enterprise Architecture support is provided for various investments within Grid Mod. The milestones vary for all projects. The tasks related to architecture deliverables are aligned within the respective investments.

h. Updated Projections for remainder of the four-year term

The projections for various Grid Mod investments where Enterprise Architecture support is provided will be covered under their respective investments.

However, from ADMS perspective the immediate architecture priorities are to complete:

Detailed Non-Functional Requirements (NFRs) for DSCADA, FLISR & Distribution PI are under investigation with business for the MVP release. Any issues identified from the data conversions will be resolved to support testing and migration activities. Conceptual Technical Model and Logical Technical Model will be updated based on key Architectural decisions. Provide support and technical governance to ensure the projects under Grid Mod are built and delivered as per the proposed architecture. A detailed NERC CIP assessment impacting ADMS connecting to EMS will be analyzed with relevant stakeholders.

Enterprise Integration Platform & Comprehensive Integration Services (CIS)

A fundamental component of grid modernization is an integration architectural framework that can deliver "any data, any service, anytime." Building this technology foundation is at the infrastructure cornerstone for delivering the capabilities of the proposed grid modernization investments, including CVR/VVO, ADA, Feeder Monitors, TOMS and ADMS/DSCADA. The major components of this framework include:

MuleSoft - MuleSoft's Platform is the world's leading integration platform for SOA, SaaS, and APIs. MuleSoft provides exceptional business agility to companies by connecting applications, data, and devices, both on-premises and in the cloud with an API-led approach. By leveraging MuleSoft technology, the Company rearchitected their integration infrastructure from legacy systems, proprietary platforms, and custom integration code to create business agility. It includes capabilities to allow data interchange through common methods such as REST Web Services, APIs and Event driven architecture. Platform offers Reliability, Scalability, Resiliency and DR capabilities.

MuleSoft is the middleware that is required to move data between systems, automate and manage business processes, transfer files between entities and enable real-time and batch integration of data. The Company is developing these capabilities to enable real time integration, automation and orchestration of business processes enterprise-wide for existing legacy systems, and

implementation of new systems building on process and systems efficiencies, needed for grid modernization. The main components of the modern grid platform include the Advanced Distribution Management System (ADMS), Geographical Information System (GIS for the network model), Telecommunications, Planning and Engineering Capabilities, Volt Var Optimization (VVO), Feeder Monitoring and Advanced Distribution Automation (ADA).

a. Description of work completed

In 2022, the Company implemented ADMS Phase 2 integration including developing real-time interface flow with ADMS, and delivery of TOMS integration. Multiple environments to support development, test and production have been provisioned, and integration work in support of the TOMS Phase 2 and the ADMS Phase 2 projects are complete. Below is the major implementation work carried out under Integration Services:

ADMS Phase 2 Integration

- Developed Real-Time Interface Flow with ADMS
- Trouble Call
- Outage Notes
- Outage Central
- Send To Dispatch
- AVLS (Vehicle Location)
- Weather Data
- Delivered in Production: Batch Interface Flows with OMS:
- CSS-OMS Account Data
- GIS-OMS Network Model
- GIS-OMS Land Base

Delivered in Production: Real-time Interface Flows with OMS:

- Trouble Call (Reusable API)
- Outage Notes (Reusable API)
- Outage Central (Reusable API)
- Send To Dispatch (Reusable API)
- OMS OMW integration for blue sky outage Management

TOMS Interfaces: Delivered in Production

- Go Anywhere platform set up
- Enabled IMS Integration with Wavestar vendor
- Enabled IMS Integration with FCC/ULS for license metadata
- Enabled IMS Integration with SAP for Work Order Parts availability
- Enabled IMS Integration with STORMS for Telecom maintenance Work Orders

Implementation in prior term:

In 2020, a Solution Vision Document ("SVD") was conditionally approved by the Company's Architecture Review Board ("ARB"). The SVD recommended the setup of a MuleSoft-based Integration Platform over which the various Grid Modernization integrations would be delivered. Later, a Conceptual Solution Architecture was approved by the same ARB. The Company progressed full sanction to progress the development and implementation phase for the project on December 30, 2020. The Company has completed the setup of the core platform which is the foundation on which the integrations to enable grid modernization will be delivered. Multiple environments to support development, testing and production have been provisioned. The platform components include Enterprise Service Repository, Business Activity Monitor, Complex Event Processor, Connectors/Adapters, Cloud Integration Platform, and Application Program Interface ("API") Management. In addition, software and associated licenses were fully deployed in November 2021, which included the setup of the core platform, which is the foundation upon which the integrations to enable grid modernization are delivered.

b. Lessons Learned, Challenges and Successes

- During the requirement phase, the project team captured MuleSoft platform features pertaining to project requirements at the very early stage. This enabled the platform-side activities to start early to provide required customized features as per project requirements, resulting in reducing last minute dependency.
- Conducting load and volume testing across all cross functional systems to abide by defined SLA. Since CNI (critical network infrastructure) applications are involved, integration platform set up in Azure had some challenges. Conducting performance testing will ensure that SLAs are met and there is no customer impact.
- Verified the right and unique set of encryption key references in each of the environments before onboarding the interface. This practice will save significant time and effort during the go-live phase and avoid additional changes for correcting the encryption key references.

c. Actual v. planned implementation and spending

Interface Reference	Interface Implementation	Planned	Actual
ADMS Phase 2 – OMS Integration	Design Completion	Feb 2022	Feb 2022
	Interface Build	June 2022	June 2022
	Interface Testing	Aug 2022	Aug 2022
	SIT Readiness	Sep 2022	Sep 2022
ADMS Phase 2 – PORT Integration	Application Requirements Workshop	Sep 2022	Sep 2022
	Integration Requirements	Dec 2022	Dec 2022
	Development	Jul 2022	Jul 2022

ADMS Phase 2 – OMW Integration	SIT	Sep 2022	Sep 2022
TOMS Phase 2 Integration	Integration Requirements	Feb 2022	Feb 2022
	FCC-IMS Go-live	May 2022	May 2022
	IMS – SAP Build	Aug 2022	Aug 2022
	IMS – SAP SIT	Oct 2022	Oct 2022
	IMS – STORMS Requirements & Design	Sep 2022	Sep 2022
	IMS – STORMS Development	Dec 2022	Dec 2022

d. Performance on implementation/deployment

a. Enabled Digital Transformation within Grid Mod Program for all the key Integration Services.
b. Enabled Outage Management within ADMS through a modern integration platform to reduce technical debt and enhance scalability, reliability, logging, monitoring, alerting and Disaster Recovery support.

e. Description of Benefits Realized as the Result of Implementation

In addition to delivering a core enabling infrastructure and services across the Grid Modernization landscape, MuleSoft platform features enabled the platform-side activities to start early to provide required customized features as per project requirements, resulting in reducing last minute dependency.

Outage Management System

The Outage Management System and Customer Support System (CSS) were integrated through a MuleSoft integration platform to reduce technical debt and enhance scalability, reliability, logging, monitoring, alerting and disaster recovery support.

Telecommunications Operations Management System (TOMS)

The TOMS Phase 2 deployment project team completed the successful go-live of one of the key Phase 2 releases in October 2022. This release continues with product and data enrichment, specifically providing data integration from two legacy NMS systems (Aviat and Wave star). Data integration improved user functionality to support Operational and Maintenance Workorders, which provide integration to SAP and STORMS to create, update, cancel and complete all necessary workflow steps.

TOMS

- Increased efficiency and speed of deployment uniformly across the company by replacing traditional manual methods with a single source repository for all telecom assets
- The ability to properly plan fiber circuits using an integrated tool that has the capability to designate and reserve both physical and logical paths as well as process the associated workflow through to completion
- The ability to locate all assets geographically on a map, with drill-down functionality via a graphical user interface (GUI)
- The ability to generate and track detailed work order packages to prepare and equip a secured network to provide new services, recover from outages and perform maintenance activities
- Automatically identify any possible single points of failure (SPOFs) for all connections

OnMyWay

This deployment enabled the Company to move from manual processes (radio and paper communication) to digital processes. OnMyWay requires a bi-directional interface where the application consumes outage data and returns status updates to the system. MuleSoft integration services were developed to support OnMyWay in these efforts. Integration services built reliable, fault-tolerant, and event-driven interfaces between the two systems. Near real-time updates are sent and received, allowing systems to sync and providing customers with accurate information across different systems.

f. Description of Capability Improvement by Capability/Status Category

- Improved user productivity by leveraging and extending services appropriately utilizing correct protocol and integration standards (e.g., lightweight APIs for Mobile and RICH Web consumption).
- Provided end-to-end traceability and audit capability and alerting for operational efficiency.
- Enabled Business Continuity with Disaster Recovery Plan.

g. Key Milestones

Milestone	Target Date	Completed Date
TOMS Phase 2	October 2022	October 2022
OMS	September 2022	November 2022
OMW – Blue Sky Outage	October 2022	November 2022

h. Updated Projections for remainder of the four-year term

ADMS

- Real-time interface flow with ADMS (Trouble call, Outage notes, Outage Central, Send to Dispatch, AVLS (Vehicle Location) & Weather data to reduce technical debt and enhance scalability, reliability, logging, monitoring, alerting and Disaster Recovery support.
- Enable Street Intersection interface
- Enable Search Pole Data Interface
- Enable ASPEN DB Data Interface

TOMS

- Enable Capital Work Order Management integration between STORMS-TOMS
- Enable TOMS to SAP and STORMS integration
- Enable GIS integration with TOMS
- Enable TOMS integration with Vistanet, 4RF (NMS)

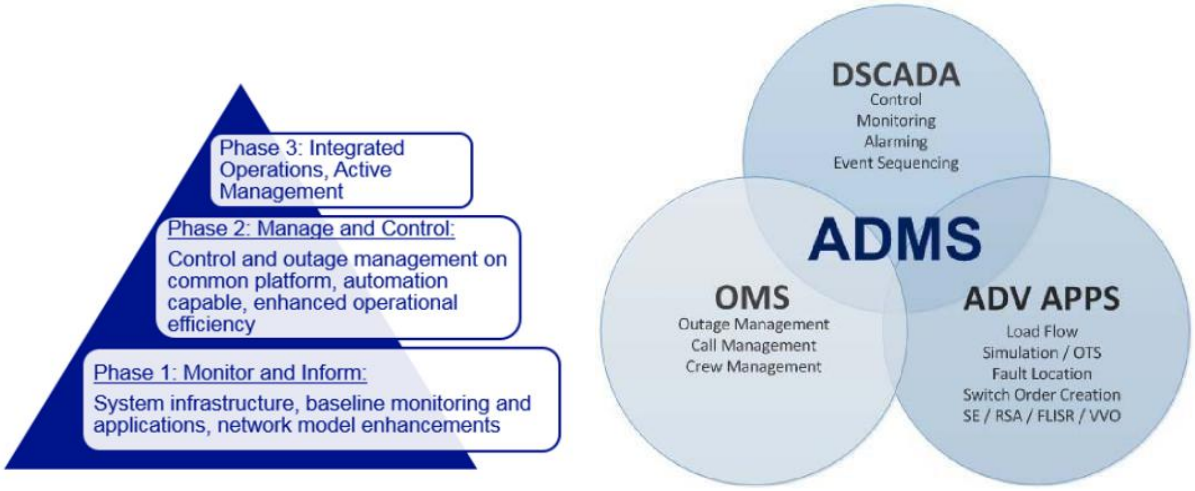
Others

- IT / OT (Operational Technology) Bus integration.
- Enhance CNI integration across CNI applications (ADMS, EMS, DSCADA) more of real-time using OT Bus
- Enhance Network Model integration between GIS and ADMS more real-time with high accuracy data.

(6) ADMS/DSCADA

The Advanced Distribution Management System (ADMS) is a group of control room-based hardware and software that electric distribution operators use to visualize, monitor, and control the electric grid with advanced functionality. With the added complexities of the modern grid, these solutions and applications support continued safe, reliable electric grid operations. The ADMS system includes three main modules; a Distribution SCADA (DSCADA), an outage management system (OMS), and a Distribution Management System (DMS) that provides advanced application functionality. These modules operate on a common platform, centralizing data, enhancing efficiencies, and digitalizing operational processes.

A phased implementation is planned, initially deploying distribution management system applications, then a refresh of the existing OMS, followed by an OMS-integrated DSCADA system dedicated to managing and controlling the distribution networks. Integrated OMS and DSCADA will simplify the manual matching of SCADA events to outage tickets. In the future, a DSCADA event will automatically create an outage ticket.



a. Description of work completed

Implementation in prior term:

During 2021, the Company implemented Phase 1 of the project, going live in May 2021, and started efforts for Phase 2.

Implementation in 2022:

During 2022, the Company continued to expand the number of ADMS-ready feeders, developed the features available to operators, and performed acceptance testing of integrated OMS functionality. Phase 2 of the ADMS project progressed in 2022, refreshing the existing OMS as a module of the ADMS, building out DSCADA functionality, and enabling management and control of the electric distribution grid from a joint operations platform. When complete, this centralized ADMS platform will allow for the continued integration of new technologies, expansion of solutions, and operational integration of DERs.

Additionally, in 2022, the Data Enhancement team completed the data cleansing effort for the ADMS electric distribution feeders with improved quality control processes implemented to enhance data accuracy. The preliminary design for DSCADA included a discussion on the acceleration of FLISR deployment.

Implementation included:

- Design, test, and enable the OMS components/modules of the ADMS, allowing for the retirement of the existing OMS
- Implementation of AMI interfaces and mobility solutions interface with OMS module to ensure alignment and benefits realization from these programs.
- Enabling DSCADA integration with OMS and applications to provide common platform visualization and management for the distribution network.
- Expansion of applications, including advanced functionality capable of automation and control
- Completed the installation of the primary system hardware and software in company data centers.
- Implemented a DSCADA, leveraging data from substations via RTU work.
- Implemented a structured data process with Distribution Engineering.
- Completed field surveys of the Massachusetts electric distribution system yielding 605,000 digital images (83.5%) of the available Massachusetts electric distribution poles accessible from the public right of way. The data team completed the review and update of the MA data from this survey.
- Performed FAT testing of integrated OMS functionality.

b. Lessons Learned/Challenges and Successes

Lessons Learned:

- A robust governance structure assisted in keeping all cross-functional teams aligned and focused on the right areas of the project and supported effective decision-making, keeping everyone and the project moving in the same direction.
- ADMS applications will be tested and rolled out on a predetermined number of feeders that benefit most from the solutions and cover a broad sample of the Company's operating areas, ensuring consistent solutions, both during system test and production system use, enhancing benefits and adoption.
- As a lesson learned from testing for Phase 1, remote testing continued in 2022.
- A thorough analysis of operational processes was required to understand how the technical solution fits into operations.
- IT standards were implemented to deliver across programs consistently and included resources, processes, standards, and tools.
- Moving forward for additional Phases of ADMS, plans to improve work with DCC leadership to establish change champions.
- A Baseline Execution Index is used to monitor the execution pace of the project. Other metrics used to monitor the project include Financial Management, Risks and Issue Management, and Resource Management. These metrics provide valuable information that assists the team in the decision-making process.

Challenges:

- Resource constraints impacted project delivery due to a tight labor market. Although the team overcame these challenges, the ramp-up of resources dedicated to the ADMS project was slower than expected
- Supply chain constraints and long lead times on critical hardware components proved challenging throughout 2022. Even though the team worked closely with suppliers to get critical components ordered earlier than anticipated to reduce supply chain strain, supply chain delays impacted the schedule for the OMS module build.
- After Phase 2 OMS went live, the Company planned to build a distribution-specific SCADA system. However, due to the extension in schedule related to the OMS infrastructure, work began on the design stage in late 2022.

Successes:

- The base network model data to support ADMS benefitted from significant additions and expansion. The definition of interdependent programs and systems, such as GIS, has been noted, and dependencies have been linked and tracked based on developed data criteria.
- New Company policies and new IT access tools allowed for the transition to remote work during the pandemic. One example of a success was the ability to shift what was designed to be on-site testing to a fully remote test Phase.
- Leveraging process analysis to target change management and training activities ensured proper user adoption and benefits realization from the systems and applications.
- Guidelines were created to assist in managing the project. This framework helped resolve obstacles and issues that can block strategic success.
- Through the established and defined roles and responsibilities of the project team members, stakeholder groups and executive steering committee, the project has been able to overcome many challenges.
- In 2022, the ADMS control room added a second dedicated expert for managing ADMS embedded in the control room whose responsibilities include the daily feeding and maintenance of the system.

c. Actual v. planned implementation and spending

The ADMS spend was in line with internal forecasts during CY 2022. The ADMS foundational phase 2 build progressed over the course of 2022. Multiple test cycles were completed, factory acceptance, site acceptance, integration testing and performance testing. Phase 2 training needs assessment was completed. For production ADMS load flow, coverage was expanded to 558 total feeders at the end of 2022.

d. Performance on implementation/deployment

The performance on the phase 2 foundational deployment progressed as expected apart from the ongoing challenges with network equipment arrival and staging dates, resulting in the expectation of seeing full implementation costs throughout most of 2023. The continued feature development, coverage expansion, and test and defect resolution work benefited from the iterative development structure of the program. The team continues testing efforts to identify, triage, and repair defects prior to major phase 2 foundational go live.

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, fault location, and distribution automation.

System Enhancements:

- Configure and program GIS to accommodate new asset types and equipment, including adding expanded equipment attributes and characteristics has been completed.
- Configure and program GIS to facilitate capture of greater data and modeling granularity for underground distribution networks.
- Configure and program GIS to facilitate more granularity for low-voltage secondary distribution networks.
- Develop substation modeling capability to support operations and planning processes have been completed.
- Develop additional tools and improve 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 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 ASPEN to Snowflake and substantially completed the design work for the Snowflake to ADMS interface.
- GIS improvements and data hardening are in progress.

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

The capability improvements include:

- Expanded situational awareness and visibility of future predicted states with respect to system operations. This effort is on track, 558 ADMS - ready feeders were completed as of December 31, 2022.
- Created a platform to enable utilization of exponential growth of remote monitoring, control and distribution automation.
- Enable system operations to improve reliability under the growing complexities of integrating DERs. The team revised the operational processes to take advantage of the ADMS foundation and increase the utilization of solar generation output during abnormal conditions such as outage restoration.
    - For all non-GIS electric system data, a data digitalization effort was started in 2022. This data is transferred to the snowflake data store and made accessible to ADMS. This will allow key information such as device settings and relay pickup to be imported into ADMS utilizing a common GIS device ID.
    - Enable operators to simulate the future state of the grid in abnormal configurations to optimize grid asset utilization. The team plans to add 150-200 more ADMS-ready feeders each calendar year. As expected, priority will be feeders with high DG penetration. As part of the 2022 work, initiated investigation of ADMS feeder-ready tasks.
    - Enable advanced applications and distribution load flow to help manage circuit performance and the optimization of DERs.

g. Key Milestones

Milestone	Target Date	Completion Date
OMS Conceptual Solution Architecture Final Approval	October 2021	January 2022
OMS Logical Technical Model Approval	December 2021	February 2022
OMS Development & Implementation Sanction Approval	January 2022	February 2022
Main Hitachi OMS SOW Signed	January 2022	March 2022
OMS Physical Technical Model Approval	January 2022	April 2022
OMS Factory Acceptance Test System Readiness	May 2022	May 2022
OMS Factory Acceptance Testing	August 2022	September 2022
OMS FAT Exit approval	September 2022	September 2022

h. Updated Projections for remainder of the four-year term

Projections for the remainder of the four-year term include Phase 3, extending automation and active network management. Interface with remote metered and grid edge devices and advanced DER control via the interface with a distributed energy resources management system. Projections include the delivery of integrated OMS / ADMS and a new DSCADA functionality, building DMS functionality, software upgrades, and enhancements. Please reference the appendix for future spending projections.

Mobile Outage Dispatch

National Grid responds to over 31,000 outages and trouble calls per year. Mobile outage dispatch results in more efficient utilization of field crews, shortening "trouble calls" and outage response times, and improving outage information. Mobile dispatch is an enterprise mobile outage dispatch and information tracking tool that enhances and digitizes the operational processes around outage dispatching by allowing crews to visualize and update outage information directly via mobile clients back to the centralized ADMS/OMS. Field crews can update details concerning their actual time of arrival, increase insights into field conditions, digitization of incident details while on location, and provide estimated restoration times digitally rather than calling that information into the centralized dispatch locations. In turn, 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 increasing time spent on the task at hand.

The mobile outage dispatch capability currently in development will be an extension of the existing mobile work dispatch solution called OnMyWay. The OnMyWay digital work dispatch solution will enable outage assignments and trouble calls to be dispatched to field crews in real-time via a mobile solution. This mobile outage dispatch solution will interface with the outage management system (OMS) to allow field crews with mobile devices to efficiently receive outage jobs based on location, capabilities, and equipment.

In summary, mobile outage dispatch is expected to improve the efficiency and accuracy of restoration efforts.

a. Description of work completed

National Grid has successfully developed a proof of concept (POC) solution that interfaces with the existing outage management system and is on schedule to establish two-way communication between mobile outage dispatch and OMS planned in 2023. This initial deployment will focus on the dispatch of trouble calls during "blue sky" events.

The product development approach is an iterative lean and agile development process that will deliver a minimum viable product (MVP) with key features and benefits shortly after deployment. As new features are prioritized, built, and deployed, there will be incremental benefits delivered. Breaking the solution into modular components will enable the team to build, test, learn, and adjust quickly to meet user requirements.

Implementation in 2022:

- Preliminary engineering was completed to access customer outage information from the existing outage management system, then feeds to OnMyWay (mobile work dispatch solution). Confirmed critical outage information with field crews and control center operators.
- Sanctioning was completed for the project and the scope identified.
- Organized and carried out team meetings (sprint planning, sprint demonstration, sprint retrospective, daily standup, financial forecast.) with critical project team members to continuously align the project goals.
- The current state of the respond and repair process map has been captured to ensure that critical tasks were not being overlooked and all responsibilities and expectations were clearly understood by each department.
- Completed user research with control center operators and field workers to capture user requirements to develop mobile outage dispatch features for Proof of Concept (POC) and Minimum Viable Product (MVP) release.
- Identified and prioritized features for POC and MVP releases with team and business Subject Matter Experts (SMEs)
- Developed one-way POC solution and launched
- Integrated mobile outage dispatch with legacy Outage Management Systems (OMS).

b. Lessons Learned/Challenges and Successes

After completion of initial user research and discovery to determine features for initial POC of mobile outage dispatch, there were several lessons learned.

Lessons Learned/Challenges:

- Building trust in the technology is a critical first step toward enabling mobile outage dispatch
- Outage information is constantly changing and this needs to be reflected in the application
- Notification settings require further investigation
- User adoption is dependent on an effective change management strategy that accounts for the needs of field workers whose needs differ compared to in-office workers
- The iterative learning cycle approach has enabled the product team to build, test, and adjust to meet user requirements, it needs to continue to mature

- Feedback from users indicates that they need more data to support better outage analysis

Successes:

- Launched POC to one work location (Leominster) in MA Dispatchers and Crews successfully using mobile outage dispatch for pilot purpose before scaling to other locations
- Integration with legacy outage management systems.

c. Actual v. planned implementation and spending

This project encountered hiring constraints due to the tight labor market and is six months behind schedule. However, from a deployment perspective, this project is on-schedule to complete the MVP deployment by June 2023.

From a spending perspective, this project is below the target budget for 2022 (please reference appendix 5a. Spending-2022 Report columns D-L, row 25). The current project timeline is aligned with the updated timeline of the new ADMS/OMS implementation to enable timely integration and future spend projection. The mobile outage dispatch solution is expected to have all foundational components in place to integrate with the new ADMS/OMS infrastructure, in late 2023 and early 2024 (please reference sections e and h of ADMS/DSCADA for more details).

d. Performance on implementation/deployment

This project is still in the early development phase. The first release of the mobile outage dispatch is expected in early 2023. This initial release will focus on foundational features and functionality for a minimum viable product (MVP) solution. The project team will continue to build and deploy new features over the next three years.

e. Description of benefits realized as the result of implementation

No benefits have been realized in 2022 as the project is still in its early development phase. The expected benefits will start in mid-2023 and increase as more features are built and deployed.

f. Description of capability improvement by capability/status category

Once mobile outage dispatch is fully built and deployed, field workers will be able to receive outage jobs or trouble calls directly from the outage management system.

a. Dispatch of outage jobs and trouble calls in real-time via mobile device
b. Enable field personnel to have access to richer and more up to date information, which will allow them to do their work more efficiently

c. Efficiencies from crews inputting more up to date information from on site in the field

g. Key milestones

Milestones	Completion Date
Business Case Approval	6/24/22
Complete Project Sanction	7/14/22
Project Kickoff	9/1/22
POC Launch	12/12/22

*Note: This is a multiple year program and the dates listed above are only reflective of 2022 key milestones. Updates in 2023 will include a user count that aligns with the deployment plan.

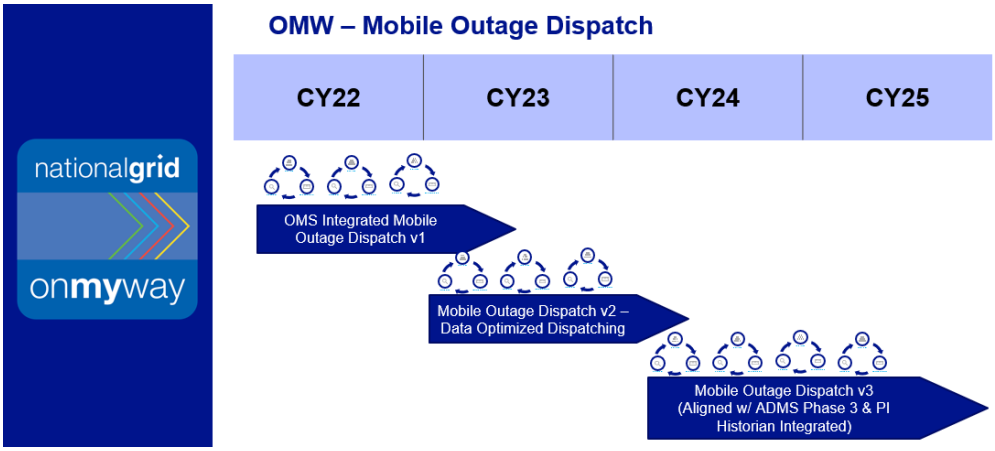
h. Updated Projections for remainder of the four-year term

The statement and numbers indicate that the company will deliver the full mobile dispatch solution by December 2025. Despite a five-month delay in the start of the project, the team has increased staffing and is quickly recovering.

The roadmap shows a clear plan for the remaining years, with each year focused on a specific project phase. In 2023, the team will integrate the mobile outage v1 MVP with the OMS, which will enhance and digitize the operational processes around outage dispatching by allowing crews to visualize and update outage information directly via mobile clients back to the existing OMS.

In 2024, the Company will develop mobile outage dispatch v2, which will be data optimized for more efficient dispatching. Finally in 2025, the Company will develop mobile outage dispatch v3, which will be integrated with the ADMS phase 3 and PI historian, providing an even more robust solution for customers.

From an optimistic viewpoint, the Company is steadily progressing towards delivering a valuable mobile dispatch solution. The clear roadmap and specific milestones show that the team has a well-defined plan for the remaining years, which will help ensure that the project is delivered on time and within budget. Additionally, the increased staffing shows the team's dedication to the project's success and their ability to adapt to changes and challenges. Overall, the leadership team can be confident in the team's ability to deliver a high-quality product that will provide significant value to the company's customers.



The cost projection aligns with the updated delivery timeline.

(7) System Level Narrative - Distribution Energy Resource Management System

The launch of the Company's track two investment projects was postponed until after the authorization of the D.P.U. 21-81-B Order was received.

Distribution Energy Resource Management System – Investigation

a. Description of work completed

Given its status as a track two investments, the DERMS Investigation project was placed on standby until order D.P.U. 21-81-B was issued. As a result, little progress was made in 2022.

In its Grid Modernization filing the Company highlighted that "Before initiating investments in the deployment of a new enterprise solution focused on specific DER management capabilities, the Company will utilize this DERMS Investigation project to assess the business needs driven by customer values and the Department's Objectives. This investigation would then translate those needs into business and technical capabilities and the associated requirements as inputs into DERMS Implementation"[3]

In its demonstration pilot for Active Resource Integration (ARI) the Company explores the benefit of offering interconnection flexibility for its solar front-of-the-meter customers. Through the ongoing collaborative discussions, the Company had with Energy Storage ("ES") developers in the Energy Storage Interconnection Review Group ("ESIRG") and through its DG ombudsperson, the Company has found the need to offer even more flexibility on the operational charge and discharge window of ES assets. Furthermore, the Company believes that there will likely be similar value for the electric distribution system and the Company's customers if Electric Vehicle ("EV") fleet chargers are offered additional flexibility as well. As a result, the Company will investigate offering flexibility to ES and EV in front of the meter customer as part of its DERMS investigation.

b. Lessons learned/challenges and successes

Offering interim solutions through product development: Working with the Company's energy storage customers through the Energy Storage Interconnection Review Group (ESIRG) the Company set up new operating requirements such as fixed charge and discharge windows to help reduce customer interconnection cost and time. The custom solution allows for energy storage owners to continue to participate in the key markets while avoiding system upgrades typically needed outside these markets operating windows. The work offers an interim solution that allows

[3] D.P.U. 21-81, Exhibit NG-GMP-2-Second Revised at page 89

some energy storage facilities to interconnect while more advanced technological solutions are being developed.

c. Actual v. planned implementation and spending, with explanations for deviation and rationale

For the actual versus spending results refer to Tab 5.a Spending – 2022 Report in the attached Department Annual Report Template provides the deviation in the implementation and spending. Refer to columns D-L, row 33.

d. Performance on implementation/deployment

The Company did not perform any implementation or deployment on its DERMS Investigation in CY2022.

e. Description of benefits realized as the result of implementation

No benefits were realized in the DERMS Investigation in CY2022.

f. Description of capability improvement by capability/status category

No Capability improvements were achieved in CY2022 due to the Company's DERMS Investigation being place on standby.

g. Key milestones

No key milestones were achieved in CY2022.

h. Updated Projections for remainder of the four-year term

	CY2022	CY2023	CY2024	CY2025	Total
CAPEX	$0	$205,113	$248,231	$131,565	$584,909
OPEX	$0	$571,000	$731,031	$13,791	$1,315,822
Total	$0	$776,113	$979,262	$145,356	$1,900,731

Distribution Energy Resource Management System – Implementation

As discussed in the Company's filing, DERMS Implementation will be based on Minimum Viable Products ("MVP") that come as a result of the Company's DERMS Investigation and the Company's Demonstration projects. "For example, the Company's Active Resource Integration demonstration project that is focused on DER management of utility-scale distributed PV facilities will serve as a minimum viable product (MVP) of the Centralized DER Dispatch Engine and Grid Edge Control products within the DERMS Platform. Through the Company's proposed DERMS Implementation investment for these products, National Grid will further scale out the MVPs from the demonstration project so that the application of these products can expand to wider use cases (ex. load relief support) and DER types (ex. energy storage) and later coupled with awareness of

an as-operated network model and load flow capabilities being delivered through the Company's ADMS Project." [4] Hence the Company will not begin implementation of its DERMS system until the MVP is completed. As a result, DERMS Implementation is scheduled to begin early 2024.

a. Description of work completed

Work is scheduled to begin early 2024

b. Lessons learned/challenges and successes

No lessons learned have been documented at this time.

c. Actual v. planned implementation and spending

For the actual versus spending results refer to Tab 5.a Spending – 2022 Report in the attached Department Annual Report Template provides the deviation in the implementation and spending. Refer to columns D-L, row 34.

d. Performance on implementation/deployment

Implementation is scheduled to begin early 2024

e. Description of benefits realized as the result of implementation

No benefits have been realized to date.

f. Description of capability improvement by capability/status category

No capability improvements have been achieved

g. Key milestones

No key milestones have been achieved.

h. Updated Projections for remainder of the four-year term

	CY2022	CY2023	CY2024	CY2025	Total

[4] D.P.U. 21-81, Exhibit NG-GMP-2-Second Revised at page 94 of 158

CAPEX	$0	$0	$4,530,941	$7,576,170	$12,107,111
OPEX	$0	$0	$1,410,049	$2,219,878	$3,629,927
Total	$0	$0	$5,940,990	$9,796,049	$15,737,038

Advanced Short Term Load Forecasting

a. Description of work completed

Given its status as a track two investments, the Company's Short-Term Load Forecasting ("STLF") project was placed on standby till order D.P.U. 21-81-B was issued. As a result, little progress was made in CY2022.

b. Lessons learned/challenges and successes

The Company has not documented any lessons learned to date.

c. Actual v. planned implementation and spending

For the actual versus spending results refer to Tab 5.a Spending – 2022 Report in the attached Department Annual Report Template provides the deviation in the implementation and spending. Refer to columns D-L, row 35.

d. Performance on implementation/deployment

The Company did not perform any implementation or deployment on its STLF project in CY2022.

e. Description of benefits realized as the result of implementation

No benefits were realized in CY2022 as a result of deployment of STLF.

f. Description of capability improvement by capability/status category

No capability improvements were achieved in CY2022 due to STLF being place on standby.

g. Key milestones

No key milestones were achieved in CY2022.

h. Updated Projections for remainder of the four-year term

	CY2022	CY2023	CY2024	CY2025	Total

CAPEX	$0	$2,221,413	$732,520	$464,234	$3,418,167
OPEX	$0	$1,520,350	$1,114,750	$900,498	$3,535,598
Total	$0	$3,741,763	$1,847,270	$1,364,732	$6,953,765

(8) System Level Narrative -Demonstration Projects

The launch of the Company's track two investment projects was postponed till after the authorization of the D.P.U. 21-81-B Order was received.

Active Resource Integration

a. Description of work completed

Given its status as a Track Two investment, the Active Resource Integration ("ARI") project was placed on standby until order D.P.U. 21-81-B was issued on November 30, 2022. As a result, minimal progress was made during 2022.

To prepare for offering ARI to its customers, the Company has reviewed the generation interconnection queue, which revealed a high volume of Energy Storage (ES) applications. In addition, stakeholder feedback through forums such as the Technical Standards Review Group (TSRG) and Energy Storage Interconnection Review Group (ESIRG) has shown a clear interest in exploring solutions to alleviate interconnection challenges associated with ES. As such, the Company intends to explore opportunities for inclusion of ES within the ARI framework, which the Company feels is a natural expansion of the ARI intent and will not change the originally proposes investigatory and demonstration effort for fundamental ARI development as originally proposed in the GMP filing.

b. Lessons learned/challenges and successes

Rapid Change in the DG industry: The Company observes rapid changes in DG industry, and the project planning is evolving to meet new dynamics. During the development of the Company's Grid Modernization Plan, challenges to DG projects were associated with high generation and light load conditions. With the rapid growth of ES, the Company is seeing load growth due to ES. Load growth resulting from ES creates a new situation where the Company must sustain traditional load capacity while finding new ways to interconnect ES. The Company believes that the underlining theory of ARI will apply and is investigating the operation schedule of ES to meet both system and DG customer needs.

c. Actual v. planned implementation and spending

For the actual versus spending results refer to Tab 5.a Spending – 2022 Report in the attached Department Annual Report Template provides the deviation in the implementation and spending. Refer to columns D-L, row 37.

d. Performance on implementation/deployment

The Company did not perform any implementation or deployment on its ARI project in CY2022.

e. Description of benefits realized as the result of implementation

No benefits were realized in CY2022 as a result of deployment of ARI.

f. Description of capability improvement by capability/status category

No Capability improvements were achieved in CY2022 due to ARI being placed on standby.

g. Key milestones

No key milestones were achieved in 2022.

h. Updated Projections for remainder of the four-year term

	CY2022	CY2023	CY2024	CY2025	Total
CAPEX	$0	$1,592,219	$922,000	$912,000	$3,426,219
OPEX	$0	$789,222	$1,104,446	$883,160	$2,776,828
Total	$0	$2,381,441	$2,026,446	$1,795,160	$6,203,047

Local Export Power Control

a. Description of work completed

Given its status as a Track Two Investments, the Local Export Power Control ("LEPC") project was placed on standby until order D.P.U. 21-81-B was issued. As a result, little progress was made in CY2022.

After the approval was received, the Company contacted the project owners representing the site described in the Grid Mod filing to inform them of the approval. The customer confirmed that they intend to proceed with the demo project. Currently the customer is modifying their design drawings to align with the requirements of the demonstration project.

b. Lessons learned/challenges and successes

No lessons learned have been documented at this time.

c. Actual v. planned implementation and spending

For the actual versus spending results refer to Tab 5.a Spending – 2022 Report in the attached Department Annual Report Template provides the deviation in the implementation and spending. Refer to columns D-L, row 38.

d. Performance on implementation/deployment

The Company did not perform any implementation or deployment on its LEPC project in 2022.

e. Description of benefits realized as the result of implementation

No benefits were realized in 2022 as a result of deployment of LEPC.

f. Description of capability improvement by capability/status category

No capability improvements were achieved in 2022 due to LEPC being placed on standby.

g. Key milestones

No key milestones were achieved in 2022 due to the project launching in the last thirty days of the year.

h. Updated Projections for remainder of the four-year term

	CY2022	CY2023	CY2024	CY2025	Total
CAPEX	$0	$20,534	$-	$-	$20,534
OPEX	$0	$129,365	$5,271	$16,234	$150,870
Total	$0	$149,900	$5,271	$16,234	$171,405

(9) Measurement, Verification & Support

Measurement and Verification

a. Description of work completed

In D.P.U. 15-120, 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. The evaluation plan will provide, to the extent possible, a uniform statewide approach and standards to study the deployment of the preauthorized grid modernization investments to ensure that benefits are both 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 the deployment of the preauthorized investments.

The Companies continue to work with Guidehouse as the evaluation consultant for the current term. The 2022 evaluation report is expected in July 2023. The data gathering process to support the 2022 evaluation report commenced in early 2023.

b. Lessons learned/challenges and successes

The lessons learned in the M&V process are generally from the 2018-2021 term and captured in the Evaluation Consultant Recommendations section within. Some examples include 1) updating data collection template and format to streamline data collection and make the process more efficient, 2) developing a case-study approach to understanding reliability impacts due to ADA investments and helping distinguish between how impacts are attributed to M&C vs ADA where these investments are deployed on same circuit and 3) agreeing to nine-month VVO on/off schedules for M&V purposes.

c. Actual v. planned implementation and spending, with explanations for deviation and rationale

For the actual versus spending results refer to Tab 5.a Spending – 2022 Report in the attached Department Annual Report Template provides the deviation in the implementation and spending. Refer to columns D-L, row 40.

d. Performance on implementation/deployment

Evaluation reports and the underlying data gathering process have been delivered on time. The reports have been 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 are annually published on July 1.

h. Updated Projections for remainder of the four-year term

For projections for the remainder of the four-year term please refer to Tabs 5.b Spending 2023 through 5.d Spending 2025 in the attached Department Annual Report Template.

Project Management

The Company established a new organization in August 2018, the Grid Modernization Execution (GME) organization, to drive the delivery of grid modernization investment areas approved in the 2018-2021 term, and the organization continues to operate to drive delivery of approved investments in the 2022-2025 term. This Grid Modernization Execution organization performs the functions of a project management office and manages the overall delivery of services which includes portfolio management and reporting, business process design and requirements definition, solution architecture, requirements management, change management, testing management, training and transfer planning and coordination, deployment operations, vendor technical implementation coordination and performance monitoring and reporting.

a. Description of work completed

In 2022, the GME organization continued its progress from the first Grid Modernization term, working to deliver Track 1 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

The costs represented here are for a subset of incremental employee costs or third-party services for delivering the grid modernization portfolio.

d. Performance on implementation/deployment

The GME organization was stood up in the first Grid Modernization Term and continues to deliver on its 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 remainder of the four-year term

For projections for the remainder of the four-year term please refer to Tabs 5.b Spending 2023 through 5.d Spending 2025 in the attached Department Annual Report Template.

IV. Performance Metrics

A. Description and Update on each Performance Metric

The Department stamp-approved the revised Performance Metrics on November 7, 2022, which the Company is reporting on in this Section.

The Department also ordered the Distribution Companies to develop a formal evaluation process, including an evaluation plan and evaluation studies, to review the Distribution Companies' preauthorized GMP investments and their progress toward meeting the Department's grid modernization objectives. D.P.U. 15-122, 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 Distribution Companies.

The data supporting the performance metrics have been provided to the Guidehouse evaluation team by the Company. Results of the Monitoring and Control ("M&C"), Distribution Automation ("DA"), Communications and IT/OT, Volt Var Optimization (VVO) and Advanced Distribution Management System ("ADMS") investment areas are expected to be shared by Guidehouse in June 2023.

2.1 VOLT VAR OPTIMIZATION AND CONSERVATION VOLTAGE REDUCTION BASELINE – At the end of 2022 the Company had a total of nine substations and 55 feeders equipped with the VVO technology. Baseline calculations for feeders equipped with VVO in 2022 are in process and will be published by Guidehouse in the 2022 Massachusetts Grid Modernization Program Evaluation Report, expected in July 2023.

2.2 VOLT VAR OPTIMIZATION (VVO) ENERGY SAVINGS – At the end of 2022 the Company had a total of nine substations and 55 feeders equipped with the VVO technology. Energy savings calculations for feeders equipped with VVO in 2022 are in process and will be published by Guidehouse in the 2022 Massachusetts Grid Modernization Program Evaluation Report, expected in July 2023.

2.3 VVO PEAK LOAD IMPACT – At the end of 2022 the Company had a total of nine substations and 55 feeders equipped with the VVO technology. Peak load impact calculations for feeders equipped with VVO in 2022 are in process and will be published by Guidehouse in the 2022 Massachusetts Grid Modernization Program Evaluation Report, expected in July 2023.

2.4 VVO – DISTRIBUTION LOSSES WITHOUT AMF (BASELINE) - At the end of 2022 the Company had a total of nine substations and 55 feeders equipped with the VVO technology. Calculation of reduction in losses for feeders equipped with VVO in 2022 are in process and will be published by Guidehouse in the 2022 Massachusetts Grid Modernization Program Evaluation Report, expected in July 2023.

2.5 VVO POWER FACTOR – At the end of 2022 the Company had a total of nine substations and 55 feeders equipped with the VVO technology. Calculation of improvement in power factor for feeders equipped with VVO in 2022 are in process and will be published by Guidehouse in the 2022 Massachusetts Grid Modernization Program Evaluation Report, expected in July 2023.

2.6 VVO ESTIMATED VVO/CVR ENERGY AND GHG IMPACT – At the end of 2022 the Company had a total of nine substations and 55 feeders equipped with the VVO technology. GHG impact calculations for feeders equipped with VVO in 2022 are in process and will be published by Guidehouse in the 2022 Massachusetts Grid Modernization Program Evaluation Report, expected in July 2023.

2.7 INCREASE IN SUBSTATIONS WITH DISTRIBUTION MANAGEMENT SYSTEM ("DMS") POWER FLOW AND CONTROL CAPABILITIES – The Company has enabled DMS power flow capability over 282 feeders in 2022. 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 (558 at the end of calendar year 2022), 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 prior to being transitioned to operational use. The engineering team performs a series of screenings,, including data check 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, 2022, 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 2022.

2.9 NUMBERS OF CUSTOMERS THAT BENEFIT FROM GMP FUNDED DISTRIBUTION AUTOMATION DEVICES - The Company has enabled 47 feeders representing 24 ADA schemes from 2019 through 2022.

Substation Name	Feeder ID	# of Customers Benefiting from DA Devices	Types of DA Devices Benefiting Customers
Ayer	01-201W2	3002	OH DA w/Ties, OH DA w/out Ties, Feeder Monitor
Fitch Rd.	01-216W6	1479	OH DA w/out Ties, Feeder Monitor
Franklin	05-341W1	1788	OH DA w/Ties, OH DA w/out Ties, Feeder Monitor
Beaver Pond	05-344W5	3113	OH DA w/Ties, OH DA w/out Ties, Feeder Monitor
Union Street	05-348W7	848	OH DA w/Ties, OH DA w/out Ties, Feeder Monitor

Union Street	05-348W8	1407	OH DA w/out Ties, Feeder Monitor
Mink Street	05-7L4	2661	OH DA w/out Ties
Chartley Pond	05-8L3	2634	OH DA w/out Ties
Chartley Pond	05-8L4	2663	OH DA w/Ties, Feeder Monitor
Read Street	05-9L1	2204	OH DA w/Ties, OH DA w/out Ties, Feeder Monitor
Read Street	05-9L3	1387	OH DA w/Ties, OH DA w/out Ties, Feeder Monitor
Read Street	05-9L6	1992	OH DA w/out Ties
Field St	07-1W5	3145	OH DA w/out Ties
West Quincy	07-3W3	2104	OH DA w/Ties, OH DA w/out Ties, Feeder Monitor
E. Bridgewater	07-797W19	2533	OH DA w/out Ties
Water St	07-910W25	2753	OH DA w/out Ties
Stoughton	07-913W43	2115	OH DA w/Ties, OH DA w/out Ties, Feeder Monitor
Stoughton	07-913W69	3595	OH DA w/out Ties, Feeder Monitor
Dupont	07-91W49	4637	OH DA w/Ties, Feeder Monitor
Phillips Lane	07-95W3	2344	OH DA w/Ties, Feeder Monitor
Belmont	07-98W19	223	OH DA w/Ties
Little Rest Rd	09-516L2	866	OH DA w/Ties, OH DA w/out Ties
Little Rest Rd	09-516L3	1485	Feeder Monitor

Maplewood	12-16W6	5626	OH DA w/Ties, OH DA w/out Ties, Feeder Monitor
N. Beverly	12-18L2	1630	OH DA w/Ties, OH DA w/out Ties, Feeder Monitor
Winthrop	12-22W5	559	OH DA w/Ties, OH DA w/out Ties, Feeder Monitor
Saugus	12-23W2	3050	OH DA w/Ties, OH DA w/out Ties, Feeder Monitor
Quinn	12-24W1	1531	OH DA w/Ties, OH DA w/out Ties, Feeder Monitor
Quinn	12-24W2	1432	OH DA w/out Ties, Feeder Monitor
Melrose	12-25W4	4624	OH DA w/out Ties, Feeder Monitor
W. Salem	12-29W1	3795	OH DA w/out Ties, Feeder Monitor
E. Beverly	12-51L3	2015	OH DA w/out Ties, Feeder Monitor
Metcalf Sq.	12-96W1	3820	OH DA w/out Ties, Feeder Monitor
Hoover Street	14-21L1	2939	OH DA w/out Ties, Feeder Monitor
Water Street	14-31L2	3985	OH DA w/Ties, OH DA w/out Ties, Feeder Monitor
East Boxford	14-33L1	991	OH DA w/Ties, OH DA w/out Ties
Ward Hill	14-43L4	3036	OH DA w/Ties, OH DA w/out Ties, Feeder Monitor
North Haverhill	14-48L2	3118	OH DA w/out Ties, Feeder Monitor
Woodchuck Hill	14-56L1	2010	OH DA w/Ties, OH DA w/out Ties, Feeder Monitor
Woodchuck Hill	14-56L3	1988	OH DA w/out Ties
Westford	14-57L2	1791	OH DA w/Ties, OH DA w/out Ties, Feeder Monitor

Westford	14-57L3	3510	OH DA w/out Ties, Feeder Monitor
East Tewksbury	14-59L6	1529	OH DA w/out Ties, Feeder Monitor
West Methuen	14-63L1	3122	OH DA w/out Ties, Feeder Monitor
East Methuen	14-74L4	1582	OH DA w/out Ties, Feeder Monitor
East Dracut	14-75L3	2346	OH DA w/Ties, OH DA w/out Ties
North Dracut	14-78L1	2308	OH DA w/Ties, OH DA w/out Ties

2.10 RELIABILITY-FOCUSED GRID MODERNIZATION INVESTMENTS' EFFECT ON OUTAGE DURATIONS - The Company has enabled 47 feeders representing 24 ADA schemes from 2019 through 2022. There were 16 events that caused operations of the ADA during the 2022 plan year and for the term which would have a direct effect on outage durations. All 16 events reduced the event CMI by 25% or more.

SAIDI Without MED				
Substation Name	**Feeder ID**	**3-yr Avg**	**2022 SAIDI**	**Difference (baseline - 2022)**
Ayer	01-201W2	304.33	59.84	244.49
Fitch Rd.	01-216W6	188.05	106.75	81.30
Franklin	05-341W1	199.25	2.31	196.94
Beaver Pond	05-344W5	67.38	51.95	15.43
Union Street	05-348W7	-	4.85	-
Union Street	05-348W8	-	162.56	-
Mink Street	05-7L4	360.58	149.46	211.12
Chartley Pond	05-8L3	81.76	80.87	0.88
Chartley Pond	05-8L4	182.44	228.55	-46.11
Read Street	05-9L1	78.38	72.56	5.82

Read Street	05-9L3	22.84	20.33	2.51
Read Street	05-9L6	104.44	94.45	9.98
Field St	07-1W5	84.59	17.82	66.78
West Quincy	07-3W3	38.34	13.88	24.46
E. Bridgewater	07-797W19	102.50	51.43	51.08
Water St	07-910W25	222.23	195.38	26.85
Stoughton	07-913W43	140.81	53.35	87.47
Stoughton	07-913W69	145.91	75.61	70.30
Dupont	07-91W49	13.29	63.97	-50.68
Phillips Lane	07-95W3	186.50	89.17	97.33
Belmont	07-98W19	19.69	41.41	-21.72
Little Rest Rd	09-516L2	121.44	81.12	40.31
Little Rest Rd	09-516L3	26.36	32.29	-5.93
Maplewood	12-16W6	39.40	19.02	20.37
N. Beverly	12-18L2	226.96	224.14	2.82
Winthrop	12-22W5	30.87	0.00	30.87
Saugus	12-23W2	165.46	37.39	128.07
Quinn	12-24W1	144.36	16.20	128.16
Quinn	12-24W2	117.32	80.97	36.35
Melrose	12-25W4	47.93	201.79	-153.87
W. Salem	12-29W1	69.08	50.32	18.76
E. Beverly	12-51L3	118.99	177.18	-58.19
Metcalf Sq.	12-96W1	268.45	16.39	252.06
Hoover Street	14-21L1	99.96	213.76	-113.80
Water Street	14-31L2	-	19.33	-
East Boxford	14-33L1	440.31	126.03	314.28
Ward Hill	14-43L4	144.07	7.20	136.87
North Haverhill	14-48L2	150.66	7.26	143.41
Woodchuck Hill	14-56L1	152.09	5.33	146.77
Woodchuck Hill	14-56L3	308.74	201.13	107.62
Westford	14-57L2	122.91	43.25	79.65

Westford	14-57L3	236.52	73.73	162.79
East Tewksbury	14-59L6	225.96	107.75	118.22
West Methuen	14-63L1	79.89	27.40	52.49
East Methuen	14-74L4	223.89	8.28	215.61
East Dracut	14-75L3	157.25	104.26	53.00
North Dracut	14-78L1	64.17	115.86	-51.69

SAIDI With MED				
Substation Name	**Feeder ID**	**3-yr Avg**	**2022 SAIDI**	**Difference (baseline - 2022)**
Ayer	01-201W2	337.03	124.18	212.85
Fitch Rd.	01-216W6	160.38	252.31	-91.93
Franklin	05-341W1	504.58	2.29	502.29
Beaver Pond	05-344W5	82.33	51.69	30.64
Union Street	05-348W7	-	4.82	-
Union Street	05-348W8	-	162.47	-
Mink Street	05-7L4	576.48	201.90	374.57
Chartley Pond	05-8L3	170.13	80.24	89.89
Chartley Pond	05-8L4	430.53	322.53	107.99
Read Street	05-9L1	165.98	71.93	94.05
Read Street	05-9L3	52.93	20.19	32.74
Read Street	05-9L6	220.71	94.19	126.52
Field St	07-1W5	84.78	20.69	64.09
West Quincy	07-3W3	40.69	13.11	27.58
E. Bridgewater	07-797W19	105.56	77.87	27.69
Water St	07-910W25	258.96	194.96	64.00
Stoughton	07-913W43	303.66	54.20	249.46
Stoughton	07-913W69	149.02	75.33	73.69
Dupont	07-91W49	32.19	63.35	-31.16
Phillips Lane	07-95W3	541.81	106.22	435.59
Belmont	07-98W19	19.93	41.24	-21.31

Little Rest Rd	09-516L2	123.61	147.29	-23.68
Little Rest Rd	09-516L3	46.26	51.87	-5.61
Maplewood	12-16W6	42.04	19.05	22.99
N. Beverly	12-18L2	788.83	228.21	560.62
Winthrop	12-22W5	30.87	0.00	30.87
Saugus	12-23W2	189.48	37.05	152.43
Quinn	12-24W1	148.71	15.57	133.13
Quinn	12-24W2	117.42	81.04	36.38
Melrose	12-25W4	54.29	205.23	-150.94
W. Salem	12-29W1	74.74	50.27	24.47
E. Beverly	12-51L3	210.67	220.96	-10.28
Metcalf Sq.	12-96W1	268.89	16.31	252.58
Hoover Street	14-21L1	638.26	222.44	415.83
Water Street	14-31L2	-	231.10	-
East Boxford	14-33L1	1281.55	348.34	933.21
Ward Hill	14-43L4	683.44	61.56	621.87
North Haverhill	14-48L2	289.22	7.00	282.22
Woodchuck Hill	14-56L1	481.14	5.33	475.81
Woodchuck Hill	14-56L3	1244.34	447.59	796.74
Westford	14-57L2	398.30	88.11	310.19
Westford	14-57L3	381.72	74.39	307.34
East Tewksbury	14-59L6	656.98	228.08	428.90
West Methuen	14-63L1	469.39	185.52	283.87
East Methuen	14-74L4	531.76	73.16	458.60
East Dracut	14-75L3	1244.84	137.97	1106.87
North Dracut	14-78L1	640.62	141.39	499.23

2.11 RELIABILITY-FOCUSED GRID MODERNIZATION INVESTMENTS' EFFECT ON OUTAGE FREQUENCY - The Company has enabled 47 feeders representing 24 ADA schemes from 2019 through 2022. Fourteen of these events involved FLISR restoring power to a significant portion (25% or more) of the customers initially impacted by the outage in less than one minute.

SAIFI Without MED				
Substation Name	**Feeder ID**	**Baseline 3-yr Avg**	**2022 SAIFI**	**Difference (baseline - 2022)**
Ayer	01-201W2	1.74	0.18	1.56
Fitch Rd.	01-216W6	1.60	1.08	0.52
Franklin	05-341W1	0.68	0.03	0.65
Beaver Pond	05-344W5	0.12	0.43	-0.31
Union Street	05-348W7	-	0.04	-
Union Street	05-348W8	-	0.81	-
Mink Street	05-7L4	1.95	1.96	0.00
Chartley Pond	05-8L3	0.70	0.92	-0.22
Chartley Pond	05-8L4	1.22	2.28	-1.06
Read Street	05-9L1	0.92	0.40	0.53
Read Street	05-9L3	0.29	0.19	0.10
Read Street	05-9L6	1.00	0.68	0.33
Field St	07-1W5	1.69	0.14	1.55
West Quincy	07-3W3	0.44	1.09	-0.65
E. Bridgewater	07-797W19	0.90	0.33	0.57
Water St	07-910W25	1.97	1.35	0.62
Stoughton	07-913W43	0.91	0.53	0.38
Stoughton	07-913W69	1.41	0.44	0.97
Dupont	07-91W49	0.15	1.48	-1.33
Phillips Lane	07-95W3	2.53	1.63	0.90
Belmont	07-98W19	0.69	0.11	0.57
Little Rest Rd	09-516L2	0.44	0.55	-0.10
Little Rest Rd	09-516L3	0.18	0.24	-0.06
Maplewood	12-16W6	0.29	0.08	0.21
N. Beverly	12-18L2	2.07	1.51	0.56
Winthrop	12-22W5	0.39	0.00	0.39
Saugus	12-23W2	0.77	0.52	0.25
Quinn	12-24W1	1.97	1.20	0.77

Quinn	12-24W2	1.28	0.58	0.70
Melrose	12-25W4	0.61	1.03	-0.41
W. Salem	12-29W1	0.75	0.09	0.66
E. Beverly	12-51L3	0.77	0.96	-0.19
Metcalf Sq.	12-96W1	2.43	0.11	2.32
Hoover Street	14-21L1	0.94	1.49	-0.56
Water Street	14-31L2	-	0.09	-
East Boxford	14-33L1	1.85	0.45	1.40
Ward Hill	14-43L4	1.41	0.10	1.31
North Haverhill	14-48L2	0.64	0.41	0.23
Woodchuck Hill	14-56L1	0.52	0.02	0.50
Woodchuck Hill	14-56L3	1.62	2.07	-0.45
Westford	14-57L2	0.65	0.25	0.39
Westford	14-57L3	1.16	0.98	0.18
East Tewksbury	14-59L6	1.10	0.42	0.67
West Methuen	14-63L1	0.79	0.41	0.38
East Methuen	14-74L4	1.58	0.22	1.36
East Dracut	14-75L3	1.36	0.74	0.62
North Dracut	14-78L1	0.61	0.47	0.14

SAIFI With MED				
Substation Name	**Feeder ID**	**Baseline 3-yr Avg**	**2022 SAIFI**	**Difference (baseline - 2022)**
Ayer	01-201W2	1.77	0.25	1.52
Fitch Rd.	01-216W6	0.80	1.71	-0.91
Franklin	05-341W1	1.01	0.03	0.99
Beaver Pond	05-344W5	0.12	2.13	-2.02
Union Street	05-348W7	-	0.04	-
Union Street	05-348W8	-	0.81	-
Mink Street	05-7L4	2.25	3.14	-0.89
Chartley Pond	05-8L3	0.74	1.21	-0.47

Chartley Pond	05-8L4	1.58	3.48	-1.90
Read Street	05-9L1	0.98	0.40	0.58
Read Street	05-9L3	0.30	0.19	0.11
Read Street	05-9L6	1.06	0.68	0.38
Field St	07-1W5	1.69	0.15	1.54
West Quincy	07-3W3	0.47	1.10	-0.63
E. Bridgewater	07-797W19	0.90	0.43	0.47
Water St	07-910W25	1.99	1.35	0.64
Stoughton	07-913W43	1.01	0.57	0.44
Stoughton	07-913W69	1.44	0.44	0.99
Dupont	07-91W49	0.16	1.49	-1.34
Phillips Lane	07-95W3	2.78	1.65	1.14
Belmont	07-98W19	0.70	0.11	0.58
Little Rest Rd	09-516L2	0.47	0.88	-0.41
Little Rest Rd	09-516L3	0.20	0.27	-0.08
Maplewood	12-16W6	0.29	0.08	0.21
N. Beverly	12-18L2	2.17	3.73	-1.56
Winthrop	12-22W5	0.39	0.00	0.39
Saugus	12-23W2	0.80	0.52	0.28
Quinn	12-24W1	1.97	1.90	0.08
Quinn	12-24W2	1.28	0.58	0.70
Melrose	12-25W4	0.62	1.05	-0.42
W. Salem	12-29W1	0.76	0.09	0.67
E. Beverly	12-51L3	0.81	1.56	-0.75
Metcalf Sq.	12-96W1	2.43	0.11	2.32
Hoover Street	14-21L1	1.27	1.50	-0.23
Water Street	14-31L2	-	2.05	-
East Boxford	14-33L1	2.42	0.62	1.80
Ward Hill	14-43L4	1.66	0.16	1.51
North Haverhill	14-48L2	0.67	0.63	0.04
Woodchuck Hill	14-56L1	0.84	0.02	0.82

Woodchuck Hill	14-56L3	1.96	2.18	-0.22
Westford	14-57L2	0.90	0.30	0.60
Westford	14-57L3	1.23	0.98	0.25
East Tewksbury	14-59L6	1.21	0.53	0.68
West Methuen	14-63L1	0.89	0.65	0.24
East Methuen	14-74L4	1.95	0.25	1.70
East Dracut	14-75L3	1.64	1.29	0.35
North Dracut	14-78L1	0.91	0.50	0.41

2.12 VVO RELATED VOLTAGE COMPLAINTS PERFORMANCE METRIC AND BASELINE -

The Company does not have an automated system to track voltage complaints but will use the OMS system to retrieve incidents. The current OMS system was installed at the end of the year 2015 providing less than one year's results. The OMS Call results of non-Outages were pulled from the 72 feeders over the twelve substations to be 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 UG (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 incidents of customer-reported voltage complaints, particular focus was given to the incidents that included terms such as Voltage, Dim, Flickering, and VRM (Voltage Recorder Monitor). The Company is working towards process improvements and system enhancements to better enable the identification and associated details of customer voltage complaints that may be related to VVO voltage optimization. Refer to Tab 3.a. – Feeder Status- 2022 Report in the attached DPU Annual Report Template at columns DL thru DM.

Substation	Feeder #	Baseline Average (2016 & 2017)	# of Voltage Complaints, 2022 Results	Change in # of Voltage Complaints (Baseline minus 2022)
Stoughton	07-913W17	2	0	2
	07-913W18	8	3	5
	07-913W43	5	7	-2
	07-913W47	3	6	-3
	07-913W67	2	1	1
	07-913W69	8	4	4
Maplewood	12-16W1	5	3	2
	12-16W2	3	6	-3
	12-16W3	1	0	1
	12-16W4	1	3	-2
	12-16W5	4	1	3
	12-16W6	5	7	-2
	12-16W7	3	5	-2
	12-16W8	4	20	-16
East Methuen	14-74L1	5	2	3
	14-74L2	3	3	0
	14-74L3	8	8	0
	14-74L4	5	1	4
	14-74L5	8	1	7
	14-74L6	2	1	1
E. Bridgewater	07-797W1	4	8	-4
	07-797W19	2	2	0
	07-797W20	5	5	0
	07-797W23	4	5	-1
	07-797W24	7	14	-7
	07-797W29	4	3	1
	07-797W42	4	0	4
East Dracut	14-75L1	5	3	2
	14-75L2	4	2	2
	14-75L3	3	2	1
	14-75L4	0	1	-1
	14-75L5	4	6	-2

	14-75L6	2	2	0
West Salem	12-29W1	6	11	-5
	12-29W2	0	2	-2
	12-29W3	2	5	-3
	12-29W4	5	3	2
	12-29W5	3	6	-3
	12-29W6	3	3	0
Easton	07-92W43	5	1	4
	07-92W44	3	3	0
	07-92W54	6	5	1
	07-92W78	5	4	1
	07-92W79	3	4	-1
Melrose	12-25W1	2	4	-2
	12-25W2	3	2	1
	12-25W3	2	2	0
	12-25W4	7	10	-3
	12-25W5	3	7	-4
Westboro	05-312W1	4	4	0
	05-312W2	0	0	0
	05-312W3	2	2	0
	05-312W4	7	0	7
	05-312W5	0	0	0
Billerica	14-70L1	9	6	3
	14-70L2	1	0	1
	14-70L3	3	7	-4
	14-70L4	2	1	1
	14-70L5	7	4	3
	14-70L6	9	2	7
	14-70L8	11	4	7
Depot St.	05-335W1	9	2	7
	05-335W2	4	4	0
	05-335W3	3	7	-4
	05-335W4	3	3	0
	05-335W5	4	13	-9
	05-335W9	5	0	5
Parkview	07-94W40	2	3	-1

	07-94W41	3	5	-2
	07-94W42	1	0	1
	07-94W43	4	1	3
	07-94W44	3	4	-1
Total			279	8

App.C.1.0 NATIONAL GRID RELIABILITY-RELATED COMPANY-SPECIFIC - This metric is designed to measure the impact of Advanced Distribution Automation (ADA) investments on the customer minutes of interruption (CMI) for main line interruptions. The Company has enabled feeders representing ADA schemes from 2019 through 2022. There were mainline events that caused operations of the ADA during the 2022 plan year.

Substation	Feeder _ID	Active	Baseline 3-yr avg	2022 CMI	Difference (baseline - 2022)
Ayer	01-201W2	12/09/21	663283.7	90	663193.7
Fitch Rd	01-216W6	12/09/21	150493	89468	61025
Franklin	05-341W1	02/24/22	7853.333	0	7853.333
Beaver Pond	05-344W5	02/24/22	0	83671	-83671
Union St	05-348W7	07/12/21	-	0	-
Union St	05-348W8	07/12/21	-	105960	-
Mink Street	05-7L4	10/13/22	473292.3	252952	220340.3
Chartley Pond	05-8L3	10/07/21	62654.33	0	62654.33
Read St	05-9L1	10/07/21	158480.3	121809	36671.33
Read St	05-9L3	10/07/21	19142.67	0	19142.67
Read St	05-9L6	10/07/21	165124	15852	149272
Field St	07-1W5	07/22/21	175761.7	0	175761.7
West Quincy	07-3W3	07/22/21	114548.3	0	114548.3
E. Bridgewater	07-797W19	02/05/21	26686.33	6028	20658.33
Water St	07-910W25	03/21/22	244431	212303	32128
Stoughton	07-913W43	10/26/20	38484	16520	21964
Stoughton	07-913W69	10/26/20	182432.3	0	182432.3
Dupont	07-91W49	03/12/21	15158	257275	-242117

Phillips Lane	07-95W3	03/21/22	370585.7	171830	198755.7
Belmont	07-98W19	02/05/21	902	0	902
Little Rest Rd	09-516L2	08/03/22	86822	0	86822
Little Rest Rd	09-516L3	08/03/22	588	0	588
Maplewood	12-16W6	12/16/21	140103.3	0	140103.3
N. Beverly	12-18L2	12/16/21	171159	266014	-94855
Winthrop	12-22W5	08/13/21	3256	0	3256
Saugus	12-23W2	03/31/21	0	49058	-49058
Quinn	12-24W1	03/29/22	165834.3	13476	152358.3
Quinn	12-24W2	03/29/22	124868	105600	19268
Melrose	12-25W4	12/16/21	152592.3	921628	-769036
W. Salem	12-29W1	03/31/21	202897.3	0	202897.3
E. Beverly	12-51L3	12/16/21	32413.67	61357	-28943.3
Metcalf Square	12-96W1	08/13/21	492125	0	492125
Hoover St	14-21L1	03/24/21	73798	457838	-384040
Water Street	14-31L2	03/25/22	-	0	-
East Boxford	14-33L1	12/31/20	121177.7	0	121177.7
Ward Hill	14-43L4	03/21/22	0	0	0
North Haverhill	14-48L2	03/25/22	104652	0	104652
Woodchuck Hill	14-56L1	02/12/21	258774	0	258774
Woodchuck Hill	14-56L3	12/31/20	176354.7	280875	-104520
Westford	14-57L2	03/18/21	116062.3	7298	108764.3
Westford	14-57L3	03/18/21	579594	62449	517145
E. Tewksbury	14-59L6	02/12/21	174498.7	69181	105317.7
West Methuen	14-63L1	05/17/22	197680.3	17699	179981.3
East Methuen	14-74L4	03/21/22	513138	12312	500826
East Dracut	14-75L3	05/17/22	105002.7	160943	-55940.3
North Dracut	14-78L1	03/24/21	61539	210202	-148663

App.C.2.0 NATIONAL GRID REPLACING FIXED CAPACITORS WITH ADVANCED DISTRIBUTION MANAGEMENT SYSTEM (“ADMS”) 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 begin reporting on this metric until after the Phase 3: Integrated Operations, Active Management of the ADMS system is deployed and operational, and smart capacitors are installed and integrated with the ADMS. The Company anticipates that this will happen in end of 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, above.

V. Evaluation Consultant Recommendations

The Department Memorandum in DPU 23-30, added this reporting section which includes narrative 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 Attachment Evaluation Consultant Recommendations.xlsx

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