Massachusetts Electric Company
and
Nantucket Electric Company
d/b/a National Grid

Grid Modernization Plan
Annual Report 2020

D.P.U. 15-120

April 1, 2021

Submitted to:
Massachusetts Department of Public Utilities

Contents

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 will submit GMPs every three years, which will 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 will 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.

The Department has established the outline/table of contents to be included in the annual report. D.P.U. 15-120/15-121/15-122, Hearing Officer Memorandum (March 29, 2019). The Department also has approved the metrics to be reported on in the annual reports. D.P.U. 15-120/15-121/15-122, Stamp Approval (July 25, 2019). The Department additionally has adopted templates to be completed and included with the annual reports. D.P.U. 15-120-C/15-121-C/15-122-C (December 6, 2019). This filing is National Grid's third Grid Modernization Annual Report, which contains the narrative documenting the Company's performance on its Grid Modernization Plan for the time period January 1, 2020 through December 31, 2020 ("Report") and is accompanied by the templates the Department has approved.

Key elements of the Department's Order approving in part the GMPs, and which are reflected in this Report, include:

- Objectives: The Department refined their grid modernization objectives to place additional focus on improved access to the distribution system planning process, in order to ensure a cleaner, more efficient and reliable grid.
- Grid-Facing Investments: The Department approved National Grid's proposed grid-facing investments and preauthorized $82 million in spending for these investments over three years from January 1, 2018 through December 31, 2020. 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.
- Customer-Facing Investments: The Department did not pre-authorize: smart meters and Advanced Metering Infrastructure ("AMI") back office infrastructure; customer load management; communications and information/operational technologies related to AMI; cybersecurity related to customer-side investments; workforce training and asset management; marketing, education and outreach; and project management office.
- Cost Recovery: The Department approved a short-term targeted cost recovery mechanism, the Grid Modernization Factor ("GMF"), for pre-authorized grid modernization investments. This is a reconciling mechanism that: (1) includes both capital and operations and maintenance ("O&M") costs; (2) includes incremental grid modernization costs that are prudently incurred, in service, and used and useful to customers; and (3) applies to investments made in the first six years of the GMPs only.

The Department preauthorized the following categories of grid-facing investments for a combined three-year budget of $82 million: (1) conservation voltage reduction/volt-VAR optimization ("CVR/VVO"); (2) advanced distribution automation ("ADA"); (3) feeder monitors; (4) communications and information/operational technologies ("IT/OT"); and (5) advanced distribution management system/supervisory control and data acquisition system ("ADMS/SCADA"). The preauthorized investments incorporated the following investments:

(1) CVR/VVO - CVR/VVO technology flattens the voltage profile of a feeder by applying intelligent control to capacitors and regulators on the feeder which serves to minimize electrical losses, followed by lowering the source voltage at the substation to provide energy savings for both the utility and the customer. The Plan included deployment of this technology on sixteen feeders in the initial three-year period, and an additional sixteen feeders in the fourth year.
(2) ADA – The Company proposed to deploy 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 the uninvolved sub-sections to be resupplied via automated tie points, significantly reducing both impacted customers and outage durations. The Plan included

deployment of this technology on sixteen feeders in the initial three-year period, and an additional thirty-two feeders in the fourth year.

(3) Feeder Monitors – The Company proposed to deploy head-end mainline feeder monitors which would be used to capture real time voltage, current and power. The operations control center will use this information, as will electric system planners, to help optimize the control and design of the electric system. The Plan included deployment of this technology on one hundred and eighty feeders in the initial three-year period.

(4) Communications and IT/OT - A fundamental component of grid modernization is a systems 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, ADMS/DSCADA, and integrating distributed generation ("DG"). The major components of the systems architectural framework are:

a. Comprehensive Integration Services ("CIS") - The integration services to enable the exchange of information between systems, services and devices.
b. Enterprise Analytics ("EA") - The big data analytics capabilities to allow for the analysis of the data gathered from grid modernization investments combined with existing and third-party data sources, providing valuable output reflecting current state as well as predictive and prescriptive outcomes.
c. Communications and Networking - A set of communication services that transfer information with the correct prioritization and quality of service to the appropriate destination.
d. Integrated Network Operations Center ("INOC") - To actively monitor, manage and maintain the integrated set of services and infrastructure and provide a single point of contact for support and operations through a cross-functional set of people, processes and technologies.
e. The Company has advanced an overall architecture assessment approach to support capability modeling to create robust long-term roadmaps. By using enterprise solutions, the Company can reduce the quantity of similar solutions, which in turn creates a more streamlined portfolio that reduces the overall costs to manage and maintain and build stronger technical and business capabilities to expand value to end customers. This will allow the Company to identify and invest in solutions that create long-term value and can be extended to meet the evolving needs and nature of technology. This 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. The enterprise services proposed as part of the GMP are aligned to this approach.

(5) ADMS/SCADA – The Company proposed a five-year deployment effort to implement an ADMS and distribution SCADA ("DSCADA") system to support the increased number of distribution devices (FLISR, CVR/ VVO, telecommunications and feeder monitors) proposed in the GMP (as well as distributed energy resources ("DERs")) to meet the requirements for grid modernization. In addition, an effort to modernize, ensure compatibility, and integrate the Company's geographic information system ("GIS") database will be required, in order to support the ADMS.

Threats to the cybersecurity of critical infrastructures emanate from a wide spectrum of potential sources, including; state-sponsored espionage and sabotage, international terrorism, domestic militants, malevolent 'hacktivists' or even disaffected insiders. A reliable and secure grid is necessary to safely enable the grid-facing aspects of grid modernization, including limiting outages with a self-healing resilient transmission and distribution network, and other strategically important functions. Cybersecurity and privacy provisions will support the GMP by maintaining a reliable and secure electricity infrastructure and ensuring the protection needed for the confidentiality and integrity of the digital overlay. Pursuant to the Department's order, the preauthorized budgets for the grid-facing investments, incorporate implementation of any incremental cybersecurity measures associated with these investments.

A. Progress Toward Grid Modernization Objectives

In the Order the Department refined its objectives for grid modernization, based on developments in the electric industry and its review of the Companies' GMPs, and described the objectives as follows:

1. Optimize system performance by attaining optimal levels of grid visibility, command and control, and self-healing;
2. Optimize system demand by facilitating consumer price responsiveness; and
3. Interconnect and integrate distributed energy resources.[1]

National Grid's GMP contained a comprehensive suite of investments and initiatives that will modernize the Company's infrastructure and deliver significant customer benefits, including energy supply savings, reduced outage duration, reduced numbers of customers impacted by outages, improved system operations and system planning, and increased DER integration capacity. National Grid reviewed the approved elements of the GMP in the context of the revised objectives and aligned and revisited the plan elements in order to ensure progress towards the

[1] Previously the Department had included a fourth objective, "improve workforce and asset management," as a stand-alone objective. In the Order the Department determined that this would be eliminated as a stand-alone objective and would be considered within the context of the other three objectives.

revised grid modernization objectives during calendar year 2018. In calendar year 2019 National Grid developed detailed plans for each investment area and has continued executing those plans through the end of 2020.

At the beginning of 2020, National Grid continued to progress plans from 2019 and completed formalization and prioritization of the IT/OT and Communications portfolio from the initial three-year plan. In mid-March, the onset of the global pandemic was realized, and the Company took immediate actions to protect the employees, customers and our energy delivery networks. This global event and the global response were unforeseen and required swift and immediate response, for which the Company invoked the Business Continuity Plans and Pandemic Plans. The program incurred several impacts that included supply chain issues, workforce impacts, work plan changes, and prioritization of health and safety, reliability and essential customers. Calendar year 2020 also saw a significant increase in storms and our response which also impacted the grid modernization work plan in Massachusetts.

With respect to optimizing system performance, the Company completed planning and engineering efforts for the selection of locations for both feeder monitors and ADA. Once locations were identified and selected, the investments were progressed to the engineering design organization. The Company also completed analysis and identification of circuits to deploy VVO, which will help to optimize system demand. Once circuits were identified and selected, the investments were progressed to the engineering design organization. These investments have been under construction with some investments being enabled during 2020.

National Grid completed a strategic assessment of the telecommunications and the IT/OT approach and finalized the portfolio of solutions for building this technology foundation and infrastructure cornerstone for delivering the capabilities of the proposed grid modernization investments, including CVR/VVO, ADA, feeder monitors, ADMS/DSCADA, and integrating DG. 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 the first term investments.

Lastly, the Company has progressed 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.

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

The Company progressed investments across all the approved categories during 2020. The plans developed were significantly impacted by the global pandemic in the first half of 2020, yet the Company was able to sustain progress and was successful in delivering many of the plans. The impacts resulted in shifting of some field device deployment and subsequent enablement into plan year 2021. Below summarize the key highlights with the supporting details contained in each investment Category within Section III.

VVO – The Company progressed twenty feeders during 2020, an additional four feeders over the plan period target of sixteen. Construction was completed on three substations and 19 feeders, and one substation (Stoughton) was VVO enabled in July and began M&V testing protocol in December. The Company also exceeded the total devices constructed against the plan. In addition, the Company constructed and commissioned an additional 11 of 23 devices to support the ASO project.

ADA – The Company progressed sixteen feeders during 2020, with construction and commissioning completed on four feeders representing two FLISR schemes. The Company also exceeded the total devices constructed against the plan.

FM – The Company completed 66 of the 153 devices planned for 2020. While this is below the initial plan, the Company expects to complete over 180 in total through plan year 2021.

ADMS - The Company has progressed the development and implementation effort of the ADMS/DSCADA platform, which supports all three Grid Modernization objectives and remains on track for a phase 1 June 2021 deployment. The associated GIS elements which includes data clean up and validation of the connected model within GIS to support ADMS requirements remains on track. The Company also started RTU efforts in preparation for the ADMS integration opportunities expected with DSCADA.

Communications and IT/OT – The Company developed and issued a Wide Area Network (WAN) equipment vendor Request for Proposal in March 2020. This was followed by an internal review and vendor selection process. Three vendors were shortlisted and progressed to an equipment testing phase at a third-party test lab in late 2020. The final lab results and vendor selection are expected in early 2021. Construction standards for WAN expansion will occur after final vendor selection, and the associated standards for the fiber entry to substations have been developed and will be finalized in early 2021. The field area network (FAN) assessment and business case as well as the balance of field surveys for WAN expansion were deferred until 2021.

The Company has provided the summary of planned versus actual deployment of devices and spending as of December 31, 2020 in Tab 5.c. Spending - 2020 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 $82 million in incremental spending for grid-facing investments over three 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.[2] 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.[3]

The Company filed its documentation for its incremental O&M costs for its GMP in CY 2018 of $98,935, in Docket D.P.U. 19-36. Due to the small amount of these costs, they did not generate a Grid Modernization Factor ("GMF") to bill to customers. The Company deferred its request to recover these costs from customers to its GMF filing on March 15, 2020. The Company included these costs with the costs for CY 2019 for recovery through the GMF that the Company filed on March 15, 2020 to go into effect beginning May 1, 2020 in D.P.U. 20-31.

The CY 2020 spending includes costs for cybersecurity, ADA, ADMS, Feeder Monitors, VVO, GIS, and communications and IT/OT. The Company also has included costs associated with managing and delivering the portfolio, required change management and the evaluation plan. The Company has spent approximately $33 million in 2020 against an initial plan of approximately $38 million. The Company also placed approximately $8.7 million of plant in service against the initial plan of approximately $14 million. While below our initial plans, the aforementioned drivers and impacts from the global pandemic were the primary drivers for the variation.

As requested in the memorandum issued on March 11, 2021, the Company is including the capital and O&M costs for the plan years 2018-2020. These can also be found in Tab 5.c. Spending – 2020 Report in the attached DPU Annual Report Template. The Company had represented Total Spending to include both capital and O&M for prior reporting periods. The capital investments for the ADMS and Communications / IT/OT contain certain investments that are to be deployed across Massachusetts, New York, and Rhode Island. The shared investment will be allocated using National Grid's standard allocation factors, and the costs presented in the table are the amounts estimated to be allocated to Massachusetts based on the allocation factors in effect as of March

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

31, 2021. For this reporting period, in alignment with the joint utilities, the Company is representing capital only in both the 2020 Actual Spending, at Row H, and the 2021 Revised Projected Spending at Row Q.

		Capital Spending			
		2018	2019	2020	2018-2020
Investment Category	**Charge Types**	**Actual**	**Actual**	**Actual**	**Actual**
Monitoring & Control (SCADA)	Labor		0.04	0.34	0.38
Monitoring & Control (SCADA)	Non Labor		0.19	2.12	2.31
Monitoring & Control (SCADA)	**Total**	$ -	**$ 0.23**	**$ 2.46**	**$ 2.69**
Distribution Automation	Labor		0.09	0.49	0.58
Distribution Automation	Non Labor		0.31	2.86	3.17
Distribution Automation	**Total**	$ -	**$ 0.40**	**$ 3.35**	**$ 3.75**
Volt-Var Optimization	Labor		0.15	1.41	1.56
Volt-Var Optimization	Non Labor		1.40	8.00	9.40
Volt-Var Optimization	**Total**	$ -	**$ 1.55**	**$ 9.41**	**$ 10.96**
Advanced Distribution Management System (ADMS)	Labor		0.08	0.90	0.98
Advanced Distribution Management System (ADMS)	Non Labor		0.27	7.98	8.25
Advanced Distribution Management System (ADMS)	**Total**	$ -	**$ 0.35**	**$ 8.88**	**$ 9.23**
Communications / IT/OT	Labor			0.09	0.09
Communications / IT/OT	Non Labor			1.29	1.29
Communications / IT/OT	**Total**	$ -	$ -	**$ 1.38**	**$ 1.38**
Workforce Management	Labor	N/A	$ -	$ -	-
Workforce Management	Non Labor	N/A	$ -	$ -	-
Workforce Management	**Total**	$ -	$ -	$ -	-
Electric Vehicles	Labor	N/A			-
Electric Vehicles	Non Labor	N/A			-
Electric Vehicles	**Total**	$ -	$ -	$ -	-
Energy Storage	Labor	N/A			-
Energy Storage	Non Labor	N/A			-
Energy Storage	**Total**	$ -	$ -	$ -	-
Total Grid Modernization	Labor	$ -	$ 0.36	$ 3.23	$ 3.59
Total Grid Modernization	Non Labor	$ -	$ 2.17	$ 22.25	$ 24.42
Total Grid Modernization	**Total**	$ -	**$ 2.53**	**$ 25.48**	**$ 28.01**

	O&M			
	2018	2019	2020	2018-2020
Investment Category	Actual	Actual	Actual	Actual
Monitoring & Control (SCADA)	$ -	$ 0.17	$ 0.19	$ 0.36
Distribution Automation	$ -	$ 0.06	$ 0.01	$ 0.07
Volt-Var Optimization	$ -	$ 0.28	$ 0.30	$ 0.58
Advanced Distribution Management System (ADMS)	$ -	$ 0.56	$ 2.97	$ 3.53
Communications / IT/OT	$ 0.10	$ 1.76	$ 2.39	$ 4.25
Electric Vehicles	N/A	$ -	$ -	$ -
Workforce Management	$ -	$ -	$ -	$ -
Energy Storage	N/A	$ -	$ -	$ -
Admin & Regulatory	$ -	$ 1.31	$ 1.79	$ 3.10
Total Grid Modernization	**$ 0.10**	**$ 4.14**	**$ 7.65**	**$ 11.89**

	Capital and O&M			
	2018	2019	2020	2018-2020
Investment Category	Actual	Actual	Actual	Actual
Monitoring & Control (SCADA)	$ -	$ 0.40	$ 2.65	$ 3.05
Distribution Automation	$ -	0.46	3.36	3.82
Volt-Var Optimization	$ -	1.83	9.71	11.54
Advanced Distribution Management System (ADMS)	$ -	0.91	11.85	12.76
Communications	0.10	1.76	3.77	5.63
Electric Vehicles	N/A	$ -	$ -	-
Workforce Management	N/A	$ -	$ -	-
Energy Storage	N/A	$ -	$ -	-
Admin & Regulatory	$ -	1.31	1.79	3.10
Total Grid Modernization	**$ 0.10**	**$ 6.67**	**$ 33.13**	**$ 39.90**

The Company is providing the complete summary of planned versus actual spending as of December 31, 2020 in Tab 5.c. Spending – 2020 Report in the attached DPU Annual Report Template. Refer to columns D-L.

II. Program Implementation Overview

A. Organizational Changes to Support Program Implementation

The Company established a new organization in August 2018, the Grid Modernization Execution organization, to drive the delivery of the Grid Modernization investment areas approved in the Order. This 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.

The Company implemented a cross-functional Steering Committee to provide guidance and oversight of the GMP implementation process. The chair of the Steering Committee is the Electric Business Unit Chief Operating Officer. The Steering Committee includes representation from

Engineering Asset Management and Planning, Information Technology, Electric Control Centers, Regulatory, Finance and Budgeting. The Steering Committee provides oversight for budget and implementation of the GMP investments, facilitates appropriate functional support and staffing, and champions program activities.

The Company has organized delivery of the core grid modernization investments, initiatives and capabilities into the following areas listed below: 1) Physical Infrastructure, 2) Advanced Distribution Management System, 3) Grid and Network Communications, 4) Program and Change Management, and 5) IT enabling platforms.

Physical Infrastructure (sensing & operating)	Advanced Distribution Management System	Grid and Network Communications	PMO, Change and Data Management	Information Technology Enabling Platforms
What's included: ▪ VVO/CVR ▪ Distribution Automation ▪ Feeder Monitoring Sensors **Type of work:** ▪ Primarily consists of installation and commissioning of new field devices for sensing and automated field operation **Current status of the work:** ▪ Majority of the work is currently between the engineering and construction phase. Primarily delivered by operational groups. **Scope of the work:** ▪ Feeder Monitors ▪ Advanced capacitors and regulators for voltage optimization ▪ Advanced reclosers to enable FLISR **IT and Cyber involvement:** ▪ IT: Low to Medium ▪ Cyber: Medium **Responsibilities of Grid Mod team:** ▪ Project Management ▪ Technical support (engineering) ▪ Field coordination ▪ Standards development ▪ Training and support **Dependencies:** ▪ Limited	**What's included:** ▪ ADMS ▪ DSCADA ▪ DERMS (future project) **Type of work:** ▪ Implement new ADMS, upgrade and integrate GIS systems, perform network data cleanup and incorporate advanced applications **Current status of the work:** ▪ Currently the projects are in the development and implementation phase. Primarily delivered by IS and the Project team. **Scope of the work:** ▪ Implement ADMS Phase 1 platform ▪ GIS data model, attribute and cleanup ▪ Advanced Applications ▪ Advanced Load Flow ▪ RTU dual porting **IT and Cyber involvement:** ▪ IT: High ▪ Cyber: High **Responsibilities of Grid Mod team:** ▪ Project Management ▪ Business requirements ▪ Technical Architecture ▪ Solution Design and Delivery ▪ Deployment and Support ▪ Change management **Dependencies:** ▪ GIS ▪ RTU	**What's included:** ▪ TOMS ▪ DMX ▪ INOC ▪ Network Tiers ▪ Lab **Type of work:** ▪ Provide a reliable, cost-effective two-way communications capability to end devices and the capability to manage, maintain and troubleshoot the communications network. **Current status of the work:** ▪ Most of the projects are in the scoping or early implementation phase. **Scope of the work:** ▪ Wide Area Network, Field Area Network ▪ Network and operational management systems ▪ Network deployment and support **IT and Cyber involvement:** ▪ IT: High ▪ Cyber: High **Responsibilities of Grid Mod team:** ▪ Project Management ▪ Business requirements ▪ Operational Telecom Services **Dependencies:** ▪ Alignment with broader organizational telecom strategy	**What's included:** ▪ Project Financial Controls ▪ Project Management Office ▪ Data Management ▪ Regulatory Reporting and Metrics ▪ Change Management **Type of work:** ▪ Drive successful program delivery in accordance with business management system and project management principles **Current status of the work:** ▪ PMO active with change and data completing resourcing and prioritization **Scope of the work:** ▪ Program PMO ▪ Change Management strategy and execution ▪ Data Architecture Design ▪ Data Analysis and Reporting ▪ Regulatory Reporting ▪ Value and Risk Management ▪ Business Process Definition and Mapping **Responsibilities of Grid Mod team:** ▪ Regulatory filings ▪ Steer Co and Mgmt reporting ▪ Program Controls and Assurance ▪ Business Readiness and Change **Dependencies:** ▪ Adherence to company frameworks and practices	**What's included:** ▪ Comprehensive Integration Services ▪ Data Management/Enterprise Analytics ▪ Cybersecurity **Type of work:** ▪ Investments integrating portfolio of GM systems, comprehensive data management, cybersecurity and data analytical functions. **Current status of the work:** ▪ Currently the projects are in the requirement and definition phase. Primarily delivered by IS and the Project team **Scope of the work:** ▪ Implement integration services platform ▪ Implement data management and analytics platform ▪ Deliver cybersecurity services **IT and Cyber involvement:** ▪ IT: High ▪ Cyber: High **Responsibilities of Grid Mod team:** ▪ Project Management ▪ Business requirements ▪ Technical Architecture ▪ Solution Design and Delivery ▪ Deployment and Support **Dependencies:** ▪ Business engagement

The Company incorporated existing business frameworks and practices and leveraged the existing capabilities, processes, procedures, departments and personnel to support 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.

In order to instill support for grid modernization activities across the organization, the Company has progressed the change management capability leveraging the outcomes from the 2019 Workforce Management Survey. During 2020, the Company developed materials and information and engaged the broader organization through staff meetings and change networks. These include Grid Modernization videos, one-pagers, Grid Modernization Minutes, and success stories.

B. Cost and Performance Tracking Measures Adopted

The Company has developed protocols and measures for identifying and tracking incremental capital and O&M expenses. The Company has grid modernization-specific work orders to distinguish the preauthorized grid modernization investments within its accounting system. 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.

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 both infrastructure and performance metrics described later in this Report. The EDCs have also supported and progressed the Evaluation Plan, which will be formally filed in June 2021.

C. Project Approval Process: Description and how it is different from the process for standard capital investments

The Company recognizes the requirement to maintain grid modernization investments separate from other capital investments, as described in the prior Section. 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. In 2020, the Electric Business Unit initiated a six-month pilot program to increase Delegations of Authority limits from $1 million to $2 million for electric projects. This pilot was active through December 2020 and included the Grid Modernization project C086675 for VVO/CVR software licenses in 2020.

III. Implementation by Investment Category

A. System Level Narrative by Investment Category

The Department preauthorized the following categories of grid-facing investments for a combined three-year budget of $82 million: (1) CVR/VVO; (2) ADA; (3) feeder monitors; (4) communications and IT/OT; and (5) ADMS/SCADA.[4] National Grid's cost estimates for the enabling infrastructure include: (1) a proposed budget of $48.4 million for three years for ADMS/SCADA; and (2) a proposed budget of $1.8 million over three years for communications and IT/OT.[5] National Grid's cost estimates for the field deployments include: (1) $10.6 million over three years for deployment of VVO; (2) $13.4 million over three years for deployment of ADA; and (3) $8 million over three years for feeder monitors.[6]

These investments and initiatives make progress on the Department's objectives for grid modernization in the following ways:

- They optimize system performance by providing automated outage and restoration notifications, assisting with determining outage locations and damage, and automatically

[4] D.P.U. 15-120, Grid Modernization Plan (filed June 14, 2016) at 29, 32, 35, Atts. 3, 5; Order at 154-155.
[5] D.P.U. 15-120, Grid Modernization Plan (filed June 14, 2016) 29, 35.
[6] D.P.U. 15-120, Grid Modernization Plan (filed June 14, 2016) at 29, 32, 35, Atts. 3, 5; Order at 155, n. 81.

rerouting power during outages in order to minimize the number of customers impacted and the length of outages. The ADA program is specifically designed to significantly reduce the minutes of interruption experienced by customers by automatically re-routing power in a way that the current system is not capable of and will be deployed on the most high-value feeders.

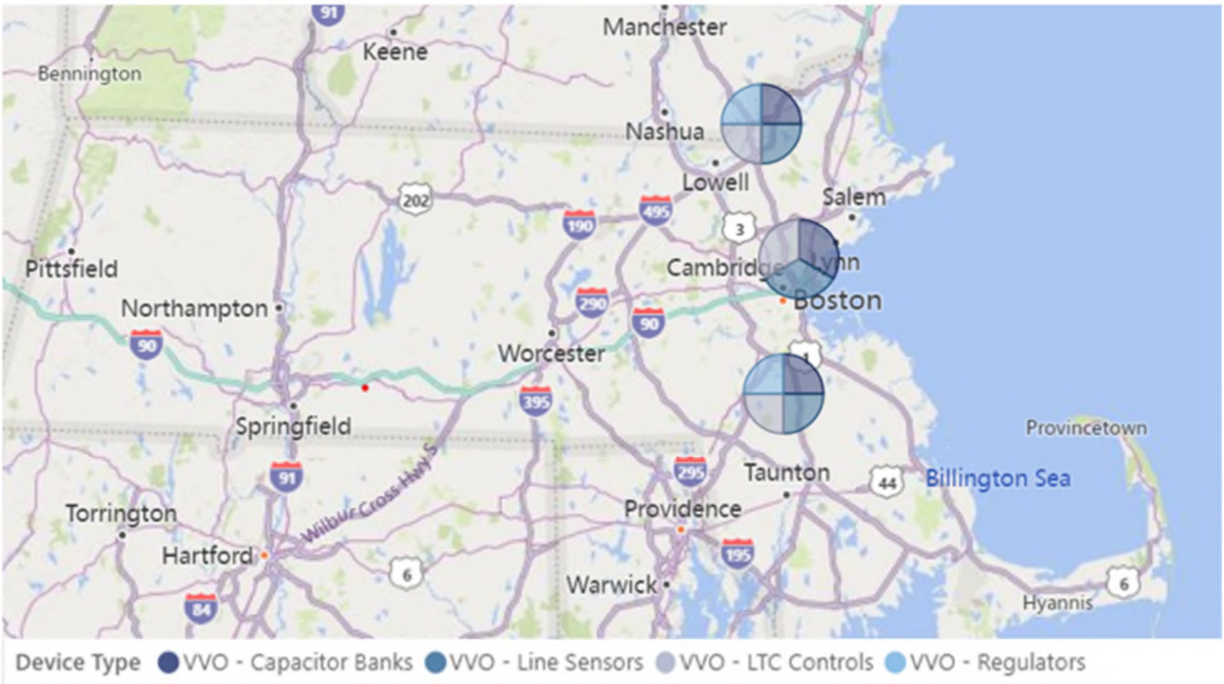
- They optimize system demand by creating a more efficient electric system with more real-time monitoring and control, better-managed system voltage and fewer losses. The CVR/VVO program will intelligently switch reactive power and voltage support devices to reduce losses, improve power factor and reduce demand in a way that the current system is unable to do. This program is designed to provide peak and demand savings to customers, without them having to take any active steps.
- They help interconnect and integrate DERs by providing more real-time information about the distribution system. The increased operational system awareness from the deployment of feeder monitors, ADA and CVR/VVO will collectively allow for much more data to be used when determining distributed generation DG impact studies.

The ADMS/DSCADA solution will enable advanced applications and distribution load flow to help manage circuit performance and the optimization of DERs.

(1) Volt Var Optimization (VVO)

VVO is a distribution-level program where voltage control devices are intelligently controlled in a coordinated manner to optimize the distribution system. This program is designed to minimize system losses, while simultaneously reducing both demand and energy use of customers.

Installed VVO Devices



(a) Description of Work Completed

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. Throughout the year, the Company made continual progress toward the goal of deploying VVO onto 20 feeders, including 16 feeders and four additional contingency feeders. The following table provides details of the equipment installed to support the VVO investments.

	Planned				
Substation	**# Feeders**	**Cap Banks**	**Regulators**	**Feeder Monitors**	**Substation Bus**
East Methuen	6	19	12	6	2
Maplewood	4	17	3	4	1
Stoughton	6	18	3	6	1
	16	**54**	**18**	**16**	**4**

	Actual				
Substation	**# Feeders**	**Cap Banks**	**Regulators**	**Feeder Monitors**	**Substation Bus**
East Methuen	6	19	12	6	2
Maplewood	8	32	15	9	2
Stoughton	6	18	3	6	1
	20	**69**	**30**	**21**	**5**

The VVO implementation process involves several stages and multiple departments throughout the company:

- Design and Work Request preparation: Distribution Planning and Asset Management, Distribution Design, Substation Engineering and Design
- Material ordering and Prep: 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

The VVO technology is new to most of the departments involved with the process, so implementation begins with training all personnel on the technology and unique requirements of VVO. The Grid Modernization Execution team is responsible to administer the training and track the progress of the work through commissioning and then Measurement & Verification (M&V) testing. Progress throughout 2020 included:

- Continued streamlining the overall process, from design to commissioning, reducing end-to-end duration of the deployment.
- Continued refining documentation for all key processes with updated check sheets, job aids, and material tracking.
- Procurement of equipment (capacitors, regulators, feeder monitors and advanced controls) to ensure a continuous flow of devices from supplier to meet project demands.
- Completed all device installations for 17 feeders.

- Continued to gain many insights into the process that allowed the Company to make improvements in design, construction, installation, commissioning and safety.
- Maintained the central repository for VVO device locations and their associated control settings.
- Updated Energy Management System ("EMS" – part of Distribution Management System ("DMS")) visual screens with all new VVO field devices.
- Two substations (Stoughton and East Methuen, total of 12 feeders) completed all construction and commissioning.
- One substation (Maplewood, eight feeders) completed all construction and approximately 90% of commissioning.
- Stoughton Site Acceptance Test was successfully completed. This involved running the system for 24 hours a day for two weeks.
- Stoughton VVO system was put into service on July 24th.
- M&V test protocol was initiated on the Stoughton Substation on December 1st.
- Developed formal training modules for Engineering, Design and Construction.

(b) Lessons learned/challenges and successes

Lessons Learned

- We recognized the importance of having a program manager facilitating the progress of the work as it transitioned from phase to phase and department to department.
- We found that, while each substation and its equipment are unique, there are still many similarities in the process. Passing Lessons Learned from one substation to the next has helped us to refine and shorten the process.
- We recognized that the process of preparing and office commissioning equipment for VVO is new to the operating personnel. We had to build a process and create manual tracking sheets to track the progress.
- We learned that roles and responsibilities vary slightly between operating areas, often based on labor agreements. We were able to adjust the process to adhere to these agreements and share best practices to improve efficiency.

Challenges

- The biggest challenge for CY2020 was learning how to work with the limitations and restrictions of COVID. This lengthened the installation process for all equipment.
- The VVO technology was new to the workforce in Massachusetts. We needed to train the workforce to familiarize them with the operation of VVO and the uniqueness of the equipment used for the program.
- We identified a challenge in our material planning and management processes that limited visibility of material availability and location. This is being addressed for future rollouts.

Successes

- We were able to build a new streamlined process for Office Commissioning that led to streamlined workflow and reductions in downstream error.
- We were able to demonstrate that a program like VVO can be completed from end to end within one calendar year (from design to in-service).
- We successfully built a Material Planning process to forecast and order long lead-time equipment, eliminating any material shortages.

(c) Actual verses planned implementation and spending, with explanations for deviation and rationale.

Tab 5.c. Spending – 2020 Report in the attached DPU Annual Report Template provides the deviation in the implementation and spending. Refer to columns D-L, rows 22-28.

(d) Performance on implementation/deployment.

The Company continued construction and commissioning of field devices and substations throughout 2020. Work was completed on three substations and 19 feeders, exceeding the goal of 16. One substation (Stoughton) began M&V testing protocol in December.

(e) Description of benefits realized as the result of implementation.

The primary benefit of VVO is 2% to 4% energy efficiency. This is realized as soon as the system is turned on. In July, just before the start of the peak summer months, the VVO system installed on the Stoughton substation and feeders was commissioned and went into service, allowing us to capture the energy efficiency during the highest demand of the year. In December, we started to run the M&V protocol on Stoughton. At the conclusion of this M&V test, we will be able to quantify the actual savings.

(f) Description of capability improvement by capability/status category.

The VVO system deployed on the Stoughton Substation/Feeders was commissioned and enabled in July 2020, which began the period in which the VVO system was optimizing energy usage based on system needs and loads. The formal measurement and verification was initiated in December 2020. Additionally, even before the system was fully operational, all equipment deployed for VVO (once installed and field commissioned) provided the ancillary benefits of providing visibility and data to the DCC and system operators. This aids the operators during storms, for example, to identify fault locations which improves response time for repairs.

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
- Reduction in greenhouse gas (“GHG”) emissions
- 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

(g) Key milestones.

Substation	East Methuen	Maplewood	Stoughton
Milestone	**Completion Date**	**Completion Date**	**Completion Date**
Complete Project Sanction	May 2019	May 2019	May 2019
Engineering Completed	July 2019	July 2019	July 2019
Design Completed	December 2019	January 2020	November 2019
Construction Completed	December 2020	December 2020	June 2020
In service date	February 2021	May 2021	July 2020

(h) Updated projections for remainder of the three-year term.

The Company is forecasting completion of 20 feeders during the three-year plan period. Tab 5.c. Spending – 2020 Report in the attached DPU Annual Report Template provides the updated projections. Refer to columns P-R, rows 22-28.

The Company is also progressing the design and construction of a modest subset of advanced capacitors that will be deployed in Central and Western Massachusetts to mitigate potential impacts of DG. There is a situation where the transmission system is seeing a high voltage concern when they model the high volume of DG proposed for central and western Massachusetts. The voltage increase is due to the offloading of the transmission line, leaving excess volt-ampere reactives ("VARs"), which is driving the voltage up. The solution being pursued is to replace existing capacitor banks on the distribution system with smart capacitor banks, which will be set to turn off during light load conditions, with a voltage override. The ISO approved this approach through the Company's Transmission Planning organization. The Company has identified 23 capacitor banks to be spread across multiple substations in Central and Western territory. As a result of these emerging DER issues and opportunities in Central and Western Massachusetts, the Company is deploying voltage optimization investments to progress grid modernization objectives.

Div.	Planned Operating District	Sub Ref	Substation	City	Feeders	Devices
BSW	Central – 01	607	Crystal Lake	Gardner	4	6
BSW	Central – 01	609	E Westminster	Westminster	2	3

BSW	Central – 01	525	Lashaway	West Brookfield	1	1
BSW	Central – 01	415	W Charlton	Charlton	1	1
BSW	Central – 01	55	Treasure Valley	Rutland	1	1
BSW	Western - 09	702	Chestnut Hill	Athol	2	4
BSW	Western - 09	507	Wilbraham	Wilbraham	1	1
BSW	Western - 09	508	E Longmeadow 1	E Longmeadow	1	1
BSW	Western - 09	503	Palmer	Palmer	2	2
BSW	Western - 09	139	N Hampden	Hampden	1	1
BSW	Western - 09	516	Little Rest Rd	Warren	1	1
BSW	Western - 09	523	Thorndike	Ware	1	1
					18	**23**

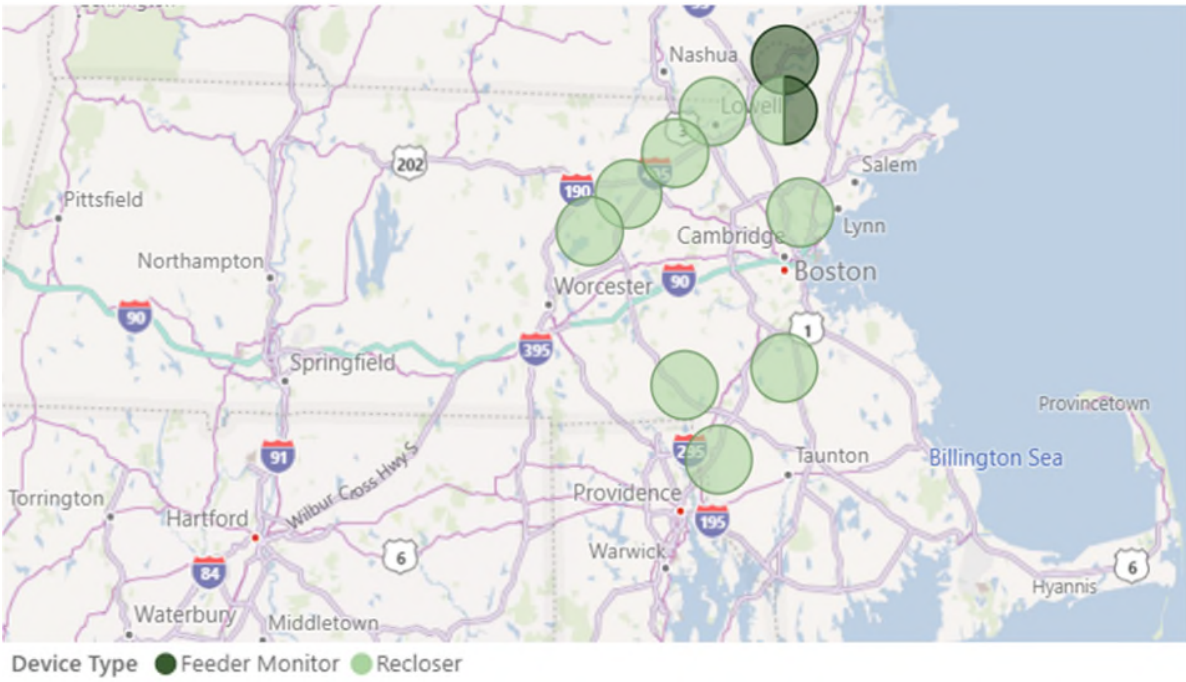
	Commissioned					
Div.	**Operating District**	**Sub Ref**	**Substation**	**City**	**Feeders**	**Devices**
BSW	Central – 01	607	Crystal Lake	Gardner	1	2
BSW	Central – 01	525	Lashaway	West Brookfield	1	1
BSW	Central – 01	415	W Charlton	Charlton	1	1
BSW	Central – 01	55	Treasure Valley	Rutland	1	1
BSW	Western - 09	507	Wilbraham	Wilbraham	1	1
BSW	Western - 09	508	E Longmeadow 1	E Longmeadow	1	1
BSW	Western - 09	503	Palmer	Palmer	2	2
BSW	Western - 09	139	N Hampden	Hampden	1	1

BSW	Western - 09	523	Thorndike	Ware	1	1
					10	**11**

(2) Advanced Distribution Automation

ADA is a FLISR-based advanced distribution automation program where sectionalizing protection equipment is automated and controlled in a coordinated manner, to minimize the effects of outages. 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 the uninvolved sub-sections to be resupplied via automated tie points, significantly reducing both impacted customers and outage durations. National Grid currently has communications capabilities to some of the reclosers on the distribution system but does not currently coordinate their operation during faults beyond their local protective control. The Company also has limited FLISR capabilities still active within the former Worcester Smart Energy Solutions Pilot ("Pilot") area. The ADA scheme will replace manual tie points between adjacent feeders, to provide for downstream restoration. It also will integrate enhanced telecommunications and additional control on existing protective switches, and potentially add switch locations as necessary to optimize system reliability.

Installed ADA Devices



(a) Description of work completed.

The FLISR/ADA program deployment for Massachusetts was initiated in the second quarter of 2019 with the selection of substations and feeders to be upgraded with the new technology. In the third quarter of 2019 the engineering team scoped out 27 additional feeders. Additionally, in the beginning of 2020, the engineering team scoped out 29 feeder monitors and 1 capacitor bank to maximize FLISR automation. The feeder monitors were added to ensure load checks were accurate so that the FLISR automation can safely tie into another feeder when the opportunity arises. The capacitor bank was included to address some voltage concerns on a FLISR feeder. Throughout the year of 2020, the Company made continual progress toward the goal of deploying FLISR/ADA onto 43 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 an automated and reliable 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 number of customers served. The second round of deployment added slightly more complexities with more reclosers per scheme and one scheme with DERs.

The following is a list of work completed for the year:

- Documentation of all key processes with updated check sheets and job aids.
- Engineering analysis of candidate circuits through evaluation of poor-performing feeders and various metrics.
- Streamlining the overall process, from planning and designing to commissioning and implementation to reduce end-to-end duration of deployment.
- Built out end-to-end FLISR process map.
- Documentation of all key processes with updated check sheets and job aids.
- Verification of good signal for field device communications with telecom surveys.
- Proactive procurement orders with Inventory Management (reclosers, control boxes, radios, feeder monitors, etc.) to get ahead of long lead times and meet project schedules.
- Completed design for all field work and issued work requests for the 43 feeders.
- Successfully identified the need for alternative settings and updated control box settings request forms to include features required for automation.
- Collected lessons learned throughout the process to make improvements in planning, engineering, design and procurement.
- Planned scheduling and construction of various FLISR work requests.
- Implementation of two FLISR schemes that went live and are currently active.

Planned

District	Substations with (Feeder)	Reclosers	Feeder Monitors
BSN	West Methuen (63L1) & East Dracut (75L3)	3	1
BSN	Hoover St (21L1) & North Dracut (78L1)	4	1
BSN	Westford (57L2 & 57L3)	5	2
BSN	East Boxford (33L1) & Woodchuck Hill (56L3)	3	0
BSW	Fitch Rd (216W6) & Ayer (201W2)	4	2
BSS	Stoughton (913W69 & 916W43)	4	0
BSS	West Quincy (3W3) & Field St (1W5)	4	0
BSS	Read St (9L3 & 9L6)	4	1

BSS	Union St (348W7 & 348W8)	5	1
BSS	Read St (9L1) & Charley Pond (8L3)	3	1
BSN	Woodchuck Hill (56L1) & East Tewksbury (59L6)	5	2
BSN	Maplewood (16W6) & Melrose (25W4)	5	2 (1 Cap)
BSN	Water St (31L2) & North Haverhill (48L2)	4	2
BSN	West Salem (29W2) & Railyard (49W2)	5	2
BSN	Saugus (23W2) & West Salem (29W1)	4	2
BSN	North Beverly (18L2) & East Beverly (51L3)	2	1
BSN	Winthrop (22W5) & Metcalf Sq (96W1)	4	2
BSN	West Newbury (47L1) & Whittier (76L1)	4	2
BSS	Franklin (341W1) & Beaver (344W5)	6	2
BSN	Quinn (24W1 & 24W2)	2	2
BSS	Belmont (98W19) & East Bridgewater (797W19)	2	0
BSS	Dupont (91W49) & East Bridgewater (797W19)	3	1
		85	29

(b) Lessons learned/challenges and successes.

The Company enabled four feeders representing two ADA schemes in 2020 and has built upon the lessons learned from its Pilot which deployed ADA. The key lessons from the grid-facing portions of the Pilot include:

- 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 a broader set of employee roles and capabilities than exists in the current utility workforce in order to deliver and manage this new, enhanced equipment and technologies.

- Using a hybrid grid communications strategy where a combination of cellular, 900Mhz and other solutions can coexist to provide options for connecting to devices when circumstances require it.
- The need to establish an independent data analytics solution and information repository for the engineering data required to support the evaluation plan and perform advanced engineering analysis.
- The significance of communication among stakeholders regarding candidate selection to avoid problematic areas of implementation. Suggestions and open discussion help bring to light the roadblocks that are not otherwise known.
- The need to ensure that zone logic and automation capabilities are programmable within the data concentrator, Orion, 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.
- Anticipating unknowns and adapting the plans and response to minimize impacts to plans and schedules. This occurred in the form of the need for alternative settings for reclosers that act as the tie points; this need was identified and implemented ensuring that it will be accounted for in future rollouts.
- The importance of staying engaged and aware of other recloser program inventory needs and construction schedules. 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 two FLISR schemes that went live.
- There were a few challenges in Design where incorrect funding and scopes with missing 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.
- A major success of 2020 was the implementation of two FLISR schemes on four feeders and collecting the lessons learned from the process. With this knowledge, the project team was able to proactively prepare for future commissioning and kick off a strong start to 2021.

(c) Actual vs. planned implementation and spending, with explanations for deviation and rationale.

Tab 5.c. Spending – 2020 Report in the attached DPU Annual Report Template provides the deviation in the implementation and spending. Refer to columns D-L, rows 17-21.

The Company planned for eight FLISR schemes to go-live in 2020 but was only able to achieve two FLISR schemes to go-live during the year. During 2020, efforts to commission sixteen feeders on eight FLISR schemes was delayed due to the on-going pandemic where resource impacts affected absences of approximately 20-25% of crews in various barns. The Company also encountered materials lead time and vendor procurement delays which impacted the ability to schedule work at the beginning of the calendar year. Additionally, 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. There is also internal prioritization of materials management and incorporation of materials demand increases described in the lessons learned. The Company progressed procurement of Orion LX servers for the program which will serve as the FLISR Automation Platform until ADMS is implemented.

(d) Performance on implementation/deployment.

The Company has installed and commissioned two FLISR Schemes in calendar year 2020. Installations are continuing to progress for ADA on circuits during 2021 where there will be six more schemes to go-live. Additionally, key accomplishments from the Company plans were as follows:

- The Company designed eight ADA Schemes on 16 feeders.
- The Company scoped out fourteen additional ADA schemes on 27 feeders.
- The Company procured server equipment for the Northborough Control Center which allowed us to test the ADA schemes and verify the proposed logic was functional.
- The Company updated and standardized the new 6IVS reclosers from the vendor.
- 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 two ADA schemes to go-live without any issues.

(e) Description of benefits realized as the result of implementation.

There are no benefits realized yet for this annual reporting period. The benefits of ADA are expected to include:

- Optimizing system performance – National Grid anticipates approximately a 25% reduction in main line customer minutes of interruption (“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.

- 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.
- 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.

(f) Description of capability improvement by capability/status category

ADA capability improvement will enhance reliability and resiliency. These metrics will be tracked once ADA is fully commissioned and live.

(g) Key milestones.

	Area of Scheme & Target Dates		
Milestones	**Bay State North – 4 ADA Schemes**	**Bay State South - 3 ADA Schemes**	**Bay State West - 1 ADA Scheme**
Project Sanction Completed	May 2019	May 2019	May 2019
Engineering Completed	July 2019	July 2019	July 2019
Design Completed	Nov. 2019	Nov. 2019	Nov. 2019
Construction Completed	April 2021 (anticipated)	April 2021 (anticipated)	April 2021 (anticipated)
Commission Completed	May 2021 (anticipated)	May 2021 (anticipated)	May 2021 (anticipated)
In service date	May 2021 (anticipated)	May 2021 (anticipated)	May 2021 (anticipated)

(h) Updated projections for the remainder of the three-year term.

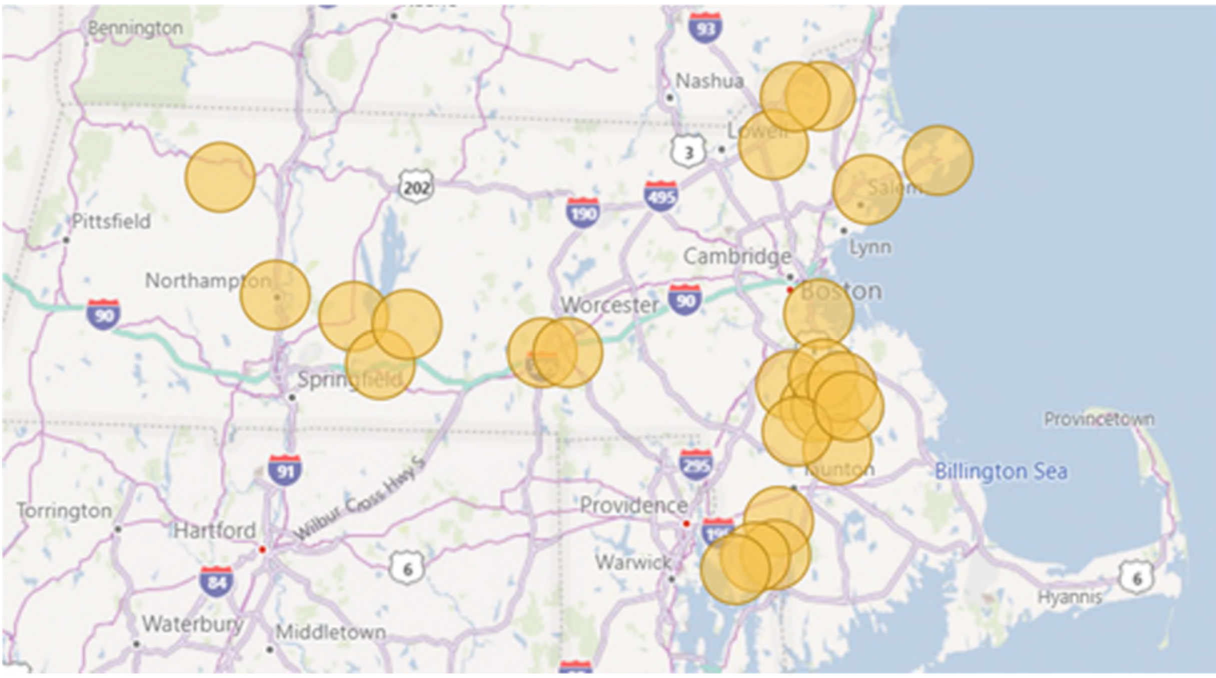
The Company is forecasting completion of 32 reclosers on the initial 16 feeders for calendar year 2021. Future deployment goals for 2021 are an additional 54 reclosers, 29 feeder monitors and 1 capacitor bank on 27 feeders. Tab 5.c. Spending – 2020 Report in the attached DPU Annual Report Template provides the deviation in the implementation and spending. Refer to columns D-L, rows 17-21.

(3) Feeder Monitors.

The feeder monitors program installs interval power monitoring devices on feeders where the Company does not currently have this information. Feeder monitors create visibility for the control centers and the information collected is used to inform the engineering planning and asset management assessments.

National Grid has over 1,100 distribution feeder circuits in Massachusetts. Of these circuits, less than half are monitored by an interval sensor and therefore do not report live data to the operational control centers or inform electric planning with interval data. This lack of historic 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 important 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, in furtherance of the Department's objectives for grid modernization.

Installed M&C Devices



(a) Description of work completed.

The Company has reviewed the population of feeders, with a focus on overhead feeders, in National Grid's distribution system which lack sensing capabilities. As large upgrades are made to substations and circuits, often this need is addressed with sensing and communicating equipment. National Grid is deploying head-end mainline feeder monitors which are used to capture real-time voltage, current and power. 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 three-year grid modernization plan term.

Following is a list of work completed this year:

- 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.
- Sanctioning was completed for the project and the scope of the project was clearly laid out.
- Design surveyed and checked the locations given to them by preliminary engineering. They take these locations and design each project in accordance with National Grid standards.

- Both Telecom Operations ("Telecom Ops") and Distribution Control and Integration ("DC&I") 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 Mod and Engineering created an office commissioning step to ensure that all communication equipment was operational before field deployment.
- Field construction and commissioning of 66 field devices was completed.

(b) Lessons learned/challenges and successes.

After going through 66 installs there were several lessons learned some of which built upon lessons learned from prior years, including:

- 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 Control Center and the Overhead group.
- 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/employees 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 Installation.
- 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.

Challenges

- Due to the COVID-19 pandemic, a work plan prioritization process was established which altered initial plans and scheduling.
- Biweekly meetings we instituted in order to track all changes to schedule resulting from the COVID-19 pandemic as well as resourcing issues and timeline concerns from all parties involved with the project completion.

Successes

- Successfully increased the intake of feeder data across the state through installing 66 Feeder Monitor devices. These data gathered has already led to important grid modernization improvements through their detection of load imbalance.

- Successfully completed training with Overhead Operation and Telecom for new Feeder Monitor equipment that we are expecting to be using next year in the field.

(c) Actual vs. planned implementation and spending, with explanations for deviation and rationale.

Tab 5.c. Spending – 2020 Report in the attached DPU Annual Report Template provides the deviation in the implementation and spending. Refer to columns D-L, rows 9-16.

Building upon the initial five feeder monitors installed in 2019, for calendar year 2020, 66 additional feeder monitor devices were completed and commissioned. The main contributing factor to the discrepancy from the goal of 150 completed was the COVID-19 pandemic. There were multiple challenges that the pandemic presented that caused delays in the project timeline. The most significant was the reduction in work hours due to COVID-19 Guidelines and prioritization of essential maintenance to enable the regional shift to work from home for our customers. A lesser but still important to note impact is also quarantine time of crews exposed to the COVID-19 virus and work-location shut downs that came from localized incidence of infection in smaller work locations. These collectively caused the reduction in work leading to the 2020 feeder monitoring goal being missed. In addition to COVID-19 concerns, one other factor that delayed installs was that certain location required two sets of sensors due issues determined during overhead precheck such as bifurcation and location-based construction constraints, including but not limited to pole replacements, pole relocation, and environmental considerations. All of these caused delays to the construction schedule. One hundred thirty feeder monitor installs are scheduled to be completed in 2021.

(d) Performance on implementation/deployment.

The deployment of the 66 sensors was successful. All sensors are reporting data back correctly and completing their designated function. 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 our PI Historian software. See Benefits in the following sub-section (e).

(e) Description of benefits realized as the result of implementation.

- Visibility of real-time demand.
- During the winter storm event on October 17th, 2019, the feeder monitors saved time in the technical assessment of the 910W2 feeder in Hanover, Massachusetts. During the emergency outage our 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 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 not 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 of the 65L3, 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 we were able to adjust the LTC such that we raised the nominal up to around 99% during its low dips and as high as 103%.

(f) Description of capability improvement by capability/status category (e.g., VVO-enabled, Fully Automated, ADMS Load Flow Modelling, Control Functions, Reduced Zone Size).

With the 66 completed installs we have already begun to see an increase in the visibility that the Distribution Control Center and Distribution Planning and Engineering teams have on the loading of lines. 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.

Milestones	Install Numbers and target dates					
FM installs	1-9	10- 25	25-55	55-90	90-130	130-196
Complete Project Sanction	Apr-19	Apr-19	Jul-19	Jul-20	Jul-20	Jul-20
Engineering Completed	Jul-19	Oct-19	Mar-20	Aug-20	Nov-20	Jan-21
Design Completed	Jul-19	Oct-19	Mar-20	Aug-20	Nov-20	Jan-21
Construction Completed	Feb-20	Jun-20	Nov-20	Feb-20	Apr-20	Aug-21
In-service date	Feb-20	Jun-20	Nov-20	Feb-20	Apr-20	Aug-21

*Note: Plan based on total number of feeder monitors installed. While there are 180 locations, each location can have multiple feeder monitor sets installed.

(h) Updated projections for remainder of the three-year term.

The Company is still targeting completion of 197 feeder monitors during the three-year plan period. Tab 5.c. Spending – 2020 Report in the attached DPU Annual Report Template provides the updated projections for the 2021 plan year. Refer to columns M-U, rows 9-16.

ACTUALS COMMISSIONED 2019

District	Town	Device	QTY
Southeast	Abington	Lindsey	2
Southeast	Pembroke	Lindsey	1
Southeast	Hanover	Lindsey	1
Southeast	Bridgewater	Lindsey	1
TOTAL			5

ACTUALS COMMISSIONED 2020

District	Town	Device	QTY
Central	Auburn	Lindsey	1
Central	Millbury	Lindsey	2
TOTAL			3

District	Town	Device	QTY
Merrimack Valley	Andover	Lindsey	3
Merrimack Valley	Haverhill	Lindsey	2
TOTAL			5

District	Town	Device	QTY
North Shore	Beverly	Lindsey	2
North Shore	Gloucester	Lindsey	1
TOTAL			3

District	Town	Device	QTY
South Shore	Dighton	Lindsey	1
South Shore	Somerset	Lindsey	1
South Shore	Swansea	Lindsey	3
TOTAL			5

District	Town	Device	QTY
Southeast	Abington	Lindsey	4
Southeast	Bridgewater	Lindsey	2
Southeast	Brockton	Lindsey	18

Southeast	Cohasset	Lindsey	1
Southeast	Easton	Lindsey	3
Southeast	Holbrook	Lindsey	2
Southeast	Quincy	Lindsey	3
Southeast	Rockland	Lindsey	1
Southeast	Stoughton	Lindsey	4
TOTAL			38

District	Town	Device	QTY
Western	Belchertown	Lindsey	1
Western	Buckland	Lindsey	1
Western	Northampton	Lindsey	1
Western	Palmer	Lindsey	5
Western	Ware	Lindsey	2
Western	Warren	Lindsey	3
TOTAL			13

(4) Communications and Information/Operational Technologies (IT/OT)

At the beginning of calendar year 2020, the Company revisited the priorities and needs for the Communications and IT/OT investment area. Based upon a review of the planning work performed in 2019 and the initial enterprise architecture assessment, the Company revised the priorities to deliver on the initial grid modernization plan investments and objectives. Specifically, it decided to defer significant investments in private fiber expansion for the initial plan period and focus on further developing the field area network ("FAN") and wide area network ("WAN") solutions. Furthermore, development and implementation of the Telecommunications Operations Management System ("TOMS") solutions will deliver greater capabilities and cost efficiencies over the longer term as well as provide the Operations groups increased capability to manage, maintain and troubleshoot the growing communications network. The Company also prioritized the IT investments for the comprehensive integration service and an enterprise analytics (EA) platform to deliver efficiencies and benefits from the inflight efforts.

The Company described the following investment priorities within Communications and IT/OT:

- **Comprehensive Integration Services (CIS)** – The integration services to enable the exchange of information between systems, services and devices.
- **Enterprise Analytics (EA)** – The big data analytics capabilities to allow for the analysis of the data gathered from grid modernization investments combined with existing and

third-party data sources, providing valuable output reflecting current state as well as predictive and prescriptive outcomes.

- **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 ("INOC")** – To actively monitor, manage and maintain the integrated set of services and infrastructure and provide a single point of contact for support and operations through a cross functional set of people, processes and technologies.
- **Applications and Devices** – The deployment of distribution solutions supporting the monitoring, management and control of the distribution grid.
- **Enterprise Architecture** – The 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.

<u>**Comprehensive Integration Services**</u>

CIS 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. National Grid 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 expected benefits are:

- A service-driven architecture establishes a framework that supports business service orientation. Standard methods of integration are leveraged.
- Business services are aligned to repeatable business tasks – e.g. Outage, Customer notification. Reusable services can be called from various processes.
- Modular applications with a set of related and integrated information services ("IS") are constructed to be flexible in supporting the business process. There is an ability to orchestrate processes across lines of business.
- Service thinking becomes the way of integrating the business through linked services with the value outcomes and agility that they bring. There is an ability to respond quickly based on information availability.

The Company has established an enterprise standard for CIS. Some of the components that make up a CIS are: an enterprise service bus (ESB) which delivers a standards-based integration where performance, scalability and reliability are critical requirements.

Enterprise Analytics

EA architecture is a storage repository that holds a vast amount of raw data in its native format until it is needed. Data can be pulled directly from the data sources into the storage area. All data in raw form will be available in one place. Once all data is brought into the storage repository, users can access relevant data for analysis and derive new insights through analytics.

The proposed scope of the EA platform includes:

- Implement a big data platform.
- Provide the toolsets to manage data governance, quality and master data.
- Establish the utility data model, which defines the data and relationships providing a flexible platform in order to be able to quickly and easily enable future changes as requirements change over time.
- Provide analytics-based visualization tools.
- Use a set of services to extract, transform and load (ingest) data from various sources and various data types.
- Provide an environment to enable collaboration and sharing analytics across the Company.
- Provide self-serve data, which empowers the business to leverage data while minimizing IS involvement.

Communications and Networking

Communication between devices in the field and Company systems is essential to the overall success of the GMP. The design of the network is driven by the communications requirements from all parts of the GMP. The main drivers for the telecommunications ("telecom") 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 performance considerations.
- Provide to the operations groups 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 will be comprised of two main layers: the FAN and WAN. The FAN will provide "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.

Integrated Network Operations Center

The INOC ensures proper operation and performance of the communication infrastructure supporting multiple GMP business services over a hybrid network. The INOC is a central location from which network administrators manage, control, troubleshoot and monitor one or more networks. The overall function is to maintain optimal network performance across a variety of platforms, mediums, networks, network segments, devices and communications channels. The INOC would monitor the health and behavior of all aspects of the grid using an Operation Support System ("OSS") and have the capabilities to provide a first level of incident response. Monitoring, provisioning and configuring are accomplished by computer-based tools that create alarms when anomalous activity, performance issues or system failures are detected. National Grid's grid modernization investments will provide many new business services and the INOC is key to their efficient operation, will eliminate the risks of a point to point system in an electric grid with a greatly increased number of systems and end points.

(a) Description of work completed.

Comprehensive Integration Services

In January 2020, a Solution Vision Document ("SVD") was conditionally approved by the 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. On June 3, 2020 a Conceptual Solution Architecture ("CSA") was approved by the same ARB. The Company progressed a partial sanction for requirements and design work on July 23, 2020. 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, test 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. Integration work in support of the GIS Phase 1 and the ADMS Phase 1 projects are underway to align with the delivery dates of those projects. Initial requirements analysis work is underway to support the Data Management and TOMS projects.

The Company considers this an ongoing and active effort that has progressed towards delivery in December 2021.

Enterprise Analytics

In 2019, a data management planning and strategy effort was undertaken to identify a framework and roadmap for implementing a Grid Modernization data management platform and associated tools to satisfy the Company's data needs of today and the data vision for the future. From this exercise, several data management use cases were identified based on the Grid Modernization Business Capability Model. In 2020, a current state assessment for the data management use cases was performed, after which the use cases were prioritized, and project scope was aligned with the objectives of maturing data management and governance practices.

The Company is working towards the creation of a standardized and comprehensive data model and the setting up of tools for data quality and data cataloging. The Company completed the analysis of business data capabilities, high-level use cases, and a preliminary inventory of data sources. Initial assumptions about the product and architecture for the Enterprise Data Platform have been re-validated and the Company has finalized the selection of software products for data catalog, data quality, data store, and visualization/reporting. There was a partial sanction submitted and approved on September 9, 2020, for requirements and design, as well as for partial build and deployment. It also includes software, hardware, and hosting costs related to new data quality, data catalog and data modeling toolsets. The project will seek full sanction in 2021 to complete development and implementation using the new toolsets, in combination with development and implementation of a staging data platform. The Company is targeting completion of this work by June 2021.

Communications and Networking

In anticipation of grid modernization, the Company undertook a strategic assessment of operational telecommunications during 2017. This initial assessment identified technologies and opportunities for progressing grid modernization investments. In 2018, the Company leveraged that strategic assessment to identify specific elements that were critical investments for progressing grid modernization. During 2019, the Company commissioned FAN coverage studies for both the 700 MHz and 900 MHz frequency bands as well as evaluated other available bands and technologies. Results provided initial baseline costs for the acquisition of 700 MHz and 900 MHz spectrum and the ability to model implementation costs for base stations across the service territory. The Company also has established a working group with joint utilities to share lessons learned and collaborate on the various types of networks that have been implemented. In addition, the Company has reviewed equipment vendors as well as companies that own spectrum or lease spectrum, and vendors that offer shared solutions to better understand the marketplace and associated costs.

The Company issued a Request for Proposals ("RFP") for a TOMS tool to enable the planning, designing, engineering, deploying, commissioning, and maintaining of telecom networks. 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 is in progress with a two-phase approach. Phase 1, which provides minimum viable product ("MVP") capabilities, will be completed in the second half of 2021 with field surveys for base lining the data to commence thereafter. Phase 2, which will deliver full product functionality, is projected to complete in 2021.

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 communication network linking critical transmission 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 to deliver a market research report to identify vendors with available technologies, product maturity, US-based implementations, and utility experience. Based upon these efforts, the Company issued an RFP for the replacement of the DMX SONET backbone equipment. The DMX SONET replacement equipment will be the technology that will be implemented to expand 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 completed in December 2020 and additional testing was planned for early February 2021. Upon completion of the testing and an evaluation of the results, a final vendor selection is targeted for March 2021.

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 including field feedback on initial use of the standard in several construction efforts. This standard will be issued early in 2021.

Field surveys were performed on recently installed Optical Ground Wire ("OPGW") fiber to document splice locations and the work remaining to complete fiber circuit termination to substations for WAN expansion.

Integrated Network Operations Center

In October of 2020, the Company initiated a review and assessment effort for the INOC 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 an INOC effort including the following: an assessment of the people, process and technology aspects, a service level basis for Service-Level Agreements ("SLAs") and Operation-Level Agreements ("OLAs") and an overall investment and business case structure. The successful vendor was selected in December 2020 and the effort will be mobilized in early 2021.

(b) Lessons learned/challenges and successes.

The Company had not planned for active installation or deployed communications or OT/IT on circuits during 2019 and limited work was started in late 2020. However, there have been some lessons learned from the initial installations that have allowed for refinement of both standards and procedures.

Through the commission of studies and spectrum evaluation, the Company has learned that spectrum acquisition is population-driven creating large cost differentials for metropolitan areas versus rural. This increases the difficulty in obtaining ubiquitous service territory coverage for the FAN using a single spectrum creating the potential need for hybrid solutions.

Successes to date include:

- 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 MPLS-TP or IP/MPLS solutions. These solutions are undergoing 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 has begun developing cost models for available spectrum and technologies to evaluate the cost-effectiveness of FAN investments in support of the GMP and other operational business needs such as replacement of analog or DS0 circuits used for teleprotection or substation RTUs.
- 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.

(c) Actual vs. planned implementation and spending, with explanations for deviation and rationale.

Tab 5.c. Spending – 2020 Report in the attached DPU Annual Report Template provides the deviation in the implementation and spending. Refer to columns D-L, rows 35-36.

The Company had limited spending in this area for the 2020 annual report period. The number of nodes completed is associated with the devices installed and commissioned. The Company had not planned for implementation and deployment of WAN investments during 2020 and continued to research and evaluate technologies and solutions for the expansion of the WAN and FAN to address future long-term growth.

(d) Performance on implementation/deployment.

The Company has continued to install cellular communications for the devices commissioned to date. The Company had not planned for implementation and deployment of the WAN and FAN in 2020.

(e) Description of benefits realized as the result of implementation.

The Company had not planned for implementation in 2020. Communications and OT/IT are enabling technologies that will enable the benefits to be realized through the other technologies to be installed as part of Grid Modernization.

(f) Description of capability improvement by capability/status category (e.g., VVO-enabled, Fully Automated, ADMS Load Flow Modelling, Control Functions, Reduced Zone Size).

The path to deliver the greatest customer benefits through WAN and FAN investments will occur over the long term. However, in the near term the Company recognizes that the use of public cellular can provide some customer benefits until final WAN/FAN solutions are delivered.

(g) Key milestones.

Milestone	**Target Date**
FAN 700MHz Implementation Costing	Completed in October 2019
WAN Market Research Report	Completed in December 2019
WAN equipment vendor RFP	Completed and issued in March 2020
Construction standards for WAN expansion	June 2020
Substation fiber termination using developed WAN construction standards	December 2020
TOMS vendor selection, procurement, and project kickoff	Completed in December 2020
WAN equipment vendor testing	February 2021
WAN vendor selection	March 2021
Field surveys for WAN expansion	August 2021

Milestone	Target Date
FAN equipment vendor testing	July 2021
FAN preliminary network design	August 2021
TOMS MVP Release	October 2021
Data Management Phase 1	June 2021
Enterprise Services Phase 1	June 2021
INOC Assessment	April 2021

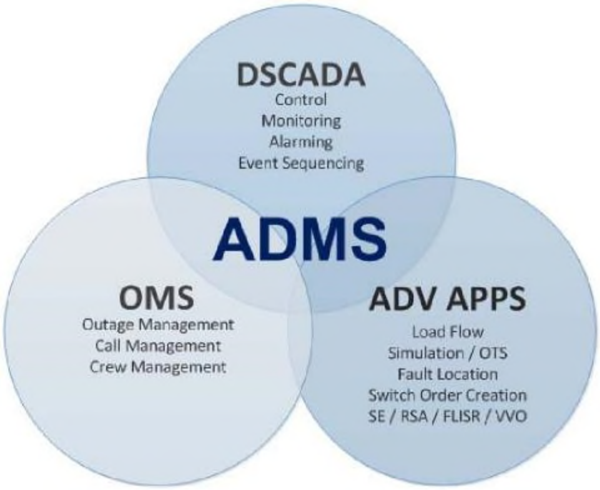
(h) Updated projections for remainder of the three-year term.

Tab 5.c. Spending – 2020 Report in the attached DPU Annual Report Template provides the updated projections for the 2021 plan year. Refer to columns M-U, rows 35-36.

(5) ADMS/DSCADA

Currently, National Grid utilizes an EMS, a SCADA system, and an OMS. EMS/SCADA is used to monitor remote devices in real time and capture data in a centralized location to be utilized to monitor and control the electrical grid. The OMS centralizes customer outage calls and trouble notifications to be displayed and compiled on a connected network model representation of the electric grid, to allow for proper analyzing and dispatching of the calls and outages.

Modern grid complexities such as electric vehicles and other nonconforming loads, DERSs and an increasing amount of remote grid device data are creating a challenging operational landscape. An ADMS is a group of control room-based hardware and software used by electric distribution operators to visualize, monitor and control the electric grid with advanced functionality. The solutions and applications in the system support continued safe and reliable electric grid operations with the added complexities of the modern grid. The ADMS system includes three main modules; a DSCADA, an OMS, and advanced application functionality (DMS). These modules operate on a common operational platform centralizing data, enhancing efficiencies and digitalizing operational processes. The system allows for greater visibility and situational awareness. The advanced applications included in the system can help the control room operator make more optimal system configuration decisions with respect to power aspects of the grid by leveraging a bi-directional load flow with the capability to simulate future states and configurations of the distribution grid taking into consideration interconnected DER. Applications can also centralize and automate distribution grid functions such as VVO, fault location, and distribution automation. The ADMS solutions incorporate real-time data via the DSCADA module from an ever-growing number of remote grid devices and DERs. The ADMS is an intelligent network platform supporting a step change in the operational integration of DERs and is a foundational investment for transition to Distribution System Operator (“DSO”).



This project will implement a phased approach for rolling out the ADMS, which includes implementing distribution management system applications followed by a refresh of the existing OMS as a module of the ADMS. The project will implement a distribution-specific DSCADA system dedicated to the management and control of the distribution networks. The resulting DSCADA system will be integrated with the distribution management system applications and OMS creating a common operations ADMS platform. The overall project is expected to take up to five years before fully implemented.

Dependency on data:
Modern grid operations require increasing granularity, accuracy and timeliness of data to achieve the benefits associated with advanced systems functionality. While the system and data maintained by the Company has been fit for purpose to date, the introduction of new use cases, such as for ADMS applications and hosting capacity analysis, requires change. Industry experience in the deployment of ADMS and similar systems has shown that significant investment in information enhancement is needed to enable the efficient use of these advanced applications. For ADMS to work properly there is an overall dependency on not only the data and data quality but also the frequency of the data updates, as DMS is used for real-time operations and will require an up-to-date, as-built network model.

A project team composed of Company and contractor resources have been convened for Massachusetts. Personnel with skills in engineering, operations, data management, and information systems (IS) will work collectively to analyze data on the Company's entire distribution system consisting of over 1,100 distribution circuits encompassing more than 6,445 circuit miles. This team will adopt a multifaceted approach that makes use of analytical models and techniques, Company and commercial data sources, and, as required, field observation and monitoring. By leveraging these techniques, the team will develop new GIS capabilities and expand and improve the data necessary to maintain network models for advanced applications.

The project is expected to take three years to complete and will be aligned with milestones for ADMS and other grid modernization projects. Additional quality control processes will be implemented to enhance data accuracy.

Project deliverables will include the following:
System Enhancements:

- Configure and program GIS to accommodate new asset types and equipment, including adding expanded equipment attributes and characteristics.
- Configure and program GIS to facilitate capture of greater data and modelling granularity for underground distribution networks.
- Configure and program GIS to facilitate more granularity for low-voltage secondary distribution networks.
- Develop substation modelling capability to support operations and planning processes.
- Develop additional tools and improve existing toolsets used to manage data quality and processes in GIS.

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 complete population of DER interconnections in GIS and populate customer equipment attributes.
- Analyze, enhance and populate additional assets to further extend underground distribution network and secondary distribution models and functionality.
- Populate enhanced substation model aligned with use in operational and planning processes.

Process Review and Improvement:

- Review procedures and standards associated with the asset data life cycle.
- Identify and implement changes to enhance processes, quality control and reductions in cycle times.

Dependency on building out DSCADA substation control capabilities:

This investment will facilitate the virtual (dual porting) and physical separation of Remote Terminal Units ("RTUs") and necessary network changes to allow for distribution components (substation and feeder level) to communicate with a dedicated DSCADA system. With the proposed separation of the SCADA system into a transmission SCADA and distribution SCADA system it will be required that any RTU presently sharing transmission and distribution equipment data points be reconfigured either virtually or physically to communicate with the separate SCADA systems. This work will allow the separation of the current single transmission and distribution SCADA system into separate transmission SCADA and DSCADA systems allowing for expansion of remote monitoring and control while supporting continued stability for transmission SCADA taking into consideration lessons learned from past control center-centric projects. The DSCADA component of ADMS is a prerequisite for advanced application control related functions such as VVO or any FLISR functions involving substation monitoring or control.

ADMS/DSCADA Implementation Approach:

The ADMS project will be implemented using a phased approach that will put different modules and functionality into service over the period of CY2021 through CY2024.

A phased approach for the ADMS has many benefits. It will allow the end users and support staff to become familiar with the system functionality and facilitate proper adoption of new ways of working before advanced functionality is enabled. By leveraging process analysis to target change management and training activities, the Company is ensuring proper adoption and benefits realization from the systems and applications. It will allow for Company processes and procedures to be refined for both operational and data support aspects of the system to ensure resiliency and sustainability as reliance on the ADMS system increases. It also allows for interdependent projects to mature as required to support full implementation.

The first phase of the ADMS project will put distribution management system applications in service for the electric distribution control rooms to use in a monitor and inform capacity. The target in-service date for this functionality is the second quarter of CY2021.

The second phase of the ADMS project will refresh the existing OMS as a module of the ADMS and build out DSCADA functionality, enabling management and control of the electric distribution grid from a common operations platform. The target in-service date for this functionality is late CY2023 through early CY2024. When complete this common centralized platform ADMS will allow for the continued integration of new technologies, expansion of solutions, and operational integration of DERs. The phased rollout will include the following steps:

Phase 1

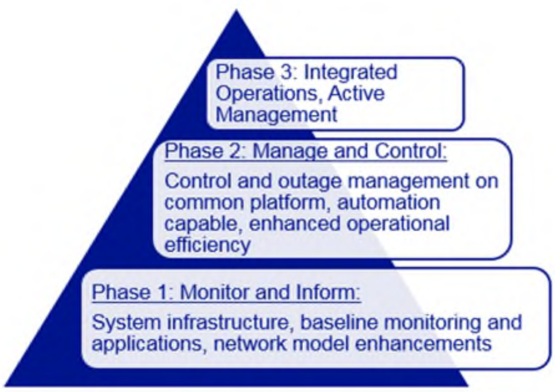
I. Build out governance frameworks, team structure, and KPIs for project
II. Requirements and capability specification, enterprise architecture review
III. Future state process design considering Phase 1 functions
IV. Change management functional impact assessment, stakeholder communications
V. Data element identification and GIS data improvements, extract improvements
VI. ADMS network and infrastructure specification, procure and build
VII. System build and data population, validate and tune application functionality
VIII. Acceptance testing of baseline monitor and inform applications
IX. Training of end users
X. Production implementation of monitor and inform functionality via baseline DMS applications on a predetermined number of feeders

Phase 2

I. Design, test and enable the OMS components/modules of the ADMS and retire the existing OMS
II. Implement AMI interfaces, and mobility solutions interfaces with OMS module to ensure alignment and benefits realization from these programs
III. Enable DSCADA integrated with OMS and applications to provide common platform visualization and management for the distribution network
IV. Expansion of applications including advanced functionality capable of automation and control
V. Implementation of a DSCADA leveraging data from substations via RTU work

Phase 3:

Move towards active network management interfacing with remote metered and grid edge devices and advanced DER control via interface build out with a distributed energy resources management system ("DERMS").



(a) Description of work completed.

Summary:

The Company has completed an analysis and scoping effort for the development of the ADMS project. As part of this effort, business capabilities and system requirements have been captured. Phase 1 ADMS system design activities are complete, major vendor contracts are in place and hardware and software have been procured. A thorough analysis of operational procedures affected by the rollout of an ADMS phase 1 as well as a review of change impacts and training requirements is completed. This will ensure the solution fits as designed into the Company's operations, is properly adopted, and delivers expected benefits. System infrastructure build out is in final stages, factory acceptance testing has been completed and final test stages are underway over the winter of 2021. GIS and engineering data incorporation into ADMS load flow solution and final solution tuning is underway. User training, business acceptance and phase 1 system go live is planned to be completed by June 2021.

Areas of work details:

Engineering, Infrastructure and Data:

In 2020 the team worked on procuring hardware and software, and system design and build out. Logical technical model and physical technical design models were completed. The building and configuration of a dedicated network for the ADMS system for local control center secure access between consoles and servers was completed and tested. The ADMS system environments were built out following internal standards to allow for proper backup and progression of software throughout environments.

Solution testing and data preparation and readiness work was done throughout this past year. In the fall of 2020 factory acceptance testing ("FAT") was carried out on the ADMS phase 1 system. As part of FAT, the team architected the data migration in conjunction with internal data owners of several key ADMS data elements (source, line, and transformer impedance characteristics, capacitor settings, and equipment limits) and worked towards identifying areas of data shortfalls. The team worked on the development and successful completion of more than 500 system test procedures designed to test ADMS system functions. The team established frameworks for monitoring and managing increasing DER penetration including incorporating DG assets into the operational network model. Feeder readiness was conducted on a predetermined set of phase 1 go-live feeders and these feeders were progressed through a series of data and engineering analysis until they were deemed test ready.

As part of the overall corporate data strategy, the data team began to coordinate a more rigid data process with Distribution Engineering. Identification of the ADMS critical data points during

FAT helped in the initial development of a business data consolidation plan. Future execution will allow the ADMS team to implement a strong data governance approach with detailed data quality monitoring in the next phase of the project.

GIS improvements and data hardening are in-progress. Field surveys to acquire digital photographs of the Massachusetts electric distribution system were completed. 83.5% of the available MA electric distribution poles accessible from public right of way were acquired, resulting in over 605,000 digital photos. The data team continues to review and update data and the required changes to baseline GIS are anticipated for June 2021 which will allow for new asset types, new equipment, expanded attributes and characteristics. The data team established a continuous-monitoring process to ensure that the cleansed data remains at the appropriate level of quality and completeness.

Process Analysis and Design:
A thorough analysis of business processes was carried out to ensure that all ADMS capabilities were correctly integrated into current control room workflows and procedures. An as-is analysis was completed and to-be processes including ADMS functions were built. The work involved project team support and input from various business groups who perform the functions affected by ADMS. A Change Impact Analysis ("CIA") was conducted on the new ADMS processes to identify and analyze the upcoming changes and rank their impact to stakeholders. This alignment will ensure that the ADMS program is integrated with the as-is business functions and identified areas of improvements with future state business functions. This work will also ensure that the implementation of ADMS into the control room will be seamless and effective for the users and deliver intended benefits.

Change Management:
The Change Management Office ("CMO") is an integral component of the ADMS program to prepare the business and other stakeholders for the deployment of this new tool. The CMO centered its effort in understanding the stakeholders and the impact of changes they face to develop a strategy and approach that addresses their needs.

During 2020 the team sat down with various key stakeholders from different groups to listen to their current understanding of the program, their concerns and their questions, to get a pulse of the current sentiments. The CMO developed a holistic approach in promoting stakeholders' engagement throughout the program, in supporting the business to reduce go-live risks through the business readiness approach and in driving adoption and proficiency of the ADMS system by the stakeholders to maximize benefit realization through training.
The CMO is broken down into the following core workstreams:

- Overall change management planning;
- Stakeholders communication and engagement;
- Business readiness; and
- Training.

Given the length of the ADMS program and its multi-phase approach, the team created a unified, stakeholder-centric, change management strategy and plan which can be leveraged in subsequent phases to both create program continuity and to reduce re-work. In addition to the strategy, other planning phase documents were developed to build a strong foundation and best practices such as establishing a governance model. A change network strategy was also developed to leverage existing ones from the EBU, to create efficiency with the rest of the business and allow for an effective two-way communication with the stakeholders.

A CIA was conducted on the new ADMS processes to identify and analyze the upcoming changes and rank their impact to stakeholders, in conjunction with the business process work. This analysis helps understand what changes each stakeholder group can expect from the ADMS, supporting the creation of future communication material, answering stakeholders' questions, and managing expectations. The team leveraged existing business process design workshops to optimize stakeholders' bandwidth and more efficiently identify the process changes. This document is foundational in developing initial stakeholders' communication, engagement, and determining training needs. As such, the team developed a comprehensive communication plan and an engagement plan which can be leveraged and scaled for future phases. The plans took into consideration communication preferences from different stakeholder groups to allow tailoring based on these preferences. The team went on to execute against these plans by creating multiple communication collaterals (for example, videos, one-pagers, emails, etc.) which have received very positive feedback. Additionally, a SharePoint and ADMS email have been set up to allow for question and feedback submissions. The team is regularly gathering feedback through these channels and through surveys to ensure the stakeholders are getting the right level of information and feel involved in the project to create buy-in. All work noted here ensures that the system is understood by the end user and functionality is leveraged properly to add value as intended overall.

The majority of ADMS end users in the phase 1 implementation are located in the control center. Given the 24/7 operations nature of their work, and the criticality of their role in keeping the lights on, a training strategy accommodating their shifts and potential storm duty roles was developed. Additionally, the unprecedented COVID-19 crisis pushed the CMO to determine a training approach that adapted to accommodate remote training needs to ensure the safety of the stakeholders. Ongoing analysis and assessments helped build a comprehensive training curriculum and training materials which are centered around the new ADMS functionalities and processes to help users understand how their roles are changing.

The training, scheduled for spring of 2021, is designed to promote the best learning experience and results by leveraging multiple training approaches such as instructor-led trainings, in-class exercises, roadshows, etc. A successful and positive training experience is an important measurement in driving the adoption of the ADMS by its users to realize the system's benefits.

Governance, controls and process:
Creation of the project governance structure set the ADMS program up for success by establishing how decisions would be made and who needed to be involved in the decision-making process. Guidelines and procedures were created to assist in managing the project. This framework assisted in resolving obstacles and issues that can block strategic success. The ADMS governance structure has created a clear communication plan that is well-defined, updated regularly and leveraged by the project team and stakeholders. This clarity and consistency in decision-making and communication has assisted the ADMS project in maintaining schedule in a critical time period with COVID-19. 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. Changing standard in-person testing to remote system testing was a key event that required multiple decisions. Setting up remote connectivity so critical areas of the program could be performed remotely was a key accomplishment. Having a strong governance structure in place has assisted in keeping all cross-functional teams aligned and focused on the right areas of the project, thus keeping everyone and the project moving in the same direction.

The addition of several key performance indicators ("KPIs") allowed the team to gain valuable insight to several areas of the project and provide transparency for all stakeholders. A Baseline Execution Index ("BEI") 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.

ADMS team members work closely with associated programs to ensure alignment continues and has support from the internal assurance team to help identify both strong areas of the project as well as areas to improve before there are any adverse impacts. Through close monitoring, the ADMS program has remained on schedule.

(b) Lessons learned/challenges and successes.

- Having a strong governance structure in place has assisted in keeping all cross-functional teams aligned and focused on the right areas of the project and supported effective decision-making, thus keeping everyone and the project moving in the same direction especially during this year considering challenges related to the COVID-19 pandemic.
- A proactive Company stance on safety as well as new IT access tools allowed for the transition to work from home during the pandemic. Although remote connection to systems and logistics surrounding remote work does create some challenges from an efficiency standpoint there are some very real successes. The ADMS team was able to think creatively and come up with multiple options to support continued progress on the project implementation, much done remotely, during the COVID-19 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. This took changes to IT infrastructure, detailed task development between the Company and our ADMS vendor and flexibility in our team's tasks. Testing was successfully completed on time even given all these challenges.
- There were some challenges surrounding team expansion due to constraints caused by COVID-19. Although the team overcame these challenges the ramp-up of resources dedicated to the ADMS project was slower than expected
- Significant additions and expansion to base network model data to support ADMS advanced applications is required beyond what is presently used for distribution operations. The definition of interdependent programs and systems such as GIS have been noted, dependencies have been linked and are tracked based on developed data criteria.
- ADMS applications will be tested and rolled out on a predetermined number of feeders that benefit most from the solutions and cover a wide sample of the Company's operating areas. This will help to ensure consistent solutions, both during system test and production system use, again enhancing benefits and adoption.
- Change management, training development and process design were properly staffed and considered a critical part of the project. Proper resourcing and skill sets were identified to ensure successful business integration and adoption of ADMS by leveraging process analysis to target change management and training activities, ensuring proper adoption and benefits realization from the systems and applications.
- A thorough analysis of operational processes was required to understand how the technical solution fits in to operations. This helps ensure that we understand where changes are needed, where training should be focused and overall supports better adoption and long-term benefits realization.
- Implementation and system testing teams were reorganized based on lessons learned from past implementations. IT standards were put in place to deliver across programs consistently and included resources, processes, standards and tools.

(c) Actual vs. planned implementation and spending, with explanations for deviation and rationale.

Tab 5.c. Spending – 2020 Report in the attached DPU Annual Report Template provides the deviation in the implementation and spending. Refer to columns D-L, rows 29-34. Planned spending was below initial estimates. National Grid performed an organizational realignment to ensure related transformational programs (ADMS being one of them) can be managed effectively to maximize operational benefits and reduce overlap. These changes along with resourcing challenges due to a tight job market and niche skillsets required created a slower than expected ramp up for the project. New roles were identified during the design phase of the project taking into consideration lessons learned from past projects. Resourcing of proper skill sets to complete business process analysis, change assessment, governance and controls was completed to ensure successful business integration, adoption and benefits realization from the systems and applications. System architecture was reviewed to ensure alignment with other Company initiatives and design was reviewed to ensure compliance with internal standards. Additional resources to support system testing and quality assurance were completed.

(d) Performance on implementation/deployment.

The Company has installed supporting infrastructure such as system hardware and networks that are the backbone of the ADMS. This work was carried out within scoped timeline and budget. Testing of this infrastructure and systems is ongoing with go-live date planned by June 2021.

Project governance, reporting and key performance indicators were developed to ensure the project continues to develop on track to yield benefits.

(e) Description of benefits realized as the result of implementation

The Company has not actively deployed ADMS during 2020. The Company had not planned to install ADMS/DSCADA in 2020. Therefore, there are no benefits realized for this annual reporting period.

(f) Description of capability improvement by capability/status category

The capability improvements expected to accrue during the ADMS/DSCADA solution include:

- Expanded situational awareness and visibility of future predicted states with respect to system operations.
- ADMS will create a platform to enable utilization of exponential growth of remote monitoring, control and distribution automation.
- Enable system operations to maintain or improve reliability under the growing system complexities associated with the integration of DERs.
- Centralizes data, visualization, monitoring, control and automation capabilities maximizing operational process efficiencies.
- Enables operators to simulate future state of the grid in abnormal configurations to optimize grid asset utilization.

- Enable advanced applications and distribution load flow to help manage circuit performance and the optimization of DERs.
- Refresh end of life hardware and software for present production OMS procured in 2009 into common system ADMS.

(g) Key Milestones

Milestone	Target Date
Complete R&D Project Sanction	April 22, 2019
Complete Requirements and Design	March 2020
Complete D&I Project Sanction	March 2020
Complete Development and Implementation	January 2021
Complete User Acceptance Testing	June 2021
Move to Production / Go Live Phase 1	June 2021

(h) Updated projections for remainder of the three-year term.

Tab 5.c. Spending – 2020 Report in the attached DPU Annual Report Template provides the deviation in the implementation and spending. Refer to columns M-U, rows 29-34.

While developing the plans in 2018 and 2019, the Company realized the early goal of implementing phase 1 of the ADMS solution by December 2020 was not practical. As a result, the final plans and updated projections have second quarter of calendar year 2021 as the projected implementation date. The Company is targeting roll out of the initial phase of capabilities of ADMS for June 2021.

B. Feeder Level Narrative by Investment Category

(1) Volt Var Optimization (VVO)

a. Highlights of feeder level implementation

In 2020, the Company started to commission feeders for VVO. Throughout the build and commission process, there were some feeder level highlights and lessons learned that were applied to subsequent work.

To start, the initial plan was to create one work request ("WR") for each feeder. This single WR encompassed all work associated with upgrading the feeder for VVO, including installation/upgrade of capacitors, feeder monitors and regulators, as well as the commissioning of each device. The Company learned that one WR for the entire feeder was too cumbersome to manage. It was difficult to track work progress because WRs are not closed until all work is complete. Learning from this, subsequent WRs were assigned by location, so a feeder might have three to five WRs. This simplified the work for the crews and aided in the management of the work and reporting.

Additionally, to streamline the process, all construction was completed on a given feeder, then the entire feeder was commissioned in one day. This created process and resource efficiencies. The commissioning process involves an operator from the DCC and other departments. With the revised process, we were able to get a dedicated DCC operator to work with the overhead crews (and other teams) to complete all the work in one day, versus having to interrupt an operator several times over the course of a couple weeks as each device is installed.

b. Feeder level lessons learned/challenges and successes

One of the challenges that the Company is working through is the pre-construction test/preparation and the field installation/commission of regulators. In some areas, where VVO is being implemented, crews are not familiar with regulators because they are infrequently deployed. This has contributed to some delays in getting regulators installed and commissioned. In response to this, the Company is working on new work methods and additional training for crews. The goal is to expand the number of work crews who are formally trained with regulators.

(2) Advanced Distribution Automation.

a. Highlights of feeder level implementation

In 2020, the Company commissioned and implemented four feeders for FLISR. These feeders are the 913W69, 916W43, 33L1 and 56L3. The 913W69 and 916W43 feeders are out of the Stoughton substation which also happens to have VVO installed. This was the first scenario presented to the engineering team to have the technologies safely co-exist. The engineering team tested FLISR functionality to ensure that VVO will be disabled once FLISR automation takes place. These feeders will not be the only examples where we see the two initiatives co-exist on the same feeders.

The 33L1 and 56L3 feeders are out of the East Boxford and Woodchuck Hill substations respectively. This was a standard three recloser FLISR scheme that provided major benefits. The 33L1 feeder has been on and off the poor performing circuit list for several years and fell back on the list in 2019. With the implementation of FLISR in 2020 for the 33L1 feeder, we are expecting to see improvements in resiliency and reliability that will remove the feeder from the poor performing circuit list.

Fortunately, while the commissioning of these feeders did not face any major challenges, the process was established and streamlined for future implementation of other feeders. The

Control Center operators were able to work with the engineering teams to seamlessly test and confirm functionality of the FLISR technology once all field devices were installed for both the FLISR schemes. However, there were some challenges with the scheduling and construction processes.

b. Feeder level lessons learned/challenges and successes

The Company faced a variety of challenges on the path to commissioning and implementing FLISR in 2020. Aside from resource impacts from the on-going pandemic and the frequency of weather events that delayed construction schedules, a big hurdle was figuring out the best method of work request completion. Work requests are created for each individual recloser or feeder monitor of a FLISR scheme and progression levels can vary for each one. This means if we have a three recloser FLISR scheme, we essentially have three separate work requests and three timelines. Each work request faces its own individual challenges when it comes to construction as one work request may have environmental issues, and another could have permitting or digging involved. These challenges were mitigated through a manual tracking process for each work request and forecasting when a FLISR scheme was able to go-live in accordance with its individual installations.

A lesson learned from the work request challenge was figuring out that there was a need for additional engagement with our resource coordination and resource planning teams. A bi-weekly meeting was set in place to help track and progress priority work requests so that FLISR schemes can go-live more efficiently and effectively. This meeting was a major success as we were able to establish a synergistic process for future FLISR implementation as we enter 2021.

(3) Feeder Monitors.

(a) Highlights of feeder level implementation

2020 brought continued success with the commissioning of 66 feeder monitors. Feeder level successes were realized through compounding prior historical data and data collected from the feeder monitor to make informed engineering decisions. These decisions included Substation LTC rebalancing to better serve our customers to avoid projected overloads through load balancing instead of reconductoring. In addition to these engineering benefits, 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 our crews are being used in the most efficient and impactful way.

(b) Feeder level lessons learned/challenges and successes

2020 came with a unique amount of feeder level challenges that caused delays due to the Covid 19 Pandemic. Work prioritization in response to Covid as well as work force impacts of Covid, introduced delays in construction as well as delays in pre-construction telecom work. As guidelines have eased and workforce impacts have lessened, the workflow has increased and begun to stabilize.

IV. Description and Report on Each Infrastructure Metric

A. Grid-Connected Distributed Generation Facilities

One of the primary objectives of grid modernization is to facilitate the interconnection of DERs and to integrate these resources into National Grid's planning and operations processes. This infrastructure metric quantifies the DER units connected to the Company's system on a circuit level and substation level. It is important to note that DER developers' decisions regarding DER interconnection may be influenced by tax incentives, subsidies, and costs and availability of the technology, which, in turn, will influence these metrics.

The table below is a summary of the number of DERs connected to the Company's distribution system as of December 31, 2020. Tab 3, Feeder Status in the attached DPU Annual Report Template provides the feeder level details. Refer to columns S-CS.

Fuel Type	***Total Units***	***Nameplate AC Rating (kW)***	***Capacity Factor***	***Est Annual Output***
Bio Gas	7	3,010	73.30%	19,327,451
Diesel	5	1,675	40.00%	5,869,200
Fuel Oil	2	5,350	40.00%	18,746,400
Hydro	10	2,127	37.40%	6,968,562
Landfill Gas	6	6,270	73.30%	40,260,172
Natural Gas	164	97,676	57.60%	484,976,754
Propane	2	10	57.60%	50,458
Solar	59,668	1,216,020	13.40%	1,427,412,534
Solar with Battery	670	67,476	13.40%	79,206,304
Wind	56	21,061	37.40%	69,000,072
Energy Storage	38	14,982	-	-
Hydrogen	1	30	N/A	-
Grand Total	60,629	1,435,687		2,151,817,907

B. System Automation Saturation

This infrastructure metric for system automation saturation measures customers served by fully automated or partially automated device(s). The terms "fully automated" and "partially automated" refer to feeders for which National Grid has attained optimal or partial, respectively, levels of visibility, command and control, and self-healing capability through the use of automation.

National Grid has initially calculated the system automation saturation to be 505. There were minimal installations in the 2019 Plan Year of Grid Modernization investments. For 2020, the Company has calculated the system automation saturation to be 434. The Company is actively validating circuit level details and is providing feeder-specific levels on Tab 3, Feeder Status in the attached DPU Annual Report Template.

C. Number/ Percentage of Circuits with Installed Sensors

This metric measures the total number of electric distribution circuits with installed sensors which will provide information useful for proactive planning and intervention. The installation of sensors provides the means to enable proactive planning and to measure a number of grid modernization initiatives such as VVO and asset management. A sensor analytics development program is an essential part of grid modernization and provides the visibility into network operations needed to move toward an effective grid modernization program.

National Grid has initially calculated the percentage of circuits with installed sensors at 66%. There were minimal installations in the 2019 Plan Year of Grid Modernization investments. For 2020, the Company has calculated the percentage of circuits with installed sensors at 72%. The Company is actively validating circuit level details and is providing feeder-specific levels on Tab 3, Feeder Status in the attached DPU Annual Report Template.

D. Number of Devices or Other Technologies Deployed

These metric measures how National Grid is progressing with its GMP from an equipment and/or device standpoint. The number of devices installed is compared to the total number of devices planned by circuit for each investment.

Tab 5.c Spending – 2020 Report in the attached DPU Annual Report Template provides the deviation in the implementation and spending. Refer to columns D-L.

E. Associated Cost for Deployment

This metric measures the associated costs for the number of devices or technologies installed and is designed to measure how National Grid is progressing under its GMP. The cost of devices installed is compared to the total cost of devices planned by circuit for each investment.

Tab 5.c Spending – 2020 Report in the attached DPU Annual Report Template provides the cost of devices installed compared to the planned costs. Refer to columns D-L.

F. Reasons for Deviation Between Actual and Planned Deployment for the Plan Year

This metric is designed to measure how National Grid is progressing under its GMP on a year-by-year basis. The quantity and cost of devices or technology installed in a given GMP investment year is compared on a year-by-year basis and any variations are quantified and addressed. Tab 5.c Spending – 2020 Report in the attached DPU Annual Report Template provides the deviation between actual and planned deployment for the 2020 plan year. Refer to columns D-L.

The Company detailed the causes for deviation from the planned deployment in each of the investment area sections. In mid-March, the onset of the global pandemic was realized, and the Company took immediate actions to protect the employees, customers and our energy delivery networks. This global event and the global response were unforeseen and required swift and immediate response, for which the Company invoked the Business Continuity Plans and Pandemic Plans. The program incurred several impacts that included supply chain issues, workforce impacts, work plan changes, and prioritization of health and safety, reliability and essential customers. Calendar year 2020 also saw a significant increase in storms and our response which also impacted the grid modernization work plan in Massachusetts.

G. Projected Deployment for The Remainder of the Three-Year (2018-2020) Term

This metric is designed to show National Grid's projected deployment for the three-year term under its GMP on a year-by-year basis. The year-by-year investment plan is subject to change based upon the quantity of work completed, the availability of the technology, material lead times, contractor availability, etc. The revised investment plan each year will be used as the basis for projecting the following year's GMP work. Tab 5.c Spending – 2020 Report in the attached DPU Annual Report Template provides the projected deployment for the remainder of the three-year term. Refer to columns V-AD[7].

---

[7] The Company notes that its 2021 GMP work could be affected by the ongoing novel coronavirus, COVID-19, pandemic response. The Company has established plans to safely progress work during the pandemic and provided the Department the Company's Business Continuity Plans for this event. See National Grid Business Continuity Plans – COVID-19, Responses to the Hearing Officer Memorandum Dated March 11, 2020. The Company plans to progress GMP work to the fullest extent possible during the COVID-19 crisis, recognizing that circumstances outside of the Company's control related to the pandemic could affect the timing of that work. In the event of a temporary work force reduction, the Company will continue GMP work that it is able to safely progress as staffing allows.

V. Distributed Energy Resources

A. Overview of DERs on the Distribution System

The Company currently has over 62,500 interconnected DERs on its system with a total nameplate capacity of 1,582 MW. The drivers of DERs continue to be state and federal incentives to promote renewable energy, utility tariffs that authorize net metering and virtual net metering, overall market developments and reductions in cost of solar PV technology, among other factors. Many of the programs initiated to progress the market for DERs continue to incent the pursuit of DER interconnection requests. The Company currently has over 6,600 active applications representing an incremental 1.41 GW. Over 6,400 of the active applications were driven through the new SMART Program representing over 744 MW in the application process.

B. Lessons Learned Integrating DERs

The Company continues to progress and support requests for interconnections. While the Company continues to evolve its understanding of the dynamics and impacts of DERs on the distribution system, the following areas represent lessons that are being incorporated into the GMP.

Lesson #1: Grid Modernization widens the range of available tools to system planners and operators for DER enablement.

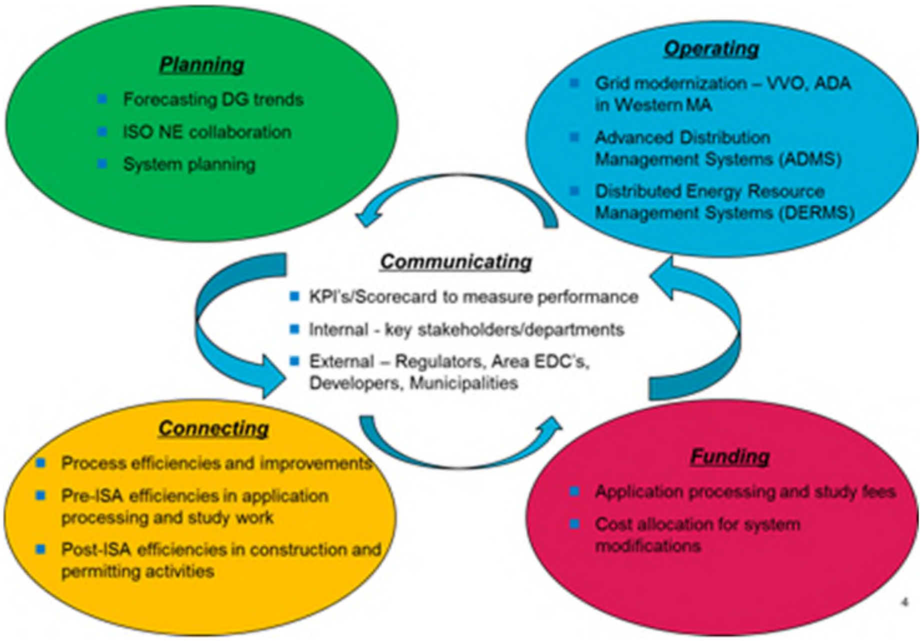
In 2017, the Commonwealth introduced a new solar incentive program, Solar Massachusetts Renewable Target (SMART), designed to promote solar at lower costs to all customers. The launch of SMART resulted in a large increase in DG applications in the Company's service territories. By 2018 approximately 500MW of new DG sites had applied to connect in the central region of Massachusetts in targeted geographic areas. These sites were proposed in already heavily-saturated areas whose distribution infrastructure was quickly pushed to its limits. The local distribution system's electrical infrastructure in these low load areas was not designed to accommodate the extremely high volume of DG customers due to high solar saturation. Engineering analysis quickly showed multiple substations would be overloaded by the proposed interconnections. Beyond the distribution system, looking upstream to the transmission system, similar challenges occurred where the capability of the New England transmission system was being challenged in western and southeastern portions of the state.

Technologies explored in Grid Modernization allowed the Company to progress the design and construction of a modest subset of advanced capacitors that will be deployed in central and western Massachusetts to mitigate potential impacts of DG. The solution being pursued is to replace existing capacitor banks on the distribution system with smart capacitor banks, which will be set to turn off during light load conditions, with a voltage override. The ISO approved this approach through the Company's Transmission Planning organization. The Company has identified 25 capacitor banks to be spread across multiple substations in its central and western territories. As a result of these emerging DER issues and opportunities in central and western Massachusetts, the Company is deploying voltage optimization investments to progress grid modernization objectives.

Lesson #2: Screening for Passive Anti-Islanding functions and extended Voltage Trip setting for Bulk System Support
National Grid has worked with the MA-TSRG to transfer its learnings from the United Kingdom's August 2019 widespread power cut to the commonwealth. Working with the MA-TSRG the company created a New England Bulk System Area Settings Requirements document that extends undervoltage trip times and prohibits passive Anti-Islanding DER functions from interfering with DER ride through, all to help improve the reliability of the bulk system.

Lesson #3: For optimal system benefits the company worked with EPRI to create a methodology that automatically analyzes and selects the best volt-var curves based on weighted feeder performance metrics.
In the company's paper titled "TAILORING IEEE1547 RECOMMENDED SMART INVERTER SETTINGS BASED ON MODELED GRID PERFORMANCE" which can be found at https://www.nationalgridus.com/media/pdfs/microsites/mass-solar/tailoringieee1547.pdf the company shared details around a methodology it created to develop a tool designed around finding the optimal reactive function for a solar facility and the most ideal IEEE 1547 settings.

Lesson#4: Created an Ombudsperson position and Five Point Plan (5PP) to improve customers experience around interconnect DER.
National Grid has created an Ombudsperson position that can work with the developer community to discuss and review creative new solution to integrate DER and among other duties is responsible for creating a strategy around integrating DER. The plan focuses on five areas:
1-Imporve the Planning and Forecasting process.
2-Improve Grid Operation using Grid Modernization Technologies.
3-Improving Communications with stakeholders Internally and Externally.
4-Identintfying process efficiencies and improvements.
5-Identifying various Funding opportunities to introduce cost synergies.



VI. METRICS

A. Description and Report on each Performance Metric

The Department stamp-approved the revised Performance Metrics on July 25, 2019, which the Company is reporting on in this Section.

2.1 VOLT VAR OPTIMIZATION AND CONSERVATION VOLTAGE REDUCTION BASELINE – The Company has enabled VVO on six circuits during the 2020 plan year and initiated M&V in December 2020. The results will establish a baseline impact factor for each VVO enabled circuit which will be used to quantify the peak load, energy savings and greenhouse gas ("GHG") impact measures.

2.2 VOLT VAR OPTIMIZATION (VVO) ENERGY SAVINGS - The Company has enabled VVO on six circuits during the 2020 plan year and initiated M&V in December 2020. The results will establish a baseline impact factor required to quantify the energy savings achieved by VVO.

2.3 VVO PEAK LOAD IMPACT - The Company has enabled VVO on six circuits during the 2020 plan year and initiated M&V in December 2020. The results will establish a baseline impact factor required to quantify the peak demand impact VVO/CVR has on the system.

2.4 VVO – DISTRIBUTION LOSSES WITHOUT AMF (BASELINE) - The Company has enabled VVO on six circuits during the 2020 plan year and initiated M&V in December 2020. The results will establish a baseline impact factor required to quantify the distribution losses.

2.5 VVO POWER FACTOR - The Company has enabled VVO on six circuits during the 2020 plan year and initiated M&V in December 2020. The results will establish a baseline impact factor required to quantify the power factor.

2.6 VVO ESTIMATED VVO/CVR ENERGY AND GHG IMPACT - The Company has enabled VVO on six circuits during the 2020 plan year and initiated M&V in December 2020. The results will establish a baseline impact factor for each VVO enabled circuit which will be used to quantify the energy savings and greenhouse gas ("GHG") impact measures.

2.7 INCREASE IN SUBSTATIONS WITH DISTRIBUTION MANAGEMENT SYSTEM ("DMS") POWER FLOW AND CONTROL CAPABILITIES – The Company has not enabled DMS power flow capability during the 2020 plan year.

2.8 CONTROL FUNCTIONS IMPLEMENTED BY CIRCUIT (VVO, AUTO RECONFIGURATION) - The Company has not enabled DMS control functions during the 2020 plan year.

2.9 NUMBERS OF CUSTOMERS THAT BENEFIT FROM GMP FUNDED DISTRIBUTION AUTOMATION DEVICES - The Company has enabled four feeders representing two ADA schemes during 2020.

Circuit Number	Substation	Type of Device	Number of Customers Impacted
05_14_33L1	East Boxford	G&W Viper recloser (1 recloser and 1 tie-recloser)	987
05_14_56L3	Woodchuck Hill	G&W Viper recloser (1 recloser)	2,002
05_07_913W43	Stoughton	G&W Viper recloser (1 recloser and 1 tie-recloser)	2,148
05_07_913W69	Stoughton	G&W Viper recloser (1 recloser)	3,746

2.10 RELIABILITY-FOCUSED GRID MODERNIZATION INVESTMENTS' EFFECT ON OUTAGE DURATIONS - The Company has enabled four feeders representing two ADA schemes during 2020. There were no mainline events that caused operations of the ADA during the 2020 plan year which would have a direct effect on outage durations.

2.11 RELIABILITY-FOCUSED GRID MODERNIZATION INVESTMENTS' EFFECT ON OUTAGE FREQUENCY - The Company has enabled four feeders representing two ADA schemes during 2020. There were no mainline events that caused operations of the ADA during the 2020 plan year which would have a direct effect on outage frequency.

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 20 feeders and three 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 taken on 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.

Total Voltage Complaints per Year

Substation Name	2016	2017	2018	2019	2020
East Methuen*	35	24	16	14	15
Maplewood*	20	31	34	50	45
Stoughton*	32	20	23	14	24
Total	87	75	73	78	84

*Complaints totaled for each substation

App.C.1.0 NATIONAL GRID RELIABILITY-RELATED COMPANY-SPECIFIC - The Company has enabled four feeders representing two ADA schemes during 2020. There were no mainline events that caused operations of the ADA during the 2020 plan year.

B. Lessons Learned/Challenges and Successes

Please see Section VI.A, above.

C. Hosting Capacity Analysis Update

On March 31, 2021 the Company submitted its annual electric distribution system resiliency report to the Department in accordance with the Act to Advance Clean Energy, St. 2018, c. 227, §18, which requires the Companies to file an annual electric distribution system resiliency report with the Department, which must include heat maps that: (i) show the electric load on the electric distribution system, including electric loads during peak electricity demand time periods; (ii) highlight the most congested or constrained areas of the electric distribution system; and (iii) identify areas of the electric distribution system most vulnerable to outages due to high electricity demand, lack of local electric generating resources and extreme weather events.

In section B.1.22.2 of the electric distribution system resiliency report the Company offers details on how to access its data portal, which includes updates to the Company's hosting capacity maps. The Company has completed its Hosting Capacity Analysis and has updated maps for all its feeders, except for 17 feeders. The 17 feeders could not be included because they are either retired feeders, private feeders serving a single customer or spare feeders planned for future expansion that have no customers connected to them currently.

VII. Research, Development and Deployment

Research and Development ("R&D") work for the National Grid US business aims to advance products, technologies, processes, systems and work methods that may be new to National Grid. This is accomplished by working with internal departments to identify where strategic R&D investment are needed and are more likely to prove beneficial. To achieve these goals, National Grid works in collaboration with technical organizations, academia and vendors in the energy sector that align with National Grid's goals and objectives to provide a safe, reliable, efficient and clean service.

This collaboration has also helped inform the strategic direction in response to jurisdictional requests for electric modernization in the states in which National Grid operates in the United States (Grid Modernization in Massachusetts and Rhode Island, and reforming the Energy Vision in New York). The Company continues to focus R&D on increasing public safety, supporting the integration of renewable resources, protecting the Company's workforce and reducing costs.

Research efforts are designed to allow research teams in each state to build on the research of other teams, to reduce cost and allow for a faster pace of technology adoption.

In 2020/21, the National Grid electric business continued to invest and participate in several significant pilot projects with the intention of obtaining operational knowledge and experience of technology-driven system impacts, both in Massachusetts and in New York. Below are a few examples of these R&D projects:

Massachusetts-Distribution

- The company worked with the Electric Power Research Institute (EPRI) to test the Eaton NX-T reclosers used in its ADA program as part of a supplemental project EPRI's Program 180:Distribution System. Under the project EPRI tested a sample that was provided for laboratory evaluation and analysis. The recloser went through a test program that was developed by EPRI to evaluate the future performance of distribution reclosers. The testing involved performing a series of functional tests and sensor accuracy testing. The results from this testing were as expected for the functional testing and accuracy tests. For example, the voltage measurements were consistent at different currents and were less than 1% for both the internal and external voltage sensors, which is better than what has been seen in some of the other reclosers tested as part of EPRI testing and evaluation.
- The next step in the testing was to perform accelerated aging on the recloser to understand how the unit may degrade over time. The recloser was exposed to a multi-stress aging test that included, temperature cycling, salt fog, and UV radiation. The unit was exposed to the cycle for 3 months. Once completed the functional and accuracy testing will be repeated.
- The final step in the evaluation of the NX-T recloser is to systematically disassemble the recloser to look for potential degradation mechanisms and to review the overall design of the recloser. The review will include chemical analysis of selected recloser components. The results from this research will provide an understanding of the long-term performance of these new reclosers.

Testing and Evaluation of this new recloser standard will continue into 2021. To date the testing of this new National Grid Standard recloser has been favorable and we expect the continued testing and evaluation into 2021 to show positive results.

Picture below of the multi-stress aged Eaton NX-T provided to EPRI by National Grid.

- Under the company's 'Solar Phase 1, 2 and 3 programs, we contracted and built approximately 35MW of PV solar and 6.2MW/12MWh of Energy Storage systems as part of our company-owned facilities portfolio. The facilities are used to explore new technologies that can help reduce the interconnection cost and time for future PV solar projects. The research also aims to help the company move from interconnecting DER to integrating it. Among the technologies researched are Smart Inverters, Energy Storage, Dynamic VAR STATCOMS, Plant Level Controllers and Dual Axis PV tracking. To enhance the learning experience the company partnered with industry leaders such as the Electric Power Research Institute (EPRI), Sandia National Laboratories (Sandia) and Fraunhofer Gesellschaft (Fraunhofer);

  Research finding from National Grid's Solar Program can be found at:
  https://www.nationalgridus.com/massachusetts-solar/document-library

- The program won two awards in 2020:
  1. The 2020 Digitalization/Technology Adoption Award by Power Magazine and was highlighted in the following article: https://www.powermag.com/team-and-individual-award-winners-recognized-at-experience-power/
  2. The Game Changer Award at the 2020 Connected Plant Conference and was highlighted in the following article: https://www.connectedplantconference.com/2020-game-changers/
- We are piloting an Active Resource Integration (ARI) Project at solar phase two and three locations in MA and at Peterboro substation in NY to test ability to increase the amount of solar DG integrated into the distribution system in constrained areas via development of curtailment capabilities.
- National Grid is heavily engaged on several EPRI & CEATI programmes, including bulk system renewables, DERs integration, planning and asset management, energy storage, asset management for transmission and distribution, system automation and integrating emerging technologies.

Massachusetts-Transmission

- Working with Boston Dynamics National Grid deployed the “Spot Robot” at its Sandy Pond HVDC station, which is responsible for importing almost 2,000MW of clean hydroelectricity into New England every day. Currently technicians inspect the thyristors twice a year visually through windows looking into a hall, during two planned outage a year.

The Spot robot can be in the hall when energized. The robot can walk around the full floor area of the thyristor hall, affording the technicians full viewing angles of the equipment which were impossible to view through the windows alone. The robot also conducts thermal scans. With both its high-resolution optical cameras and sensors it can pick up on very small water leaks (which were before difficult to detect visually) and identify hot spots (places of possible mechanical fatigue). This is all without entering the environment such that the station can stay in operation and energized.

The pilot of the robot was successful, and the company is collaborating with Boston Dynamics to have two robots at the station. One of the robots will be permanently in the thyristor hall, and the other to use in the DC yard, which can also be used to pilot other use cases at the facility.

- Smart Wires manufactures a power flow control device called the Smart Valve. Smart Valve are FACTS ("Flexible Alternating Current Transmission System") devices that use power electronics to "push and pull" power over a transmission network thus increasing transmission capacity over AC lines without the need to build additional capability (e.g., reconductoring, new lines, or other typical upgrades)
  National Grid US deployed the SmartValve system on a 69kV line near the Fitch Road substation (Lancaster, MA north of Worcester, MA). The deployment will give us operational experience with the technology, prove out the capabilities and discuss use of the technology with ISO New England. (In parallel, but separate, we are working with DOE Idaho National Labs to address and mitigate cyber security issues with installation of line monitoring, sensors, and power flow control devices on the network).
- Over the next 10 years we will be deploying up to 150 digital substations in New England and New York as we transition to fully digital substations on our transmission network, which will utilise the IEC 61850 communications standard. The digital substation reduces construction and operation costs, engineering and construction time, increases system flexibility, and helps facilitate the large-scale incorporation of renewable power.