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April 1, 2020

Mark D. Marini, Secretary
Department of Public Utilities
One South Station, 5th Floor
Boston, MA 02110

Re: D.P.U. 15-122 - NSTAR Electric Company d/b/a Eversource Energy 2019 Annual Grid Modernization Report

Dear Secretary Marini:

On behalf of NSTAR Electric Company d/b/a Eversource Energy ("Eversource" or the "Company"), enclosed is the Eversource-specific 2019 Annual Grid Modernization Report. Today's filing is being made consistent with the directives issued by the Department of Public Utilities (the "Department") in D.P.U. 15-120-C/15-121-C/15-122-C.

Thank you for your attention to this matter. Please contact me with any questions you may have.

Sincerely,

Danielle C. Winter, Esq.

Enclosures

cc: Tina Chin, Hearing Officer
Daniel Licata, Hearing Officer
Greggory Wade, Hearing Officer
D.P.U. 15-120, 15-121, and 15-122 Service Lists

EVERSOURCE

NSTAR Electric Company
d/b/a Eversource Energy

Grid Modernization Plan
2019 Annual Report

D.P.U. 15-122

April 1, 2020

Submitted to:
Massachusetts Department of Public Utilities

I. Introduction

A. Background

In October 2012, the Department of Public Utilities (the "Department") initiated a wide-ranging and comprehensive investigation into the modernization of the Massachusetts electric grid. Modernization of the Electric Grid, D.P.U. 12-76 (2012). NSTAR Electric Company d/b/a Eversource Energy ("Eversource" or the "Company")[1] was an active and engaged partner in the Department's long-running investigation, bringing its expertise and innovation to bear on the effort. Eversource had always been, and continues to be, at the forefront of implementing technologies to further improve service to customers and lessen/mitigate the impact of outages on customers. The Department's Grid Modernization investigation enabled the Company to further expand its efforts on behalf of its customers and in making significant strides to achieve critical Massachusetts energy and environmental policies.

Over the course of several orders incorporating Eversource and other stakeholder input, the Department set out a Grid Modernization framework for Eversource, along with Massachusetts Electric Company and Nantucket Electric Company, each d/b/a National Grid ("National Grid") and Fitchburg Gas and Electric Light Company d/b/a Unitil ("Unitil")(collectively, the "Distribution Companies"), to develop and invest in an innovative and comprehensive Distribution Company-specific Grid Modernization Plans ("GMPs") designed to advance achievement in four grid modernization objectives, specifically to: (1) reduce the effect of outages; (2) optimize demand, including reducing system and customer costs; (3) integrate distributed resources; and (4) improve workforce and asset management.[2]

Consistent with the directives set out in the Department's various D.P.U. 12-76 orders, on August 19, 2015, Eversource filed its first GMP. The Department conducted a lengthy and thorough investigation of the Company's GMP. On May 10, 2018, the Department issued an order approving in part and modifying in part the Company's GMP. NSTAR Electric Company d/b/a Eversource Energy d/b/a Eversource Energy, D.P.U. 15-122 (2018) ("D.P.U. 15-122"). In its order, the Department approved the Company's proposed grid-facing grid modernization investments, as well as a three-year (2018-2020) budget of $133 million to undertake the approved investments. D.P.U. 15-122, at 172-173, 186-187. The Department also determined that it was appropriate for Eversource to recover the costs of its energy storage demonstration projects and its

[1] On December 31, 2017, Western Massachusetts Electric Company ("WMECO") was merged with and into NSTAR Electric Company ("NSTAR Electric"), with NSTAR Electric as the surviving entity pursuant to the Department's approval in D.P.U. 17-05 under G.L. c. 164, § 96. D.P.U. 17-05, at 36-44. Beginning January 1, 2018, the legal name of Eversource Energy's electric distribution company in Massachusetts is NSTAR Electric Company d/b/a Eversource Energy.

[2] The Department refined the grid modernization objectives in its order on the Distribution Companies' 2018-2020 GMPs, with the following established as the final objectives: (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 ("DER"). D.P.U. 15-122, at 106.

electric vehicle ("EV") infrastructure program, approved in the Company's 2017 base distribution rate case, D.P.U. 17-05, through its targeted grid modernization cost recovery mechanism ("Grid Modernization Factor" or "GMF").

As part of its ongoing review of Eversource's 2018-2020 and future GMPs, the Department required the Company to file annual GMP progress reports detailing its performance under the GMP during the relevant year ("Grid Modernization Annual Report" or "Report"). D.P.U. 15-122, at 112. The Company is required to report on its performance under the statewide and Eversource-specific infrastructure and performance metrics. The Department stamp approved the Company's performance metrics on July 25, 2019. Following the completion of its 2018-2020 and future three-year GMPs, the Company will file a performance report covering the term of the GMP in question ("Grid Modernization Term Report"). Id. The Company's first Grid Modernization Term Report, covering the 2018-2020 GMP, will be filed on April 1, 2021.

After the May 10, 2018 issuance of the D.P.U. 15-122 order, the Department conducted a sub-proceeding designed to formalize the contents and form of the Grid Modernization Annual Reports, including the development of templates to comprehensively and clearly provide data demonstrating the Company's annual progress under its GMP. When the Company submitted its 2018 Annual Report, the Grid Modernization Annual Report Templates had not yet been finalized. Accordingly, the Department directed Eversource and the other Distribution Companies to file, by May 1, 2019, a narrative detailing their performance under their respective 2018 GMPs. D.P.U. 15-122, March 29, 2019 Memorandum, at 2. The Company filed this narrative on May 1, 2019.

On December 6, 2019, following a stakeholder comment period and a comprehensive technical conference to discuss the form and content of the Grid Modernization Annual Reports, the Department issued its order on the templates and the information required for the Annual Reports. NSTAR Electric Company d/b/a Eversource Energy, D.P.U. 15-122-C (2019) ("D.P.U. 15-122-C"). Consistent with the Department's directives in the D.P.U. 15-122-C order, the Company submitted a supplemental 2018 Annual Report on January 31, 2020 to conform to the Annual Report template contemplated in the order. The Department also confirmed that each Distribution Company must file their Annual Report on or before April 1st of each year. D.P.U/ 15-122-C, at 13.

Consistent with the Department's directives in the D.P.U. 15-122-C Order, Eversource hereby files its 2019 Grid Modernization Annual Report.

B. 2019 Progress Toward Grid Modernization Objectives

1. 2019 Overview

At the beginning of 2019, the Company initiated execution of a work plan for the year designed to cost-effectively meet or exceed its GMP targets, while ensuring completion of its traditional capital plan. Guided by a Grid Modernization Executive Steering Committee and supported by a small team dedicated to tracking and risk management of program scope, schedule and budget, the Company established an aggressive 2019 schedule designed to bring the benefits of grid

modernization to customers as soon as possible. Leveraging the processes, controls and program management structure established in 2018, the Company was able to effectively scale up operations achieving an eight-fold increase in commissioning of GMP supervisory control and data acquisition ("SCADA") and Distribution Automation ("DA") devices relative to 2018.

In many respects, the Company exceeded expectations by establishing efficient work practices that enabled more work to be completed relative to targets, often at or below budgeted unit costs. In some cases, work expected to be completed in 2020 was advanced into 2019, accelerating customer benefits. In other cases, lower than expected unit cost enabled more work to be completed such that the Company is expecting to exceed target quantities by the end of 2020. For a few programs, including line sensors and DA with circuit ties, as of the end of 2019, the Company has completed its work for the 2018-2020 GMP term. With respect to electric vehicle ("EV") make ready infrastructure, the Company continued to support the Commonwealth's goal of decarbonization of the transportation sector by energizing 113 new EV charging station sites with over 400 ports. Of the 113 sites, 25 sites are located in Environmental Justice Communities ("EJC"). The EV program is expected to be fully subscribed by Summer 2020.

Additional milestones were achieved in 2019 related to investments that are not tracked on a unit basis. The Company completed is geographical information system ("GIS") survey program, with all improvements in data related to customer-to-transformer connectivity updated in its GIS system. For the energy storage program, the Company completed the important milestone of selecting an engineering, procurement and construction ("EPC") vendor to supply the battery systems for Martha's Vineyard and Provincetown and completed procurement of associated services. Permitting for the Provincetown project is complete, and construction is scheduled to begin in April 2020. Permitting is underway for Martha's Vineyard and project completion is scheduled for the first quarter of 2021. For the advanced load flow project, the Company achieved its first milestone target of implementing a software solution that allows engineers to build static models of the system based on information from GIS and supporting databases.

In some cases, the Company encountered unexpected barriers preventing completion of the work plan as expected. With respect to substation construction projects, the Company was challenged to execute its plan within established schedules and/or budgets. The level of complexity associated with the substation projects, including the need for planned outages requested well in advance of construction, proved difficult to manage as incremental to the existing substation work plan. Over the course of 2019, the Company established new work practices aimed at scaling up capacity for engineering, design, construction and commissioning of these projects. At this time, assuming limited disruption due to construction work stoppages associated with the Covid-19 pandemic, the Company expects these new practices will enable it to achieve GMP targets for substation projects for the GMP term.

As a part of the engineering and cost estimating process for all GMP investments, the Company maintains oversight and review of investment cost-effectiveness and value proposition for customers. Using its established capital project approval process described below, all projects are reviewed to confirm the project need, justification, scope, comparison to alternatives and budget.

In one instance, following completion of detailed engineering, the project review process determined that the project did not demonstrate a reasonable benefit relative to the cost to customers. In its initial GMP filing with respect to communications investments, the Company had originally planned to build out 250 miles of fiber to connect distribution substations across Massachusetts into the Company's existing fiber network. Based on the results of the engineering analysis, the Company determined the per mile cost of deploying fiber averaged approximately four times the original estimate. The needs assessment determined that, although this fiber build out would augment and reinforce the Company's communications infrastructure for future grid modernization investments, the additional fiber was not required to deliver any of the benefits associated with the 2018-2020 GMP. The decision not to move forward with the fiber program was reviewed and approved by the Company's Grid Modernization Executive Steering Committee. The Steering Committee also approved a reallocation of $15 million from the communications budget to enable completion of substation projects and to add additional overhead ("OH") DA to the work plan.

In the beginning of 2020, the Company conducted multiple lessons learned sessions to review processes and outcomes from the prior year to identify opportunities to increase efficiency and improve operations going forward. The following is a summary of selected key findings. More specific lessons learned are detailed in Section III.

- Following disciplined planning and scheduling processes is essential to managing scope, schedule and budget. Ensuring engineering and procurement of long-lead materials well in advance of construction allows for optimal project execution. Good communication in departmental hand-offs for complex tasks such as commissioning supports more efficient deployments. Optimizing scheduling of internal and contracted field workforce creates cost-saving opportunities.
- Deployment of new technologies will inevitably involve unforeseen challenges that will stress schedule and budget. Setting detailed requirements and statements of work up-front with technology vendors enables more rapid issue resolution as concerns arise.
- Complexities associated with information technology / operational technology ("IT/OT") projects require sufficient lead time and planning. Implementation of real-time systems used by System Operations are particularly challenging and have far-reaching consequences outside the control room.

Efforts to stand up the GMP portfolio implementation capability reinforced the Company's ongoing efforts to build the workforce of the future required to continue to transition the distribution grid into a platform that enables higher penetration of distributed energy resources ("DER"). A grid characterized by widespread sensing, monitoring and control technology requires specialized and highly-trained resources in electrical and telecommunications engineering, field communications, field engineering, system operations, project management and information technology. Approval of the Company's GMP has further emphasized the importance of identifying near and long-term opportunities to build skills, attract talent and grow the execution efficiency of the Company's workforce. Many of the successes and lessons learned described in

this Report demonstrate the power of a motivated and well-organized workforce to scale up operations and identify creative solutions to technical challenges as well as the opportunities to augment technical capabilities required to build the grid of the future.

As the Company continued to implement its GMP in 2019, it has continued to experience increasing levels of DER penetration on the distribution system. In 2019, the Company interconnected an additional 5,000 solar generation facilities, for a total of 45,000 solar generation facilities interconnected to the system. These solar generation facilities represent over 112 MW of incremental capacity. Further, the number of facilities waiting to interconnect to the system increased to 1,400 MW in 2018 to over 1,600 MW in 2019. As described in Section V, many of the new solar projects are incorporating energy storage, increasing the complexity of the interconnection study process. High saturation of solar and energy storage in certain areas of the Company's system have resulted in increased need for substation upgrades and Independent System Operator ("ISO") studies. These factors support the fundamental need for grid modernization efforts that aid in the transparent, cost-effective and efficient planning and deployment of DER on the system.

2. Implementation Strategy

Following the Department's approval of the GMP, the Company initiated a GMP implementation strategy based on the following key principles:

- **Leverage proven, established processes to the extent possible.** As described above, the Company's ability to execute its 2019 GMP work plan was largely attributable to its ability to leverage existing processes and organizational capabilities. These efforts commenced in 2018 and continued in 2019. Using its existing project approval processes, the Company ensured consistency with its overall policies for capital budget spending authorization. In 2019, the Company continued to leverage its existing work management systems and processes to create dedicated work orders for grid modernization projects; order standardized materials based on the Company's established competitive procurement policies; support planning and scheduling of work and enable robust and accurate tracking of GMP investments. With respect to planning and scheduling, the Company created an integrated schedule for both 2019 GMP and base capital projects to ensure maximum execution efficiency and completion of the Company's full scope of work.

- **Dedicate effort to maximize cost-effectiveness of implementation.** Many of the decisions made in the first year of GMP implementation drove cost-effectiveness in achieving plan objectives in the second year of the plan. The Company prioritized equipment location in 2018 which lead to maximum value for the GMP deployment in 2019. =With the locations prioritized and ranked, the Company was able to continue to efficiently and effectively install grid modernization investments as planned. Having this prioritization step completed in 2018 helped to maximize customer benefits and minimize cost. Further, in 2019, the Company hired additional engineering resources to support the

Advanced Load Flow ("ALF") and Volt VAR optimization ("VVO") programs, minimizing the cost associated with external contracted engineering.

- **Establish a dedicated team for portfolio management and financial tracking.** The Company recognizes the critical importance of transparency and visibility in implementing its GMP portfolio. Ensuring accurate, timely tracking and reporting is a principal component required to ensure actions are taken to manage scope, schedule and budget. Focus on tracking and reporting will also support robust performance reporting and active engagement in the measurement and verification ("M&V") process. For the 2018-2020 GMP program, the Company established three positions dedicated solely to GMP program and financial management responsible for developing and executing the integration plan for the GMP portfolio. These key employees were hired in 2018 and continued to support the GMP in 2019.

- **Engage senior Operations leadership to provide implementation guidance and support.** The Company's senior Operations leadership has demonstrated a strong commitment to supporting implementation of GMP objectives. Leaders recognize the direct customer benefit and importance in enabling the continued transition to the grid of the future. Periodic meetings to review progress were held in 2019, and leadership feedback continued to provide critical guidance on the implementation of the 2019 GMP.

Develop an effective approach to implementation of new grid modernization technologies and capabilities. Many of the programs included in the Company's GMP support deployment of existing monitoring and control, communication and automation technologies. These types of programs are relatively more amenable to leveraging existing processes and capabilities. Investments in VVO and Advanced Distribution Management System ("ADMS") investment categories require more of an innovative approach. In order to implement these new programs, the Company established, beginning in 2018, organizational structures and assessed workforce needs. Additional work was also required relative to competitive procurement of new technologies. The Company utilized this structure and workforce and leveraged its existing competitive procurement processes for the 2018-2020 GMP and these processes continued to provide significant support in the deployment of grid modernization technologies in 2019. Through this process, the Company was able to competitively procure the resources needed to construct and implement the ALF and VVO projects in 2019.

The process framework described above provided the Company with concrete methods to undertake the necessary preparatory work prior to initiating investments under the 2018 GMP. The groundwork also provided a solid implementation framework for the 2019 GMP. First, using the established prioritization methodologies, the Company utilized investment deployment locations to maximize the investment's value to customers. For example, the Company was able to install critical investments first on overhead customer isolation zones in order to further enhance historical reliability performance. This methodology was utilized by Engineering to develop

prioritized locations to deploy the overhead sectionalizing devices in locations that would provide the most benefit to customers.

In addition, Engineering teams continued to utilize multiple technology selection efforts to implement the 2019 GMP.

Similar to its practice under the 2018 GMP, the Engineering teams drafted Project Approval Forms ("PAFs") for each investment category in accordance with the Company's Capital Authorization Policy in order to ensure that all 2019 GMP investments had the requisite spending authorization. The PAFs describe the project need, justification, scope, budget and alternatives considered. The PAFs were approved through the Company's delegation of authority consistent with the process used to authorize all capital expenditures.

Following the practice established under the 2018 GMP, the Planning and Scheduling team conducted an analysis to estimate the number of labor hours required to engineer, construct and commission the 2019 GMP work plan. This analysis supported the development of a labor resource strategy designed to maximize the efficiency of GMP execution by leveraging incremental internal resources where possible, particularly for highly technical tasks related to field engineering and communication. This strategy also supported a competitive procurement process to obtain external engineering and construction resources to complete the 2019 GMP work plan.

Under the 2019 GMP, the Eversource Investment Planning team again utilized specific and dedicated cost control processes to isolate and monitor all costs associated with the GMP. The Company relied on an accounting process to specifically track GMP costs and expenditures, which includes the continued use of a work order process to track grid modernization investments separately from other capital projects undertaken by the Company. All grid modernization work orders for the 2018 and 2019 GMPs link to a specific grid modernization project, which in turn links to a specific line of business. This process is discussed in more detail in its May 15, 2020 filing regarding recovery of 2019 grid modernization investment costs through the GMF.

Consistent with its experience under the 2018 GMP, the foundational steps described above enabled the Company to implement its 2019 GMP in an efficient and cost-effective manner. Additionally, this framework allowed the Company to proactively look forward through the portfolio to understand and plan for areas of opportunity to accelerate the deployment schedule to the maximum extent possible over the remainder of the 2018-2020 GMP.

C. Summary of 2019 GMP Investment Deployment (Actual vs. Planned)

Drawing upon the implementation strategy described above, the Company continued to implement its GMP in 2019. Planning efforts for the 2019 GMP focused on achieving the milestone targets established in the Company's August 15, 2018 *Grid Modernization Plan Statewide and Eversource-Specific Infrastructure Metrics Baselines and Targets* filing ("Baseline and Targets Filing")(see Table 2.4.7). The Company's planning efforts were also informed by the grid modernization infrastructure and performance metrics approved by the Department on July 25, 2019.

The 2019 GMP unit targets from the Baseline and Targets filing is reproduced below *Table 1: 2019 Units Status* in column "Plan Units (2019)." In Table 1, the Company has reflected its progress relative to 2019 targets in the columns "Construction Complete Units (2019)" and "Commissioned Units (2019)". If the unit was not both constructed and commissioned, Table 1 provides the units to be installed in the 2020 GMP year under the column, "2019 Unit Carry Over (2020)".

Table 1: 2019 Units Status

Investment Categories	Preauthorized Device Types	2018 Unit Carry Over (2019)	Plan Units (2019)	Construction Complete Units (2019)	Commissioned Units (2019)	2019 Unit Carry Over (2020)
Monitoring & Control (SCADA)	Microprocessor Relays (SS)	3	100	87	87	16
	4kV Circuit Breaker SCADA (SS)	n/a	21	16	16	5
	Recloser SCADA	3	11	19	19	0
	Padmount Switch SCADA	18	24	41	41	1
	Network Protector SCADA	n/a	50	83	0	50
Distribution Automation	Overhead DA	4	100	165	148	0
	Overhead DA w/Ties	n/a	23	45	45	0
	4kV Oil Switch Replacement	10	57	89	89	0
	4kV AR Loops	n/a	16	17	17	0
Volt-Var Optimization	VVO - Regulators	15	80	69	69	26
	VVO - Capacitor Banks	n/a	76	71	71	3
	VVO - LTC Controls	0	6	4	4	0
	VVO - Line Sensors	n/a	125	189	189	0
	VVO - IT Work	n/a	n/a	n/a	n/a	n/a
Advanced Distribution Management System (ADMS)	Advanced Load Flow	n/a	n/a	n/a	n/a	n/a
	GIS Verification	n/a	n/a	n/a	n/a	n/a
	Distribution Management System	n/a	n/a	n/a	n/a	n/a
Communications	Communication - FAN	n/a	6	4	4	2
	Communication - Fiber	5	125	0	0	0

In order to appropriately assess the Company's performance under its 2019 GMP, understanding the manner in which the Company tracks progress under its GMP work orders is important. The Company utilizes two classifications when categorizing the status of an investment:

- **Construction Complete**: the Company classifies a GMP unit as "Construction Complete" when a device is placed in-service, meaning that it is used and useful. Due to the nature of the Company's GMP investment categories, it is often the case, particularly in regards to line-equipment devices, that a piece of equipment is installed and electrically placed into service, but has not yet gone through its commissioning process, which, when complete, places that piece of equipment into the Company's monitoring and control systems (i.e., SCADA).

- **Commissioned**: once a device is commissioned, the piece of equipment is electrically connected to the system, classified as in-service, and has been connected into the Company's monitoring and control systems, typically SCADA, which allows authorized personnel control and/or visibility of that device. The Company refers to the completion of the commissioning step as communicating and functioning consistent with the specifications set out in the GMP.

In terms of reporting its progress on the GMP in the Annual Report, the Company is reporting on both the Construction Complete and Commissioned statuses in order to provide a complete, accurate and transparent view of progress. As shown in *Table 2: 2019 Capital and In-Service Spend Summary*, any grid modernization device or system that has been categorized as Construction Complete is reflected in the Plant In-Service columns.[3] While a GMP investment is classified as in-service when it falls in the "Construction Complete" category, the Company does not consider it to be operating and providing benefits consistent with the GMP in such a manner that it helps to advance the Department's grid modernization goals, until the investment is "Commissioned". When an investment is "Commissioned", it is complete within the GMP process.

Cost recovery under the GMP is initiated when an investment is "Construction Complete," which is in-service, and used and useful in accordance with the Department's cost recovery standard and precedent. It is at this point that the Company reviews the work orders associated with that investment to ensure the costs charged to-date were appropriately charged to the GMP work order and recoverable through the GMF. Costs will continue to accrue on a work order until the work order is "Commissioned." After the work order is "Commissioned," the Company will undertake the same review of the additional costs incurred to move the investment into the "Commissioned" category.

For the investments that were classified as Construction Complete in 2019, the Company will include the costs associated with the investment in its 2019 cost recovery filing to be submitted on May 15, 2020.

As can be seen in *Table 1: 2019 Unit Status* above, the Company undertook an aggressive approach to implementing the 2019 GMP and made significant strides in implementing the GMP. In a few investment categories, the Company did not fully meet its target for 2019. The primary driver of missed targets was an aggressive incremental workload driving an implementation schedule that did not provide for extra time to address unforeseen field conditions. This was particularly significant in the case of the more complex substation projects that involved system outages planned well in advance of construction. In order to provide transparency in the process, the Company differentiated "carry-over" work in the 2020 work plan and established an internal target to complete all 2019 carry-over work in the first quarter of 2020.

As of April 1, 2020, carry-over work from the 2019 GMP associated with Microprocessor Relays, 4kV Circuit Breaker SCADA, Padmount SCADA and Network Protector SCADA have been constructed and commissioned. The Network Protector SCADA program completed all 83 units planned for the 2018-2020 GMP term, exceeding the 50-unit 2019 target.

Carry-over work for VVO regulators, VVO capacitor banks and Communications nodes and fiber investments were not completed prior to April 1, 2020. Commissioning of one VVO capacitor bank is on hold pending receipt of a replacement unit from the equipment vendor. Construction

[3] The Company will also provide a similar summary of grid modernization devices and systems categorization in its May 15, 2020 cost recovery filing.

and commissioning of all 27 VVO regulators (nine locations) is on hold due to both permitting delays and issuance of a revised construction standard for platform regulators that includes additional standards for resilient design. One communications node remains outstanding due to site restrictions established due to a suspected positive test for COVID-19. As described above, the Company suspended the communications fiber program due to cost considerations.

In addition to the progress relative to GMP device targets, the Company achieved milestones associated with GMP programs for which unit targets are not appropriate. For instance, the Company made substantial progress on its ALF project. The Company completed a competitive procurement process for load flow software, selecting the DNV-GL product Synergi. The Company also defined the data structures and functional requirements, established IT and security protocols, built the model forge process and provided training to engineers. These efforts enabled the Company to achieve its first implementation milestone such that engineers can now use the Synergi tool to build and analyze models for all non-network feeders in Massachusetts. For the VVO program, the Company completed a competitive procurement process, selecting the Eaton product Yukon Integrated Volt Var Control system. The VVO project team made substantial progress building out models of 26 feeders and the Company expects to begin measurement and verification activities in the second quarter of 2020.

Additionally, during 2019, all remaining work associated with the GIS Verification for the eastern MA overhead infrastructure has been surveyed and all data updates to the Company's GIS system has been completed. The completion of this survey and verification work completes the three-year goal for this investment.

D. Summary of Spending (Actual v. Planned)

In *"Table 2: 2019 Capital and In-Service Spend Summary"* provided below, the Company has broken out the "Total Capital Spend" and "Plant In-Service" to correspond to the work order progress, as explained in the "*Summary of Grid Modernization Deployment (Actual v. Planned)*" table above. The Company has provided specific, detailed narratives in this Report on the details of each GMP investment category and device type.

Table 1: 2019 Capital and In-Service Spend Summary

Grid Modernization		2019 Capital Spend			2019 Plant in Service		
		Actual	Budget	Variance	Actual	Budget	Variance
		82,851,919	101,593,952	(18,742,033)	57,119,430	51,420,004	5,699,426
Investment Category	**Preauthorized Device Type**						
Monitoring & Control (SCADA)	Microprocessor Relay	14,991,129	20,319,438	(5,328,309)	9,693,573	9,051,121	642,452
	4kV Circuit Breaker SCADA	4,085,366	2,413,892	1,671,474	2,650,164	1,750,000	900,164
	Recloser SCADA	888,665	1,024,000	(135,335)	608,248	681,817	(73,569)
	Padmount Switch SCADA	615,476	299,000	316,476	631,169	622,605	8,564
	Network Protector SCADA	871,602	2,200,000	(1,328,398)	678,977	678,238	739
	OMS/AMI Integration	-	-	-	-	-	-
Distribution Automation	OH DA w/o Ties	12,069,703	13,167,000	(1,097,297)	12,532,547	9,982,818	2,549,729
	OH DA w/Ties	2,797,738	3,135,000	(337,262)	2,585,627	2,494,402	91,225
	4kV Oil Switch Replacement	13,881,098	10,010,000	3,871,098	12,280,567	10,525,154	1,755,413
	4kV AR Loop	891,645	880,000	11,645	217,240	-	217,240
Volt-Var Optimization	VVO - Regs, Cap Banks, Line Sensors	5,602,795	5,223,000	379,795	5,191,554	4,494,151	697,403
	VVO - LTC Controls	1,044,867	882,804	162,063	1,202,622	1,197,745	4,877
	VVO - IT Work	1,159,861	5,147,030	(3,987,169)	-	-	-
Advanced Distribution Management System (ADMS)	Advanced Load Flow	2,775,876	4,662,150	(1,886,274)	-	-	-
	GIS Survey (Expense)	6,338,926	-	6,338,926	-	-	-
	Dist. Management System	-	2,059,791	(2,059,791)	-	-	-
Communications	Numbers of Nodes	522,256	974,299	(452,044)	415,578	57,750	357,828
	Miles of Fiber	309,896	13,450,322	(13,140,426)	-	3,000,000	(3,000,000)
Workforce Management	Mobile Damage Assessment	-	-	-	-	-	-
Electric Vehicles	Electric Vehicles	10,979,264	6,378,693	4,600,571	8,431,565	6,884,203	1,547,362
Energy Storage	Martha's Vineyard	1,302,875	3,360,030	(2,057,155)	-	-	-
	Provincetown	1,722,882	6,007,503	(4,284,621)	-	-	-

Below are several aspects of the 2019 GMP implementation that impact the financial performance under the 2019 GMP, as related to the capital spend:

- Microprocessor Relays: Though the unit costs are higher than expected, the program was short of its unit and budget goals for the year. Work continued uninterrupted into 2020 when the remaining capital expense and plant in-service funds will be expended.
- 4kV Circuit Breaker SCADA: Unit costs were found to be higher than expected for this investment, which drove the overage in 2019.
- Padmount Switch SCADA: There was more work at many sites than had originally been expected and budgeted, which is why this program was over-budget for 2019. Budgeted unit costs for this investment are relatively low, therefore small cost deviations can appear as larger percentage deviations. The Company expects the unit costs to come further in line with budget.
- Network Protector SCADA: Though the goal was not formally met in 2019, significant work was completed in 2019 on this investment and unit costs are expected to be significantly lower than expected.
- OH DA w/o Ties: Unit costs were consistently below the budgeted amounts and even in lieu of completing additional units, this investment was under budget for 2019.
- 4kV Oil Switch Replacements: The unit costs for this investment are averaging on budget and the reason for the overage in 2019 was due to the increased units completed above the 2019 target.
- VVO Devices: As a combined category, VVO regulators, VVO capacitor banks and line sensors were close to budget and unit costs were close to expectations for each equipment type.

- VVO IT: After final design and vendor selection, the costs to implement this investment were substantially lower than expected and budgeted.
- ALF: Similar to the VVO IT investment, after selecting a vendor and implementing the program, costs were lower than expected and budgeted.
- DMS: Even though budgeted for 2019, the Company deferred the DMS budget to 2020 in order to better analyze the overall IT/OT investments and ensure that the selection of DMS projects complemented the long-term vision.
- Miles of Fiber: As is elaborated upon in Section III of this Report, following a thorough analysis, the Company determined that there was not a cost-effective solution that would benefit customers under the Miles of Fiber program. This investment was limited to minor work in support of another GMP investment.
- EV: The Company made a concerted effort to accelerate this program in 2019 and therefore exceeded originally budgeted expectations.
- Energy Storage: The deviation in the energy storage spend is primarily due to the shift in the execution of the major contracts with the battery vendor, NEC.

The Company closely monitors the current and expected spend for the various investments and has made, and will continue to make, adjustments and shifts between authorized investments to ensure that the most appropriate, cost-effective and customer-beneficial devices and technology are deployed within the authorized GMP timeframe.

Table 2 above includes capital spending and expense spending associated with the GIS Verification program. In addition, the Company spent an additional $1,242,806 in expense associated with the evaluation work undertaken by Guidehouse (formerly Navigant) on behalf of Eversource and the other Distribution Companies are required by the Department in D.P.U. 15-122, EV Make-Ready work and internal GMP labor. The internal GMP labor is the labor that was validated through the GMP testing process for recovery.

II. Program Implementation Overview

A. Organizational Changes Designed to Support Program Implementation

In order to ensure the successful and efficient implementation of the GMP, beginning in 2018the Company layered the GMP into its existing business practices and leveraged the existing capabilities, processes, procedures, departments and personnel within the Eversource system. Administratively, the portfolio of GMP programs is managed by a group of three dedicated employees, the Grid Modernization Portfolio Manager, Program Analyst and Financial Analyst shown in Figure 1 below. These personnel were charged with developing and constructing the execution platform, and reporting, closing and dispositioning each of the GMP programs. The remaining personnel identified in Figure 1 depict existing employees who are supporting the implementation of the GMP efforts.

Administratively, to support the integration, the team developed a process framework to evaluate, analyze, align and mange cross-functional responsibilities. Though a robust system from the outset, the Company made several enhancements during 2019, to its repository and tracking process. Under this process framework, the Company has undertaken the following steps in order to successfully implement and manage the GMP.

- **Evaluate/Inventory:** The team continued to study the strategic and end-state goals of the GMP program, identified the internal and external stakeholders who will/can influence program completion and success, and mapped the data repositories with relevant information, such as STORMs and Passport, the Company's work management systems, PowerPlan, the Company's financial repository system, the Company's Geographical Information System ("GIS"), the Outage Management System, the Primavera P6 scheduling systems, and various other data sources. This data was aggregated into a centrally housed database to enable report generation and analysis that will be used over the course of the GMP to track investments and the Company's overall progress under the GMP.

- **Analyze:** The GMP analysts further refined the data into the GMP Portfolio Tracker allowing for internal monitoring and reporting for quality assurance/quality control ("QA/QC") checks. This step is critical to successful GMP execution as it allows for visibility into the GMP implementation, which enables the Company to identify potential issues as early as possible during a given investment and develop and apply a resolution before program impact. During 2019, enhancements were made to the GMP Portfolio Tracker to include:

    - More granular tracking of the various elements of individual work orders. This allowed the team to understand and communicate what open tasks/requirements may be left to completed, within a specific work order, and adds another quality check on closing out work orders.

    - A more robust set of data has been added to the recurring data downloads from the various Company systems. Some of these additions include the tracking to the

circuit and substation for a given work order, with a quality assurance process to ensure these are accurate for reporting purposes. The team also now tracks on a recurring basis the number of customers affected by the OH DA investments and another quality assurance check on when a specific work order is placed in-service, which ensures accurate reporting.

- **Align:** The GMP represents incremental work that was overlaid onto and integrated with Eversource's existing controls and processes. Therefore, the core team coordinated and facilitated a blended oversight and engagement of the various departments responsible for the execution of the GMP, such as Procurement, Planning, Operations, Information Technology, and various administrative functions. This provides inter-departmental visibility into the various GMP program types and enables more effective and efficient planning of work and resources. For 2019, the team, shown in Figure 1, below, developed several enhanced reporting elements to assist in the monitoring of and communication regarding the portfolio. Some of those enhancements include: 1) the addition of "Workdown Curves" that graphically communicate how the plan has been executed to date, and the remaining planned trajectory through the year end; and 2) monthly financial review meetings with key team members that allow for immediate and decisive review, understanding and communication of the portfolio financials to ensure alignment across the Company's organization.

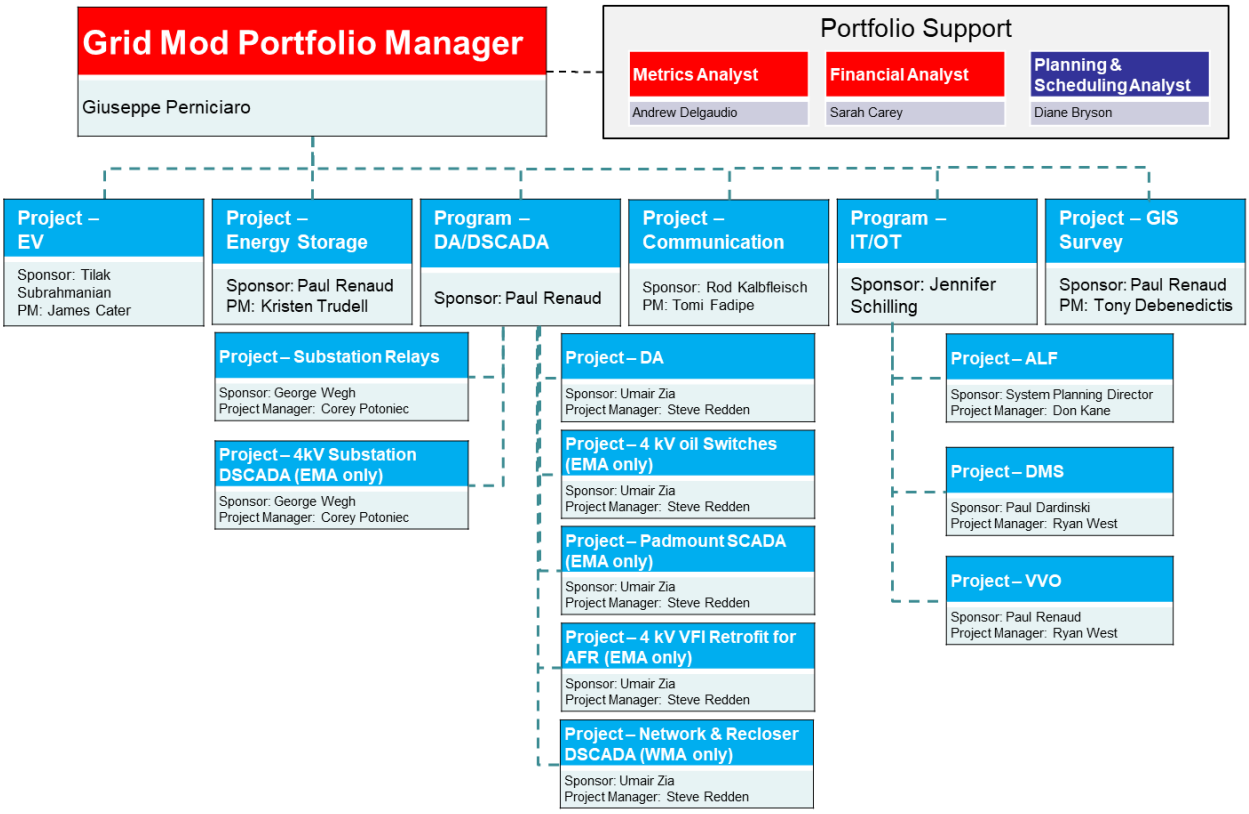
Figure 1 Grid Modernization Team

Core Grid Mod Team	
Name	**Title**
Andrew DelGaudio	Program Analyst
Sarah Carey	Financial Analyst
Don Kane	Lead Engineer
Emilio Cepeda	Engineer
Giuseppe Perniciaro	Portfolio Manager
Ryan West	Manager - Grid Mod
Akhil Punnoose	Lead Engineer
Tony Lasa	Lead Engineer
Hicham Khireddine	Associate Engineer
Kelsey McGlashan	Engineer
John Kreso	Engineer
Deb DiNuzzo	Admin Assistant
Jennifer Schilling	Director - Grid Mod

- **Manage:** Through the use of cross-functional GMP project managers, recurring status and coordination meetings, and recurring reporting, the core GMP team utilizes an execution platform to oversee and guide the implementation of the GMP program to ensure Eversource deploys the GMP investments in an efficient and effective manner designed to advance the achievement of the Department's identified grid modernization objectives. Enhancements to 2019 include the establishment of recurring meetings, chiefly at the project level, but also with individual and team leadership meetings, which enhanced the communication flow of the fast-paced programs of the GMP throughout the large organization.

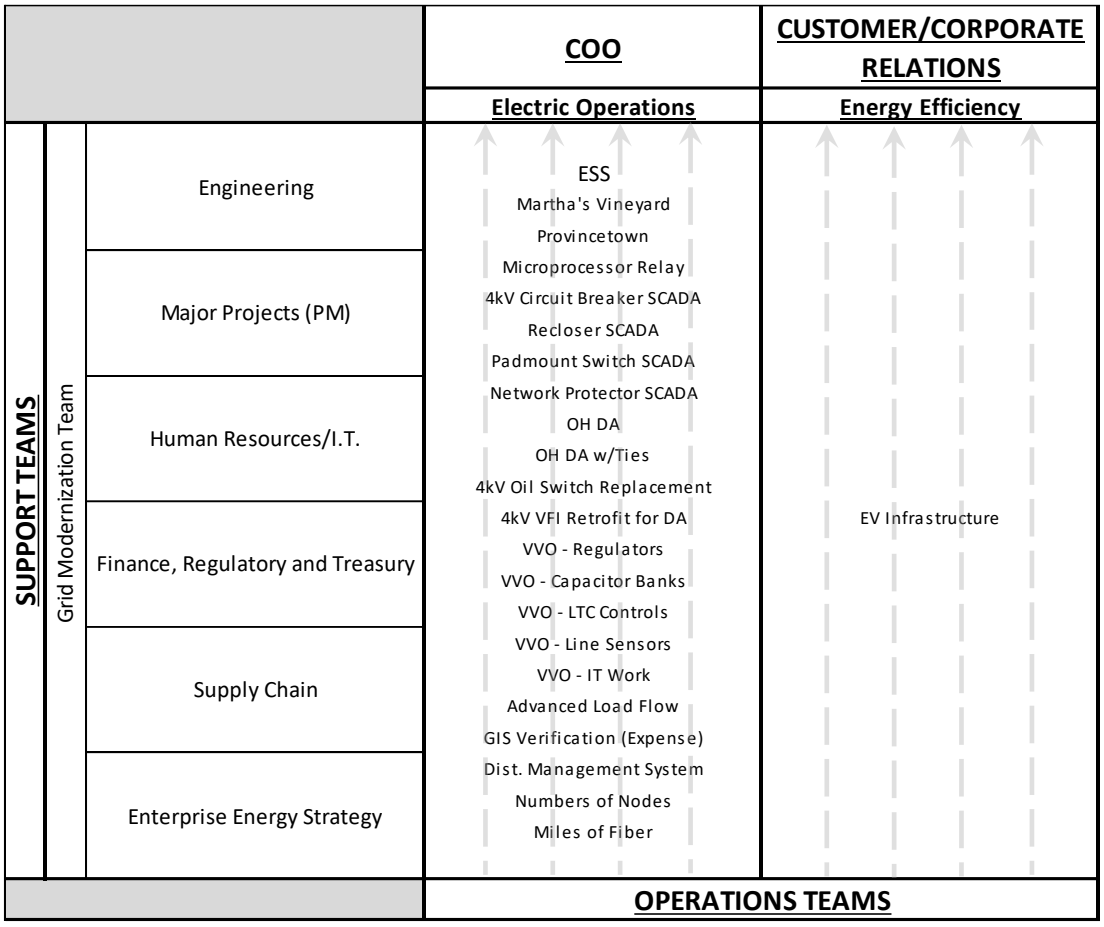
These steps represent critical foundational steps that were developed and deployed in order to ensure that all GMP investments were undertaken in a deliberate and efficient manner. This framework was utilized in the execution of the 2019 GMP and will be used for future GMPs.

Figure 2 Grid Modernization Organization



Operationally, the GMP is being implemented by a combination of internal and contracted operational personnel, such as line workers, electricians, technicians, IT developers, and commissioning agents. Eversource uses a matrix organizational structure, as can be seen in Figure 3 below, with many support functions cutting horizontally across the various operational resources. This structure promotes consistency across the enterprise and the ability to scale the organization to incorporate significant initiatives, such as the GMP.

Figure 3 Eversource Organizational Structure



B. Cost and Performance Tracking Measures

GMP Accounting Process

The Company developed a distinct accounting structure to ensure that GMP costs were isolated from all other capital project costs and were incremental to existing or business as usual investments. The GMP accounting structure started with the creation of new cost control centers for both Eastern Massachusetts (E98) and Western Massachusetts (5GW). Although the GMP was designed and will be implemented across the Company's service territory, the Company is still required, consistent with the Department's directives, to maintain separate financial records for NSTAR Electric and the former WMECO. D.P.U. 17-05, at 44-45. Next, the Company created separate lines of business for each investment type to track GMP projects and work orders separately from any base capital work. The separate lines of business are listed below:

- Electric Vehicle – 12165
- Energy Storage – 12160
- Advanced Sensing Technology – 12190
- Automated Feeder Reconfiguration – 12170

- Urban Underground System Automation – 12175
- Communications – 12180
- Distribution System Network Operator – 12185.

The Company also created a mechanism for properly tracking all GMP Labor charges. Originally a specific work order, GMPLBR21, was established to track these labor charges, but a new specific work order (GMPLBR00) was created to track all new external hires whose work is dedicated 100 percent to the GMP, i.e., these new hires do not perform any work on other Eversource programs or initiatives. The change in work orders was completed so that costs associated with the external hires would be completely segregated and independent of costs associated with the pre-authorized investments. All charges from the old work order were migrated to the new work order to retain all historic entries. Eversource internal labor direct charges their time to the relevant GMP work orders whenever possible and appropriate. In the event that these individuals cannot direct charge their time, their time is charged to Engineering & Supervision ("E&S") to be spread across all work orders consistent with Eversource accounting practice for all capital work. For existing employees, i.e., those individuals employed prior to March 15, 2018, all of their labor expense and productive and non-productive time will remain as an expense in the employee's home cost center and is not recoverable under the current GMF. All outside services procured to design/implement/construct grid modernization capital units of property will charge the GMP capital work orders and be recoverable through the GMF.

GMP Cost Tracking Process

Total O&M and Capital Spend

The Company created a cost tracking process to track total spending for the entire GMP portfolio. This process was designed to be an accurate and repeatable process that required minimal manual effort to ensure data consistency and that the spending was incremental. A customized view was created in Eversource's budgeting and financial application, Planning Analytics,[4] that contains only GMP projects and lines of business. The view contains monthly Actuals, Budget, Variance, and Projection information that are automatically populated in Planning Analytics.

- Actuals – numbers feed into Planning Analytics directly from Eversource's other financial reporting system, PowerPlan.

- Budget – numbers are input into Planning Analytics at the end of each calendar/budgeting year for the following calendar/budgeting year. Budget numbers are then 'locked down' within the first week of the calendar year so that there cannot be any changes to the budget throughout the year.

- Variance – automatically calculated in Planning Analytics (Actuals-Budget).

[4] The Company changed its software package from TM1 to Planning Analytics in 2019.

- Projection – numbers are input into Planning Analytics monthly, based on historical performance and Actuals from the prior month.

As Actuals accrue for each project, the Projections are manually entered into Planning Analytics by the Budgeting group, who receive updated figures from Project Managers. The Actuals, Budget, Variance, and Projections populate in both a Month to Date and Year to Date view, and the data from the Planning Analytics view is extracted directly into Excel. On or around Business Day 4 of each month's accounting close process, the Grid Modernization Financial Analyst extracts the Planning Analytics data to perform a year-to-date and month-to-date variance analysis of the GMP portfolio and report results to various groups internally. Analysis of Planning Analytics Actuals is also performed to further ensure that the Planning Analytics data is the same as the PowerPlan data.

Total Plant in Service

The Company has created a cost tracking process to track total plant in service dollars for the entire GMP portfolio. Total dollars placed in service cannot be tracked in the same manner as total capital spending because Planning Analytics does not contain the necessary FERC account information used to classify a work order/project as being in service. This information is extracted from PowerPlan, Eversource's Fixed Asset system. To populate this information, the Grid Modernization team established a query in PowerPlan to capture all costs distinctly associated with the GMP. The query contains detailed information needed to accurately and comprehensively track GMP costs, such as FERC Account, Accounting Work Order, Entity, Funding Project, Line of Business, etc. FERC Accounts 106010 and 101010 denote that an Accounting Work Order is Plant in Service. Similar to the total capital spending Planning Analytics process, the PowerPlan extract is performed by the Grid Modernization Financial Analyst on or around Business Day 4 of each month's accounting close process.

Controls and Ensuring Data Accuracy

The Company created various informal and formal tracking mechanisms to report on portfolio performance and ensure the accuracy of the data. In addition to the established accounting process described above, the Company carefully scrutinizes and assesses the reported data. A mechanism was created to track GMP portfolio operational performance and analyze GMP work order activity. The reporting combines both financial and operational metrics of the GMP portfolio. Operational work order details are formally tracked using this reporting. Work order detail, including but not limited to, work order description, service center, costs and work order status are pulled into the reports from various Eversource systems. The Grid Modernization Program Analyst refreshes the data weekly. Eversource's work management systems (Passport and STORMS) are queried weekly to pull GMP work orders that have been created. The population of work orders is cross checked to the Company's financial reporting tool, PowerPlan. Data is organized by project and by the GMP-specific lines of business discussed above in the GMP Accounting Process section. Any identified inconsistencies are addressed and corrected in a timely manner. For example, if it is determined that a work order was inadvertently written to the wrong GMP project and/or line of

business, the analyst would work with engineering to cancel and rewrite the work order to the correct GMP project and line of business.

As a further review of the data, weekly meetings are held with diverse groups of Eversource personnel. The summarized GMP data, as well as detailed data from the tracking mechanism, is shared and analyzed during this meeting. In addition, the Grid Modernization Portfolio Manager shares additional information related to the program, such as program risks, issues, and progress towards internally established targets. The Grid Modernization Project Managers also report on progress made for their respective areas of responsibility. The weekly meetings provide a recurring opportunity and platform to discuss any issues related to or potentially impacting the GMP.

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

Grid Modernization Unit Tracking Process

GMP-qualified units are manually tracked by the Grid Modernization Program Analyst in the GMP portfolio tracking reports. As discussed above, all GMP work orders are reviewed and analyzed on a weekly basis, with any inconsistencies or other issues addressed proactively in a timely manner. Based on the attributes assigned to a GMP work order and depending on the outcome of the discussions and collaborations with the GMP Project Manager and/or Engineering, a GMP-qualified unit(s) is assigned to the appropriate GMP work order.

As described above, Eversource has developed a robust and detailed set of multi-disciplinary processes and procedures to track the costs associated with GMP projects to ensure that the Department's directives from D.P.U. 15-122 are comprehensively addressed. The Company's procedures allow for detailed analysis to support GMP investments and, eventually, cost recovery. Over the course of the 2018-2020 (and future) GMPs, the Company will continuously assess its tracking and reporting processes and, as appropriate, modify those processes and adopt best practices.

C. Project Approval Process

Consistent with the Company's Capital Authorization Policy and procedures, all GMP projects that were placed in service in 2019 have received the requisite spending authorization (adhering to the APS 1 Project Authorization Policy). All GMP projects link to one of the specific GMP lines of business and all GMP work orders link to a specific GMP project, which rolls up to a GMP line of business. For GMP projects where the total costs are below $100,000, the authorization

has been granted via the annual program blanket approval that occurs as part of the capital plan book review by the Company's Board of Directors. For GMP projects where the total cost exceeds $100,000, a specific project identification number is assigned and a Project Approval Form ("PAF") is written and approved through the PowerPlan system following the delegation of authority process set out in the Capital Authorization Policy. If a GMP project is expected to exceed the original authorized dollar amount, then a supplemental project authorization form is required when the direct costs of the project exceed or are expected to exceed the original authorized amount by the following levels:

- $25,000 for projects less than $250,000;
- $50,000 for projects greater than $250,000 and less than $500,000; and
- 10 percent for projects greater than or equal to $500,000.

III. Implementation by Investment Category

III.A.1. Monitoring and Control

(Microprocessor Relays, 4kV Circuit Breaker SCADA, Recloser SCADA, Padmount SCADA, Network Protector SCADA)

A. Description of work completed

MICROPROCESSOR RELAYS: Under the 2019 GMP, the Company continued to replace the Electromechanical feeder overcurrent, reclosing, and under-frequency relaying schemes with a Primary 351S relay and a Backup 751 relay and associated test devices. The primary relay will include pushbutton controls for the breaker(s), primary overcurrent protection, Hot Line Tag, reclosing, breaker failure, and under-frequency load-shedding schemes. The backup relay will serve as the SCADA interface and will include backup overcurrent protection and breaker timing logic.

4KV CIRCUIT BREAKER SCADA: Under the 2019 GMP, the Company commenced construction on several projects to upgrade circuit breakers to have DSCADA capabilities (control, indications, and analogs) at 4kV underground substations in Eastern Massachusetts. The work includes replacing distribution feeder electro-mechanical relays with modern microprocessor relay protection schemes and installing new, or upgrading existing, station remote terminal units ("RTUs") or adding real-time automation control ("RTACs"), to add control, indication, and analog functionality at all feeder breakers, tie-breakers, and secondary transformer breakers where they currently do not exist.

RECLOSER SCADA: Under the 2019 GMP, the Company exhausted its overhead recloser devices in the field that were both compatible and did not have communications capability. Accordingly, the strategy was modified so that, instead of simply adding a communications package, the Company replaced oil-filled recloser locations with new reclosers, which included the communications equipment necessary so that the device can be centrally monitored and controlled by the Company's System Operations Center ("SOC").

PADMOUNT SWITCH SCADA: Under the 2019 GMP, the Company identified existing motor-operated padmount switch devices in the field that are both compatible and do not currently have communications capability. Once these devices were identified, the Company added a radio package to the location, so that the device can be centrally monitored and controlled by the Company's SOC.

NETWORK PROTECTOR SCADA: Under the 2019 GMP, the Company installed the Digital Grid network monitoring system to the network system in the Springfield, MA area. The system includes enhancing relays at various field locations and, at the substation, the installation of communications couplers on each of the affected circuits, tying back to a control panel, which will ultimately to be tied into the Company's communications infrastructure. At this time, the field

devices will not be built into the Company's existing SCADA system. The reason for this is to allow the Company to continue to build and implement its new enterprise-wide SCADA system, which has been in progress and will be cutover, for Massachusetts, during the 2020 GMP plan year. Once the SCADA cutover is completed and operational, the teams will evaluate and plan to integrate the Digital Grid system directly into the SCADA platform. Until the transition to SCADA, the Digital Grid relays and station devices will be monitored and controlled via the Digital Grid software platform, which provides monitory capability for the status of the network protectors, in addition to the several additional data points that were added at each location. These new data points included but are not limited to information such as, voltage, current, fault current, hot line tagging status, power factor, reactive power, under frequency status and hardware information. The system will be centrally monitored and controlled by the Company's SOC.

B. Lessons-Learned/Challenges and Successes

As a general lessons learned and after reviewing the 2018 Appendix 1 data submitted on January 31, 2020, supplementing the 2018 Grid Modernization Report, an error was discovered in the plant in-service ("PIS") data, identified in column "L" of tab "5.a Spending – 2018 Report" within the 2018 Appendix 1 spreadsheet. The cost data had inadvertently been broken out to the investment type level, as opposed to being retained as a total value for the entire Monitoring & Control investment category. The Company corrected this mistake in tab "5.a Spending – 2018 Report" within the 2019 Grid Modernization Annual Report's Appendix 1. This change was also noted at the bottom of the tab in the 2019 Report's Appendix 1. Additionally, and because this spending tab of Appendix 1 is essentially all capital, the GIS Verification projects' spending, which was entirely expense, was removed from the entire portfolio summation of investments. This oversight was only contained in the Appendix 1 supplemental report. The 2018 Grid Modernization Annual Report, filed May 1, 2019, is accurate, as submitted.

MICROPROCESSOR RELAYS:

- Work completed within a substation typically requires significant coordination between Company departments. Due to the fast-paced nature of each of the substation projects, ensuring tight coordination still presented challenges in 2019. Obtaining the right mix of internal and external resources also provided some challenges, mostly during the solicitation and onboarding process. As an example, the contracted resources required for this work are both highly specialized and limited within the marketplace. To compete for services and receive competitive pricing, it was important for the Company to solicit multiple projects to provide a definitive pipeline of work that could be completed in succession under a single mobilization as opposed to single projects spread out over the year with numerous mobilization/demobilization in between.

  Once contracted and scheduled, the onboarding of new, external employees to an existing workforce will always provide challenges until both teams learn each other's cultures, habits and work styles, and become integrated. The time

frame for this integration can vary greatly. However, once the teams work out these initial interactions and processes, production and efficiency will continue to increase. The Company worked hard to limit any demobilization of a contracted resource once they had been onboarded to avoid the inherent slow-down of the integration process.

- Substation work is often complex and comprehensive. It has been the Company's experience with previous, non-GMP substation projects, that during the execution of the initially scheduled project, it is possible to identify unforeseen conditions and/or additional conditions that are appropriate and prudent to repair/replace in concurrence with the original work scope. This approach is logical, common in the industry and cost-efficient. The Company is following this same operational approach for any substation work being constructed under the GMP, while ensuring that all costs associated with any work completed that is not due to or related to GMP investments are segregated from the GMP and accounted for separately. The Company has successfully balanced funding and completing all prudent ancillary substation work and maintaining a strict segregation between GMP and non-GMP costs. For 2019, the Company continued to leverage economies of scale by concurrently completing multiple projects within the same substation. After reviewing several completed project locations (substations) the team determined that these efficiencies resulted in a unit-cost savings of 30-40 percent, as compared to performing this work independently and stand-alone.

- Since all GMP-related substation work is incremental to the Company's base capital business, and because much of the substation work requires the use of highly skilled or niche-skilled resources, securing external labor with the requisite skills and experience to assist with this aggressive program has posed challenging, though not insurmountable. The Company has continued to work with the appropriate vendors, as far ahead of construction as possible, utilizing the 2018-2020 GMP set of projects to help secure these contracts, when/where needed.

- For the 2020 GMP plan year and beyond, the Company will explore the possibility of utilizing third-party packager/kitting firms to assist with aggregating and coordinating materials (often from 3rd party vendors), so that the correct material is delivered when needed. Investments such as the Microprocessor Relay and 4kV Circuit Breaker programs do not require overly complex materials. However, there are many common parts and pieces that need to be coordinated to ensure they're on site at the correct times. Additionally, the volume of these projects is not insignificant. Since the procurement process requires multiple Company departments to be involved in the specification, procurement ordering, delivery and receipt of material, the advantage of using a firm such as a 3rd party packager is the ability to free up these internal Company resources to focus on more pressing and complex issues as opposed to these fairly standard and recurring projects.

- After reviewing the 2018 Appendix 1 data submitted on January 31, 2020 that supplemented the 2018 Annual Grid Modernization Report, the Company determined that there was an error in unit data, identified in column "G" of tab "5.a Spending – 2018 Report" within the 2018 Annual Report Appendix 1 spreadsheet. The data inadvertently omitted three relay units that were carried over from 2018 to 2019. The Company made this correction to tab "5.a Spending – 2018 Report" within the 2019 Grid Modernization Annual Report's Appendix 1. This change was also noted at the bottom of the spreadsheet. This oversight was only contained in the January 31, 2020 Appendix 1 supplemental filing. The 2018 Grid Modernization Annual Report, filed May 1, 2019, is accurate, as submitted.

4KV CIRCUIT BREAKER SCADA:

- The 4kV circuit breaker SCADA work is very similar to the Microprocessor Relay program and has similar feedback on the lessons learned.

RECLOSER SCADA:

- This program has been instituted in the Company's Western Region where the Company identified significant opportunities to enhance SCADA sectionalizing capabilities, particularly on long feeders. The Company is nearing the completion of all possible locations which can accommodate the addition of a communications package or complete recloser replacement (with communications).

- Commissioning resources, due to their specialized skill set, was identified as an area of opportunity by the Company. For 2019, the Company placed emphasis on planning and monitoring of the Commissioning team and developed an aggressive but executable plan to complete the work. Though front-loaded toward the first half of the year, this plan utilized the entirety of 2019 and was socialized further in advance with relevant parties, so that the various Company departments were aware of the larger-than-normal influx of work. This helped with: pre-programing devices in the area work centers; making sure devices were ready to go for physical installation; and allowing for better coordination of commissioning to avoid overly extended workloads. This allowed for a reasonable work curve, opposed to "bow waves" of work.

- In 2018, the Company exhausted the list of locations on its distribution system that have compatible existing equipment, which can be upgraded by adding radio communications to enable SCADA capability. Based on this, the Company modified this GMP program to focus on a "replace, in-place" program where locations utilizing older, oil-filled equipment have the entire recloser replaced with new, SCADA-capable equipment.

- After reviewing the 2018 Appendix 1 data submitted on January 31, 2020 that supplemented the 2018 Annual Grid Modernization Report, the Company determined that there was an error in unit data, identified in column "G" of tab "5.a Spending – 2018 Report" within the 2018 Annual Report Appendix 1 spreadsheet. The data inadvertently omitted three recloser units that were carried over from 2018 to 2019. The Company made this correction to tab "5.a Spending – 2018 Report" within the 2019 Grid Modernization Annual Report's Appendix 1. This change was also noted at the bottom of the spreadsheet. This oversight was only contained in the January 31, 2020 Appendix 1 supplemental filing. The 2018 Grid Modernization Annual Report, filed May 1, 2019, is accurate, as submitted.

PADMOUNT SWITCH SCADA:

- During 2018, the Company initially had timing challenges with finding the correct combination of device type locations and sufficient communications methods. This placed the program behind schedule.

- As of the submission of the 2018 Annual Grid Modernization Report on May 1, 2019, the Company had validated all the previously selected 2018, 2019 and 2020 locations, designed the projects and was ready to commence construction. However, similar to its experience with the Recloser SCADA program, the Company may exhaust the list of those locations where simply adding a communications package to an existing padmount switch is feasible. If this is the case, the Company will evaluate redeploying funds from an alternative investment category(s), and performing a "replace, in-place" installation of new pad mounted switch gear in areas of high customer impact.

- After reviewing the 2018 Appendix 1 data submitted on January 31, 2020 that supplemented the 2018 Annual Grid Modernization Report, the Company determined that there was an error in unit data, identified in column "G" of tab "5.a Spending – 2018 Report" within the 2018 Annual Report Appendix 1 spreadsheet. The data inadvertently omitted 18 padmount units that were carried over from 2018 to 2019. The Company made this correction to tab "5.a Spending – 2018 Report" within the 2019 Grid Modernization Annual Report's Appendix 1. This change was also noted at the bottom of the spreadsheet. This oversight was only contained in the January 31, 2020 Appendix 1 supplemental filing. The 2018 Grid Modernization Annual Report, filed May 1, 2019, is accurate, as submitted.

NETWORK PROTECTOR SCADA:

- The most significant lesson learned for this program was that the Company should have segregated the field work, which was presented to the Department on a unit-basis, from the substation work, which comprised the more significant work effort and is not attributable to a "unit." The completion of the substation

work was required prior to any of the 83 field relay devices being able to be commissioned into the new system. Therefore, even though the Company exceeded the commitment of installation of the relays in 2019, and completed most all of the substation work, it was not able to commission any of the devices and therefore did not categorize the devices as "Grid Mod Qualified."

- The Company underestimated the material lead-time on communications couplers (that receive information from the devices in the field), which caused the completion of the substation work to be pushed into 2020. This was mainly due to the Company's substation feeders being fed from reactors, which required a capacitive coupler, instead of the much more common inductive couplers. Therefore, the related equipment from the vendor was not as readily available. The team analyzed multiple paths that may have retained the original unit delivery schedule, but ultimately, none of them provided an increased financial or customer benefit and therefore were abandoned. Work on this project continued directly into 2020 and the long-lead couplers were received in February 2020, after which the team scheduled feeder outages and installed and commissioned all the couplers at the substation reactors. As of April 1, 2020, this project is fully commissioned, online, and has completed its three-year term commitment. Even with the shift of this completion, the project was still completed well before the three-year term-end and significantly underbudget. The budget under-run is primarily due to the Company not having full engineering and design completed during the original filing period. After vendor selection and full design, costs ended up being less than expected.

C. Actual vs. Planned Implementation and Spending

Refer to Tables 3 and 4 below for the Company's 2019 implementation unit and spending summaries for the Monitoring and Control GMP Investments. Spending was broken down into "Total Capital Spend" and "Plant In-Service." As indicated in section I. Introduction, Plant In-Service is initiated by a device being "Construction Complete" and therefore cost recoverable.

Table 3: 2019 Implementation Summary

Investment Categories	Preauthorized Device Types	2018 Unit Carry Over (2019)	Plan Units (2019)	Construction Complete Units (2019)	Commissioned Units (2019)	2019 Unit Carry Over (2020)
Monitoring & Control (SCADA)	Microprocessor Relays (SS)	3	100	87	87	16
	4kV Circuit Breaker SCADA (SS)	n/a	21	16	16	5
	Recloser SCADA	3	11	19	19	0
	Padmount Switch SCADA	18	24	41	41	1
	Network Protector SCADA	n/a	50	83	0	50

Table 4: 2019 Implementation Cost Summary

Grid Modernization		2019 Capital Spend			2019 Plant in Service		
		Actual	Budget	Variance	Actual	Budget	Variance
		21,452,238	26,256,330	(4,804,092)	14,262,131	12,783,781	1,478,350
Investment Category	Preauthorized Device Type						
Monitoring & Control (SCADA)	Microprocessor Relay	14,991,129	20,319,438	(5,328,309)	9,693,573	9,051,121	642,452
	4kV Circuit Breaker SCADA	4,085,366	2,413,892	1,671,474	2,650,164	1,750,000	900,164
	Recloser SCADA	888,665	1,024,000	(135,335)	608,248	681,817	(73,569)
	Padmount Switch SCADA	615,476	299,000	316,476	631,169	622,605	8,564
	Network Protector SCADA	871,602	2,200,000	(1,328,398)	678,977	678,238	739
	OMS/AMI Integration	N/A	N/A	N/A	N/A	N/A	N/A

MICROPROCESSOR RELAYS:

The Company's implementation of the microprocessor relays was short of its 100-unit target by 16 units in 2019. The unit count plan for 2019 projected the Company to achieve 100 commissioned units. It became apparent during the resource planning stages of these projects earlier in 2019 that achieving 100 units in 2019 was going to prove challenging due to the man-power resource limitations and the outage sequencing constraints, at the end of the year due to a high-volume of both GMP and typical Company base commitment work.

Work in 2018 had been concentrated solely in Western Massachusetts. For 2019, work continued in Western Massachusetts, but, for the first time, the Company expanded this program to Eastern Massachusetts. Significant effort was taken to build a team, validate locations, and execute the 2019 plan to install the microprocessors simultaneously at multiple locations. To leverage experience, the Company utilized the same teams that were undertaking the 4kV Circuit Breaker SCADA program. Although the Company fell short of its 2019 goal, this significant coordination and concerted effort represents a level of success at the Company and demonstrates the Company's ability to leverage internal expertise to continue the implementation of the GMP.

Through the development of new project teams, engineering and design of the projects, and limited outage work allowed over the summer months, the outage sequencing associated with these investments resulted in a very busy second half of 2019. Some of the projects ended up on the critical path, with no leeway for schedule changes without affecting the project end-date. A combination of storms for one station and unforeseen conditions at two others ultimately pushed the projects into 2020, despite significant recovery efforts. Some of these efforts included:

- interdepartmental coordination at the senior levels of the organization to ensure timely decisions and real-time updates;
- shifting resources in order to accelerate the schedule, working towards completing two feeder relays per week;
- working portions of the weeks of Thanksgiving and Christmas; and
- increased reporting to all levels to ensure timely information exchange

As of March 31, 2020, all 2019 carry-over relays have been completed and commissioned.

- Similar to 2018, for the Total Capital Spend the unit-costs for this program continued to average higher than budgeted unit costs. Some economies of scale were realized during 2019 when Microprocessor Relay projects were completed in parallel with other projects within the same substation. The Company reviews project costs in real-time and made adjustments/decisions where needed at the project level to analyze and reallocate funds across GMP programs as appropriate. In this case, funds were imported from other under-run (such as OH DA) or modified investments (such as the Miles of Fiber) in order to account for higher budgeted costs. Based on its 2018-2019 experience and projections for 2020, the Company has revised its original budget upward. Originally, the Company expected that the initial program startup costs and compressed-duration contracted work that was observed in 2018 was a portion of the costs of the overrun and that actual unit-costs would come further in alignment with budgeted unit costs. But even after continued operations and a competitive procurement process, that did not prove to be the case. This is principally due to the use of specialty contracted resources and the overtime required to perform this incremental work internally. Based on its experience in both the Eastern and Western regions of the state in 2018 and 2019, the revised term-end cost projections, as they relate to the overall GMP portfolio, provide for increased budgetary and projections accuracy.

- In analyzing the cost increases from budget to actual, the Company has identified several drivers of the increases, as discussed below.
    a. Each substation addressed in the Microprocessor Relay program had some commonality, but also a level of uniqueness that required various levels of effort, and money, to address. It was the unique nature of the substations, coupled with the corresponding resource/skillset(s), that resulted in the variations in implementing Microprocessor Relays at the substations, including the unit costs.
    b. Due to the incremental nature of the Grid Mod work, it is often necessary to engage vendor resources to augment the Company's internal staff. Many of these resources have limited availability, such as Lead Commissioning Engineers ("LCEs") and Substation Test Engineers, both of which perform work for many aspects of the Company, not just for the GMP. The Company's solicitations are typically limited to approximately four technically qualified companies. Due to their significant experience, two of the four firms are highly sought after. These resource limitations in the market have led to increased negotiated rates over the last several years. This trend is expected to continue as more and more of the Company's, and the electric distribution sector in general, devices become more complex and interconnected.

4KV CIRCUIT BREAKER SCADA:

- The Company's implementation of the 4kV Circuit Breaker SCADA relays was short of its 21-unit target by 5 units in 2019. The unit count plan for 2019 projected the Company to achieve 21 commissioned units. It became apparent during the engineering stages of these projects earlier in 2019 that achieving 21 units in 2019 was going to prove very challenging due to the need to engineer and design for an entire additional substation which requires hundreds of man-hours worth of work, and which would have significantly overallocated resources. Ultimately, it was not feasible to accomplish this complex and detailed work in 2019 in order to meet the original 21-unit plan and therefore the Company's actual 2019 plan was 18 units.

  As with the Microprocessor Relay program, the 4kV Circuit Breaker SCADA program experienced identical challenges. Through the development of new project teams, engineering and design of the projects, and limited outage work allowed over the summer months, the outage sequencing ended up with a very busy last-half of the year. One of these projects ended up on the critical path, again, with no leeway for schedule changes without affecting the project end-date, after a getaway cable fault prevented the substation outage sequence from proceeding on schedule. This was a time-consuming repair and pushed the project into 2020, despite significant recovery efforts, similar to those efforts undertaken in connection with the microprocessor relay investments. As of March 31, 2020, all 2019 carry-over relays have been completed and commissioned.

- Total Capital Spend for this program averaged higher than budgeted unit costs. The Company reviews project costs in real-time and makes adjustments/decision where needed at the project level and analyzes and reallocates funds across GMP programs as appropriate. In this case, funds were imported in order to account for higher budgeted costs. The Company has revised its original budget upward based on the results of 2019 and the projections into 2020. This was done both for the added unit cost, and for the increase in actual units planned (see section H of this document). The increase in unit costs was principally due to the use of specialty contracted resources and the overtime required to perform this incremental work internally. Based on its experience in 2019, the revised term-end cost projections, as they relate to the overall GMP portfolio, provide for increased budgetary and projections accuracy.

RECLOSER SCADA:

- The recloser SCADA program continued to be implemented in a very efficient and cost-effective manner over the course of 2019. The Eversource GMP team is familiar with completing this type of work and was able to leverage existing processes to implement this incremental investment on the Company's system.

Due to its efficient and effective processes and planning, the Company was able to exceed its 2019 goal of 11 units by five units.

- As discussed in the "Lessons Learned" section above, the Company had shifted this program into a 'replace, in-place' program as an efficient way to continue to deploy SCADA communications to existing field locations.

- The Total Capital Spend for this program is still below budgeted unit costs, even after modifying the implementation of this GMP program to a "replace, in place." Based on its experience to date with this GMP program, the Company anticipates that it will continue to remain consistent with or slightly under the budgeted costs.

PADMOUNT SWITCH SCADA:

- The Company's implementation of the Padmount Switch SCADA program was short of its 24-unit target by one unit in 2019. This was unfortunately due to a work order accounting error which was identified during project reviews as a duplicate entry. This error was identified too late in the year for the Company to be able to install an additional unit to meet the goal. During 2018, the Company experienced challenges in field validating padmount locations to ensure that both the equipment type and communications infrastructure was adequate. Many of these challenges were related to the existing equipment being unable to accept a bolt-on communications package. Although this delay hindered 2018 implementation, the outcome of the extended field validation surveys was that the 2019 list of locations was ultimately confirmed, which positioned the team for a successful 2019 execution. The Company was able to meet its 2019 goal of 24 units. There is the possibility that the Company will exhaust sufficient locations to reach the original 62-unit, three-year goal. This would be similar to the condition experienced in the Recloser SCADA program. Should that situation arise, the Company will look to perform several "replace, in-place" locations of padmounted switch equipment.

- The Total Capital Spend for this program indicates that the average unit costs are slightly higher than budgeted. Based on the Company's analysis into the cost increases, it determined that the majority of the increase was associated with the time and effort to analyze and validate the chosen locations for these devices, as well as the additional work that was sometimes required to allow the existing device to operate with the installed communications package. Following the completion of the 2019 implementation and the review of costs, an additional increase to the overall budget for the GMP program may be necessary. If additional funds are needed, the Company will reallocate the necessary funds from other GMP programs that are under budget.

NETWORK PROTECTOR SCADA:

- Under the Network Protector SCADA program, which encompassed the integration of the Digital Grid solution, the Company was unable to successfully commission any of its 50-unit target. As discussed above, after final designs were completed, there was a significant portion of the work that was required to be completed within the substation related to the respective network feeders. The timing of the engineering and design of this work, coupled with an unforeseen long lead material item, resulted in the completion of the substation work being rescheduled for 2020, which therefore prevented the commissioning of any field relay devices in 2019.

  Although no units were commissioned in 2019, the Company completed the construction of the majority of the entire project, including replacing all 83 relays, which were placed in service in 2019. Despite the fact that these devices could not be remotely viewed or operated in 2019, their implementation did still allow for a Company personnel to locally review and analyze the new relays' functionality via a laptop computer and umbilical cord that connects to the relay. Additionally, the majority of the substation work was completed in 2019, such that the project would be ready to receive the long-lead material (feeder couplers that receive field relay information) in mid Q1 2020, allowing the 11 feeders to be cut-over into the new Digital Grid system. As of March 31, 2020, all 2019 carry-over relays and all 2020 relays have been completed and commissioned.

- The total Capital Spend for this program is significantly below budgeted costs. Digital Grid was the vendor selected for the project as their products are on the Company's Standards. In addition, the Digital Grid system is used in various forms in other parts of the Company's franchise. At the time of the original GMP filing in D.P.U. 15-122, the exact system configuration was not known. However, after final design and the efficiencies in work execution, it was evident that there would be significantly more budget to allocate. The Company will employ the Digital Grid system at additional networks within the Western Massachusetts territory and will re-deploy the remaining portion of the budget to other GMP programs consistent with the Department's order in D.P.U. 15-122

D. Performance on Implementation/Deployment

Refer to Appendix 1 for the year-to-year and overall portfolio implementation/deployment data.

E. Description of Benefits Realized as the Result of Implementation

There are immediate benefits to the Company and ultimately its customers by having visibility and control of additional devices in the field, such as insight into emergent conditions, remote switching and acquisition of load data. Additionally, the increase of the investment types identified

in this section will have an effect on several of metrics identified in section IV and VI of the 2019 Grid Modernization Annual Report and Appendix 1. Refer to "Massachusetts Grid Modernization Program Year 2019 Evaluation – Monitoring and Control" provided by Guidehouse (formerly Navigant) for further analysis.

F. Description of Capability Improvement by Capability/Status Category

METHODOLOGY

Microprocessor Relays: The specific relays selected for this program were based on a list of feeders and their characteristics. One characteristic was an indication if SCADA was available. Selecting non-SCADA feeders was the first pass analysis. Next, substations for which there was major (non-GMP) work scheduled but not anticipated to be completed prior to year 2020 were eliminated from consideration. Next, all substations that utilized overhead reclosers serving as feeder breakers were removed from consideration. Finally, all substations with scheduled retirements were removed from consideration. What followed from this analysis was the list of substations and feeders that were good candidates for the microprocessor relay upgrades.

SCADA Switches (Recloser, Padmount, Network): Prioritization for reclosers, secondary network[5] protectors and padmount switches was based on the same zone size and reliability ranking methodology as described in the Distribution Automation section of the 2018 Grid Modernization Annual Report (Section III.A.2). These criteria included: number of customers impacted by the device (higher); and the circuit reliability (lower). Padmount switches had an additional criterion: motorized switches were prioritized and were a requirement for investment.

EXPECTED CAPABILITY IMPROVEMENT:

Enabling Monitoring and Control (SCADA) on distribution system equipment provides Eversource with accurate minimum load data for circuit segments. This data is required for Eversource to perform load flow analysis in support of Demand Response ("DR") integration and automated feeder reconfigurations within a centralized, real-time logic system like a Distribution Management System ("DMS"). Additionally, and even prior to full circuit automation and integration with the GMP-driven IT systems, these new/upgraded devices will provide an enhanced level of visibility and control to the system operators.

Enabling monitoring and control of motor-operated padmount switches will have significant reliability benefits by enabling a scheme in which switches will indicate the fault location, enabling dispatch to remotely isolate the faulted cable section and restore power to all customers on the loop.

5 The 2018 GMP investment plan did not include "Network SCADA" switches.

G. Key Milestones

The Company maintains an execution plan and schedule of all its GMP investment categories. This schedule, which encompasses all three years of the GMP, was developed and is administered with the requisite flexibility that enables the Company to adjust its investment schedule and timing over the course of the GMP in the event that external factors, such as third-party resource availability, material availability, outage authorization, or unforeseen conditions (substations)impact the GMP and the relevant investment schedule. However, a sampling of the key 2019 milestones follows:

- Accelerated deployment of Recloser SCADA investment.
- Selection and engineering for all remaining Microprocessor Relay and 4kV SCADA investments complete.
- Full design of Network Protector SCADA investment and accelerated deployment of field relays.

H. Updated Projections for Remainder of the Three-Year Term

On August 15, 2018, the Company submitted its Baseline and Targets Filing, which included the 2018-2020 GMP base line (Baseline and Targets Filing at 15, Table 2.4.7). *Table 5: Three Year Term Projections* provided below provides the projections for 2020 for all remaining investment categories. It should be noted that the Company decreased its term projection for Microprocessor Relays and increased its projection for 4kV Circuit Breaker SCADA. This results in a net reduction between the two investment types of six units. The Company will work to identify six additional relays to include in the 2020 GMP investment year to come back in-line with baseline goals. Additionally, throughout 2020, the Company will continue its analysis on the GMP portfolio and will make the necessary adjustments to effectively utilize the total $133 million authorized 2018-2020 GMP budget.

Table 5: Three-Year Term Projections

Investment Categories	Preauthorized Device Types	Total (3-Year Plan)	2020 Plan
Monitoring & Control (SCADA)	Microprocessor Relay	193	96
	4kV Circuit Breaker SCADA	55	39
	Recloser SCADA	37	3
	Padmount Switch SCADA	62	18
	Network Protector SCADA	83	83

III.A.2. Distribution Automation

(OH DA, OH DA w/Ties, 4kV Oil Switch, 4kV AR Loop)

A. Description of Work Completed

Overhead Distribution Automation ("OH DA"): Under the 2019 GMP, the Company continued to install new OH Reclosers (typically Nova Form 6) with full SCADA capability to coordinate with the existing devices/equipment in the field and further reduce the number of customers affected during an outage. This was as very successful program and has aided in reducing the average customer zone size.

Overhead Distribution Automation with Ties ("OH DA w/Ties"): Under the 2019 GMP, the Company identified areas and installed recloser technology in order to tie circuits together. The majority of these locations were areas originally consisting of manual tie points, which were automated into existing loop schemes in addition to being remotely viewed and operated via the System Operations Center.

4kV Oil Switches: Under the 2019 GMP, the Company identified locations and replaced existing oil-filled underground switches with new G&W Vacuum Fault Interrupter ("VFI") switches with full SCADA capability. Under the 2018-2020 GMP, switches are being installed in strategic locations to support the 4kV Auto-Restoration ("AR") Loop" program when it comes online.

4kV AR Loops: Under the 2019 GMP, the Company made a decision to move from the purely "4kV VFI Retrofit" investment and into a system that will allow for a decentralized automated loop restoration solution. This solution allows for a controller to be placed at the substation to have peer-to-peer communication with all of the other field switching devices on a particular circuit (and adjacent circuit). In the event of a cable failure, the circuit(s) will be able to quickly and autonomously reconfigure themselves, thereby restoring the maximum number of customers in the shortest time. The Company selected a substation, with its respective circuits, to develop into an automated loop system utilizing a Schweitzer Engineering Laboratories ("SEL") application and equipment. This included installing the communications and distribution automation controller ("DAC") infrastructure in the substation and upgrading field devices, which were overlapped with "4kv Oil Switch" replacements, to ensure remote operability. This GMP investment represents a significant step forward into an area of 4kV automation that the COmpany has not previously included on its distribution system.

B. Lessons-Learned/Challenges and Successes

OH DA:

- The OH DA program contains typical device installation that is consistent with the Company's experience in installing devices on its system. Given that the Company had processes and procedures in place to address these types of

installation, it was efficient in leveraging those processes to set up and undertake these incremental GMP investments.

- The Company identified commissioning resources as an area of opportunity going forward. The emphasis that that Company placed on planning and monitoring of the Commissioning team for 2019 enabled it to develop and implement an achievable yet aggressive plan. Continuous communication and situational awareness was the key factor in achieving the Company's objectives under the OH DA program.

- A grouping of 20 reclosers in the Company's South region was installed in order to cutover these circuits from an older network into a radial/loop configuration. The Company had expected to install these units and allow them to coordinate without further work. However, after implementation, it was determined that the local substations also required upgraded protection and control settings to ensure the reliable and safe operation of the new devices. The time frame of this development occurred too late in 2019 to be able to design and install the required settings at the substations. Therefore, the Company took these 20 new reclosers offline until all remaining substation settings work could be completed.

- After reviewing the 2018 Appendix 1 data submitted on January 31, 2020 that supplemented the 2018 Annual Grid Modernization Report, the Company discovered an error discovered in the unit data, identified in column "G" of tab "5.a Spending – 2018 Report" within the 2018 Appendix 1 spreadsheet. The data inadvertently omitted four recloser units that were carried over from 2018 to 2019. The Company has made a correction to tab "5.a Spending – 2018 Report" within the 2019 Annual Grid Modernization Report's Appendix 1. This change was also noted at the bottom of the relevant tab of the Appendix 1 spreadsheet. This oversight was only contained in the Appendix 1 supplemental report. The 2018 Grid Modernization Annual Report, filed May 1, 2019, is accurate, as submitted.

OH DA w/Ties:

- This Company's experience with this program in 2019 was very similar to its experience with the OH DA program discussed above and the Recloser SCADA program discussed in section III.A.1.

- One of the lessons learned from 2018 was the need to closely coordinate OH DA, OH DA with Ties and Recloser SCADA work undertaken by the Company's Protection and Control engineering teams. Such close coordination is necessary because any changes in automated, switchable devices in a circuit will affect the coordination aspects for all remaining devices on that circuit. Therefore, if each of the aforementioned investment types had been completed independently of each other, there would have been constant and inefficient engineering rework to achieve the necessary coordination between these

investments. The wholistic approach that the Company implemented and the rigor that was placed on program oversight and communication prevented this potential inefficiency.

4kV AR Loop:

- As previously discussed, the 4kV automation had never been implemented by the Company. As with any new technology implementation there was a learning curve. Specific to this investment was the challenge of finding the correct blend of communications infrastructure, compatible equipment, and relevant customer counts, so as to have a meaningful reliability improvement for as many customers as possible. This was further compounded by the need to iterate the loop system design to be able to determine the correct blend of infrastructure and equipment. The search to find adequate substations that did not require substantial upgrades to account for communications infrastructure or compatible equipment resulted in the design associated with this program being extended well into 2019. This schedule extension placed significant pressure on the Company's commissioning teams because their established execution plan was shifted to overlap with other work. Now that the Company has a design of the loop system as a template, the most significant lessons learned were the need to have a detailed survey of prospective substations. This effort is complex and time consuming and will be one of the challenges the Company faces in 2020.

4kV OIL SWITCHES:

- The replacement of the underground oil switches is a complex process. The challenge is due in part to the high customer density and the electrical outage boundaries that need to be established in order to perform the work. Though 2018 had a truncated execution timetable for these investments, the volume of these replacements in 2019 was significantly higher. The teams responsible for these replacements continued to:

  - closely coordinate, so that the work could be planned and executed as efficiently as possible to limit the extent and duration of the planned outage. The teams accomplished this balance by planning as much maintenance and/or non-GMP work as possible to be undertaken during the outage. The teams ensured that GMP work was maintained separately (administrative/financially) from the other work. The specific GMP work and cost tracking processes developed to implement the GMP consistent with the Department's directives were followed in order to maintain this strict separation.

  - in order to avoid having to schedule a second planned outage, the teams identified all of the GMP switch locations in advance so that, were an emergency outage to occur that happened to overlap the GMP location, the installation team could work to install the GMP device at the same time as

undertaking the work to address the initial emergency outage. The decision to complete GMP work in this manner was and will continue to be evaluated on a case-by-case basis to determine the merits of extending the existing outage to install the GMP device versus requiring a second, separate outage to install the device.

- when an emergency outage occurred in the 4kV underground system, if an oil switch was identified as being within the electrical outage boundaries and could be efficiently replaced without extending the existing outage, crews would react quickly to replace the oil switch. The crew's supervisor and management teams carefully review field work charging to ensure that costs were maintained separately from the outage event, and vice versa, that outage event costs were not included in the oil switch replacement. This was a very effective process and prevented customers from experiencing a future, planned outage, in order to remove the oil switch.

- After reviewing the 2018 Appendix 1 data submitted on January 31, 2020 that supplemented the 2018 Annual Grid Modernization Report, the Company discovered an error discovered in the unit data, identified in column "G" of tab "5.a Spending – 2018 Report" within the 2018 Appendix 1 spreadsheet. The data inadvertently omitted ten oil switch units that were carried over from 2018 to 2019. The Company has made a correction to tab "5.a Spending – 2018 Report" within the 2019 Annual Grid Modernization Report's Appendix 1. This change was also noted at the bottom of the relevant tab of the Appendix 1 spreadsheet. This oversight was only contained in the Appendix 1 supplemental report. The 2018 Grid Modernization Annual Report, filed May 1, 2019, is accurate, as submitted.

C. Actual vs. Planned Implementation and Spending

Tables 6 and 7 below show the implementation unit and spending summaries for the Distribution Automation work undertaken in 2019. Spending was broken down into "Total Capital Spend" and "Plant In-Service." As indicated in section I. Introduction, Plant In-Service is triggered by a device being "Construction Complete" and therefore cost recoverable.

Table 6: 2019 Implementation Summary

Investment Categories	Preauthorized Device Types	2018 Unit Carry Over (2019)	Plan Units (2019)	Construction Complete Units (2019)	Commissioned Units (2019)	2019 Unit Carry Over (2020)
Distribution Automation	Overhead DA	4	100	165	148	0
	Overhead DA w/Ties	n/a	23	45	45	0
	4kV Oil Switch Replacement	10	57	89	89	0
	4kV AR Loops	n/a	16	17	17	0

Table 7: 2019 Implementation Cost Summary

Grid Modernization		2019 Capital Spend			2019 Plant in Service		
		Actual	Budget	Variance	Actual	Budget	Variance
		29,640,184	27,192,000	2,448,184	27,615,980	23,002,374	4,613,606
Investment Category	Preauthorized Device Type						
Distribution Automation	OH DA w/o Ties	12,069,703	13,167,000	(1,097,297)	12,532,547	9,982,818	2,549,729
	OH DA w/Ties	2,797,738	3,135,000	(337,262)	2,585,627	2,494,402	91,225
	4kV Oil Switch Replacement	13,881,098	10,010,000	3,871,098	12,280,567	10,525,154	1,755,413
	4kV AR Loops	891,645	880,000	11,645	217,240	-	217,240

OH DA:

- The Company exceeded the 100-unit target for 2019 by 44 units. The Company also installed and commissioned an additional 20 units. This work was completed to increase reliability in a portion of the distribution system by cutting over from an older network system. However, without performing additional work to change the protection and control settings for the substations feeding these areas, potential protection and control coordination issues were possible for the newly installed reclosers. Because of this potential for coordination issues, and the fact that the substation work could not be completed in 2019, the newly installed and commissioned recloser devices were taken off-line. The Company did not include these devices as "Grid Mod Qualified," but they are effectively built and ready to be placed back online after additional work is completed in the first part of 2020.

- The Total Capital Spend for this program is below budgeted unit costs. Because the Company essentially completed all remaining units for the three-year term in 2019, there will be a significant underrun in this investment budget, which will be redeployed to other GMP investment areas. Plant In-Service is slightly higher than capital spend due to several units from 2018 not being categorized as in-service units in the early part of 2019. The Company's 2018 GMP Annual Report provides additional details.

OH DA w/Ties:

- The Company exceeded the 23-unit target for 2019 by 22 units, which is seven units above the three-year goal. Installation of the 45 units resulted in 18 circuit ties. These ties were generally simple circuit ties in which a manual switch was replaced with a tie-recloser. In some instances, additional reclosers were added on either side of the tie to either reduce customer counts between load or to facilitate recloser coordination.

  The Total Capital Spend for this program is below budgeted unit costs, even while completing installations above the three-year term goal. Because the Company has completed all remaining units for the three-year term in 2019, there will be a significant underrun in this investment budget, which may be utilized for additional ties or will be redeployed to other investment areas.

4kV AR Loop:

- The Company completed its 2019 goal by achieving remote visibility and control of 4kV underground field devices, including a tie switch. However, because the program was changed from an exclusively VFI retrofit program to an automated restoration loop program, the use of "units" in the sense of field units was no longer appropriate. A more appropriate unit of measure is "loops created." This is primarily due to the diversity of work required in the field to obtain remote visibility and control. In some instances, a communications package was the only requirement, while in other instances an entire switch replacement was necessary. Given this, the Company has worked to dovetail the "4kV Oil Switch" replacement program into the loops, where possible.

  As discussed in section A, above, the Company has selected an SEL system to administer the loop logic. After much iteration, a final design was established in 2019 and, in addition to the completed field devices, the Company completed the installation of the SEL distribution automation controller cabinet and established radio and cellular communication nodes so that field devices could communicate to the SEL DAC.

  Time in 2019 expired before the final communications commissioning could occur between the SEL DAC and the Company's front-end SCADA processors. Consequently, this also meant that the site acceptance ("SAT") testing and final system configuration could not occur in 2019.

  As of March 31, 2020, the communications path between the SEL DAC and the Company's SCADA system has been completed. The SAT is scheduled to occur in early Q2 of 2020. This timeframe was necessary due to the Company cutting over its existing SCADA platform to a new system in mid-late Q1 2020. The Company expects to have the auto-restoration loops functional by mid-Q2 2020.

- The Total Capital Spend for this program is on schedule but will not reflect originally expected deployment, due to the change in program function. The Company is planning for additional stations to develop 4kV AR loops but due to the challenges discussed above, it is possible that the entire budget will not be expended. The Company will continue to evaluate the progress of the program and expend or redeploy funds to other investments, as appropriate.

4kV OIL SWITCHES:

- The Company exceeded its 57-unit goal by 22 units. This was a significant undertaking and the lessons learned from 2018 were fully employed in order to make the 2019 execution successful.
- The Total Capital Spend for this program is higher than originally budgeted because the Company executed a stretch goal plan and commissioned many more switches that originally projected. As discussed in various areas of this Report, the ability to effectively coordinate across various Company departments was instrumental in

executing an aggressive GMP. This is particularly true with the execution complexity of working within the 4kV underground system. To aid this process, the Company provided specific points of contact in the form of a task-force for execution. Once the 2019 unit goal was met, the Company maintained the execution momentum and continued to install and commission devices. Average actual unit costs are in-line with budgeted unit costs. However, individual locations vary in their degree of complexity and therefore costs from location, to location, can also vary.

D. Performance on Implementation/Deployment

Refer to Appendix 1 for the year to year and overall portfolio implementation/deployment data.
Description of Benefits Realized as the Result of Implementation

There are immediate benefits to the Company of having visibility and control of additional devices in the field, such as insight into emergent conditions, remote switching and acquisition of load data. Additionally, the increase of the investment types identified in this section will have an effect on several of metrics identified in section IV and VI of this 2019 Grid Modernization Annual Report and Appendix 1. Refer to "Massachusetts Grid Modernization Program Year 2019 Evaluation Report – Advanced Distribution Automation" provided by Guidehouse for further analysis.

E. Description of Capability Improvement by Capability/Status Category

METHODOLOGY:

To prioritize circuit investment, each circuit was analyzed to identify existing isolation segments or zones. Zone sizes were determined by the number of customers impacted in each zone. Zones with customers greater than the 500 for Eversource West (former WMECO service territory) and 1,000 customers for Eversource East (NSTAR Electric service territory) were prioritized. Circuit reliability based on historical System Average Interruption Duration Index ("SAIDI") and System Average Interruption Frequency Index ("SAIFI") from 2015, 2016 and 2017 was also considered when selecting circuits for investment. The poorer the reliability of the circuit, the higher priority the circuit and its associated zones received. A weight of 60 percent was applied to the zone size and 40 percent for their reliability score and then normalized on a 1 to100 scale, with 100 being the highest priority for investment. Zones were ranked separately between Eversource East and West. For feeders that lack alternate supply sources, infrastructure will be built where cost-effective to tie radial circuits to deliver the benefits of automation. Existing circuit ties will be bolstered to increase their back-up capability where cost-effective.

The Company selected OH DA with Circuit Tie locations using a list of radial zones with existing manual three phase tie equipment installed. Circuit reliability performance and number of customers within the zone were then used as factors to prioritize each zone for the addition of DSCADA enabled, automatic sectionalizing equipment. Radial zones without a manual alternate source were not considered as viable options for this project.

In siting the investments for automating and upgrading the existing 4kV switching, sectionalization and SCADA infrastructure, the Company focused on the Greater Boston and Cambridge areas. The current, existing 4 kV sectionalization, which is a critical component of the system serving high-density residential and commercial areas, was installed in the period of 1920-1940, making it the least modernized portion of the Company's distribution system. The investment consists of replacing existing switches with the latest technology and SCADA, so these devices have the same functionality as their overhead counterparts.

GMP investments in 4kV switches were prioritized using the same zone size and reliability ranking methodology as described above for the overhead circuit.

The selection criteria for the 4kV AR Loop program was based on the related substation having a long-range plan of staying at the 4kV operating voltage in addition to having sufficient space for the new DAC and telecommunications equipment and compatible RTU's/RTAC's and relays. In addition to the substation criteria, the team looked for areas: 1) with a high density of exiting field switches that could be used as-is, replaced, or upgraded; 2) where there are underground switches that are difficult to access (since the AR Loops will help prevent manual entries); and 3) with high customer impact such as large customer concentrations or important infrastructure.

EXPECTED CAPABILITY IMPROVEMENT:

DA technology will allow the grid to sense the existence of a fault, automatically isolate it to the smallest possible segment and then restore service to all customers outside the faulted zone with supply from alternate sources. By decreasing the number of customers in each segment between sectionalizing automated devices, the Company can reduce the impact of outages. With this added sectionalization and tie capability, the grid will dramatically increase its ability to reconfigure itself based on systems conditions. In the case of outages during major events, e.g., storms, these DA investments will reduce the duration and extent of the storm events and can result in meaningful benefit to customers.

In addition to these benefits, the automated devices in the field will reduce the amount of day- to-day manual switching operations which occur as a normal part of maintaining the electric system and adding new customers. From a system planning perspective, the enhanced flexibility to shift load based on prevailing conditions has the potential to defer capital upgrades.

Upgrading existing 4kV switches with automation technology will bring the benefits of DA to the Greater Boston and Cambridge areas, as described above. Automated feeder reconfiguration will work by automating the midpoint and tie switches on a circuit such that the midpoint will open for a fault between it and the station breaker allowing the tie to close in and automatically restore the unaffected back half of the circuit. The midpoint switch will operate like a conventional VFI and open for faults beyond it, so the front half of the circuit is unaffected. The Company anticipates that this added automation will reduce the impact of outages to the customers on circuits where it is deployed.

F. Key Milestones:

The Company maintains an execution plan and schedule of all its GMP investment categories. This schedule, which encompasses all three years of the GMP, was developed and is administered with the requisite flexibility that enables the Company to adjust its investment schedule and timing over the course of the GMP in the event that external factors, such as third-party resource availability, commissioning resources, and material availability. However, a sampling of the key milestones from 2019 follows:

- Development and finalization of engineering and design for the first-ever 4kV AR Loop on the Company's system.
- Completed the three-year goal for the OH DA w/Ties investment type, ahead of schedule.
- Completed 44 more reclosers than planned for 2019 and essentially completed the three-year goal for the OH DA, ahead of schedule.
- Completed 22 more 4kV oil switch replacements than planned for 2019.

G. Updated projections for remainder of the three-year term

On August 15, 2018, the Company submitted its Baseline and Targets Filing, which included the 2018-2020 GMP baseline (Baseline and Targets Filing at 15, Table 2.4.7). *Table 8: Three Year Term Projections* provides the projections for 2020 for all remaining investment categories. Because of the efficiencies of the OH DA and OH DA w/Ties investment programs, and in addition to redeploying funds, the Company added an additional 24 units and eight units, respectively, above the three-year term goal for completion in 2020. Additionally, throughout 2020, the Company will continue its analysis on the GMP portfolio and will make the necessary adjustments to effectively utilize the total $133 million authorized 2018-2020 GMP budget.

Table 8: Three-Year Term Projections

Investment Categories	Preauthorized Device Types	Total (3-Year Plan)	2020 Plan
Distribution Automation	OH DA	220	47
	OH DA w/Ties	45	0
	4kV Oil Switch Replacement	105	16
	4kV AR Loop	78	61

III.A.3. Volt-Var Optimization

(Regulators, Capacitors, Line Sensors, LTC's, IT)

A. Description of Work Completed

REGULATORS: Under the 2019 GMP, the Company continued to install voltage regulators on select feeders from select substations to support the Volt-Var Optimization ("VVO") program. The regulators are generally similar to those the Company typically installs on its system, with the exception being that communications equipment is added to the control in order to enable remote control and monitoring by system operators and the central VVO software.

CAPACITORS: Under the 2019 GMP, the Company installed capacitor banks on select feeders from select substations to support the VVO program. The capacitor banks are generally similar to those the Company typically installs on its system, with the exception being that communications equipment is added to the control in order to enable remote control and monitoring by system operators and the central VVO software.

LINE SENSORS: Under the 2019 GMP, the Company installed line sensors on select feeders from select substations to support the VVO program. The Company installed two types of sensors: 1) Aclara feeder-head monitoring sensor, which is currently used by the Company to measure current and voltage across its distribution system; and 2) a Bitronics end-of-line/grid-edge sensor, which is new to the Eversource system. This sensor is a unique solution that measures current and voltage at the grid edge using its own power supply as opposed to the power harvesting method used by the Aclara sensor. These line sensors enable remote monitoring of select data, by the central VVO software.

LOAD TAP CHANGERS: Under the 2019 GMP, the Company installed new controls on substation transformer load tap changers ("LTCs") at select substations. These devices enable direct communication from the VVO system. The LTCs will automatically adjust feeder voltage based on local measurement and will be optimized by the central VVO software located in the system operations center ("SOC").

VVO IT: The Company has completed procurement and installation of the VVO software and hardware. The software component includes Eaton's Yukon Integrated Volt-Var Control ("IVVC") program paired with Eaton's Visual T&D ("V-T&D") program. IVVC is the VVO control algorithm, while V-T&D provides the visual system one-line overlay through which the system operators will control and monitor the VVO deployment. In order to support efficient and secure implementation, the hardware was configured in three separate components (development, pre-production and production).

B. Lessons-Learned/Challenges and Successes

LTCs: The lessons learned with the LTC program were similar to that of the microprocessor relay program, specifically in requiring close coordination between Company departments undertaking

these GMP investments. Please see Section III.B. for further discussion around the lessons learned.

- The Company took the lessons learned from the 2018 GMP investment year and applied them to the remaining units in 2019. The Company focused specifically on ensuring that it had sufficient time to plan and allocate the correct resources. This program was successful in 2019 and completed all of the three-year term goals, ahead of schedule.

REGULATORS:

- Since the VVO program is a new initiative for the Company, it took additional engineering time to locate and design the specific field components. The Company completed the engineering for all regulator locations in late 2018. For all but the largest-sized regulators, installations were quick and efficient. However, for the larger 548A platform regulators, the Company experienced two challenges. First, due to the physical size of these devices, any new locations were required to be sited through the respective town's planning department, including public hearing. For many locations, this process was conducted on anormal schedule, but in several locations, the planning and permitting process was very lengthy. In several instances, the process is still on-going as of March 31, 2020. Second, prior to construction, the Company identified the need to revisit the design standard for large, platform-mounted voltage regulators to increase resiliency. As a part of this process, the Company performed a full review of the installation process, which caused delay. As of March 31, 2020, the design standard has been published and the Company is moving forward to complete construction for the remaining GMP voltage regulators based on new requirements. The Company will endeavor, in the future, to utilize different equipment/technology that will enable the regulator function but at a significantly smaller and less obtrusive size.

- As a part of the quality assurance review process, in a limited number of circumstances, the Company identified factory-caused communication and wiring discrepancies that needed to be addressed prior to commissioning into the central VVO software. This is often the consequence of utilizing a device new to the Company, and each took time to review and correct.

- After reviewing the 2018 Appendix 1 data submitted on January 31, 2020 that supplemented the 2018 Annual Grid Modernization Report, the Company discovered an error discovered in the unit data, identified in column "G" of tab "5.a Spending – 2018 Report" within the 2018 Appendix 1 spreadsheet. The data inadvertently omitted 15 regulator units that were carried over from 2018 to 2019. The Company has made a correction to tab "5.a Spending – 2018 Report" within the 2019 Annual Grid Modernization Report's Appendix 1. This change was also noted at the bottom of the relevant tab of the Appendix 1 spreadsheet. This oversight was only contained in the Appendix 1 supplemental report. The 2018 Grid Modernization Annual Report, filed May 1, 2019, is accurate, as submitted.

CAPACITORS:

- The capacitor banks were a relatively straightforward piece of equipment to install and there were limited challenges except, as with the regulators, when field commissioning several devices. As with the regulators, the Company discovered several factory-caused communication and wiring discrepancies when field testing the devices. This is often the consequence of utilizing a new system/device, and each took time to review and correct.

LINE SENSORS:

- The selection of the feeder-head monitoring sensor was straightforward, and the Company's process for procurement, installation and commissioning of the devices was performed very efficiently.

- The design, selection and procurement of the end-of-line/grid-edge sensors was challenging. This was primarily due to the lack of industry standardization on this nascent technology that the Company could utilize to guide the selection process. As a result, the procurement process was iterative and time consuming. However, even with the unforeseen delays, the installation of the end-of-line/grid-edge sensors was straightforward and the work was completed on schedule within the 2019 GMP plan year.

VVO IT

- During the procurement process, the project team found the live demonstrations and reference calls to be quite valuable. The team held detailed reference calls with other utility customers that had procured similar IT platforms and implemented VVO pilots and was able to ask questions about their experience and lessons-learned from their respective VVO pilots and deployments. – The Eversource team incorporated that insight into its deployment strategy, both for the field devices and in the contract for the VVO software package.

- During the IT system deployment, the project team faced challenges in implementing the VVO system architecture. One challenge involved having to provide access to the engineering and analytical teams outside of the control room while still meeting the stringent IT security requirements that apply to electric operations infrastructure. This necessitated a significant collaboration between multiple Company departments and a series of architectural modifications which resulted in a creative solution that successfully balanced the competing requirements.

C. Actual vs. Planned Implementation and Spending

Refer to Tables 9 and 10 below for the Company's 2019 implementation unit and spending summaries for the VVO GMP investments. Spending was broken down into "Total Capital Spend"

and "Plant In-Service." As indicated in the Introduction of the 2019 GMP Annual Report, Plant In-Service is triggered by a device being "Construction Complete" and therefore cost recoverable.

Table 9: 2019 Implementation Summary

Investment Categories	Preauthorized Device Types	2018 Unit Carry Over (2019)	Plan Units (2019)	Construction Complete Units (2019)	Commissioned Units (2019)	2019 Unit Carry Over (2020)
Volt-Var Optimization	VVO - Regulators	15	80	69	69	26
	VVO - Capacitor Banks	n/a	76	71	71	3
	VVO - LTC Controls	0	6	4	4	0
	VVO - Line Sensors	n/a	125	189	189	0
	VVO - IT Work	n/a	n/a	n/a	n/a	n/a

Table 10: 2019 Implementation Cost Summary

Grid Modernization		2019 Capital Spend			2019 Plant in Service		
		Actual	Budget	Variance	Actual	Budget	Variance
		7,807,523	11,252,834	(3,445,311)	6,394,176	5,691,896	702,280
Investment Category	Preauthorized Device Type						
Volt-Var Optimization	VVO - Regulators	5,602,795	5,223,000	379,795	5,191,554	4,494,151	697,403
	VVO - Capacitor Banks	-	-	-	-	-	-
	VVO - LTC Controls	1,044,867	882,804	162,063	1,202,622	1,197,745	4,877
	VVO - Line Sensors	-	-	-	-	-	-
	VVO - IT Work	1,159,861	5,147,030	(3,987,169)	-	-	-

REGULATORS:

- Although it completed 69 voltage regulators in 2019, the Company's implementation of the VVO regulators was short of its 95 unit target by 26 units (nine locations) in 2019. Note that the Company treated each individual regulator as a unit. In some instances, a location would have one unit (for single phase), and in other instances a location may have three units (for three-phase). Engineering and design were completed in 2018 for the VVO regulators.

  During the engineering process, the Company determined the three-year total number of voltage regulators needed to achieve full VVO functionality on the program feeders is 96 units, a decrease relative to the original estimate of 105 units. As noted above, issues with permitting and a delay due to updated platform voltage regulator design standards prevented the Company from achieving its target for 2019. As of March 31, 2020, no additional units have been installed relative to the end of 2019.

- The Total Capital Spend for this investment is at budgeted unit costs. However, due to additional work required to install the remaining larger 548A platform regulators, the Company expects to see the average unit installation costs increase for the remaining units to be commissioned in 2020.

CAPACITORS:

- Relative to its goal of installing 76 units, the Company installed 71 units in 2019. As a result, the Company was short of its 76 unit target by five units in 2019. Two

of the five locations were constructed in the field but were not commissioned due to damaged parts that needed to be replaced by the vendor. One location was not completed due to an unexpected and lengthy permitting process with the local municipality. Following detailed engineering, the Company determined that the two remaining units are not necessary to achieve full VVO functionality on the program feeders.

- The Total Capital Spend for this investment is at budgeted unit costs.

LINE SENSORS:

- The Company exceeded its 125-unit target by 64 units in 2019. Completion of the engineering for the VVO line sensors went generally as expected for feeder-head sensors but was a very iterative process for the end-of-line/grid-edge sensors, as was discussed earlier in this section. Engineering and design work were completed in Q2 2019. Based on this engineering and design work, the Company determined that additional line sensors would be required to provide telemetry for the VVO software to optimize voltage on the program feeders. As a result, the Company adjusted the line sensor quantity to 189 units, an increase relative to the original estimate of 140 units. The Company treated each individual sensor as a unit, with some locations having one unit for single phase and other locations having three units for three-phase. The line sensor work is completed for the three-year term.

- In aggregate, the total capital spend for this investment is slightly higher than budgeted due to the increased number of installed line sensors. On average, line sensor unit costs were on budget. The 78 Aclara line sensors were installed at lower than expected unit cost. Due to the complex design requirements to ensure adequate power supply, the 111 end-of-line sensors were installed at a higher than expected unit cost. As a part of the process of designing the end-of-line sensor solution, the Company identified opportunities to lower cost by avoiding low-value features such as battery back-up. In an effort to lower total cost, the Company limited the deployment of end-of-line sensors and used Aclara line sensors whenever possible. Any budget overrun here will be supported via underruns in other investment categories.

LOAD TAP CHANGERS:

- The Company installed four LTC controls in 2019, two fewer than target. Due to the final engineering design for the VVO system, the Company reduced its three-year target from 10 LTC controls to 8 units. As a result, only four LTC controls were required in 2019 to complete the LTC program for the three-year term. As was the case with the microprocessor relays, the Company leveraged the lessons learned from 2018 and capitalized on a longer planning process in order to successfully implement these GMP investments.

- The Total Capital Spend for this investment indicates a significantly higher than budgeted unit costs. As the year progressed, the Company's team carefully monitored costs and made the decision to move forward with this investment due to its in interrelated nature with the rest of the VVO devices. Originally, it was expected that the actual unit-costs would come further in alignment with budgeted unit costs, but that did not prove to be the case. The primary drivers of the of the unit costs overruns were the need to perform some work with internal resources on overtime and the need for higher cost specialized external contractors. To address the budget overruns, funds were allocated from other underrun or modified investment budgets in order to account for higher budgeted costs.

VVO - IT

- Company has completed procurement and installation of the VVO software and hardware components (described above) in three physical environments (Development, Pre-Production, and Production). The completed IT work also includes system configuration, database builds, and testing. The testing is currently ongoing with completion and go-live scheduled for end of Q1 2020.

- As discussed in the 2018 Grid Mod Annual Report, the Company did expect to have the VVO IT system completed and commissioned in 2019. However, consistent with the implementation of new technologies, challenges were experienced along the way, which extended the go-live date into Q1 2020, as described above.

- The Company is pressing forward aggressively, so that the VVO system can be brought online and operational, so that measurement and verification testing can commence as soon as possible and extend through the required evaluation duration.

- The Total Capital Spend for this investment is coming in lower than expected. The primary drivers of the budget underrun is lower than expected software costs and implementation of a more efficient work plan for the model build process. The Company is evaluating costs and progress in real-time and will redeploy under-run funds to other IT/OT programs.

D. Performance on Implementation/Deployment

Refer to Appendix 1 for the year to year and overall portfolio implementation/deployment data.

E. Description of Benefits Realized as the Result of Implementation

There are immediate benefits to the Company in having visibility and control of additional devices in the field, such as increased voltage regulation, as additional regulators are added to the Company's system. However, measurable benefits will not be realized until substation and circuit level reporting is completed, in accordance with the proposed performance metrics. Additionally, the increase of the investment types identified in this section will have an effect on several of metrics identified in section IV and VI of this 2019 Grid Modernization Annual Report and

Appendix 1. Refer to "Massachusetts Grid Modernization Program Year 2019 Evaluation Report – VVO" provided by Guidehouse for further analysis.

F. Description of Capability Improvement by Capability/Status Category

METHODOLOGY:

Eversource is targeting the deployment of VVO in a limited geographic region (Western MA) that consists of substations and circuits under the jurisdiction of a single control room. The circuits in the target region offer a diverse mix of load and distributed generation ("DG") penetration, which will provide a comprehensive understanding of the impact of VVO across a broad range of circuit types. Within the target region, Eversource picked locations for the pole-top devices based on a combination of load flow analyses, engineering judgment, wireless communication coverage, and any local siting concerns.

The strategy for deployment is focused on maximizing the Company's ability to understand and quantify the benefits from VVO while minimizing the number of and disruption to control room and field personnel impacted by the deployment.

IT:

In tandem with the deployment of the VVO field devices described above, Eversource will be deploying a VVO monitoring and control software package in the control room that normally supervises and operates the VVO target region. During a competitive and rigorous procurement process which started with six qualified vendors, a cross-functional project team thoroughly reviewed all submitted proposals and further vetted a shortlist of vendors through live product demonstrations and reference calls. Eversource has selected a software solution from among the proposals that best meets the scope and requirements of this deployment, as well as compliance with Eversource IT/OT standards. Software delivery, installation, and testing is scheduled for 4Q 2019.

EXPECTED CAPABILITY IMPROVEMENT:

VVO is expected to lower peak demand, reduce line losses, lower energy supply costs, and reduced greenhouse gas ("GHG") emissions. The Company also expects that customers in the VVO area potentially could see a reduction in their bills, without any adverse impact to their power quality or change in their normal electric use.

IT:

As described in the previous section, the overall VVO deployment is expected to lower peak demand, reduce line losses, lower energy supply costs, and reduce GHG emissions. The Company also expects that customers in the VVO area potentially could see a reduction in their bills, without any adverse impact to their power quality or change in their normal electric use.

Eversource anticipates that the metering capabilities of the field devices at the feeder heads and the end of the line, which will be timestamped and archived by the VVO control software, will deliver a level of visibility and monitoring into the distribution system that was previously unavailable. In addition to understanding and quantifying the benefits of VVO, the Company expects that this data will also provide valuable insight into energy use patterns, DG and weather impacts, undetected power quality issues, etc.

G. Key Milestones

The Company maintains an execution plan and schedule of all its GMP investment categories. However, the VVO program is an entirely new system to the Eversource distribution infrastructure. Significant work has been placed on developing milestones and schedules, but as with any new system, it may be necessary to amend these milestones as the program progresses. A current sampling of the key milestones follows:

VVO – Line Devices:

- Finalized and completed engineering and design of the VVO system.
- Procured and received all major equipment.
- Completed the three-year unit targets for line sensors and LTCs.
- 70 percent and 96 percent complete for installation of regulator and capacitor banks, respectively.

VVO – IT

- Detailed project plan (Q2-2019).
- Build Complete (Q4-2019).
- Acceptance Testing (Q1-2020).
- Full Commissioning (system operational) (End of Q1-2020).

H. Updated projections for remainder of the three-year term

On August 15, 2018, the Company submitted its Baseline and Targets Filing, which included the 2018-2020 GMP baseline (Baseline and Targets Filing at 15, Table 2.4.7). *Table 11: Three Year Term Projections* provides the projections for 2020 for all remaining investment categories.

The VVO control software slipped from end of Q4 2019 to the end of Q1 2020. The company will still move forward with a phased approach for enabling VVO at the targeted substations and the respective circuits. The Company projects having VVO enabled on all selected feeders by 2Q 2020 with the measurement and verification ("M&V") commencing in 2Q 2020.

Table 11: Three-Year Term Projections

Investment Categories	Preauthorized Device Types	Total (3-Year Plan)	2020 Plan
Volt-Var Optimization	VVO - Regulators	96	27
	VVO - Capacitor Banks	74	3
	VVO - LTC Controls	8	0
	VVO - Line Sensors	189	0
	VVO - IT Work	N/A	N/A

III.A.4. Advanced Distribution Management System ("ADMS")

(GIS Verification, Advanced Load Flow)

A. Description of Work Completed

Geographic Information System ("GIS") Verification: The objective of the GIS verification project is to physically visit all overhead facilities in the eastern MA service territory to verify existing data against assets as they currently exist in the field. The final output of the project will provide an accurate GIS database of pole location and attribute information, associated equipment, phasing information and a verification of customer addresses fed by each individual transformer. Improved GIS data accuracy will, among other things, improve the functionality of the Company's advanced load flow ("ALF") tool and increase the accuracy of customer event restoration notifications.

Work progressed as planned during the 2019 GMP investment year. The Company's vendor continued field data collection activities for the remainder of the eastern MA overhead system and, as of year-end 2019, had completed all elements of the project, including uploading the data into the Company GIS database.

ALF: This GMP program includes the implementation of ALF software to create detailed computer models of the Company's distribution system. In parallel, the data sources critical to the accuracy of the models will be assessed and enhanced as necessary to leverage the advanced functionality of the software. This enhancement of model data sources will also be critical to the operation of other functions, including VVO and ADMS. During the 2019 GMP investment year, the Company:

- Defined GIS and other sources' data structure and integration requirements to the Synergi Software.
- Defined functional requirements to be delivered during implementation.
- Built a central engineering database to collect, prepare, and load non-GIS data into the Synergi model build.
- Established the IT networking, environments, and security protocols to provide a production software solution to the business.
- Built the model forge process to produce initial draft models of the Eversource distribution system within the Synergi software.
- Assessed and prioritized data quality that directly impacts the accuracy of the models.
- Provided basic training to impacted engineering groups to enable end-user acceptance.

B. Lessons-Learned/Challenges and Successes

GIS VERIFICATION: After resolving the upload issues in 2018, the remainder of this program continued to be implemented efficiently in 2019 without additional challenges.

ALF: In 2019, the Company was focused on implementing the Synergi software which included project planning, design, and implementation activities. During design, the Company focused on defining the underlying data structure in GIS and then mapped these attributes to the needs of the Synergi software. This effort spent reviewing data structure and attributes provided a solid foundation to then build from for the remainder of the project. This effort was critical to the success of the model build process.

C. Actual vs. Planned Implementation and Spending

The GIS Verification program had signfiacnt expense-only spend in 2019. The ALF program had capital spending during the 2019 GMP investment year, but the Company has not yet placed anything in-service in relation to this program: therefore, the 2019 capital spending will not be included in the the May 15, 2020 Grid Modernization Factor ("GMF") filing. Additionally, given the nature of these investments, neither of these programs are being tracked on a unitized basis. The GIS verification is tracked based on percent of survey and data transfer complete. Survey data collected by the vendor is subject to a quality assurance and quality control review by the Company that must be satisfied prior to considering the survey completed. The ALF project is tracked based on milestone completion.

GIS VERIFICATION:

- During the 2019 GMP investment year, the Company completed all remaining work associated with this program, for the entire three-year GMP term.

- The Total Capital Spend for this program is zero because this is an expense-only initiative. The Company was scheduled to spend all of the total $6 million budget through 2019, but due to some necessary additional survey points that were collected in the field to enable further efficient data gathering, the budget increased to ~$6.4 million.. The increase in spending relative to budget for the GIS Verification project will be addressed by reallocation from other GMP programs. The Company is not projecting to exceed its approved GMP budget.

ALF:

- The plan for 2019 included detailed project planning, design, implementation and delivery of a static model in Synergi for all circuits in the Company's service territory.
- The Company completed the detailed project plan for project milestones, budget and resources. This project plan then drove the remaining tasks for 2019.
- A detailed design describing the IT systems, as well as the functional requirements, was completed for the Synergi software solution.
- The Company executed the project plan and design for a static model build by building the IT environments, installing software, delivering code for data translation, performing functional and security testing, training end users, and delivering a product to be automated in phase 2.

- The Total Capital Spend for this program is lower than budgeted. The Company will continue to review costs allocations and redeploy funds as needed to other GMP IT/OT investments.

Grid Modernization		2019 Capital Spend			2019 Plant in Service		
		Actual	Budget	Variance	Actual	Budget	Variance
		9,114,802	6,721,941	2,392,861	-	-	-
Investment Category	Preauthorized Device Type						
Advanced Distribution Management System (ADMS)	Advanced Load Flow	2,775,876	4,662,150	(1,886,274)	-	-	-
	GIS Survey (Expense)	6,338,926	-	6,338,926	-	-	-
	Dist. Management System	-	2,059,791	(2,059,791)	-	-	-

D. Performance on Implementation/Deployment

Given the nature of the GIS investment, the relatively short duration of the project and its categorization as a foundational investment necessary to support other GMP investments, the Company has not proposed specific performance metrics for this GMP investment. Regarding the ALF program, please refer to Appendix 1 for the year-to-year and overall portfolio implementation/deployment data.

E. Description of Benefits Realized as the Result of Implementation

While there will be immediate benefits to the Company via the verification of field conditions, those benefits do not currently have a measurable output. The verification of data will directly contribute to the various existing and new electric distribution system GMP platforms.

- Benefits of GIS Verification: Greater accuracy in customer outage communications.
- Benefits for ALF:
  - Improved ability to optimize capital asset deployment and system reconfiguration.
  - Better contingency scenario planning.
  - Increased accuracy of GIS and other related data, lowering the cost and timeline to achieve the level of data accuracy required to support a DMS load flow.
  - Lowered cost and time to perform impact studies for customers applying to interconnect DER to the Company's distribution system.
  - Platform to perform more advanced analysis with automated logic, including automated hosting capacity analysis.

Refer to "Massachusetts Grid Modernization Program Year 2019 Evaluation – Advanced Distribution Management System/ Advanced Load Flow (ADMS/ALF)" provided by Guidehouse (formerly Navigant) for further analysis.

F. Description of Capability Improvement by Capability/Status Category

With the completed work in 2019, the Company has improved its distribution modeling capability. A static model built from GIS and other data sources improves the Company's ability to perform system planning studies across the entire distribution network on an ad hoc basis with direct engineering department involvement. This model is also the platform for which future automated analysis can be built.

G. Key Milestones

GIS VERIFICATION:

- The full deployment of the program is completed for the three-year term.

ALF: The ALF program represents a major improvement from prior load flow capability for Eversource, including new automation of model builds and a new software product for the eastern Massachusetts portion of the Company's service territory. Significant work has been undertaken in developing milestones and schedules, but as with any new system, it may be necessary to amend these milestones as the program progresses. A current sampling of the key milestones follows, with note that these milestones indicate future events, whereas other "Key Milestones" sections in this Report reflect the progress under the 2019 plan.

- Phase 1:
  - Mobilization and Design Complete (Q3-2019)
  - Build Complete (Q4-2019)
  - Testing Complete (Q4-2019)
  - Phase 1 Commissioning (Q4-2019)

- Phase 2:
  - ALF Automation design Complete (Q2-2020)
  - ALF Automation build Complete (Q3-2020)
  - Testing Complete (Q3-2020)
  - Phase 2 Commissioning (Q4-2020)

H. Updated Projections for Remainder of the Three-Year Term

GIS Verification:

- All work for the GIS Verification program was completed in 2019.

ALF:

- 2019: Phase 1 included implementation of required hardware and base software, including automation of the model build process from GIS. Additional data source enhancement continued through Phase 1, with limited inclusion in the automated model build process.

- 2020: Phase 2 will include completion of automated model build process, including additional enhanced data sources, and any required software configuration to accommodate those additional sources. The Company expects to enable semi-automated load flow capability for all non-mesh circuits by year-end.

III.A.5. Communications

(Miles of Fiber, Nodes)

A. Description of Work Completed

Communications investments are defined by two categories, Nodes and Fiber. The Company continued to execute the Nodes program in 2019. The objective of the Nodes program is to improve the capacity of the Company's communications network to transmit signals between field devices and the Company's system operations centers. In total, four nodes projects were completed in 2019. The first project was a critical upgrade of two front end processing units required for the SCADA system to collect and utilize data from field devices. Three additional wireless node projects were completed in 2019, increasing the capacity of existing radio infrastructure in eastern Massachusetts.

As described in Section B, with respect to the Fiber program, the Company made the decision in 2019 to discontinue work originally planned to build out fiber to the Company's distribution substations. The Company did extend less than a mile of fiber to Station 60 in eastern Massachusetts as a part of the 4kV Circuit Breaker SCADA program.

B. Lessons-Learned/Challenges and Successes

ADSS MILES OF FIBER:

- Following completion of detailed engineering, the project review process determined that the Fiber project did not demonstrate a reasonable benefit relative to the cost to customers. In its initial filing with respect to communications investments, the Company had originally planned to build out 250 miles of fiber to connect distribution substations across Massachusetts into the Company's existing fiber network. Based on the results of its engineering analysis, the Company determined the per mile cost of deploying fiber averaged approximately four times the original estimate, chiefly due to the identified and designed make-ready work. The needs assessment determined that although this fiber build out would augment and reinforce the Company's communications infrastructure for future grid modernization investments, the additional fiber was not required to deliver any of the benefits associated with the 2018-2020 GMP. The decision not to move forward with the fiber program was reviewed and approved by the Company's Grid Modernization Executive Steering Committee.

NODES:

- The Company has confirmed that augmenting wireless communications infrastructure is a cost-effective option to ensure increase throughput of data transmission.

C. Actual vs. Planned Implementation and Spending

Refer to Tables 12 and 13 below for the Company's 2019 implementation unit and spending summaries for the Communications Investments. Spending was broken down into "Total Capital Spend" and "Plant In-Service." As indicated in Section I. Introduction, Plant In-Service is triggered by a device being "Construction Complete" and therefore cost recoverable.

Table 12: 2019 Implementation Summary

Investment Categories	Preauthorized Device Types	2018 Unit Carry Over (2019)	Plan Units (2019)	Construction Complete Units (2019)	Commissioned Units (2019)	2019 Unit Carry Over (2020)
Communications	Communication - FAN	n/a	6	4	4	2
	Communication - Fiber	5	125	0	0	0

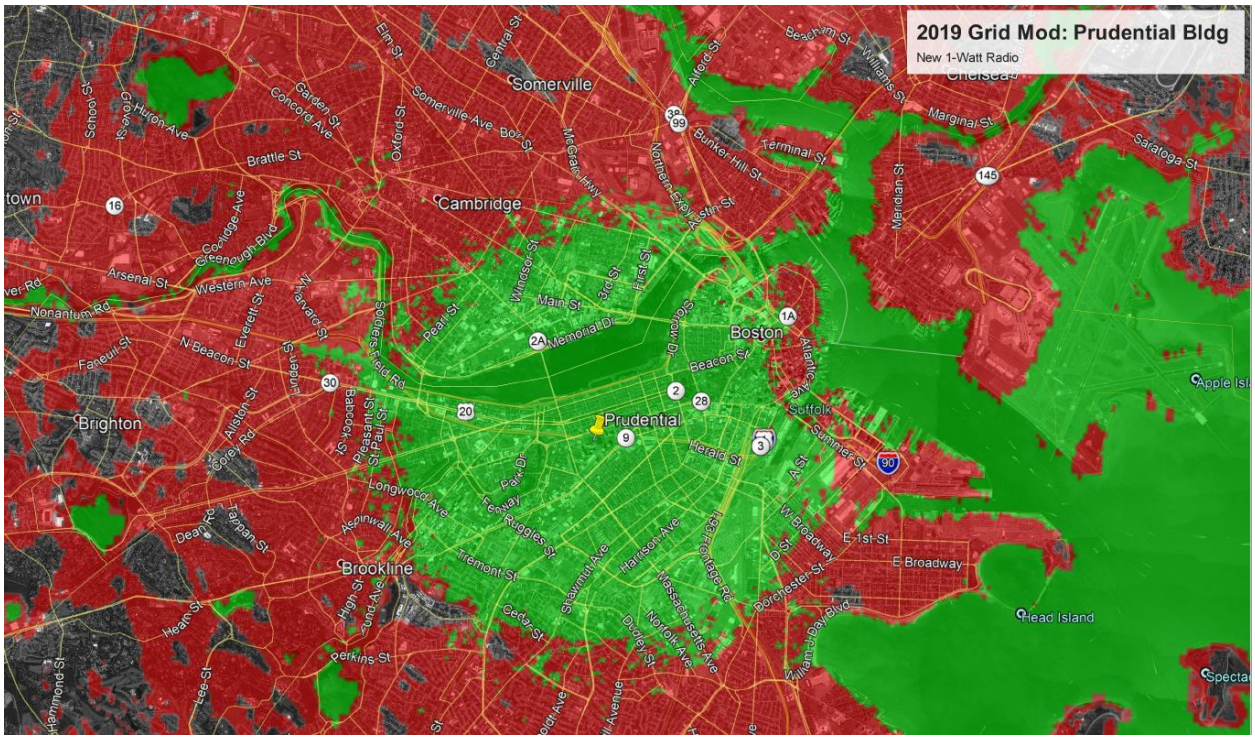
Table 13: 2019 Implementation Cost Summary

Grid Modernization		2019 Capital Spend			2019 Plant in Service		
		Actual	Budget	Variance	Actual	Budget	Variance
		832,151	14,424,621	(13,592,470)	415,578	3,057,750	(2,642,172)
Investment Category	Preauthorized Device Type						
Communications	Numbers of Nodes	522,256	974,299	(452,044)	415,578	57,750	357,828
	Miles of Fiber	309,896	13,450,322	(13,140,426)	-	3,000,000	(3,000,000)

MILES OF FIBER: As discussed in above, the ADSS Miles of Fiber program was eliminated from the 2018-2020 GMP due to significant unit cost increases that the Company did not consider prudent to expend and funds were redeployed to other investments.

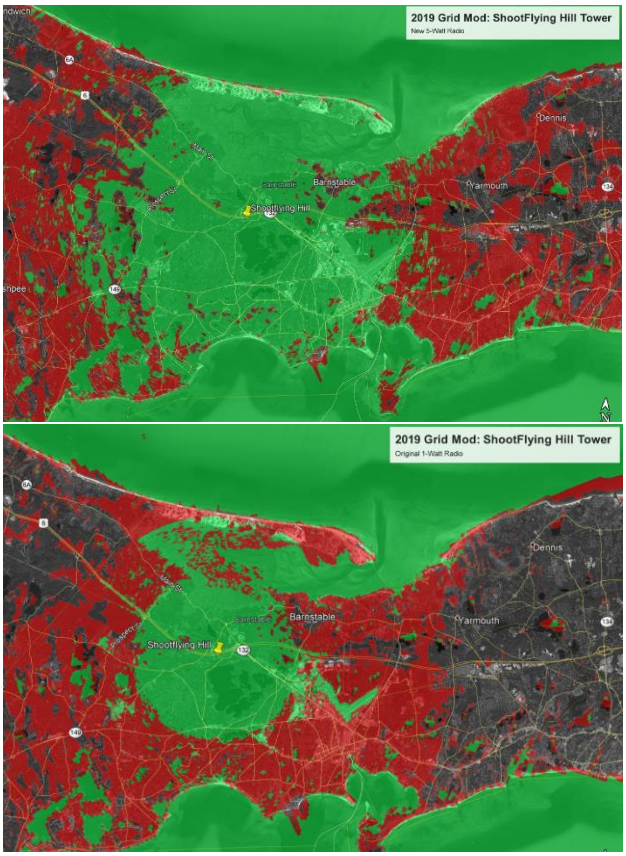
NODES: The Company's implementation of the node program was short of its 6-unit goal by two units. This is primarily due to the need to change two locations of the nodes late into the year. The first change was necessary because the Company could not obtain the required frequency for one location due to the FCC license freeze on the 900MHz radio band. The other change was necessary due to a medium range plan to rebuild the substation where one of the new nodes was to be placed. It was determined that any work now install a radio master would be required to be removed and reinstalled at a later date and therefore was not prudent use of the investment funds. This change caused a strain on construction and commissioning resources that could not be overcome. A sampling of the coverage increases of the nodes that were installed in 2019 can be found below in Figures 4 and 5.

Figure 4: Prudential – New Radio Master Installation Coverage



The Prudential Center (Figure 4) was a new radio Master installation and is one of the best performing distribution automation ("DA") Master sites in the Company's North region providing coverage for remote radios in the Metro Boston area. It was beginning to be oversubscribed due to the number of remote units programmed to it. The new Master radio added under the GMP in 2019 allowed the Company to supplement the existing Master radio, pick up any new DA remotes and avoid the overloading issue. It also provided additional redundancy in the radio Network, allowing for the distribution of the remote radios across two Masters, thereby eliminating one as a single point of failure.

Figure 5: Shoot Flying Hill – New Master Radio, Before and After Coverage



The Shoot Flying Hill (Figure 5) was an existing radio Master that provided minimal coverage. Multiple repeaters were required to extend the signal to remote switches. The new Master radio, a licensed 5-Watt radio, added under the GMP in 2019 provides added coverage, allowing the Company to supplement the existing Master radio, significantly reducing the need for repeaters. Having a large number of repeaters in a radio network introduces latency which can negatively impact performance. Not only does the new radio Master provide added coverage, it also allows for improved radio network performance.

For the Total Capital Spend, work is progressing as planned and will remain in line with the revised total budget, as described above.

D. Performance on Implementation/Deployment

It is not possible to quantify the performance increases experiences with broader coverage and increased throughput of data, other than to note that communication failure rates will decrease, with fewer field locations that will fail a communications check. This allows remote devices to operate in new areas on the system. See Section C, above for sampling of coverage maps.

E. Description of Benefits Realized as the Result of Implementation

The immediate benefits from this program are namely the increased coverage areas with the upgraded radio node locations and the ability to process significantly more communication traffic via the upgrade front-end processors of the SCADA system. Refer to Appendix 1 for the year-to-year and overall portfolio implementation/deployment data. Refer to "Massachusetts Grid Modernization Program Year 2019 Evaluation – Communications" provided by Guidehouse (formerly Navigant) for further analysis.

F. Description of Capability Improvement by Capability/Status Category

The capability improvements associated with the upgrade or addition of radio nodes within the territory provide for an expanded coverage area which will allow locations that may have previously been inaccessible by radio to now have remotely monitored and/or control equipment installed and commissioned into the Company's system at the most efficient rate. In addition to the nodes, upgrades to the Company's front-end SCADA processing units were completed to allow for the significant increase in deployed field devices, as part of the GMP, to communicate with the Company's system operations center.

G. Key Milestones

The Company retains an execution plan and schedule of all its investment categories. This schedule, which encompasses all three years of the GMP, was developed and is administered with the requisite flexibility that enables the Company to adjust its investment schedule and timing over the course of the GMP in the event that external factors, such as third-party resource availability, material availability, etc. However, a sampling of the key 2019 milestones follows:

- Engineering and design was completed for a significant portion of the ADSS Miles of Fiber work, ultimately leading to the decision to discontinue the Fiber program as a component of the 2018-2020 GMP.
- All node locations for the GMP plan were identified.

H. Updated Projections for Remainder of the Three-Year Term

On August 15, 2018, the Company submitted its Baseline and Targets Filing (see page 15, Table 2.4.7). *Table 14: Three Year Term Projections* provided below provides the projections for 2020 for all remaining investment categories. As was discussed above, the ADSS Miles of Fiber investment was eliminated from the GMP. The funds associated with the fiber investment were redeployed to other GMP investment categories

Table 14: Three-Year Term Projections

Investment Categories	Preauthorized Device Types	Total (3-Year Plan)	2020 Plan
Communications	Numbers of Nodes	10	6
	Miles of Fiber	0	0

III.B. Feeder Level Implementation By Investment Category

A. Monitoring and Control:

1. Highlights of Feeder Level Implementation

The Monitoring and Control program is specifically designed to increase remote visibility and control of existing devices already located on the Company's system. For 2019, the Company continued to install microprocessor relays and convert, or replace, existing padmounted and overhead switches to be SCADA-capable. Although already part of the system, these devices will now allow for:

- Increased visibility and remote operability by the system operators.
- Provision of valuable data related to load conditions and switch position (open/closed).
- The ability for the system operators to remotely apply protection schemes to the devices, when crews need to work within the device boundaries.
- In terms of the overhead, the reclosers can be built into existing loop schemes, allowing for autonomous system healing.
- In terms of the underground (4kV), the switches will be available for future loop scheme build out.

2. Feeder Level Lessons Learned/Challenges and Successes

As discussed in Section III, due to the volume and incremental nature of a technical program such as this, securing the correct blend of internal and external resources was challenging. The Company determined that it needed to start the solicitation of these outsourced resources earlier than its typical process. In addition to resource availability, there were times when all site conditions of a new project cannot be fully reviewed ahead of time, i.e., there may be the need to schedule electrical outage simply to observe the condition of energized parts in order to understand how to proceed with design work. Because of the compressed nature of this work, it is typically not feasible/practical to schedule this additional up-front outage in order to verify site conditions. Therefore, the Company makes a calculated assessment to move forward with the understanding that unforeseen conditions may arise. Unforeseen conditions did occasionally arise during the 2019 GMP, and the Company determined that it was necessary to gather immediate responses to the unforeseen conditions, so not to affect the over-all schedule, which included pre-planned outages.

The Recloser SCADA program was successful in its design and construction, and leveraging the lessons learned from 2018, the Company developed an execution plan for 2019 that did not overly stress the commissioning resources, originally identified to be a potential constraint on GMP progress. Also, as discussed in the 2018 Grid Modernization Annual Report, the Company modified the Recloser SCADA program to encompass a "replace in-place" alternative that enabled the continued successful implementation of the program while keeping the per-unit installation costs below original budgeted costs.

In 2018, the Padmount SCADA program presented challenges from the stand-point of coordinating the correct type of existing field equipment with a location suitable for communications. During 2018, a significant amount of time was spent coordinating these requirements and locating suitable locations to fulfill the entire 2018-2020 GMP commitment. Because of this up-front effort, the Company was on track to complete its 2019 goal but was ultimately one unit short of its 2019 goal due to an administrative mistake where one location was inadvertently counted twice. However, after a further refined reviewed of the eligible and available locations, Company determined that it has exhausted the locations which would only require a communications package. Therefore, the Company anticipates that there will be a small subset of devices which will have to be replaced in their entirety. Due to the low budgeted unit costs for this investment and the relatively high replace in-place costs for padmount switches, the Company will further evaluate in 2020 how best to meet the unit goals established in the August 15, 2018 Compliance filing.

The Network Protector SCADA program was largely a success, as the Company successfully installed and commissioned all of the 83 relays, which was 33 more than planned. However, and as discussed in Section III.A of this Report, the substation component of this project was required to be fully constructed and commissioned prior to any of the 83 devices being qualified for inclusion under the GMP. The commissioning of the substation work was delayed due to an unforeseen long lead piece of equipment. In hindsight, the Company should have divided the relay work and the substation work for tracking purposes.

B. Distribution Automation:

1. Highlights of Feeder Level Implementation

Any time a device is placed on the system which will allow for increased fault location precision and the ability to further minimize the effects of that fault, the system's capabilities will inherently improve. The overhead reclosers (new locations, replace in-place, and field ties) and 4kV (VFI switches and 4kV VFI retrofits for AR Loops) installations in 2019 contributed to both areas of improvement. In addition, these devices allow for:

- Increased visibility and remote operability by the system operators.
- Provision of valuable data, as related to load conditions and switch position (open/closed).
- The ability for the system operators to remotely apply protection schemes to the devices when crews need to work within the device boundaries.
- In terms of the overhead system, the reclosers can be built into existing loop schemes, allowing for autonomous system healing.
- In terms of the underground (4kV) system, the switches will be available for future loop scheme build out.

2. Feeder Level Lessons Learned/Challenges and Successes

Given that the penetration levels of the current GMP program investments, devices in one program must be closely reviewed and coordinated with the devices of another program. As a result, and particularly for the overhead devices, this made choosing and installing the 2019 reclosers a challenge because of the future work, via other programs, that may affect the current installation. For example, if an overhead recloser is placed on a particular feeder, that recloser would get specific data settings for its controller, to accommodate the circuit as it is configured. However, if through the Recloser SCADA or Overhead DA with Circuit Ties programs, other devices are also to be placed on that circuit, then the controller settings of the first recloser would need to be changed, so that all devices coordinate together. This issue was discussed in the 2018 Grid Modernization Annual Report and fed directly into the engineering and management of the device deployment in 2019. Although this coordinated approach increased the time to engineer and design these investments, it was critical to use this deliberate and holistic approach to help lay the groundwork for continued very successful device deployment in 2019 which saw the Company significantly surpass its original goal.

Implementing GMP programs on the 4kV underground systems, which are often located in densely populated city environments, is affected by numerous factors, such as the coordination of vehicle removal, police details, city permits and manhole/vault cleaning in order to first inspect the site and equipment to ensure compatibility with the program's intent. These factors were present during the 2019 investment year, but by leveraging the coordination lessons learned from 2018, including the implementation of a task-force approach that identified owners and key points of contact within the process, the Company was able to continue to successfully deploy devices well in excess of its original goal.

A significant lesson lessons learned from the Company's experience with the 2018 GMP implementation, which carried into the 2019 GMP, was the need for careful and upfront planning to ensure that all necessary tasks are undertaken and accomplished in the necessary order and under to correct timing. This planning enabled the Company to identify situations (emergent or planned) that existed in areas adjacent to the GMP work area in question, allowing the Company to leverage those ancillary projects and obtain data while other work was progressing. For instance, if there is a circuit outage evolution for a non-GMP project in the vicinity of a future GMP device installation, the Company utilized that outage to collect data and/or perform pre-work on the GMP device location. These efforts required close coordination between GMP and non-GMP projects, which the requisite separation and tracking of costs.

C. Volt-Var Optimization

1. Highlights of Feeder Level Implementation

As discussed in the 2018 Grid Modernization Annual Report, the Company completed the VVO analysis, selected substations and circuits, identified the specific field device locations and selected the software platform. The Company had targeted 2019 as the year to install all VVO field

components to have them ready for final commissioning when the IT portion of the program was completed in 2020. The Company's execution plan was well designed, and all LTC controls and line sensors were installed and commissioned with communications. Capacitor banks and regulators were on target for completion in 2019, but unforeseen conditions, as described in section III.A.3, resulted in the Company being short of their overall goal.

2. Feeder Level Lessons Learned/Challenges and Successes

As discussed in the 2018 Grid Modernization Annual Report, the regulator field devices come in three different sizes. The largest of these devices requires a significant amount of pole/platform infrastructure to enable its installation. As a preliminary step to their installation at new locations, the Company (or Verizon for their pole-set areas) must petition the local municipal siting authority for permission. These petitions can be denied and/or held up by the siting authority and, given that only certain select feeders have been identified for inclusion in this program, there are limited opportunities for the Company to adjust the installation locations. Back up locations, in the event that a primary location is not feasible, that stay consistent with the overall VVO plan can sometimes be identified. For instance, siting locations can sometimes be shifted along the pole line. However, because of the specific function of the VVO field devices, the opportunity for deviation from the designed location is typically quite small. Even with proactively managed communications with the municipalities, there ultimately ended up being siting challenges for the largest of the regulator units. Additionally, because the VVO design encompasses all feeders for a specifically-selected substation, it is not feasible to simply select another feeder that is not part of the planned substation.

The permitting constraints, coupled with identified stability issues discussed earlier in this Report, significantly extended the 2019 installation timeframes into 2020. As of early Q1, 2020 the Company has resolved the stability issues and permitting is progressing forward. The installation teams plan to install all outstanding field units early Q2, 2020.

In addition to the challenges with the regulators, the end of line sensors were a challenge to design and source. This is a nascent technology, and the Company needed to work with a vendor to develop the and prove out the specification before being able to take delivery for installation. The installations were successfully done in 2019 but took much longer than anticipated.

D. Advanced Distribution Management System

1. Highlights of Feeder Level Implementation

The Advance Distribution Management System program was not administered on a feeder basis. For 2019, the Company obtained a "static model" status for the ALF investment for all of the Company's circuits. Additionally, the GIS Survey investment was completed for all circuits in the Eastern Massachusetts (NSTAR Electric) region of the service territory.

2. Feeder Level Lessons Learned/Challenges and Successes

For the ALF investment, significant time and effort was taken to define and map underlying data structures to ensure the Synergi tool would operate as intended.

E. Communications

1. Highlights of Feeder Level Implementation

The Communications program is not being implemented on a "Feeder Level." Please see Section III of this Report for a further discussion of the Communications program.

2. Feeder Level Lessons Learned/Challenges and Successes

The Communications program is not being implemented on a "Feeder Level." Please see Section III of this Report for a further discussion of the Communications program.

IV. Description and Report on Each Infrastructure Metric

As part of its approval of the Company's GMP, the Department approved the proposed statewide and company-specific infrastructure metrics. Regarding statewide infrastructure metrics, the Department required the Distribution Companies to report on the following: (1) system automation saturation; (2) number/percentage of sensors installed versus planned; (3) percentage of circuits with installed sensors; and (4) total number of grid-connected DG facilities, nameplate capacity and estimate output of each unit and type of customer-owned or operated units. D.P.U. 15-122, at 198-199. As for the Eversource-specific infrastructure metrics, the Company is required to report on the following for each category of preauthorized grid-facing investment: (1) the number of devices or other technologies deployed; (2) the associated cost for deployment; (3) reasons for deviation between actual and planned deployment for the GMP investment year; and (4) projected deployment for the remainder of the GMP term. Id. at 200-201. To assist in the development of these baselines, the Department directed each of the Distribution Companies to develop and maintain information on its system design, operational characteristics (e.g., voltage, loading, line losses), and ratings prior to any deployment of preauthorized grid-facing technologies. Id. at 203. Additionally, the Department directed the Distribution Companies, when developing their proposed baselines to use, to the extent possible, information reported in the annual service quality filings, as well as other publicly available information. Id.

While the purpose of these infrastructure metrics is to determine how performance can be changed because of grid modernization investments, there are outside factors, over which the Company has no control, that can and will impact performance. Weather, customer behavior, economic conditions and other factors will have a significant influence on the parameters being measured under these metrics.

The statewide infrastructure metrics use the following common definitions across the Distribution Companies.

Grid Modernization Device - any device that meets the requirements of either a fully automated or a partially automated device.

Fully Automated Device – a device that meets all of the following requirements:

- reacts to system conditions to isolate or restore portions of the electric system;
- communicates system quantities (e.g., voltage, trip counts) to a central location, such as SCADA; and
- the state of the device can be remotely controlled by dispatch.

Partially Automated Device – a device that meets at least one of following requirements:

- Reacts to system conditions to isolate or restore portions of the electric system;

• Communicates system quantities (e.g., voltage, trip counts) to a central location, such as SCADA;

• The state of the device can be remotely controlled by dispatch; or

• Be capable of upgrade to a fully automated device without full replacement.

Sensor – Equipment that sends or records information of the electric system that can be used to improve the efficiency or effectiveness of workforce or asset management (e.g., Fault locators that would help pinpoint a problem for more efficient crew deployment).

Statewide Infrastructure Metrics

1.1 Grid Connected Distribution Generation Facilities

The data used in the calculation of this metric consider units that have an executed Interconnection Service Agreement ("ISA") and are in service and connected to the distribution system.[6]

The Company has tracked the following data on a substation and circuit basis:

a. Total number by technology or fuel type – count of units by technology or fuel type

b. Nameplate capacity by technology or fuel type – sum total of nameplate capacity

c. Estimated output by technology or fuel type – sum of nameplate capacity * capacity factor * 8760 hours

d. Type of customer-owned or operated units by technology and fuel type – (i.e., count of Photo Voltaic ("PV"), wind, Combined Heat and Power ("CHP"), Fuel Cell, etc.)

e. Nameplate as a Percent of Peak Load – calculated as total nameplate capacity (MW) / peak load (MW)

The baseline for this metric has been quantified and calculated based upon units in service by December 31, 2017. Please refer to the Company's Baselines and Targets Filing for the detailed baseline quantities.

The 2019 results for this metric are summarized in the table below. The 45,427 facilities represent an increase of 10,314 facilities over the baseline amount of 35,113. The increase was primarily driven by PV facilities. The supporting details can be found in Attachment SI-1.

[6] 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.

SI-1 Grid Connected Distribution Generation Facilities 2019

a. Number of Facilities

Technology Type	Number of Facilities
Fuel Cell	5
Gas Turbine	15
Hydro Electric Turbine	23
Internal Combustion Engine	220
Internal Combustion Turbine	4
Micro Turbine	5
Other	1
PV	45,033
Steam Turbine	4
Wind Turbine	117
Grand Total	**45,427**

1.2 System Automation Saturation

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

The baseline saturation rate has been calculated based on what existed on the Eversource system as of the date the baseline was first calculated on August 1, 2018. Customers that can benefit from multiple devices will be counted as one for purposes of calculating the baseline. The installations will not be limited to the main line infrastructure and will include no-load lines and distribution system supply lines.

The following matrix has been provided as guidance to determine which type of equipment would be considered partially automated, fully automated or included as a sensor.

Device Type	Not Included	Partial Automation	Full Automation	Included as a Sensor
Feeder Breakers (No SCADA)		X		
Feeder Breakers (SCADA)			X	X
Reclosers (including sectionalizers, single phase reclosers, intellirupters, ASU) (No		X		
Reclosers (including sectionalizers, single phase reclosers, intellirupters, ASU)			X	X
Padmount Switchgear (No SCADA)		X		
Padmount Switchgear (SCADA)			X	X
Network Transformer/Protector with full SCADA			X	X
Network Transformer/Protectors with monitoring, no control		X		X
Network Transformer/Protector with no SCADA	X			
Feeder Meter (e.g., ION, with comms)				X
Capacitor and Regulator with SCADA		X		X
Capacitor and Regulator no SCADA	X			
Line Sensor (with comms)				X
Fault Indicator (with comms)				X
Other Fault Indicators (no comms)	X			
Other Voltage Sensing (with comms)			X	X
Sectionalizer (no SCADA)		X		
Sectionalizer (SCADA)			X	
Customer Meter	X			
Distribution /step down Transformer	X			
Other Substation Breakers	X			
Fuse	X			

As more automation is installed on the Company's system, both under the GMP and pursuant to other system investment outside of the GMP, the results of this metric will be reduced.

Metric Calculation:

Customers Served

_____

Fully Automated Device + 0.5*(Partially Automated Device)

The baseline for this metric has been quantified and calculated based upon equipment in service as of August 1, 2018. Eversource's baseline is 247.1. Please see the Company's Baselines and Targets Compliance Filing for circuit level detail.

The calculated score at the end of 2019 was 179.8. This is an improvement of 67.3 over the baseline amount of 247.1. Please see Attachment SI-2 and Attachment SI-3 for circuit level detail.

1.3 Number/Percentage of Circuits with Installed Sensors

This metric measures the total number of electric distribution circuits with installed sensors[7] which will provide information useful for proactive planning and intervention. The installation of sensors provides the means to enable proactive planning and measure several 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.

The baseline for this metric consists of all sensor installations on Eversource's distribution circuits and substations, including existing installations.

The baseline for this metric has been quantified and calculated based upon equipment in service as of August 1, 2018. Eversource's baseline has been calculated as 82.3 percent. Please see the Company's Baselines and Targets Filing for the circuit detail used to develop the baseline.

For 2019, Eversource's number and percentage of circuits with installed sensors has increased to 83.7 percent. Please see the Table SI-3 below for further details.

TABLE SI-3 NUMBER/ PERCENTAGE OF CIRCUITS WITH INSTALLED SENSORS 2019

Sensor	Number of Feeders	Percent
Y	1,735	83.7%
N	339	16.3%

[7] Please see the previous matrix for devices that have been defined as "sensor" for the purpose of determining whether a circuit has a sensor.

Eversource-Specific Infrastructure Metrics

2.1 Number of devices or other technologies deployed

Under this metric, Eversource has tracked the following information per GMP investment at the substation and circuit level where appropriate:

a. Number of devices or other technologies deployed

b. Total number of devices planned

c. Percent – Number of devices installed / total number of devices planned

This metric is strictly a GMP deployment metric: accordingly, the baseline for this metric necessarily starts at zero to ensure that pre-GMP investments are not captured in the baseline.

Please refer to Table **S2-1** below for the Company's GMP investment deployment for 2019.

Table S2-1

Grid Modernization - 2019 Unit Deployment

	Commissioned Units		
Investment Areas and Preauthorized Device Types	**2019 Actual**	**2019 Plan**	**%**
Monitoring & Control (SCADA)	**163**	**230**	**71%**
Microprocessor Relay	87	103	84%
4kV Circuit Breaker SCADA	16	21	76%
Recloser SCADA	19	14	136%
Padmount Switch SCADA	41	42	98%
Network Protector SCADA	-	50	0%
Distribution Automation	**299**	**210**	**142%**
OH DA	148	104	142%
OH DA w/Ties	45	23	196%
4kV Oil Switch Replacement	89	67	133%
4kV AR Loop	17	16	106%
Volt-Var Optimization	**333**	**302**	**110%**
VVO - Regulators	69	95	73%
VVO - Capacitor Banks	71	76	93%
VVO - LTC Controls	4	6	67%
VVO - Line Sensors	189	125	151%
VVO - IT Work	N/A	N/A	N/A
Advanced Distribution Management System (ADMS)	**N/A**	**N/A**	**N/A**
Communications	**4**	**136**	**3%**
Numbers of Nodes	4	6	67%
Miles of Fiber	-	130	0%
Electric Vehicles	**N/A**	**N/A**	**N/A**
Energy Storage	**N/A**	**N/A**	**N/A**
Martha's Vineyard	N/A	N/A	N/A
Provincetown	N/A	N/A	N/A
Totals	**799**	**878**	**91%**

2.2 Associated cost for deployment

Under this metric, the Company has tracked the following information per investment type at the substation and circuit level where appropriate:

a. Cost of devices or other technologies deployed

b. Total cost of devices planned

c. Percent – Cost of devices installed / total cost of devices planned

Please refer to Table S2-2 below for the Company's associated cost for deployment for 2019.

Table S2-2

Grid Modernization - 2019 Deployment ($)

	Capital Spend (in thousands $)		
Investment Areas and Preauthorized Device Types	**2019 Actual**	**2019 Budget**	**%**
Monitoring & Control (SCADA)	**21,452**	**26,256**	**82%**
Microprocessor Relay	14,991	20,319	74%
4kV Circuit Breaker SCADA	4,085	2,414	169%
Recloser SCADA	889	1,024	87%
Padmount Switch SCADA	615	299	206%
Network Protector SCADA	872	2,200	40%
Distribution Automation	**29,640**	**27,192**	**109%**
OH DA	12,070	13,167	92%
OH DA w/Ties	2,798	3,135	89%
4kV Oil Switch Replacement	13,881	10,010	139%
4kV AR Loop	892	880	101%
Volt-Var Optimization	**7,808**	**11,253**	**69%**
VVO - Regulators	2,375	5,223	45%
VVO - Capacitor Banks	2,549	0	N/A
VVO - LTC Controls	1,045	883	118%
VVO - Line Sensors	679	0	N/A
VVO - IT Work	1,160	5,147	23%
Advanced Distribution Management System (ADMS)	**2,776**	**6,722**	**41%**
Advanced Load Flow	2,776	4,662	60%
GIS Verification (Expense)	0	0	N/A
Dist. Management System	0	2,060	0%
Communications	**832**	**14,425**	**6%**
Numbers of Nodes	522	974	54%
Miles of Fiber	310	13,450	2%
Electric Vehicles	**10,979**	**6,379**	**172%**
Energy Storage	**3,026**	**9,368**	**32%**
Martha's Vineyard	1,303	3,360	39%
Provincetown	1,723	6,008	29%
Totals	**76,513**	**101,594**	**75%**

2.3 Reasons for deviation between actual and planned deployment for the plan year

Under this metric, the Company tracked the following information per investment at the substation and circuit level where appropriate:

a. Number of devices or technology installed versus plan for a given year

b. Cost of devices or technologies installed versus plan for a given year

c. Reason for discrepancies

Please refer to Table S2-3 below for the Company's reasons for deviation between actual and planned deployment for the plan year.

Table S2-3

Grid Modernization - 2019 Unit vs. Cost Deployment

	Commissioned Units			Plant In-service (in thousands $)		
Investment Areas and Preauthorized Device Types	**2019 Actual**	**2019 Plan**	**(%)**	**2019 Actual**	**2019 Budget**	**(%)**
Monitoring & Control (SCADA)	**163**	**230**	**71%**	**14,262**	**12,784**	**112%**
Microprocessor Relay	87	103	84%	9,694	9,051	107%
4kV Circuit Breaker SCADA	16	21	76%	2,650	1,750	151%
Recloser SCADA	19	14	136%	608	682	89%
Padmount Switch SCADA	41	42	98%	631	623	101%
Network Protector SCADA	-	50	0%	679	678	100%
Distribution Automation	**299**	**210**	**142%**	**27,616**	**23,002**	**120%**
OH DA	148	104	142%	12,533	9,983	126%
OH DA w/Ties	45	23	196%	2,586	2,494	104%
4kV Oil Switch Replacement	89	67	133%	12,281	10,525	117%
4kV AR Loop	17	16	106%	217	0	N/A
Volt-Var Optimization	**333**	**302**	**110%**	**6,394**	**5,692**	**112%**
VVO - Regulators	69	95	73%	2,136	4,494	48%
VVO - Capacitor Banks	71	76	93%	2,384	0	N/A
VVO - LTC Controls	4	6	67%	1,203	1,198	100%
VVO - Line Sensors	189	125	151%	672	0	N/A
VVO - IT Work	N/A	N/A	N/A	0	0	N/A
Advanced Distribution Management System (ADMS)	**N/A**	**N/A**	**N/A**	**0**	**0**	**N/A**
Advanced Load Flow	N/A	N/A	N/A	0	0	N/A
GIS Verification (Expense)	N/A	N/A	N/A	0	0	N/A
Dist. Management System	N/A	N/A	N/A	0	0	N/A
Communications	**4**	**136**	**3%**	**416**	**3,058**	**14%**
Numbers of Nodes	4	6	67%	416	58	720%
Miles of Fiber	-	130	0%	0	3,000	0%
Electric Vehicles	**N/A**	**N/A**	**N/A**	**8,432**	**6,884**	**122%**
Energy Storage	**N/A**	**N/A**	**N/A**	**0**	**0**	**N/A**
Martha's Vineyard	N/A	N/A	N/A	0	0	N/A
Provincetown	N/A	N/A	N/A	0	0	N/A
Totals	**799**	**878**	**91%**	**57,119**	**51,420**	**111%**

As is further discussed in section III.A of this Report, there were a variety of factors that precluded the Company from commissioning all the units planned for calendar year 2019. Most common among these was the aggressive schedule set forth by the Company and the unforeseen constructability issues with the VVO devices. With the exception of several VVO devices and one communications Node, whose commissioning was impacted by the Covid-19 pandemic and the related Massachusetts State of Emergency work and other restrictions, all of the work not completed in 2019 was placed in-service and commissioned as of April 1, 2020.

2.4 Projected deployment for the remainder of the three-year GMP term

The metric compares the revised projected deployment with the original targeted deployment as the Company implements its GMP. 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. Each year's revised investment plan will be used as the basis of comparison for the following year's GMP work.

Under this metric, the Company has tracked the following information per investment at the substation and circuit level where appropriate:

a. Number of devices or technology to be installed the following year

b. Cost of devices or technologies installed the following year

The metric will be used as the baseline and target for the following year's work and will be reported on an annual basis. Please refer to Table S2-4 below for the Company's projected GMP investment deployment for 2020.

Table S2-4

Grid Modernization - Total Deployment Plan (Cost vs. Units)

	Commissioned Units			Capital Spend (in thousands $)		
Investment Areas and Preauthorized Device Types	**2018 Actual**	**2019 Actual**	**2020 Plan**	**2018 Actual**	**2019 Actual**	**2020 Plan**
Monitoring & Control (SCADA)	**28**	**163**	**239**	**4,516**	**21,452**	**23,822**
Microprocessor Relay	10	87	96	3,363	14,991	14,762
4kV Circuit Breaker SCADA	-	16	39	84	4,085	6,983
Recloser SCADA	15	19	3	963	889	675
Padmount Switch SCADA	3	41	18	106	615	270
Network Protector SCADA	-	-	83	0	872	1,132
Distribution Automation	**25**	**299**	**124**	**3,200**	**29,640**	**15,804**
OH DA	25	148	47	2,268	12,070	4,185
OH DA w/Ties	-	45	-	0	2,798	1,720
4kV Oil Switch Replacement	-	89	16	932	13,881	6,500
4kV AR Loop	-	17	61	0	892	3,399
Volt-Var Optimization	**4**	**333**	**30**	**377**	**7,808**	**4,165**
VVO - Regulators	-	69	27	0	2,375	620
VVO - Capacitor Banks	-	71	3	0	2,549	0
VVO - LTC Controls	4	4	-	377	1,045	0
VVO - Line Sensors	-	189	-	0	679	0
VVO - IT Work	N/A	N/A	N/A	0	1,160	3,545
Advanced Distribution Management System (ADMS)	**N/A**	**N/A**	**N/A**	**0**	**2,776**	**9,107**
Advanced Load Flow	N/A	N/A	N/A	0	2,776	9,102
GIS Verification (Expense)	N/A	N/A	N/A	0	0	0
Dist. Management System	N/A	N/A	N/A	0	0	5
Communications	**-**	**4**	**6**	**0**	**832**	**1,435**
Numbers of Nodes	-	4	6	0	522	1,435
Miles of Fiber	-	-	-	0	310	0
Electric Vehicles	**N/A**	**N/A**	**N/A**	**2,860**	**10,979**	**18,981**
Energy Storage	**N/A**	**N/A**	**N/A**	**1,583**	**3,026**	**44,427**
Martha's Vineyard	N/A	N/A	N/A	959	1,303	11,945
Provincetown	N/A	N/A	N/A	625	1,723	32,482
Totals	**57**	**799**	**399**	**12,536**	**76,513**	**117,742**

The Company submitted its Baseline and Targets Filing in the Compliance Filing on August 15, 2018, which included the 2018-2020 GMP baseline (Baseline and Targets Filing at 15, Table 2.4.7). As discussed in section I.B of this Report, the Company is continuously seeking opportunities to accelerate the preauthorized device type unit deployments in an efficient and cost-effective manner. In accordance with this perspective, the Company did accelerate several of their deployment schedules in 2019. Additionally, for some GMP programs, the Company completed all of the investments planned over for the three-year term, in 2019. The statuses, including deployment schedules, for each respective investment category and type are discussed in Section III of this Report. Please also refer to the Company's Attachment ES-1, which provides the Excel versions of the Eversource-specific tables included in Section 2.1, Section 2.2, Section 3.3, and Section 2.4.

V. Distributed Energy Resources ("DER")

Installations of DER are growing at an astonishing rate in many parts of the United States, including Massachusetts. This surge in DER deployment on utility distribution systems has been accelerating over the last decade and is forecast to continue for the foreseeable future

The vast majority of DER installations are solar projects. The projects range from the high-volume residential roof top to large multi-MW stand-alone projects. The success of DER installations in recent years has led to high saturation levels in many areas of the Company's distribution system. The DER activity of large scale solar in areas of relatively low electric load has been high over the last decade and, as shown in Figure 6, continues to see significant application activity.

Figure 6: 2019 Interconnection Applications

Territory	Status	Simplified	EXP/STD	Totals
EM	Applications Online in 2019	3,467	103	3,570
	Applications Received in 2019	4,808	654	5,462
WM	Applications Online in 2019	1,496	32	1,528
	Applications Received in 2019	1,804	59	1,863

There are new complicating factors that are now evolving in the market that require more technical review time and integrated system work to ensure the safety and reliability of the system. These factors include the emergence of:

1) Solar plus-storage market

    a. This market has added complexity to DER studies and screens as well as metering and incentive program applicability.

    b. Applicants are interested in maximizing incentive programs across state and Independent System Operator ("ISO") markets which leads to confusion on application tracks.

2) Substation upgrades

    a. Due to high saturation levels in certain areas of the system, studies are determining that substation upgrades are required to allow for project interconnection. This makes studies and construction activities more complicated and time-consuming. It also requires the Company's planning teams to account for the potential for additional sub-station work or dedicated express feeders due to the expected continuing DER activity. The Company must ensure that resources are utilized, and projects are executed in an efficient fashion, which requires careful planning and coordination.

3) More frequent ISO transmission studies

    a. ISO is requiring studies for projects less than 5 MW in areas it deems saturated. This adds additional time, cost and engineering effort to many projects that historically did not have this extra layer of administrative and engineering complexity. Utilities and Transmission Groups are performing more level 0/1 and level 3 transmission studies and, in some cases, doing them in groups to process them more quickly than if they were processed sequentially. ISO and Eversource work together on the study process to minimize customer impact, but Eversource is aware that these new requirements are confusing to customers.

4) New metering and design configurations

    a. Metering configurations that vary based on system design and/or incentive program (e.g., ISO program participation, SMART program energy storage adder).

    b. Multiple service requests on single parcel and/or building (dedicated service for the DER which is separate from the existing customer).

5) Aggregation of small projects in certain areas

    a. Over time the number of small projects interconnected in an area leads to significant installed capacity.

    b. Simplified applications for multiple small projects in the same area require additional study and administrative and engineering burden to execute outside of the normal simplified process.

Eversource has participated in the D.P.U. 19-55 discussions with DER stakeholders to work on alignment and updates to the statewide Interconnection Tariff. Discussions have been targeted on topics such as group studies, cost allocation, metering, communications, energy storage, ASO Studies and ISO market participation.

Eversource is constantly exploring opportunities to better manage its DER grid interconnection processes in ways that can more fully leverage technology advances (e.g., advanced inverter functionalities), enable procedural transparency, and recognize evolving technical standards.

- Eversource recognizes first and foremost that a core group of technical experts is needed to streamline the application studies and effectively adapt to the changing dynamics. Accordingly, the Company has hired and is currently hiring additional engineers, analysts, and program managers into the DER Planning organization. During 2019, six engineers, one analyst and one program manager have been hired into the team, with the following objectives:

    - Streamline the interconnection process;

    - Provide additional resources to continue to perform efficient and cost-effective system impact studies;

- Support faster adaptation of new/updated industry standards and regulatory policies;

- Further refine and improve the Company's interconnection standards, processes, procedures;

- Provide developers/customers with additional technical experts to facilitate interconnection options; and

- Perform rapid DER impact analyses for off-normal system configurations to reduce outages to the interconnected sites.

Eversource also recognizes that research in these emerging issues is critical in order to continue to support additional integration of DERs, especially with the emergence of a multitude of varying types of technologies. As such, Eversource has provided $16,000 to the Worcester Polytechnic Institute ("WPI") MPQ project where engineering students in their final year at WPI are conducting a research project on the evaluation of the flicker analysis. Furthermore, Eversource has also provided approximately $300,000 in 2019 in research organizations such as the Electric Power Research Institute ("EPRI") for performing relevant research to improve the integration and operability of DERs. For example, the Company has provided funding for studies related to enhanced modeling and simulation techniques for DER integration.

Additionally, the Company has rolled out and is continually exploring initiatives associated with mapping tools, an interactive self-service application portal, and proposing selective locations for storage to meet utility needs. Accurate, up-to-date maps of the distribution system can play a useful role for both the Company and potential DER interconnection applicants. For the utility, having this information can support a more rapid review of an interconnection application on a specific feeder. For applicants, having access to a more dynamic version of the map, specifically one that indicates remaining hosting capacity for new DER projects, allows them to be more selective in the types of projects and their specifics (e.g., capacity, technology deployed, etc.) to pursue in a formal interconnection application. By increasing visibility into the characteristics and feasibility of individual circuits, these maps can save both customers and the Company time and money.

The Company has published the first and second version of the Hosting Capacity Maps in its CT and Western MA service territories. In March 2020, the DER team also published the Hosting Capacity Map for Eastern Massachusetts ("EMA") and is currently working towards the monthly update on that data. These maps, which do not depend on the use of an ALF tool, expeditiously provide key preliminary information to developers. The Company continues to work to incorporate feedback and data requests from the Department of Energy Resources ("DOER") and DER developers into the maps.

As demonstrated at the February 13, 2019 technical session, the Company recognizes that hosting capacity maps are of critical importance to developers. As described in Section III, as a part of its GMP, the Company is making progress on its ALF program that will ultimately support the development and deployment of subsequent versions of hosting capacity maps based on more sophisticated logic as calculated by the ALF tool. Given the dynamic nature of DER in

Massachusetts, the Company's continued investment in foundational grid modernization investments is crucial to ensuring that the Company is able to aid these developers in siting and interconnecting their projects as part of an expedient and efficient process.

VI. Performance Metrics

A. Description and Report on Each Performance Metric

In D.P.U. 12-76-B, the Department directed Eversource, National Grid and Until (collectively, the "Distribution Companies" or "Companies") to include in their respective GMPs performance metrics that measure progress towards the objectives of grid modernization. D.P.U. 12-76-B, at 30. Eversource filed proposed performance metrics with its GMP in D.P.U. 15-122, as did National Grid and Unitil in each of their respective GMP dockets. The Department determined that additional work was needed to develop performance metrics that appropriately track the quantitative benefits associated with pre-authorized grid-facing investments, and progress toward the Grid Modernization objectives. D.P.U. 15-122, at 95-106. The Department ordered the Distribution Companies to file revised proposed performance metrics designed to address the preauthorized grid-facing investments and noted that it would convene a stakeholder process to facilitate review of the revised performance metrics. Id. at 202.

On August 15, 2018, the Distribution Companies filed revised proposed performance metrics. Following that filing, the Department, the Department of Energy Resources ("DOER") and the Cape Light Compact ("Compact") issued information requests to the Distribution Companies regarding the revised proposed performance metrics. On February 13, 2019, the Department held a technical conference to aid its review of the Distribution Companies' revised proposed performance metrics. Following the technical conference, the Department issued a Memorandum on March 19, 2019, ordering the Distribution Companies to file further revised performance metrics consistent with the directives set out in the Memorandum. March 19, 2019 Memorandum at 2-5. The Companies submitted final revised proposed performance metrics on April 9, 2019.

On July 25, 2019, the Department stamp approved the Companies' proposed performance metrics dated April 9, 2019. This section of the Grid Modernization Annual Report describes the statewide, as well as company-specific, performance metrics that Eversource is using to evaluate progress towards the grid modernization objectives. Please note that, as the statewide metrics apply to Eversource, National Grid and Unitil, this section of Eversource's 2020 Annual Grid Modernization Report will refer to all three Distribution Companies when describing the statewide metrics. For each performance metric, this section will identify the type, objective, assumptions, calculation approach, organization of results, and baselines.

The Department also ordered the Distribution Companies to develop a formal evaluation process, including an evaluation plan and evaluation studies, to review the Distribution Companies' preauthorized grid modernization plan investments and their progress toward meeting the Department's grid modernization objectives. D.P.U. 15-122, at 204-205. Guidehouse (formerly Navigant Consulting, Inc.) is completing the evaluation to ensure a uniform statewide approach and to facilitate coordination and comparability across the Distribution Companies.

The data supporting the performance metrics have been provided to the Guidehouse evaluation team by the Company. Results of the Monitoring and Control, as well as the Distribution Automation, investment areas are expected to be shared by Guidehouse in June 2020, as stated in DPU-EP-1-1. Results of other investment areas, such as Volt Var Optimizaton ("VVO"), are expected to be shared in June 2021. The performance metrics will be based on statistical analyses performed by the evaluation team using data provided by each Distribution Company and are to be evaluated in 2021 to allow adequate data collection to be completed.

The underlying data that supports a number of the performance metrics can also be found in the 2019 Annual Report Appendix 1.

The next section provides the accompanying details behind the performance metrics. As noted above, the results of these metrics and supporting analysis will be provided by Guidehouse in the Evaluation Reports to be filed in Q3 2020 and Q3 2021. The following matrix has been provided to summarize the relationship between each performance metric and its associated investment category.

	Investment Category					
Metric	**M&C**	**DA**	**VVO**	**ADMS**	**Comms**	**ALF**
Volt Var Optimization (VVO) Baseline			X			
VVO Energy Savings			X			
VVO Peak Load Impact			X			
VVO Distribution Losses w/o AMF (Baseline)			X			
VVO Power Factor			X			
VVO – Energy and GHG Impact			X			
VVO Related Voltage Complaints Performance Metric and Baseline			X			
Increase in Substations with DMS Power Flow and Control Capabilities				X		
Control Functions Implemented by Circuit (VVO, Auto Reconfiguration)				X		
Numbers of Customers that benefit from GMP funded Distribution Automation Devices		X				
Reliability-Focused Grid Modernization Investments' Effect on Outage Durations	X	X				
Reliability-Focused Grid Modernization Investments' Effect on Outage Frequency	X	X				
Advanced Load Flow - Percent Milestone Completion						X
Eversource Customer Outage Metric (Average Zone Size)		X				

1.1 VOLT VAR OPTIMIZATION AND CONSERVATION VOLTAGE REDUCTION BASELINE

Volt VAR Optimization and Conservation Voltage Reduction ("VVO/CVR") is a solution that reduces energy consumption and demand without the need for customer interaction or participation. The core principle behind VVO/CVR is that load is more optimally utilized at lower voltages. The primary focus of VVO/CVR is to reduce circuit demand and energy consumption by flattening and lowering voltage profile on the circuit while maintaining customer service voltage standards. In addition, VVO/CVR systems allow for more gradual and responsive control of reactive power devices, such as capacitors, which will help improve the overall system power factor and reduce system losses. VVO/CVR allows customers to realize lower consumption without experiencing a reduction on the level of comfort and service.

Quantifying the exact impact of VVO/CVR is difficult to achieve given the Companies' current level of visibility into their systems. In a VVO/CVR system, the Companies will not have visibility into exactly what customer loads are being impacted, nor will they be able to identify the impact of the VVO/CVR system at any specific point in time. In order to have this level of visibility, the Companies would need to have interval metering at each residential customer's premises. At this time, none of the Companies have this level of residential metering. The metrics discussed below are all based on a measurement and verification ("M&V") process, which uses a statistical process to quantify the impact the VVO/CVR system has on the customers it serves.

1.1.1 Type of Metric

Statewide Performance Metric

1.1.2 Objective

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.

1.1.3 Assumptions

VVO dynamically controls and coordinates multiple devices to manage both voltage and reactive power. System-wide efficiency is achieved by simultaneously coordinating operations using continuous measurements from multiple sensors distributed across the circuit.

Once a circuit has VVO enabled, a M&V process will be performed through operating VVO using a predetermined time period and series. Based on the results of this M&V process, a circuit level VVO impact and baseline will be created.

1.1.4 Calculation Approach

The following data will be tracked and reported on a substation and circuit basis:

a. Determine circuit loads through measurements during on/off periods
b. Apply temperature corrections.
c. Develop load profiles.

As part of the baseline data capture, each VVO circuit will capture hourly circuit data for real and reactive power.

Time	P (kW)	Q (kVAR)
1:00 AM	4298	1949
2:00 AM	4061	1542
3:00 AM	3284	1574
4:00 AM	3408	1277
5:00 AM	2896	1519
6:00 AM	2900	1200
7:00 AM	3185	1388
8:00 AM	3103	1476
9:00 AM	4006	1868
10:00 AM	3817	1884
11:00 AM	4351	1997
12:00 PM	4635	2323
1:00 PM	5129	2390
2:00 PM	5213	2673
3:00 PM	5517	2677
4:00 PM	5378	2478
5:00 PM	5400	2855
6:00 PM	5658	2986
7:00 PM	5720	2638
8:00 PM	5643	2922
9:00 PM	5290	2664
10:00 PM	5346	2628
11:00 PM	5019	2496
12:00 AM	4801	2667

1.1.5 Organization of Results

This information will be provided for each VVO enabled circuit and serve as the baseline variable for calculating demand reductions or serve as variables for other calculations, such as reductions in GHG emissions. This calculation will be performed once and will support both circuit and system level impacts.

1.1.6 Baseline

The baseline will be calculated through M&V after each circuit and/or substation is placed into service. The Company recommends that each VVO/CVR circuit undergo a three to six-month M&V process, the results of which will be used to estimate the impact the system has on system load for the next five-years. At the end of five years, the M&V would be repeated to ensure that each Company is using recent and relevant results for metric reporting. Baselines will be reported during the first Annual Report following the field verification.

1.2 VVO ENERGY SAVINGS

1.2.1 Type of Metric

Statewide Performance Metric

1.2.2 Objective

Quantify the energy savings achieved by VVO using the baseline established for the circuit against the annual circuit load with the intent of optimizing system performance.

1.2.3 Assumptions

Once a circuit has VVO enabled, a M&V process will be performed through operating VVO using a predetermined time period and series. Based on the results of this M&V process, a circuit level VVO impact and baseline will be created.

1.2.4 Calculation Approach

The following data will be tracked and reported upon on a substation and circuit basis:

a. Annual energy delivered in kilowatt hours ("kWh") for 2015, 2016, and 2017.

Energy Savings will be represented by the net impact of VVO using the baseline established for the circuit against the annual circuit load.

1.2.5 Organization of Results

This information will be provided for each VVO enabled circuit and serve as the baseline variable for calculating demand reductions or serve as variables for other calculations. This will be performed annually, and support both circuit and system level impacts.

1.2.6 Baseline

VVO-related pre-investment baseline of energy delivered in kilowatt hours ("kWh") will be provided for each feeder and substation within the service territory for the years 2015, 2016, and 2017 to the extent that historical metering data are available. For feeders where such data are currently not available, the Companies shall estimate the VVO-related pre-investment baseline of annual energy delivered in kWh and identify these feeders with estimates until the necessary metering in installed.

1.3 VVO PEAK LOAD IMPACT

1.3.1 Type of Metric

Statewide Performance Metric

1.3.2 Objective

This metric is designed to quantify the peak demand impact VVO/CVR has on the system with the intent of optimizing system demand.

1.3.3 Assumptions

For this metric, the Companies will utilize active circuit M&V peak demand reduction results from individual circuits. No M&V results older than five years will be used.

1.3.4 Calculation Approach

This metric will use the following data:

- Circuit level M&V estimated hourly demand reduction
- Circuit level hourly on/off VVO/CVR Status
- Circuit level hourly peak demand
- System Level yearly peak time

Each Company will apply the corresponding M&V estimated hourly demand reduction on all circuits with active VVO/CVR for the appropriate peak hour. As some circuits have different peak times, using the appropriate demand estimated reduction for the correct hour is important. This will result in a single (GW) estimated demand reduction attributed to VVO/CVR for each Company. Each Company's individual demand reduction attributed to VVO/CVR will be aggregated, resulting in the statewide estimated reduction.

1.3.5 Organization of Results

Each Company will provide individual circuit VVO/CVR performance, GWs estimated demand reduction, as well as the summation of total system impact.

1.3.6 Baseline

VVO-related pre-investment baseline of annual peak load in million-volt ampere ("MVA") will be provided for each feeder and substation within the service territory for the years 2015, 2016, and 2017.

1.4 VVO – DISTRIBUTION LOSSES WITHOUT AMF (BASELINE)

1.4.1 Type of Metric

Statewide Performance Metric

1.4.2 Objective

VVO reduces circuit demand by flattening and lowering circuit voltages, primarily by using voltage regulators. At the same time, VVO actively controls capacitor banks to maintain circuit power factors near unity. This distribution automation project will implement better voltage

regulation to improve power quality and reduce losses. This includes the coordinated operation of a voltage regulator with a transformer load-tap changer at a substation.

Electrical loss in the circuit can be investigated using the difference between power provided by the circuit regulator and the total power delivered to the consumer loads. This impact metric presents the difference between circuit load measured at the substation via the SCADA system and the metered load measured both at the substation and at line devices capable of capturing load over the necessary intervals.

1.4.3 Assumptions

There are many elements that contribute to differences between circuit load data and the hourly measurements. These factors include:
• Unmetered load, such as street lights
• Electricity theft
• Circuit line losses

1.4.4 Calculation Approach

Using hourly data for real and reactive power, one can determine hourly line losses. This represents both technical and non-technical, e.g., theft, losses.

1.4.5 Organization of Results

This information will be provided on an annual basis for VVO enabled circuits. Results will be based upon the results at the end of each calendar year.

1.4.6 Baseline

The baseline for line losses will need to be developed once the circuit is enabled and the data is captured. The baseline for this metric will be reported in the first annual report after the M&V is completed.

1.5 VVO POWER FACTOR

1.5.1 Type of Metric

Statewide Performance Metric

1.5.2 Objective

VVO reduces circuit demand by flattening and lowering circuit voltages, primarily by using voltage regulators. Simultaneously, VVO actively controls capacitor banks to maintain circuit power factors near unity. Power factor is an indication of how efficiently the distribution system is delivering power. A distribution system operating at unity power factor delivers real power more efficiently than one operating at either a leading or lagging power factor. This performance metric seeks to quantify the improvement that VVO/CVR is providing. However,

power factor alone is not sufficient to accurately describe the impact VVO/CVR has on the system. At low demand levels, a poor power factor is not as significant than at high demand levels. Therefore, some qualifications must be made to accurately track power factor.

1.5.3 Assumptions

Performance will be based on circuit level hourly power quality measurements at the substation.

1.5.4 Calculation Approach

This metric will use the following data:

- Circuit level hourly Power Factor
- Circuit level hourly on/off VVO/CVR Status
- Circuit level hourly peak demand

For this performance metric, only power factors corresponding to greater than 75 percent of a circuit's peak annual demand will be used. This qualified data will then be averaged to provide a circuit by circuit power factor performance metric. These averages will then be used to generate a system power factor performance, weighted by the peak demand of each respective circuit.

1.5.5 Organization of Result

The results of this metric will be reported in a tabular format on a circuit by circuit basis and a total system tally. Power factor is a dimensionless metric.

1.5.6 Baseline

The baseline will be measured with VVO disabled and then again with VVO enabled to develop a baseline. The baseline for this metric will be reported in the first Annual Grid Modernization Report after the M&V is completed.

1.6 VVO ESTIMATED VVO/CVR ENERGY AND GHG IMPACT

1.6.1 Type of Metric

Statewide Performance Metric

1.6.2 Objective

This metric is designed to quantify the overall GHG impact VVO/CVR has on the system. A GHG reduction estimate will be derived from the circuit level energy savings.

1.6.3 Assumptions

For this metric, each Company will utilize active circuit M&V energy reduction results from individual circuits. No M&V results older than five years will be used. To calculate GHG

reductions, each Company will use GHG emissions factors consistent with those used in the 2019-2021 Three-Year Energy Efficiency Plans for displaced GHG.

1.6.4 Calculation Approach

This metric will use the following data:

- Circuit level M&V estimated Energy Reduction
- Circuit level hourly on/off VVO/CVR Status
- Circuit level hourly energy
- GHG emissions factors consistent with those used in the 2019-2021 Three-Year Energy Efficiency Plans

Each Company will accumulate all hours with active VVO/CVR and use the respective M&V energy reduction estimate, applied against the hourly demand. This will result in a single (GWhr) estimated energy reduction attributed to VVO/CVR for each Company, and, when combined with other companies, statewide.

CO2 avoided due to VVO/CVR will be calculated by multiplying the above energy reduction by a typical generation emissions factor based upon metric tons per MWh.

$$CO_2\ Emissions(tons) = Energy\ Savings(MWh) \times CO_2\ Emissions\ Factor\left(tons/MWh\right)$$

The calculation will use the GHG emissions factors consistent with those used in the most recent version (currently 2019-2021) Three-Year Energy Efficiency Plans.

1.6.5 Organization of Results

Each Company will provide individual circuit VVO/CVR performance, GWhrs estimated energy reduction, as well as the summation of total system impact.

1.6.6 Baseline

The baseline for this metric will be reported in the first Annual Grid Modernization Report after the M&V is completed.

1.7 INCREASE IN SUBSTATIONS WITH DISTRIBUTION MANAGEMENT SYSTEM ("DMS") POWER FLOW AND CONTROL CAPABILITIES

1.7.1 Type

Statewide Performance Metric

1.7.2 Objective

This metric will demonstrate the progress in the Advanced Distribution Management System ("ADMS") investment by tracking the substations that have been equipped with power flow

capabilities as well as the number of customers benefitting from the technology on each feeder. This metric will support the objective of optimizing system performance and more specifically improve asset utilization, improve reliability and integrate distributed energy resources. ADMS gives system operators increased visibility on the real time output of generating facilities. This metric is designed to demonstrate that the model is an accurate representation of field conditions.

1.7.3 Assumptions

A substation will be assumed to have DMS power flow capability when all feeders are modeled daily with no unwarranted voltage or capacity violations over a consecutive 30-day period.

1.7.4 Calculation Approach

This metric will track and report on the following:
From the time that a substation model is available on a daily basis, for each substation, number of voltage or capacity violations for a consecutive 30-day period, with explanation of any warranted voltage or capacity violations.

In addition, the Companies will report on the number of customers on each feeder benefitting from this technology.

1.7.5 Organization of Results

This information will be provided on an annual basis. Results will be based upon the results at the end of the calendar year.

1.7.6 Baseline

The baseline for this metric will start at zero since no feeders have been equipped with this technology. A chart with the total number of feeders installed each year along with a detailed report supporting the chart will be provided to support the tracking of this metric.

1.8 CONTROL FUNCTIONS IMPLEMENTED BY CIRCUIT (VVO, AUTO RECONFIGURATION)

1.8.1 Type

Statewide Performance Metric

1.8.2 Objective

This metric will show the progress in the ADMS investment by tracking the control functions implemented at the circuit level as well as the number of customers affected by the technology on each feeder. This metric will support the objective of optimizing system performance and more specifically minimize electrical losses and improve reliability.

1.8.3 Assumptions

A control function will be defined as the ability for the DMS to automatically issue command to field devices based on real time system condition, and a circuit will be included in this metric when all devices defined as "fully automated" can be automatically controlled.

1.8.4 Calculation Approach

This metric will track and report on the following:

- Circuits with control function implemented
- Type of control function implemented

In addition, the Companies will report on the number of customers on each feeder affected by this technology.

1.8.5 Organization of Results

This information will be provided on an annual basis. Results will be based upon the results at the end of the calendar year.

1.8.6 Baseline

The baseline for this metric will start at zero since the specific control functions laid out as part of the Companies' respective GMPs have never been deployed. A table outlining the details behind the control functions implemented at the circuit level will be provided to support the tracking of this metric.

1.9 NUMBERS OF CUSTOMERS THAT BENEFIT FROM GMP FUNDED DISTRIBUTION AUTOMATION DEVICES

1.9.1 Type

Statewide Performance Metric

1.9.2 Objective

This metric will show the progress in the Distribution Automation ("DA") investment by tracking the numbers of customers that have benefitted from the installation of DA devices. This metric will support the objective of optimizing system performance and more specifically reduce the duration and number of customers impacted by outage events. These investments will also allow for a reduction in manual switching operations, reduce operations cost and potentially defer capital upgrades with enhanced flexibility to shift load.

1.9.3 Assumptions

A customer will benefit from DA when their automated zone size is reduced.

1.9.4 Calculation Approach

This metric will track and report on the following:

Circuit number
Number of customers impacted

1.9.5 Organization of Results

This information will be provided on an annual basis. Results will be based upon the results at the end of the calendar year.

1.9.6 Baseline

The baseline for this metric will start at zero since this will be tracking only the customers that benefit from GMP investments. A table with the type of device, circuit number where installed and number of customers benefitted will be provided to support the tracking of this metric.

1.10 RELIABILITY-FOCUSED GRID MODERNIZATION INVESTMENTS' EFFECT ON OUTAGE DURATIONS

1.10.1 Type

Statewide Performance Metric

1.10.2 Objective

This metric will compare the experience of customers on GMP DA-enabled circuits as compared to the prior three-year average for the same circuit. This metric will provide insight into how DA can reduce the duration of outages.

1.10.3 Assumptions

Outages and their impact are typically situational in nature. The DA solutions must be capable of performing intended actions in under the one-minute threshold set by the Department. There may be circumstances where more complex FLISR schemes may take longer than one minute, but less than five, to properly locate, isolate and restore an impacted area safely. The circuit must have three years of System Average Interruption Duration Index ("SAIDI") history to be included in the metric. Additionally, numerous factors, such as a Company's tree trimming cycle, weather and vehicular accidents, can impact system reliability, regardless of a Company's grid modernization investments.

1.10.4 Calculation Approach

This metric will track and report on the following:

- Circuit level SAIDI for circuits that have DA enabled in the GMP plan year
- Three-year average circuit level SAIDI covering the years 2015, 2016, and 2017
- Compare the current year circuit SAIDI with the three-year historic average SAIDI of the circuit

AVERAGE ('CKAIDI 2015'+' CKAIDI 2016'+' CKAIDI 2017') - 'CKAIDI Year n' = if greater than 0, positive impact.

1.10.5 Organization of Results

This information will be provided on an annual basis. Results will be based upon the results at the end of the calendar year.

1.10.6 Baseline

The pre-investment baseline of a static three-year average circuit level SAIDI in 2015, 2016, and 2017 shall be provided for each feeder within the service territory. Additionally, the baseline shall be provided with and without Excludable Major Events[8] along with a summary of the main causes of outages on each feeder. The metric will use the circuit three-year SAIDI covering the years 2015-2017 average as the baseline. It will compare the SAIDI results of the plan year to the circuit's 2015-2017 three-year historic average.

1.11 RELIABILITY-FOCUSED GRID MODERNIZATION INVESTMENTS' EFFECT ON OUTAGE FREQUENCY

1.11.1 Type

Statewide Performance Metric

1.11.2 Objective

This metric will compare the experience of customers on DA-enabled circuits as compared to the prior three-year average for the same circuit. This metric will provide insight into how DA can reduce the frequency of outages.

1.11.3 Assumptions

Outages and their impact are typically situational in nature. The DA solutions must be capable of performing intended actions in under the one-minute threshold set by the Department. There may be circumstances where more complex FLISR schemes may take longer than one minute, but less than five, to properly locate, isolate and restore an impacted area safely. The circuit must have three years of SAIFI history to be included in the metric.

1.11.4 Calculation Approach

This metric will track and report on the following:

[8] The Department has defined an "Excludable Major Event" as a major interruption event that meets one of the three following criteria: (1) the event is caused by earthquake, fire or storm of sufficient intensity to give rise to a state of emergency proclaimed by the Governor (as provided under the Massachusetts Civil Defense Act); (2) any other event that causes an unplanned interruption of service to fifteen percent or more of an Electric Company's total customers in its entire service territory; or (3) the event was a result of the failure of another company's transmission or power supply system. D.P.U. 12-120-D, §I.B (2015). An interruption event caused by extreme temperature condition is not an Excludable Major Event. Id.

- Circuit level SAIFI for circuits that have DA enabled in the GMP plan year
- Three-year average circuit level System Average Interruption Frequency Index ("SAIFI") covering the years 2015, 2016, and 2017
- Compare the current year circuit SAIFI with the three-year historic average SAIFI of that circuit

AVERAGE ('CKAIFI 2015'+' CKAIFI 2016'+' CKAIFI 2017') - 'CKAIFI Year n' = if greater than 0, positive impact.

1.11.5 Organization of Results

This information will be provided on an annual basis. Results will be based upon the results at the end of the calendar year.

1.11.6 Baseline

The pre-investment baseline of a static three-year average circuit level SAIFI in 2015, 2016, and 2017 shall be provided for each feeder within the service territory. Additionally, the baseline shall be provided with and without Excludable Major Events along with a summary of the main causes of outages on each feeder. The metric will use the circuit three-year SAIFI average covering the years 2015-2017 as the baseline for this metric. It will compare the SAIFI results of the GMP plan year to the circuit's 2015-2017 three-year historic average.

1.11.6 VVO RELATED VOLTAGE COMPLAINTS PERFORMANCE METRIC AND BASELINE

1.11.7 Type of Metric

Statewide Performance Metric

1.11.8 Objective

The primary focus of the VVO investments is to manage circuit voltages at a lower threshold while maintaining minimum voltage service requirements for all customers on a substation and circuit. Since VVO will be actively managing voltages, there is a desire to track and report on the potential for the introduction of VVO-related voltage complaints. While VVO is not an active solution in use by the Companies today in Massachusetts, there may be historical low voltage causes that exist outside of a customer's service connection and equipment. Certain voltage issues, such as those that are ultimately determined to have been caused by customer-owned equipment, will not be mitigated by the Companies' VVO investments. The Companies will measure the change in voltage complaints following deployment of VVO technology to determine the impact relative to a pre-deployment baseline.

1.11.9 Assumptions

Prior to the requirement to track and report on whether VVO investments could potentially contribute to customer voltage complaints, there was never a need for the Companies to track

customer voltage complaints in this manner. For instance, in some cases large commercial and industrial ("C&I") customers' voltage complaints were processed through their customer account executives and were not necessarily logged in the Companies' work management systems: thus, there is no data as to the cause of the voltage issue that gave rise to the complaint. While residential customer voltage complaints were logged in the respective systems, given that VVO is a new investment the Companies cannot reasonably associate these historical complaints as being caused or impacted by VVO investments. In an effort to develop a baseline for this metric, the Companies must manually review the available records to determine the cause and remedy of the voltage issue that led to the customer complaint.

Going forward, the Companies intend to specifically track customer voltage complaints to determine if VVO investments led to the voltage condition giving rise to the customer complaint. Eversource currently has a tracking and reporting process in its Western Massachusetts ("WMA") service territory that enables it to capture and categorize the necessary data related to these voltage complaints. Eversource will expand this process into its Eastern Massachusetts ("EMA") service territory in the near-term to ensure that all relevant data related to the impact of VVO investments on customer voltage complaints is tracked and reported. Unitil currently tracks customer voltage complaints in its Customer Information System ("CIS") and plans to revise the system coding to better capture the data necessary to determine if a voltage issue was impacted by VVO investments. National Grid is currently exploring system and process improvements and enhancements to ensure it is able to track the necessary data on these customer complaints.

Given the lack of consistent and comprehensive data as to whether a customer's voltage complaint was influenced by VVO investments, the Companies propose to utilize all customer voltage complaints received in 2015, 2016 and 2017 to develop the baseline for this performance metric. Additionally, since the compilation of the voltage complaints is a significant manual process, the Companies propose, for the 2018-2020 GMPs, to utilize the following circuits to establish the initial baseline for this performance metric.

Eversource – In its 2018-2020 GMP plans, Eversource will deploy VVO on circuits in Western MA. As previously mentioned, there was a voltage complaint tracking system in Western MA so Eversource will establish a baseline based on the information included in the Western MA tracking system and report on the Western MA performance. There are no VVO investments planned in Eastern MA during 2018-2020. Eversource will incorporate Eastern MA in its baseline, tracking and reporting process in 2021 for the next three-year GMP (2021-2023).

Unitil – Under its approved GMP, Unitil intends to install VVO investments on all of the circuits in its service territory. For this performance metric, Unitil proposes to utilize all of its circuits in establishing the baseline

National Grid – National Grid proposes, as an initial baseline, to use the 16 feeders on which it intends to install VVO investments under its 2018-2021 GMP. National Grid is targeting larger circuits in its service territory, that serve approximately 1000 customers or more. National Grid will, following its development and implementation of system and process improvements and enhancements to track these customer complaints and the relevant data, incorporate the remainder of the circuits in its service territory into the baseline for this performance metric for the 2021-2023 GMP.

Eversource and National Grid propose to update the baseline for this metric with respect to the 2021-2023 GMPs to include all circuits within their respective service territories.

1.11.10 Calculation Approach

This metric will track and report on the following:

- Quantity of voltage complaints for the current year that are deemed caused by VVO voltage management by circuit for circuits that will have VVO installed.
- Three-year average of all voltage complaints by circuit covering the years 2015, 2016, and 2017
- Compare the current year quantity of voltage complaints with the three-year historic average

AVERAGE ('Voltage Complaints 2015'+ 'Voltage Complaints 2016' + 'Voltage Complaints 2017') = Voltage Complaint Baseline

1.11.11 Organization of Result

The baseline voltage complaints and the annual VVO-related voltage complaints (once VVO investments are active and enabled) will be provided on an annual basis for each circuit. Results will be based upon the results at the end of the calendar year. This will provide the Department an opportunity to assess the effectiveness of the VVO investments while minimizing the introduction of new customer impact.

1.11.12 Baseline

Utilizing the assumptions discussed above, the Companies will calculate the 2015 through 2017 baseline to use to measure process under this metric. Given the manual and time-consuming nature of the process to review and compile the customer complaint data, the Companies have determined that this process can be undertaken and completed by June 28, 2019 for incorporation into the Companies' respective 2018 Annual Grid Modernization Reports.

1.11.13 EVERSOURCE ADVANCED LOAD FLOW – PERCENT MILESTONE COMPLETION

1.11.14 Type of Metric

Eversource-specific Performance Metric

1.11.15 Objective

The metric is designed to demonstrate progress towards the final completion of a fully automated modelling tool. The metric will measure percent completion relative to a final deliverable of a fully automated load flow tool used by Eversource engineers and system operators to perform multi-circuit analysis for all non-network circuits.

1.11.16 Assumptions

Demonstration of progress will be measured by assessment of achieved functionality. Models and capabilities will continue to improve in functionality and accuracy with further refinements in a process of continuous improvement of modeling tools.

1.11.17 Calculation Approach

Under this metric, the percent completion will be determined based on the demonstrated progress with respect to the following milestone targets:

Static Analysis: Ability to analyze results at an individual circuit level - for new load, for Distributed Generation ("DG") pre-application screening, fault analysis, high/low voltage complaint investigations.

Semi-Automatic 1: Ability to run basic analysis in an automated process at an individual circuit level – for new load, DG pre-application screening, fault analysis, high/low voltage complaint investigations

Semi-Automatic 2: Added capability to automatically run processes on groups of circuits – advanced DG impact studies, including contingencies and alternate source analysis.

Fully Automated: Capability to automatically run processes on all circuits, storing results in a database that can be used by engineering and operations, as well as for customer facing information tools like hosting capacity maps.

1.11.18 Organization of Results

Results will be organized by percent of feeders meeting each milestone target.

1.11.19 Baseline

The baseline is estimated at 40 percent of circuits meeting the Static Automation milestone and 10 percent of feeders meeting the Semi-Automatic 1 metric. Baseline for Static Automation 2 and Fully Automated are each 0 percent.

1.12 EVERSOURCE CUSTOMER OUTAGE METRIC

1.12.1 Objective

This metric is intended to measure progress in sectionalizing circuits into protective zones designed to limit outages to customers located within the zone. This metric will measure progress in achieving the grid modernization objective of reducing the impact of outages.

1.12.2 Assumptions

A protective zone is defined as the portion of a circuit or circuits that would be isolated by automated backbone devices that will operate automatically to minimize the number of customers affected in the event of an outage.

1.12.3 Calculation Approach

For each circuit and for the sum of circuits in eastern and western MA, the metric will track and report on the average zone size in terms of number of customers interconnected in each protective zone.

1.12.4 Organization of Results

This information will be provided on an annual basis. Results will be based upon the results at the end of the calendar year.

1.12.5 Baseline

The Company will provide the average zone size by circuit as of the end of 2017 as the baseline for this metric.

B. Lessons Learned/Challenges and Successes

Given that the reported performance metrics data is in the early stages, comparative analysis is not yet available to make a determination as to the efficacy of the GMP investments toward their objectives.

C. Hosting Capacity Analysis Update

The Advanced Load Flow ("ALF") component of the Eversource GMP, which is a key enabler of future detailed Hosting Capacity ("HC") maps, is proceeding on schedule, improving the automation capability to produce detailed distribution circuit models. This effort will enable

the creation of the HC maps during the early stages of the 2021-2023 GMP. Creating those maps will involve some additional model improvement (to achieve full automation capability) as well as the coding and automation within the load flow software and associated results database to produce the customer-facing maps.

In the meantime, Eversource has produced initial Hosting Capacity Maps, available via the Company website, providing a circuit level capacity value. This first step has not only provided some basic information to the public but has also given the Company some experience in HC map presentation options. Feedback from this tool will provide valuable input to the more detailed and robust maps to be developed in the next GMP.

VII. Research, Design and Development

In D.P.U. 12-76-B, the Department directed the Distribution Companies, as part of their GMPs, to propose research, design and development ("RD&D") projects that focus on the testing, piloting, and deployment of new and emerging technologies to meet their grid modernization objectives. D.P.U. 12-76-B at 27-30. As part of its GMP, Eversource filed an RD&D proposal to undertake projects in the following areas: (1) sensing and monitoring; (2) advanced analytics; (3) real-time flexible action and dynamic integration of distributed energy resources; (4) impact of grid modernization technologies on low income customers; (5) pricing options; (6) customer engagement and behavioral response; and (7) microgrids. D.P.U. 15-122, at 44.

Ultimately, the Department did not approve the Company's proposed RD&D projects, nor did it approve the proposals filed by National Grid and Unitil. Id. at 185. The Department indicated that any future RD&D proposals incorporated into future GMPs would be reviewed consistent with the standards developed by the Department in light of RD&D proposals made in other contexts. Id. at 185, citing D.P.U. 17-05, at 457-460; NSTAR Electric Company and Western Massachusetts Electric Company, D.P.U. 16-178, at 26, 29-30 (2017); Fitchburg Gas and Electric Light Company, D.P.U. 16-184, at 11 (2017). In reaching its decision, the Department emphasized that any future RD&D proposals contained in future GMPs should be the result of collaboration between the Distribution Companies and other stakeholders. Id.

Consistent with the Department's decision in D.P.U. 15-122, the Company is not undertaking any RD&D efforts as part of its 2018-2020 GMP. The Company will, in developing any future RD&D proposals, collaborate with National Grid and Unitil, as well as relevant stakeholders, prior to filing any proposal with the Department for its review and approval.

VIII. Energy Storage

This Section discusses activity to-date on Eversource's two battery energy storage ("BES") projects following the Department's final decision in the Company's rate case, D.P.U. 17-05.

A. Outer Cape BES

Overview

The Outer Cape BES project will be constructed as a 24.9 MW / 38 MWh lithium ion battery system, located on approximately 1.4 acres at the Provincetown transfer station on land leased from the Town of Provincetown.

The primary purpose of the Outer Cape BES project is to provide back-up power during outages on Line 96, which is a single, three-phase distribution line that serves as many as 11,000 customers from the Towns of Wellfleet, Truro, North Truro and Provincetown.

Line 96 starts at Wellfleet substation and extends along Route 6 going east to the tip of Provincetown. Due to its proximity to harsh Atlantic winds and weather conditions, Line 96 has poor reliability statistics, which made it an appropriate candidate for the BES project and the reliability improvements it is anticipated to provide to customers. In fact, customers on Line 96 and all tapped circuits and low voltage stations in Wellfleet, Truro, and Provincetown have experienced over 137,756 customer outage hours over the last five years. This is an average of 27,551 per year from 2015-2019. Since the beginning of 2019 there have been two events on Line 96 for which the BES would have avoided a total of 14,600 sustained customer outages.

One solution to improve this significant reliability issue for the Company's customers on Line 96 would be to build a 13-mile redundant distribution line. This line would require construction through a significant portion of the Cape Cod National Seashore, which would generate potential environmental impacts.

The Eversource engineering team identified this area as a key target for a BES project. This recommendation was confirmed by Eversource's expert consultant, Doosan, in its preliminary feasibility analysis. The Department approved the Company's BES project proposal in D.P.U. 17-05, with a projected cost of $40 million.

Design, Site Selection, and Outreach Activity

At the time of the preliminary feasibility analysis, Eversource expected to construct the BES project in Wellfleet, Massachusetts. However, Eversource and its experts confirmed as part of the final feasibility analysis that siting the BES project as close to the tip of Provincetown as possible would be the optimal solution to maximize potential benefits for customers on the Outer Cape.

Eversource now estimates that, during times when loading is at lower levels (particularly in the non-summer months), the BES project could provide back-up power for up to 10 hours. This is a duration that would cover most outages. Eversource further estimates that, during summer peak

loads, the BES project will provide between 1.5 to 3 hours of back-up power depending on the precise location of the outage.

In January 2018, Eversource met with the Town of Provincetown (the "Town") to discuss the purpose of the BES project and to inquire whether there were any Town-owned locations on which Eversource could site the BES project. Eversource also examined privately-owned potential sites in the Town and North Truro but found no viable candidates.

The Town was a strong partner from the start. Starting in April 2018, the Town worked with the Eversource team to evaluate three potential sites. The sites were evaluated based on a set of criteria that would assure the BES project would be situated so as to: (1) minimize the visibility of the BES project for aesthetic purposes; (2) involve minimal sound impacts to surrounding properties from the BES project; (3) have approximately an acre and a half of space with limited or no environmental impact (i.e., no wetlands, rare species habitat); (4) enable an optimal electrical connection to the distribution system; and (5) be supported by the Town's residents and leadership.

Based on these criteria, one site proved infeasible due to lack of space and an environmental issue. A second site presented with potential visibility from a bike path. A third, on the Town Transfer Station, met all the criteria.

Accordingly, with the Town's support, Eversource began a permitting-level design of the BES project with its expert consultant, TRC, in the late summer of 2018. A permitting-level design means that the first 30 percent of the project is designed, enabling Eversource to commence permitting and to solicit competitive bids through a request for proposals ("RFP") process for engineering and construction services (more detail on this process is provided below).

During this time, Eversource continued extensive outreach with the Town leadership and its various departments. This included many face-to-face meetings and two publicly televised presentations to the Provincetown Select Board, which provided vital feedback and guidance on how to make the BES project the best possible project for Provincetown and its residents. The Town indicated the BES project would need to be constructed and housed in a building rather than in a container solution to conform to the Town's aesthetic requirements and meet Town bylaw building height requirements. Eversource appreciated the collaboration with the Town. This construction standard was included as a new requirement in this part of the project-development phase.

The Town voted at its October 2018 Town Meeting to amend its zoning by-laws to make the project a permitted, special use at the Transfer Station. On April 2, 2019, Eversource appeared before more than 300 residents at the Town's Annual Meeting to request approval to lease 1.4 acres of Town-owned land at the Transfer Station to construct the BES project. The warrant was presented by Town leadership and Eversource was called to the floor to answer multiple questions from Town residents about the BES project. Provincetown residents voted unanimously to authorize the Town to enter into a long-term lease with Eversource to construct the BES project at the Transfer Station. The lease to utilize the Transfer Station has been completed with the first payment to support the project made in March 2020. The Town's cooperation was invaluable in the timely and cost-effective deployment of the BES project.

Permitting

The Outer Cape BES project permitting process is substantially complete. Local permits were secured from the Provincetown Planning Board, Zoning Board, Select Board and Conservation Commission. Permits were also secured from the Department of Transportation Highway Permit and the National Heritage & Endangered Species Program. Eversource has also secured a Landfill Post-Closure Minor Modification Permit.

B. Martha's Vineyard BES

Overview

The Martha's Vineyard BES project will be a 4.9 MW / 20 MWh lithium ion battery located on just over an acre of Eversource-owned land adjacent to its Area Work Center in Oak Bluffs.

The primary purpose of the Martha's Vineyard BES project is to significantly reduce reliance on five diesel-fired peaking generators on Martha's Vineyard that are used to supply power to the Island during high load conditions.

Martha's Vineyard is served by four undersea cables that connect into the mainland at Falmouth. The year-round population on the Island is around 15,000 but increases to approximately 125,000 residents in the summer. This causes electricity use on the Island to surge and the undersea cables become strained. When this happens, Eversource relies on five diesel-fired peaking units, providing approximately 12.5 MW of supplemental power. These units were constructed in the 1950s.

Eversource engineers identified Martha's Vineyard as a potential BES location due to the potential for the BES to significantly reduce reliance on the diesel-fired peaking generators, as well as to enable the interconnection of additional solar photovoltaics ("PV") on the Island (see DP.U. 15-122, Eversource response to DPU-ES-2-1). This recommendation was confirmed by Eversource's expert consultant, Doosan, and its preliminary feasibility analysis. The Department approved the Company's BES project proposal in D.P.U. 17-05, with a projected cost of $15 million.

Eversource contemplates the Martha's Vineyard BES project as having two phases. The first phase would reduce reliance on two of the five peaking units. The second phase of the BES project (constructing additional battery capacity) will be evaluated for the feasibility of reducing reliance of all five peaking generators.

Design, Site Selection, and Outreach Activity

Since the issuance of the Department's final decision in D.P.U. 17-05, Eversource and Doosan completed a final feasibility study for the project. This study confirmed that the BES project would also help reduce the impact during an N-1 contingency condition on the Island, potentially deferring the construction of an additional undersea cable. The Eversource team also subsequently confirmed that the BES project could be used to shave yearly and monthly peaks when not needed to reduce reliance on the peaking units, resulting in additional capacity and transmission Regional Network Savings ("RNS") savings.

In January 2018, Eversource commenced outreach to the Town of Oak Bluffs (the "Town") about the project and specific work with the Town began in April 2018. Eversource advised of its intent to construct the BES project on Company-owned land behind its Area Work Center in Oak Bluffs. This location met the Eversource siting criteria by: (1) minimizing the visibility of the BES project for aesthetic purposes; (2) involving minimal sound impacts to surrounding properties from the BES project; (3) offering approximately one acre of space with limited or no environmental impact (i.e., no wetlands, rare species habitat); and (4) enabling an optimal electrical connection to the distribution system. The Town indicated the BES project would need to be constructed and housed in a building rather than a container solution to meet the Town's aesthetic requirements.

Eversource has worked closely with the Town, meeting multiple times in person with Town Select board members, the Town Manager, the Fire Chief and Building Inspector, and the Planning Board. The Town provided feedback on height of the BES facility, roof pitch, fire safety, and other design details that Eversource was able to incorporate into an updated design of the BES project. Using this feedback, in late summer 2018, Eversource performed a permitting-level design for the BES (i.e., 30 percent engineering).

Permitting

Eversource and the Town's leadership spent a significant amount of time working through issues related to a parcel of land not related to the BES project. The Town's bylaws did not authorize the Planning Board to grant Eversource the right to construct the project. Therefore, Eversource filed for a land-use permit (zoning relief) with the Department pursuant to G.L. c. 40-A ("Chapter 40-A"). The Oak Bluffs Planning Board expressed disappointment with this outcome, taking the view that it could have granted a variance.

Eversource filed a Chapter 40-A land-use permit with the Department in late November of 2018. Leading up to the filing, Eversource met multiple times with the Oak Bluffs Fire Chief and Building Inspector and incorporated their input into fire safety and other design aspects. Eversource also conducted abutter outreach and, since filing, has held a public hearing in Oak Bluffs.

Eversource and the Town continued to work together during the initial siting process. In May 2019, Eversource executed a Memorandum of Understanding ("MOU") with the Town where the Town will work collaboratively with Eversource to facilitate progress of the BES project and Eversource will make certain public-health and safety and environmental commitments to assist the Town.

The Company has continued to provide information on the BES project to the Oak Bluffs Planning Board and to obtain substantive feedback, notwithstanding the zoning exemption process. The Company filed a site plan with the Planning Board and gave a presentation in April 2019, seeking recommendations from the Oak Bluffs Planning Board before filing the site plan with the Martha's Vineyard Commission ("MVC"), which is the other required permit approval needed to construct the BES.

Eversource continues to work with the MVC on approvals and anticipates receiving final approval by August 2020. This effort has included coordination with Oak Bluffs Fire Department, as well

as Tisbury and Edgartown Fire Departments. A fire-safety plan and an evacuation plan are being developed in consultation with the three Fire Departments and the MVC. In addition to the fire safety plans, an analysis on groundwater has been completed and submitted to MVC and the Town. All parties have committed to maintaining continuous communication to keep the permitting process moving forward. The Company appreciates the commitment of the Town and its efforts to move the process forward.

C. Competitive Procurement

Eversource used a competitive procurement to select vendors for all aspects of the Outer Cape and Martha's Vineyard BES projects with significant emphasis on the major cost components of the projects. Specifically, Eversource competitively procured: (1) a vendor to perform the engineering, procurement, and construction ("EPC") of the BES project (batteries, inverters, balance of plant); and (2) the civil site work and building construction for both projects. This process was conducted by the Eversource procurement team, which is experienced in negotiation and evaluation of all of Eversource's purchasing contracts.

For the BES project, the process began with a field of over 80 leading BES vendors in Spring 2018. In October 2018, six bidders were short-listed. This selection was based on each vendor's safety record and financial solvency (particularly important given that the BES project will be relatively new technology, serving as a long-lived asset within the distribution system). The Company also considered experience with prior, similar BES projects completed on time and on budget, and engineering and project management expertise. Full and formal bids were received from three of these six vendors. A cross-functional Eversource team exhaustively reviewed and ranked the bids based on cost, technical design, and project plan strength. One vendor, NEC, a local Massachusetts company, rose to the top and Eversource has completed successful negotiations with NEC to construct both BES projects at a cost consistent with budget expectations for both projects, inclusive of ongoing operations and maintenance support. The Company also negotiated the agreement with strong warranties and other performance guarantees.

NEC is responsible for the full design of the BES portion of the projects. For the Outer Cape project, NEC has been released to order long lead material and advance final design work. For Martha's Vineyard, once the BES project receives all permits, Eversource will release NEC to order all equipment and final design work.

For the civil site work and building construction phases of the Martha's Vineyard and Outer Cape BES projects, an RFP was issued to four qualified vendors with established Terms & Conditions in the Eversource procurement program. These vendors all have experience building electrical facilities for Eversource. All four bidders responded to the Provincetown ESS project Civil and Building RFP. Only two vendors responded to the Martha's Vineyard Civil and Building RFP.

The bids received for the civil and building project scope were higher than expected and therefore, the Company reopened the bid to additional vendors in an attempt to lower the pricing and/or validate the bids that were received. The Company's internal engineering and external consulting groups also performed additional reviews and assessed whether any re-engineering would reduce costs. Following this effort, the initial low bidder, one of the few local companies that performed work on the Cape and Martha's Vineyard on a regular basis, provided the lowest revised bid and

best work plan for both the projects. The Company updated its PAF (project authorization form) to move from a conceptual-design estimate to an engineering-design estimate.

The unique site constraints and access challenges associated with relatively remote locations had an impact on project costs, determined only on the basis of the competitive bid process. Also, as the Outer Cape BES project progresses, the Company estimates that the site preparation work and building costs will be higher than expected due to changes after the conceptual-design phase. For example, at both locations, the costs will be higher than estimated due to the municipal requirements to house the BES unit in a building rather than using container housing. Similarly, in relation to site preparation for the Outer Cape BES project, the Company will ultimately remove approximately 18,700 cubic yards of sand and soil at the location and install retaining and sound walls to meet site requirements for the project. Other cost categories are occurring as planned.

D. Lessons Learned/Challenges and Successes

Eversource is immersed in the development of the BES projects and has developed a strong cross-functional team to develop these projects. Lessons learned to date include the following:

First, it is clear that municipal support is a critical aspect of developing BES projects encompassing a variety of stakeholders. Municipal coordination is an iterative process that requires careful attention to inputs. The Company has worked diligently to balance stakeholder input with the core obligation to provide safe and reliable service through the BES projects.

Second, there are unique challenges to permitting and site development for new technology projects, particularly in areas such as Martha's Vineyard and Provincetown where construction of large utility-scale projects on land adjacent to community land is not typical. Although the BES projects were welcomed in these communities, challenges had to be surmounted to progress forward due to the relatively remote locations and geographical attributes.

Third, by their nature, BES projects have to be situated at precise locations to have the beneficial impact associated with installation. This means that the Company will need to have a level of flexibility to made accommodations and adapt the conceptual design to incorporate requests by the hosting municipalities. Without this flexibility to work with, and incorporate input from, the municipalities, these projects will be difficult and challenging to install, rather than becoming easier to site. Detailed engineering and cost estimation can only be completed once there is agreement with a municipality on location and facility housing, among other details.

Fourth, the Company has learned a great deal about sound issues connected to BES. With respect to sound, the batteries require HVAC systems that have some sound impact. To attain the goal of ensuring the batteries will not be audible to the human ear from any surrounding residences or businesses, the Company has now developed plans to include sound walls, shrouds and to house some equipment within the battery building.

Fifth, regarding fire safety, the new NFPA 855 fire code has been issued since the approval of these projects in D.P.U. 17-05, and the Company has had to incur additional costs to construct the BES projects in compliance with the new code requirements. Eversource has consulted with industry experts to ensure the BES projects will immediately disconnect in the event of any trouble warning and will be equipped with the leading BES fire suppression equipment.

Eversource obtained information on a BES fire in Arizona in April 2019. Eversource has requested that its vendor give a complete fire safety analysis of the BES design for both projects; to incorporate lessons learned from Arizona and best practices more generally; and to make any further adjustments needed. Once completed, the Company will provide the Department with the outcome of the analysis.

Lastly, Eversource has identified that implementation of new technologies including BES projects must take into account requirements for complex engineering and design of new solutions such as islanding and advanced distribution automation schemes that require specialized technical input in areas such as protection and control and communications engineering, which will occur through the bid selection process for an engineering, design and construction vendor.

E. Project Costs

Through December 31, 2019, the Company has expended $2,261,529 for the Martha's Vineyard BES project and $2,347,571 for the Outer Cape BES project. The majority of this spending was related to engineering, procurement, siting and permitting efforts on the projects. Actual spend through 2019 is slightly over budget due primarily to the project permitting process.

F. Performance on Implementation/Deployment

Please see sections (A) and (B), above.

G. Description of Benefits Realized from Implementation

Please see sections (A) and (B), above.

H. Key Milestones

Key milestones through commissioning are listed below. The Company anticipates that all construction milestone dates are at risk due to restrictions associated with the Covid-19 pandemic. Delivery dates for the battery system are also at risk given that NEC has issued multiple force majeure warnings regarding implication to contract execution due to the pandemic. As currently estimated, upcoming milestones are:

- Obtain all permits for the Martha's Vineyard project by August 2020. Outer Cape permits are substantially complete as of March 2020.

- Construction on the Outer Cape Project began in March 2020. Martha's Vineyard start of construction is anticipated for September 2020.

- Complete civil and building construction, including battery installation of the Outer Cape BES project by October 2020. Complete construction of the Martha's Vineyard BES project is expected by May 2021.

- Commence operations of the Outer Cape BES project by December 2020. Commence operations of the Martha's Vineyard BES project by July 2021.

I. Updated Projections for Remainder of 2018-2020 GMP

The Company expects that expenditures related to the commencement of construction and the purchase of equipment will begin in the April 2020 timeframe for the Outer Cape project and September 2020 for the Martha's Vineyard project. Costs for the Outer Cape project remain on target relative to the initial, conceptual-level cost estimate of $40 million presented in D.P.U. 17-05. Costs for the Martha's Vineyard project are currently estimated at $22 million as compared to the conceptual-level cost estimate of $15 million, with the differential necessitated by permitting requirements and revised construction costs determined through the competitive bid process for the civil and building portion of the project.

IX. Electric Vehicle Make Ready Program

Introduction

As part of Eversource's proposed Electric Vehicle ("EV") Make Ready program (the "Make Ready Program" or "Program") that was approved by the Department of Public Utilities (the "Department") in D.P.U. 17-05, the Company developed a robust two-part evaluation plan. The first phase, to be completed after the first two years of program implementation, focuses on site host recruitment and operational lessons learned that could be incorporated into the program going forward. Phase 2 will be focused on the analysis of all data captured as a result of these deployments. The Company intends to include a thorough and inclusive analysis of charging station data as part of its Phase 2 evaluation efforts. In preparation for this work, Eversource has engaged with a data analytics vendor to begin aggregating, analyzing, synthesizing, and reporting on this data. Quarterly, data and analyses are being prepared, reviewed and improved on in an iterative process to ensure that a quality final analysis will be available for all stakeholders once the program has been fully deployed. A preliminary data report is explained in Section E and provided as Exhibit 2.

This document, which serves as the Eversource EV Make Ready Phase 1 Evaluation, includes the following sections:

1) Program overview and summary of the work completed to-date;
2) Implementation metrics & site cost analysis;
3) Successes, challenges and lessons learned; and
4) Interim charging data analysis and findings.

A. Description of Work Completed:

Background

On November 30, 2017, the Department approved the Company's proposal to spend up to $45 million over five years on the EV Program. (D.P.U. 17-05, at 475-478, 501.)

Consistent with the Department's findings and directives in D.P.U. 15-122 and D.P.U. 17-05, the Company is providing this report on the Make Ready Program's status and achievements, as well as the lessons learned from the Program in 2019. This Program update contains operational information including: the number of EV charging stations and sites deployed; site host enrollment; number of EV supply equipment tools installed; costs; and deployment in or adjacent to disadvantaged communities. The Company's progress report also provides information and ideas gathered from the Company's targeted outreach with various stakeholders and work with environmental justice ("EJ") communities and stakeholders.

As part of its proposal in D.P.U. 17-05, the Company proposed to track and report on six proposed performance metrics to evaluate the implementation and customer benefits of the Make Ready Program. D.P.U. 17-05, at 474. In D.P.U. 15-122, the Department noted that it would develop performance metrics for the Program through a separate EV metrics stakeholder

process. D.P.U. 15-122, at 187. In the interest of providing the Department and stakeholders with a robust review of the Company's 2019 progress under the Make Ready Program, the Company is providing its progress under the six proposed performance metrics first introduced in D.P.U. 17-05. The specific performance metrics include:

(1) total number of "make ready" sites developed;

(2) ten percent capital invested in direct charging ("DC") fast charging sites;

(3) ten percent capital invested in EJ communities;[9]

(4) utilization of EV charging stations separately for Level II chargers and DC fast chargers (measured in annual kWh per port);

(5) the percentage of Eversource residential customers within the range of an Eversource "make ready" site constructed as part of the EV program (i.e., percentage within 20-mile range and within 40-mile range); and

(6) available data on plug-in EV adoption and CO_2 emissions reductions

Program Overview

Launched in 2018, the Make-Ready Program seeks to help accelerate EV charging infrastructure development within its service territory, encourage EV purchases, and contribute to greenhouse gas ("GHG") emissions reduction in the Commonwealth. The Program is designed to help meet the Commonwealth's goal contained in the Global Warming Solutions Act ("GWSA") and support the campaign of the EEA to encourage zero emissions vehicles ("ZEVs") via a commitment for 300,000 ZEVs registered in Massachusetts by 2025.

The Make-Ready Program's primary component is increased investment in long dwell-time EV charging make-ready infrastructure in public and workplace settings and at multi-unit dwellings ("MUDs"). Under the Program, Eversource invests in infrastructure beyond the meter up to the charging station, specifically for the service panel and the associated conduit and conductor necessary to connect each piece of equipment.

The Make-Ready Program will be run in two phases: Phase I extended from January 1, 2018 through December 31, 2019; and Phase II will extend from January 1, 2020 through December 31, 2022. Over the course of five years, Eversource plans to support the deployment of up to 72 DC fast charging ports at 36 charging sites, and up to 3,500 Level II charging ports at 400

[9] Generally, EJ communities are defined in terms of demographic and socioeconomic characteristics, with certain environmental policy implementation practices aimed at these communities because of race/ethnicity/class-based environmental inequities. The Department directed the Company to select EJ communities that meet two of the following three criteria established by the Massachusetts Executive Office of Energy and Environmental Affairs ("EEA") in Eastern Massachusetts and one of the following in Western Massachusetts: (1) 25 percent or more of the population in the communities must earn 65 percent or less than the Massachusetts median household income; (2) 25 percent of more of the population in the communities must identify as a race other than white; and (3) 25 percent of households lack a person over the age of 14 who speaks only English or speaks English very well.

charging sites, throughout its service territory in Massachusetts. Based on customer demand for the Program, in 2019 Eversource accelerated implementation of the Make-Ready Program.

Eversource will support the deployment of EV charging ports by installing electrical equipment and components necessary to connect EV chargers to its distribution system. Eversource will install the "Eversource-side Infrastructure," and contract with third-party electrical contractors to install behind the meter "Participant-side Infrastructure." Specifically, the EV infrastructure that Eversource is proposing to install and own includes the following: (1) distribution primary lateral service feed; (2) necessary transformer and transformer pad; (3) new service meter; (4) new service panel; and (5) associated conduit and conductor necessary to connect each piece of equipment.

Vendor Prequalification

In the Spring of 2018, Eversource issued a Request for Information / Proposal to begin the process to pre-qualify vendors to participate in the Make-Ready program. This process was undertaken to give EV charging station manufacturers, network integrators, and installers the opportunity to have their equipment and services pre-authorized for inclusion in the Program. Recognizing that new technologies and new vendors may emerge over the duration of the program, Eversource issued a subsequent Request for Proposal in April 2019, to further deepen its bench of partners. A complete listing of these vendors can be found on the program website: https://www.eversource.com/content/ema-c/residential/save-money-energy/explore-alternatives/electric-vehicles/charging-stations/preferred-vendor-list

Being selected indicates that Eversource has reviewed and approved the equipment and services and verified that they meet its specifications and standards, and that the vendors have signed Eversource qualification agreement terms and conditions. Site hosts are welcome to use equipment, installers, or network integrators not selected by Eversource for pre-approval, if those vendors agree to Eversource qualification agreement terms and conditions.

Contractor Qualification

Under the program, Eversource uses third-party electrical contractors for the installation of the "behind the meter" infrastructure. This infrastructure primarily includes the new service panel and enclosure and associated conduit and conductor necessary to connect each piece of equipment.

Eversource chose to use electrical contractors with proven track records already approved by the Company to work on Eversource Energy Efficiency programs. Those contractors include (but are not necessarily limited to):

- Maverick Construction Corporation (Boston, MA)
- J.&M. Brown Company, Inc. (Jamaica Plain, MA)
- Horizon Energy (Taunton, MA)

In 2019, a fourth contractor was added through a response to a Company issued RFP:

- Volta (Boston, MA)

Stakeholder Outreach

Throughout Phase 1 (2018-2019) Eversource presented updates and solicited continual program feedback from multiple stakeholders in the Make-Ready Program. Specifically, the Company met with the Massachusetts Department of Energy Resources ("DOER"); EEA; Department of Transportation; Massachusetts Bay Transportation Authority; Massachusetts Department of Environmental Protection; Environmental Business Council of New England; Sierra Club of Massachusetts; Union of Concerned Scientists; Natural Resources Defense Council; Acadia Center; the Zero Emission Vehicle Commission; Georgetown Climate Center, Green Energy Consumers Alliance; National Grid; Electrify America; Plug-In America; Nissan; General Motors; Tesla; multiple charging station vendors; multiple towns and municipalities in Massachusetts.

In addition to meeting with the various stakeholders identified above, Eversource presented at various forums to help its sight host recruitment and general raise awareness efforts. The Company attended and spoke at quarterly meetings hosted by the Advanced Energy Group to provide regular updates on program status and recent activities, and to solicit and incorporate feedback from the public.

Finally, Eversource maintained close coordination with National Grid through quarterly meetings to share lessons learned and discuss opportunities to collaborate jointly on the deployment of the companies separate yet similar EV programs.

Common themes from stakeholders included general support for the infrastructure program, a need for general market awareness, confirmation of the barriers to DC fast charging implementation, and suggestions regarding the application and legal agreements.

B. Implementation Metrics

Phase 1 Metrics

The following tables provide information on EV Make-Ready charging station projects as of December 31, 2019:

Figure 7 Station Profiles

	Level 2		DC Fast Charger		Total	
	2018	2019	2018	2019	2018	2019
Charging Ports Installed	60	398	0	3	60	401
Charging ports Enabled	85	900	0	5	85	905
Avg. # Ports Installed Per Site	5	4	n/a	3	5	4
Public Sites	8	65	0	1	8	66
Workplace Sites	4	41	0	0	4	41
Multi-Unit Dwelling Sites	0	6	0	0	0	6
Environmental Justice Sites	2	23	0	0	2	23
Annual kWh/port	n/a	1,976	n/a	n/a	n/a	1,976

Figure 8 Station Locations

	Level 2		DC Fast Charger		Total	
	2018	2019	2018	2019	2018	2019
Metro Boston	9	67	0	1	9	68
South Coast	1	7	0	0	1	7
Cape & Martha's Vineyard	0	12	0	0	0	12
Western MA	2	26	0	0	2	26
% of residential customers "within range" (40 miles)	100%	100%	n/a	~50%	100%	100%

Environmental

Operating under the assumption that each charging port installed incentivizes the adoption of six incremental electric vehicles,[10] Phase 1 of the Make Ready Program enabled 2,766 EVs

[10] Workplace Charging Challenge, U.S. Department of Energy, https://www.energy.gov/sites/prod/files/2017/01/f34/WPCC_2016%20Annual%20Progress%20Report.pdf

(372 in 2018 and 2,394 in 2019), equating to an annual CO2 reduction of 9,681 MT, 1,302 MT in 2018, and 8,379 MT in 2019.

C. Lessons Learned/Challenges and Successes:

Phase 1 of the Make Ready Program implementation has provided provided numerous opportunities to learn and adjust processes to manage towards optimization. Lessons learned related to operational execution, site host recruitment and market segmentation are described below:

Operational Execution

Timelier Legal Agreements

To participate in the program and complete installation of charging station infrastructure, a customer must execute several documents. These include a Site Host Agreement, agreeing to the terms and conditions of participation in the Program, and an Easement granting permission to Eversource for construction and maintenance of the infrastructure that leads to the charging station. These documents can be long lead time items, leading to a delay in infrastructure deployment.

Eversource has taken steps to minimize delays from execution of these legal agreements to help ensure the timely installation of infrastructure. First, the Site Host Agreement is introduced to customers as one of the first steps in the enrollment process. Second, Eversource introduced a Site License Agreement, which grants the Company permission from the Site Host to access the site and perform the work of installing the charging infrastructure until a permanent easement for the facilities at the site is granted. Both steps have helped to reduce the time it takes for legal documents to be executed and facilitated timelier infrastructure deployment.

Modifying Use Cases based on Costs to Scale

The Make-Ready Program was designed to help customers avoid future costs of expansion while enabling future charging expectations. As originally envisioned, Eversource offered two primary level 2 charging station deployment use cases: 1) “Up to five ports” – if customers requested two to five ports, the infrastructure would be put in place to support up to five single, or two dual and one single port stations; and 2) “Ten ports” – if customers requested six or more charging ports, the infrastructure would be put in place to support up to ten potential ports.

As Eversource examined the actual implementation costs of both use cases, the Company determined that the cost to deploy the infrastructure to support 10 ports was only marginally more expensive than the cost to support five ports. Additionally, consolidating to a single level 2 use case allows the Company to standardize electrical infrastructure equipment an enable procurement efficiencies. Going forward, Eversource, where possible, will put in place the infrastructure to support 10 charging ports, with the expectation that customers will install additional charging stations as the market continues to develop.

Initial Ports Installed Per Site

Though Eversource has installed the infrastructure to support 10 charging ports at the majority of sites where feasible, the average number of ports installed in Phase 1 has been 4 per site.

Need for additional electrical contractors

Upon the program's inception in 2018, Eversource contracted with three vendors to install the behind the meter electrical infrastructure. While these contractors were instrumental in helping to get the program off the ground, it was determined that more partners will be needed to scale program implementation to the level anticipated in Phase 2. The project team issued a subsequent RFP in 2019 to establish a wider network of electrical contractors throughout the Commonwealth. On February 14th, 2019, Eversource issued an RFP to electrical contractors and EV charging network vendors. In total, 33 vendors were invited to participate in this RFP, and 22 vendors provided a formal response. Eversource ultimately contracted with 15 partners, including one electrical contractor.

Standardization

Owning and operating infrastructure on the customer side of the meter also provided an opportunity (and necessity) to standardize where possible the physical components, both to reduce costs through the ability to scale and to maximize deployment efficiency through the ability to order and inventory necessary equipment. Specifications were standardized for the EV Supply Cabinet (electrical panel), and Eversource contracted with Merrimac to design and construct the panels for this program.

Also, to the extent possible, site design and engineering has been standardized to provide consistent station configurations across the infrastructure that Eversource owns as part of the Make-Ready program.

Building channel and supply chain in the Northeast

To efficiently deploy the number of charging stations demanded by the program, Eversource needed to significantly grow the EV Infrastructure vendor channel in Massachusetts. The two RFPs were used to create a pre-qualified bench of contractors, vendors, installers and manufacturers for the program. In 2019, Eversource also conducted various vendor workshops with charging station manufacturers and electric distributors, designed to educate them on the program, Eversource standards and processes, and the local market conditions and value propositions.

Eversource has been in regular weekly conferences with charging station vendors to coordinate sales and installation support and optimize pipeline management.

Every site is unique

Understanding that every deployment is different and brings its own unique challenges has been a key learning in Phase 1. From both a scheduling and cost standpoint, site-specific

characteristics can make it difficult to determine an "average" or expected timeline and budget early in the project.

Permitting processes can be very different from one site to the next. Each town or municipality has its own permitting requirements and associated timelines and waiting on the necessary approvals to begin construction work has the potential to delay a project. Additionally, Eversource must also obtain the necessary rights to do work on customer property, and the execution of these legal agreements typically takes a substantial amount of time. Both of these elements are key inputs into the development of an electrification schedule.

The high standard deviation of costs across all of the sites that have been completed to-date can be tied back to a number of factors: distance from utility electrical supply to the charging stations, topography of the land being trenched, availability of capacity at the site transformer, and potential upgrades needed to enable charger electrification all result in some sites being relatively cheap and others being rather expensive to construct. Being diligent in upfront engineering and design work is key to limiting surprises and unexpected cost adders during the construction process.

Costs

As shown in the table below, average site costs on a per port basis are in line with or better than similar programs in other jurisdictions based on initial comparison with California utility programs.

Figure 9 California Utility EV Programs (Through 1Q19) and Eversource (Through 4Q19) Site Costs

Utility	Program	Average Cost per L2 Port (including To-the-Meter, Behind the Meter, Final Design, Permitting
Pacific Gas and Electric	EV Charge Network[11]	$17,956
San Diego Gas and Electric	Power Your Drive[12]	$24,000
Southern California Edison	Charge Ready Pilot[13]	$13,430
Eversource	Make Ready[14]	$12,100

[11] https://www.pge.com/pge_global/common/pdfs/solar-and-vehicles/your-options/clean-vehicles/charging-stations/program-participants/PGE-EVCN-Quarterly-Report-Q1-2019.pdf

[12] https://www.sdge.com/sites/default/files/regulatory/March%202019%20PYD%20Report%20Final_0.pdf

[13] https://www.sce.com/sites/default/files/inline-files/SCE%20Quarterly%20Charge%20Ready%20Pilot%20Program%20Report%202019%20Q1%20WCAG.pdf

[14] Detailed table referenced in Section E: Performance on Implementation / Deployment

In 2018, Eversource's average site cost per charging port enabled was $17,404. In 2019, average cost per port enabled was $11,563. To-date, the average site cost per port enabled is $12,100.

Site Host Recruitment

Site Host Marketing

The Company's site host recruitment efforts revealed that customers are in various places on their education – some being very advanced and knowledgeable about EVs and EV charging, some just hearing about it for the first time, and every place in between.

Marketing the Make-Ready program to potential site hosts is a high touch sales effort supported by tailored marketing content. Eversource created coordinated Print, Social Media, and Mailing campaigns to appropriate Commercial & Industrial ("C&I") customers, and multi-unit dwelling property owners. The Company also conducted targeted outreach to various sectors, including EJ Community site hosts.

The Company developed a customer package and roadmap to completion of sites, including the Intake application, Site Host Agreements, License / Easement agreement, and Marketing pieces targeted to the facility.

Eversource also hosted a series of ride and drive events (funded outside the Make-Ready program) at various site host locations in both 2018 and 2019.

Early in the Program it became clear that customer education and stakeholder engagement would be imperative for program success. Beginning in 2019, the Company worked with Advanced Energy Boston to convene quarterly stakeholder events to solicit customer and community stakeholder feedback.

Equipment Incentives

Besides the ongoing operational costs, the primary cost for customers participating in the Make-Ready program is the purchase of EVSE – the charging stations themselves.

Rebates or incentives are helpful in defraying or eliminating the cost of the EVSE to the site host and eliminating barriers to participation in the program. The two primary sources of EVSE incentive have been 1) rebates on level 2 chargers to qualified site hosts in EJ Communities, and 2) level 2 charger incentives from the Mass EVIP program.

The Mass EVIP incentives have been very helpful, particularly to municipal customers, in encouraging them to apply and participate in the Make-Ready Program. The two programs are naturally complimentary. There can be timing issues, where customers wait to learn if they have been awarded Mass EVIP grants before committing to participate in the Make-Ready program. This has the potential, if not well coordinated, to slow down the deployment process of the Make Ready Program.

Understanding operational issues

Part of customer site host education is making sure customers understand the bill impacts of hosting EV charging stations. The electric bill is the largest ongoing operational cost of being an EV charging station host. Customers have looked to Eversource to help understand what to expect given various demand scenarios. Eversource has taken on a consultative role, describing different utilization scenarios and their impact. Customers have also looked to Eversource to understand the impact of what pricing levels might have on demand, and on their overall charging operations. The Company has provided guidance on strategies to increase utilization and manage demand.

Customer interest exceeded expectations

Eversource's site host recruitment efforts to date have been very successful for Level 2 charging. In 2018 the Company received 150 applications and signed site agreements with 55 customers. In 2019 the Company received over 450 applications and signed site agreements with 219 customers. The significant interest from customers in hosting EV charging stations has led to a very healthy backlog heading into Phase 2 of the program. The Company expects that the program will be fully subscribed by mid-2020.

Customer appetite for larger deployments

Several customers have expressed interest in hosting more than the 10 charging ports that the current program design allows. In some cases, there is an appetite for the deployment of 30 or more charging ports to be electrified at one location. While the Program was initially designed with the intention to spread customer dollars across as many sites as possible, having the flexibility to selectively choose exceptions where a greater number of chargers makes sense and helps to accelerate EV adoption is beneficial to advancing the Commonwealth's goals.

Market Segmentation

Multi-Unit Dwellings

Eversource's site host recruitment efforts have confirmed the experience of many other utilities that have implemented EV infrastructure programs – multi-unit dwellings are a challenging use case. Parking spaces in multi-unit dwellings tend to be a scarce resource and often building owners do not yet see EV charging as an amenity by which to increase property value and attract tenants. There are also logistical hurdles, such as payment, scheduling parking, and monitoring use. The Company was able to electrify 6 multi-use dwelling sites in 2019.

Customer Owned Distribution Networks

One of the requirements for participation in the Program is that the charging station site must be separately metered, and therefore must be wired directly to Eversource equipment. Several customers who own their own distribution network behind the meter, including universities,

airports, and other large campus customers, are not eligible for participation. Many customers who were initially flagged as good targets based on parking characteristics (large, publicly accessible, long dwell-time, highly utilized), were ineligible.

Low-Moderate Income (Environmental Justice) Communities

In Phase 1, the Company was successful in meeting its target of 10 percent of capital deployed at installations in EJ Communities. Of the 125 stations electrified in Phase 1, 25 were in EJCs, accounting for approximately 20 percent of total Make Ready Program investment. Of the 25 sites installed in EJC's, 2 were deployed in 2018 and the remaining 23 were installed in 2019.

The Company actively participates in cross-jurisdictional internal groups with its affiliates and other utilities and collaborates with stakeholders representing disadvantaged and low-income communities.

It is too early to evaluate the impact on actual EV adoption in these communities, or the direct benefit of EV charging there. The Company anticipates being able to conduct this analysis by the end of the program implementation in its final report.

DC Fast Chargers

Eversource's site host recruitment efforts for DC fast chargers have not been successful. In Phase 1, only one DC fast charger site was electrified and 12 applications were received.

Eversource did have a strategy to recruit site hosts for this type of deployment. The Company targeted locations that meet a specified set of criteria to support electrification of main travel corridors. Selection of locations included: peak traffic areas, ensuring gap coverage between service territories, a 40-mile max distance to next station, more stations in higher traffic areas and off-exit deployment to enable easy access. The Company met with MA DOT and other stakeholders to try and identify appropriate sites.

The Company concluded that there are two primary barriers to customers willing to be site hosts for DC fast chargers: 1) the high upfront cost of the hardware/software; and 2) high anticipated operating costs.

DC Fast Chargers can cost between $35,000 and $50,000 for a 50kW charger and up to $150,000 for a 150kW charger. Compared to the average $3,500 per port for Level 2 chargers, the upfront cost of purchasing a DC Fast Charger is significant. Massachusetts, through Appendix D of the Volkswagen Settlement, has allocated more than $11 million to EV charging infrastructure. This provides a good opportunity to leverage non-taxpayer, non-ratepayer funds to help advance the deployment of this much needed infrastructure. Eversource will work together with the Massachusetts Department of Environmental Protection ("DEP") to better understand plans for the remaining VW funding and explore ways to synergize between the two programs.

Operating expenses, particularly related to the bill impacts associated with powering DC fast chargers, are an additional concern for potential charging station site hosts. Demand charges for these installations can be significant, in some cases accounting for 80 percent of the

monthly electric bill. The operating profile of these assets, resulting from the combination of higher power and lower utilization, has resulted in several customers that initially expressed an interest in deploying this equipment at their facilities being hesitant to move forward. Eversource continues to explore potential rate solutions that could be tailored to the unique load curve of DC fast chargers.

Barriers to Adoption

As part of the original proposal, Eversource identified several barriers to EV adoption including the upfront cost of EVs, lack of available charging infrastructure and EV range. Recent market studies continue to affirm the same barriers to EV adoption exist today.[15]

D. Actual v. Planned Implementation and Spending:

Phase 1 Milestones Achieved

January 2018: Project and Construction leads assigned to Eversource implementation team

March 2018: Presented DC Fast Charger Deployment Plan to EEA/DOER/DOT

April 2018: Request for Information / Proposals issued to qualify EV charging station vendors

April 2018: Site host recruitment efforts initiated

May 2018: Site host agreement / license forms finalized

June 2018: Pre-qualified vendors selected

June 2018: Third-party electrical contractors selected

July 2018: First site host contract executed

October 2018: First charging station site electrified

December 2018: Launched web-site: https://www.eversource.com/content/ema-c/residential/save-money-energy/explore-alternatives/electric-vehicles

April 2019: Additional charging station vendors qualified through subsequent Request for Proposal

June 2019: Finalized development of standardized panel enclosure

September 2019: Received 500th customer intake application

December 2019: Electrified 1st Multi-Unit Dwelling

December 2019: Electrified 100th customer site

[15] https://www.greencarreports.com/news/1121698_poll-suggests-more-americans-might-buy-an-ev-if-only-they-had-a-place-to-charge

E. Performance on Implementation/Deployment:

Exhibit 1 summarizes the investments in the 125 charging station sites placed in service in Phase 1 of the Make Ready Program.

F. Description of Benefits Realized from Implementation:

As detailed in Section B (Implementation Metrics), the deployment of the 125 charging station sites with 461 installed ports in Phase 1 supports 2,766 incremental EVs on the road, resulting in an annualized CO2e reduction of 9,681 MT.

G. Summary of Interval Charging Data:

As indicated in Eversource's Make Ready Program filing in D.P.U. 17-05, the Company intends to include a thorough and inclusive analysis of charging station data as part of its Phase 2 evaluation efforts. In preparation for this work, Eversource has engaged with a data analytics vendor to begin aggregating, analyzing, synthesizing, and reporting on this data. Quarterly, data and analyses are being prepared, reviewed and improved on in an iterative process to ensure that a quality final analysis will be available for all stakeholders once the program has been fully deployed.

Attached as Exhibit 2 is a report ("Eversource Massachusetts Electric Vehicle Infrastructure Program Charging Station Analysis Report 2019") that captures data for 198 of the 461 ports that have been installed through December 31, 2019. Data for the remaining 263 ports exists, however Eversource is still working on establishing the necessary protocols with charging station manufacturers to gain visibility to this information. This has been a key learning from Phase 1 and the goal is to develop a seamless process that will improve the efficiency and speed of data access moving forward. It is also important to note that 70 of the 125 sites were energized in the fourth quarter of 2019 and therefore have limited data associated with station usage.

Given the truncated sample size and short time duration the data covers, any conclusions drawn are preliminary. The exhibit is provided as an illustrative example and preview of the more robust analysis that will be performed once the Make Ready program has concluded.

Some of the preliminary conclusions include but are not limited to:

- Stations at Business Offices experience some longer plug-in times (workday durations of 8-10 hours) than other venues, although stations a Leisure Destinations had some long durations. At all venues, most charging is completed after 4 hours.
- A large portion of charging events at Business Offices start earlier in the day, around 7-9 am, most likely when employees arrive for work. Stations at other locations also have many charging events starting during the morning hours, but show flatter distributions, indicating charging events starting throughout the day. Charging events at Multi-unit Dwellings also appear to mostly start at the beginning of the day.

- Weekday peak is during the late morning hours, whereas the weekend has a less defined peak with high periods around mid-day.
- The total number of unique users at Program charging stations has consistently increased over time.
- Each market segment appears to have unique load curves.

EVERSOURCE

Massachusetts
Electric Vehicle Infrastructure Program

Charging Station Analysis Report
2019

Prepared by:

ENERGETICS
A Division of Akimeka, LLC

Electric Vehicle Infrastructure Program

On November 30, 2017, the Department of Public Utilities issued Order 17-05, approving NSTAR ELECTRIC COMPANY AND WESTERN MASSACHUSETTS ELECTRIC COMPANY d.b.a. Eversource Energy (Eversource) to spend up to $45 million over five years on an electric vehicle (EV) infrastructure program (Program).

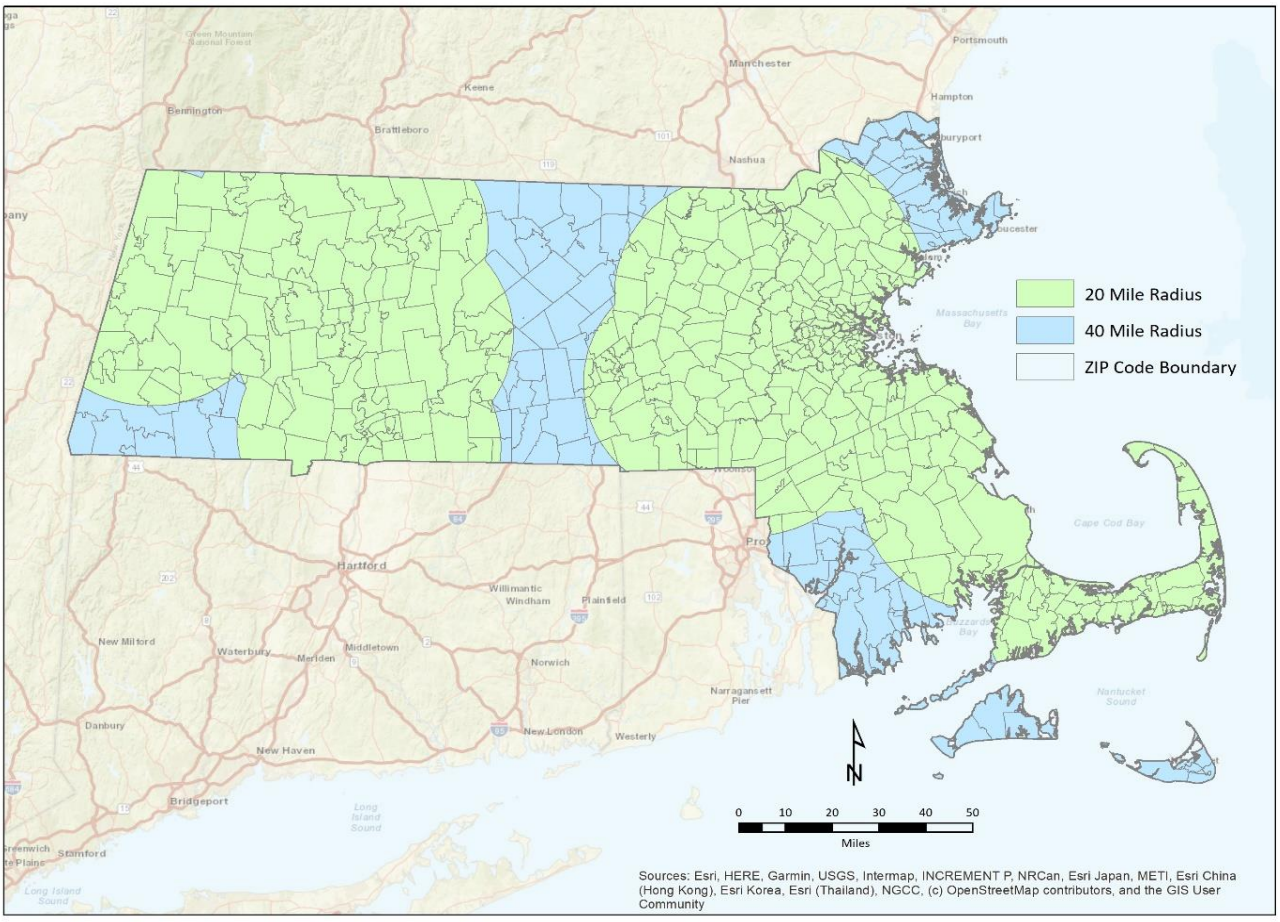
Eversource is supporting the deployment of EV charging ports by installing electrical equipment and components necessary to connect EV chargers to its distribution system. Eversource is installing the "Eversource-side Infrastructure," and contracting with third-party electrical contractors to install behind the meter "Participant-side Infrastructure." Specifically, the EV infrastructure that Eversource installs and owns includes: (1) distribution primary lateral service feed; (2) necessary transformer and transformer pad; (3) new service meter; (4) new service panel; and (5) associated conduit and conductor necessary to connect each piece of equipment.

Between 2018 and 2022, Eversource plans to support the deployment of up to 72 direct current fast charging (DCFC) ports at 36 sites, and up to 3,500 Level 2 charging ports at 450 sites, throughout its service territories in Massachusetts. Eversource hopes to accelerate implementation of the Make-Ready Program based on customer demand.

Eversource Customers Served by Program Installations

Approximately **87%** of Eversource customers are within 20 miles of a Program charging station

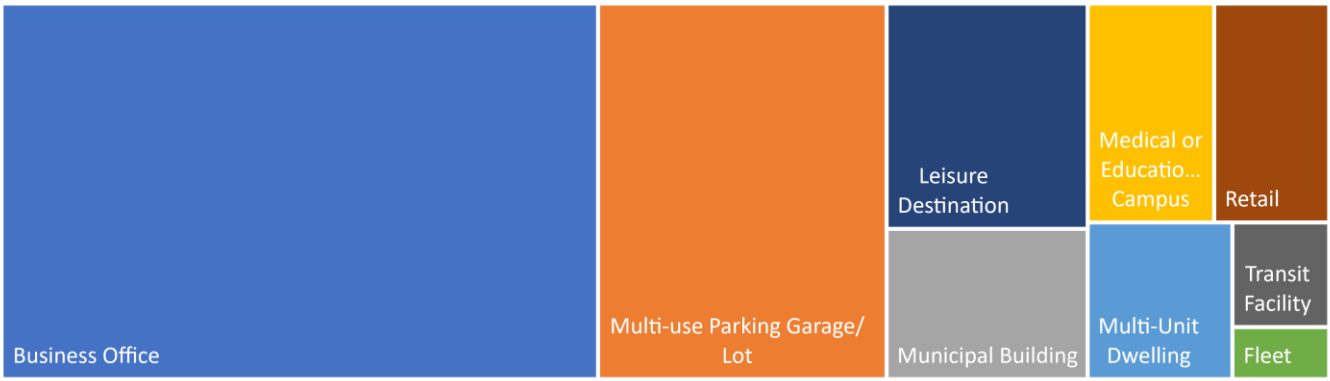
100% of Eversource customers are within 40 miles of a Program charging station



Program Station Installations

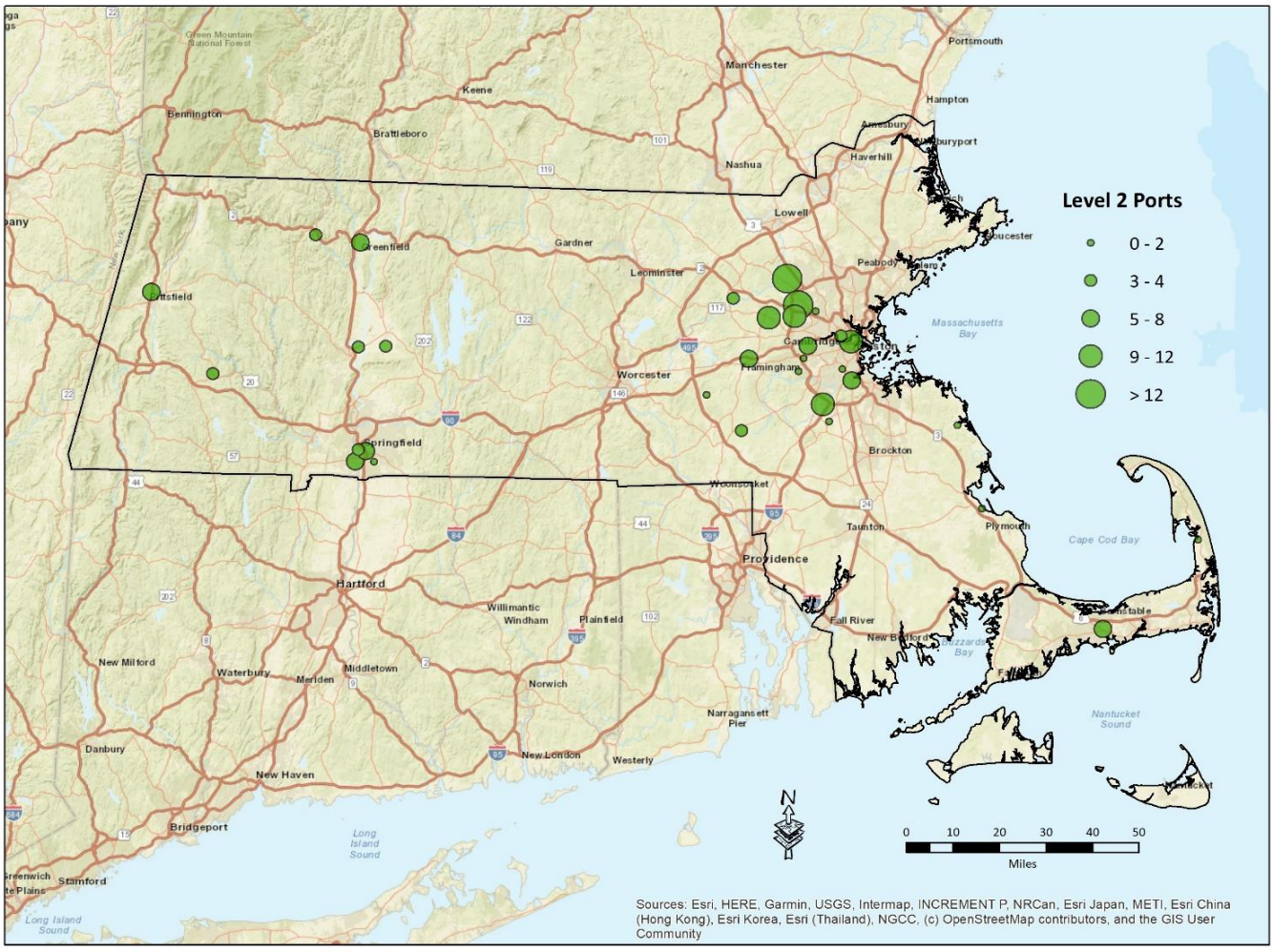
Level 2 ports provide drivers approximately 20 miles of electric driving range for each hour of charging.

198 **Level 2 Ports Installed by the Program to Date**



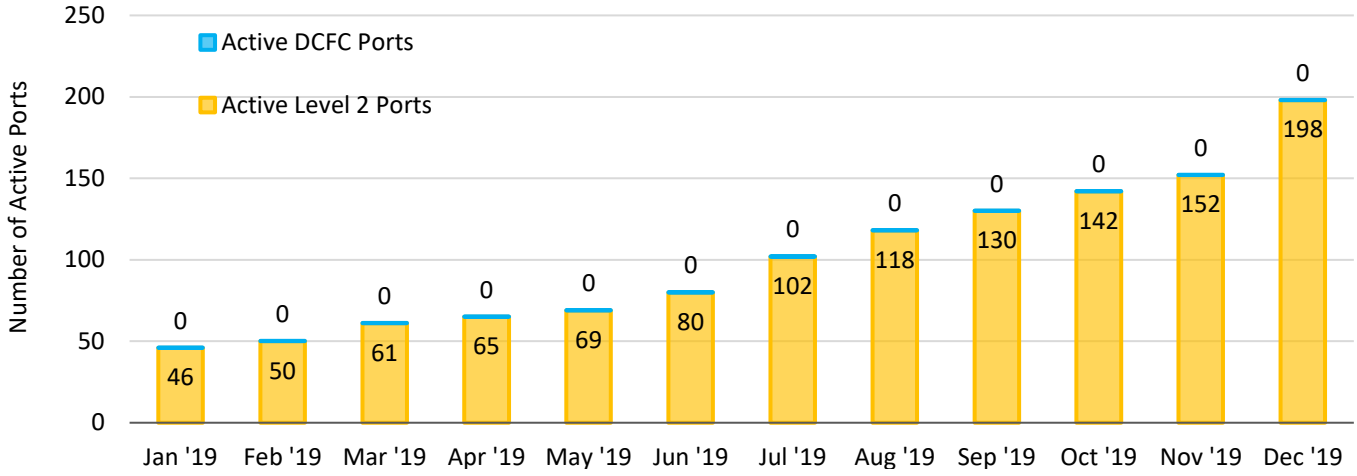
DCFC ports provide drivers 50-150 miles of electric range in 20 minutes of charging.

0 **DCFC Ports Installed by the Program to Date**

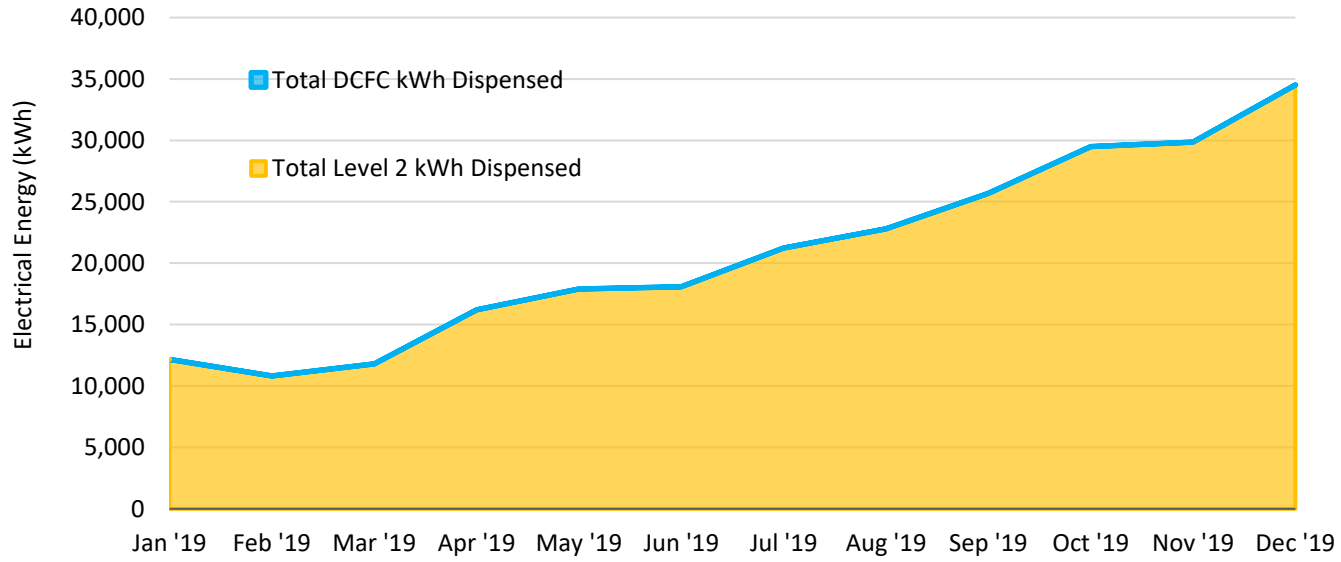


Program Station Installations

Ports are "Active" based on activation date provided by service provider, excluding known periods when repairs were needed.



Energy Dispensed



Environmental Impacts

		2019 Q1	2019 Q2	2019 Q3	2019 Q4	2019 Total
Total Charging Events[1]	Level 2	2,881	4,274	5,597	7,236	**19,988**
	DCFC	0	0	0	0	**0**
	Total	**2,881**	**4,274**	**5,597**	**7,236**	**19,988**
Total Energy Dispensed (kWh)	Level 2	34,803	52,189	69,730	93,866	**250,588**
	DCFC	0	0	0	0	**0**
	Total	**34,803**	**52,189**	**69,730**	**93,866**	**250,588**
Gallons of Gasoline Displaced[2]		**5,202**	**7,801**	**10,423**	**14,031**	**37,457**
Tons of Carbon Dioxide Saved[3]		**36.7**	**55.0**	**73.5**	**99.0**	**264.2**

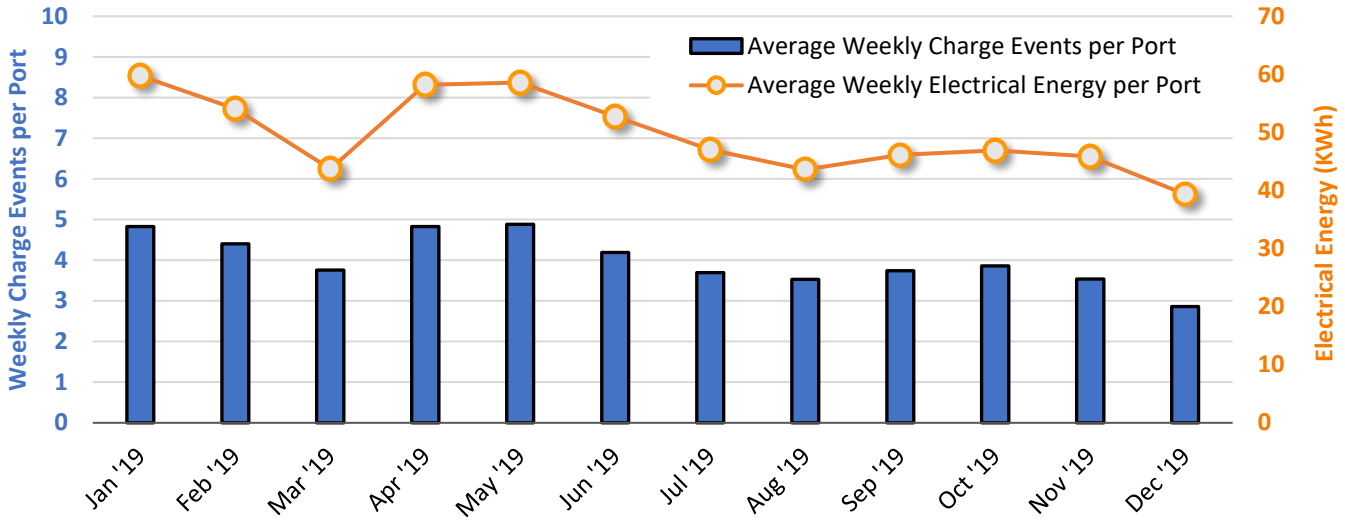
[1] *A recorded event is classified as a charging event if at least 0.2 kilowatt-hours (kWh) is dispensed.*

[2] *Average EV efficiency = 0.3 kWh/mile (Plug In America). Average U.S. light duty vehicle fuel efficiency (2017) = 22.3 mpg (USDOT)*

[3] *CO_2 emmissions/gallon = 19.6 pounds. MA output emmission rate = 821 lb/MWh (USEPA)*

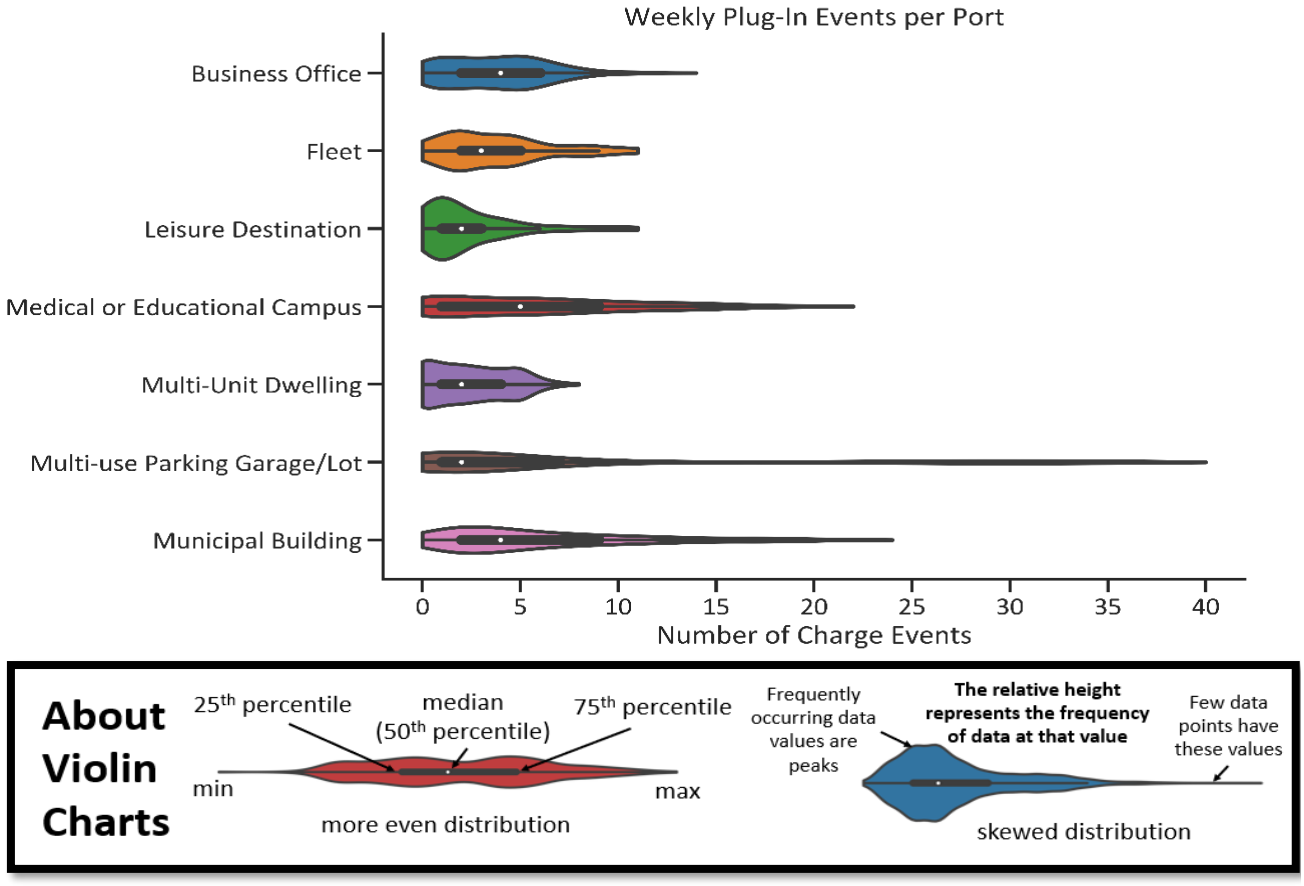
Level 2 Port Utilization

Average station utilization has slightly decreased throughout the year as more program stations were installed (utilization at newly installed stations is typically a little lower initially before EV drivers become familiar with the station location).



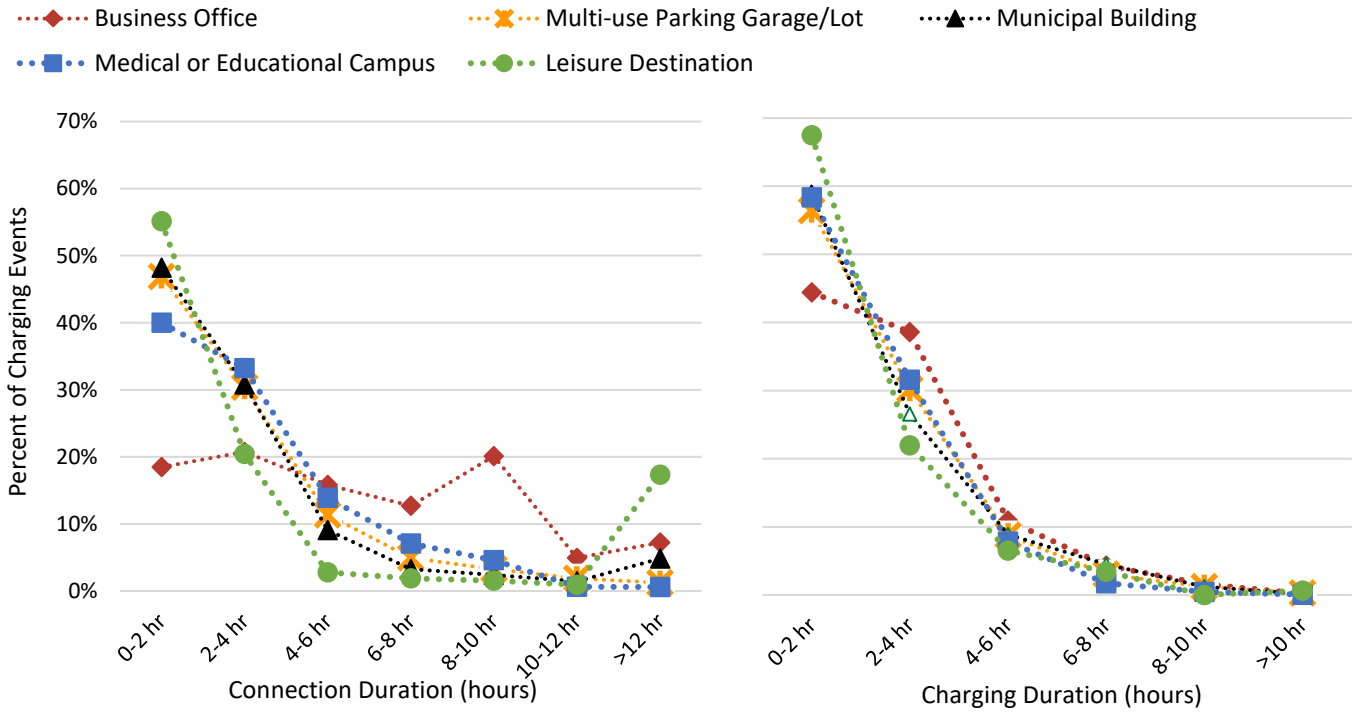
Level 2 Weekly Charging Events by Venue Type

Stations at Medical/Educational campuses, Multi-use Parking Garages/Lots and Municipal Buildings experience the broadest range of utilization, with Medical/Educational campuses and Municipal Buildings having the highest median charging events per week.



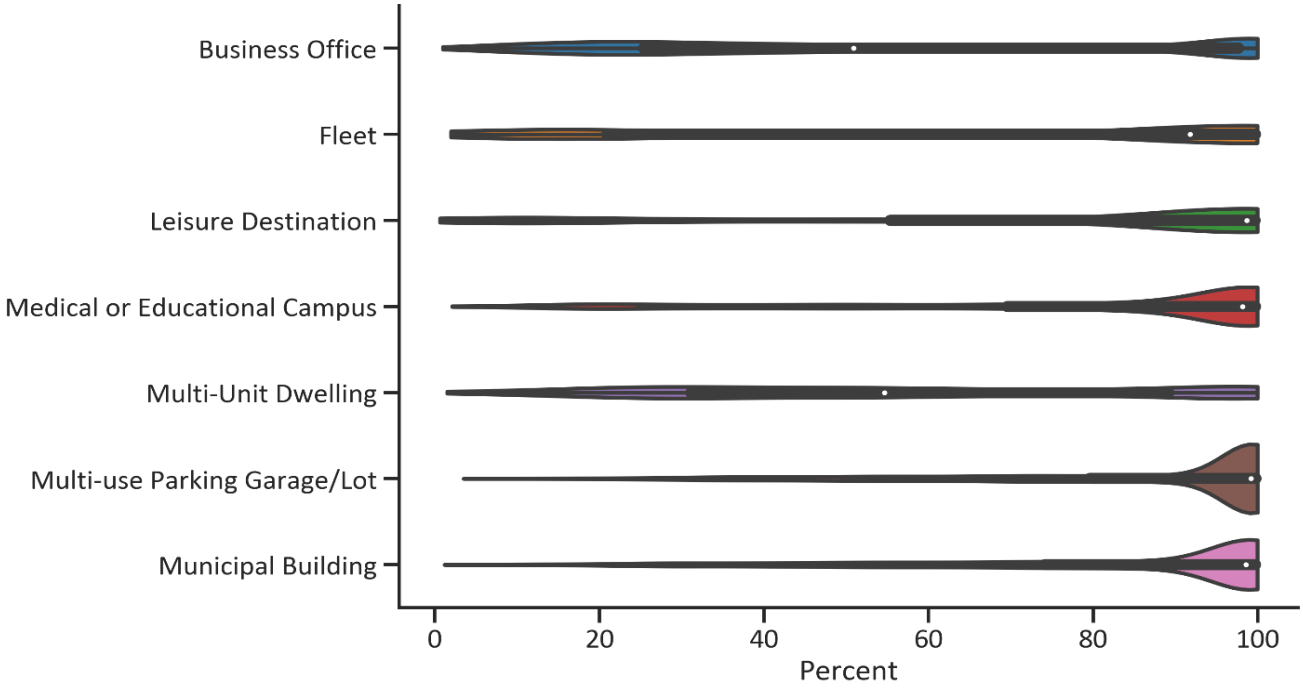
Durations for Level 2 Charging Events

Stations at Business Offices experience some longer plug-in times (workday durations of 8-10 hours) than other venues, although stations a Leisure Destinations had some long durations. At all venues, most charging is completed after 4 hours.



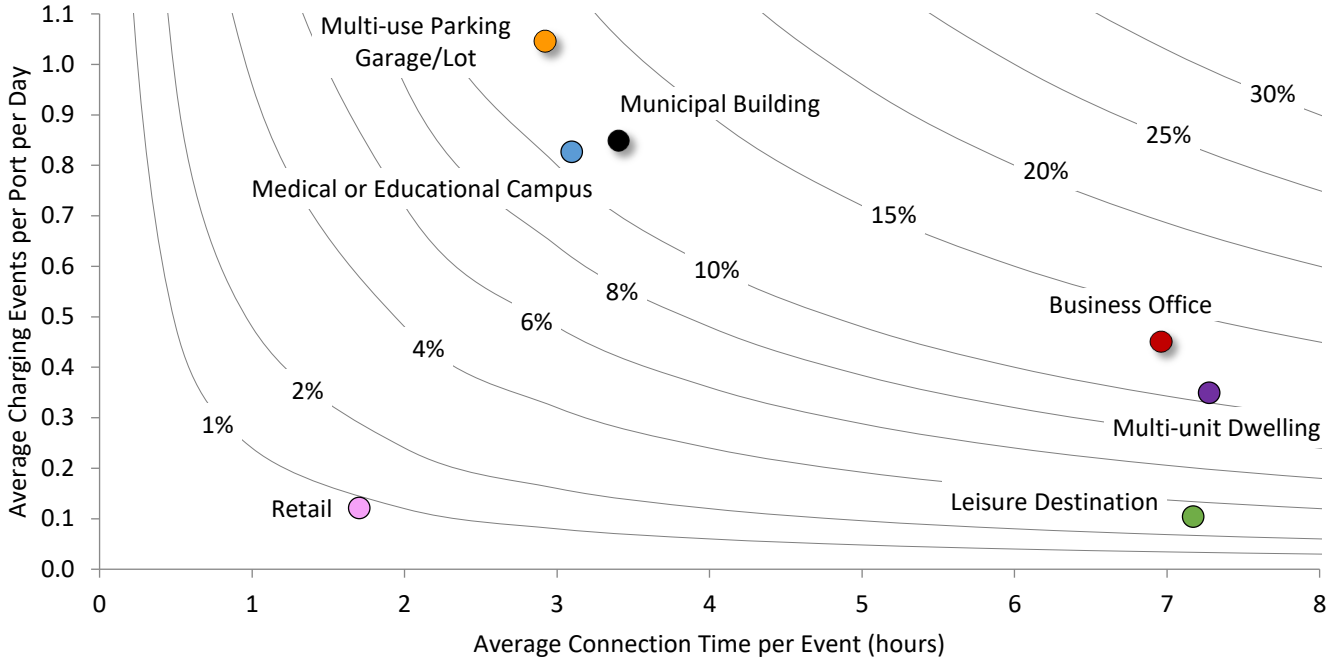
Connection Time Spent Charging for Level 2 Charging Ports

EVs often remain plugged in at Business Office and Multi-unit Dwelling stations longer than needed (charging only about half of the time is the median), whereas at other venues the connection and charge times are often similar.



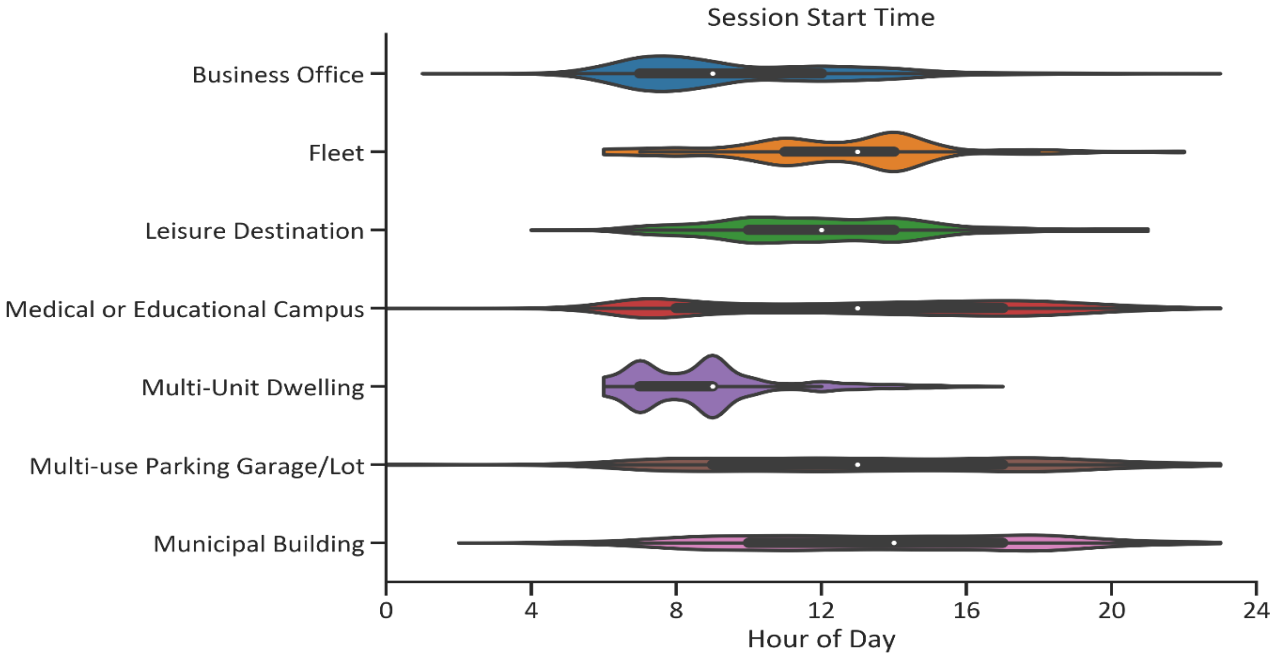
Level 2 Charging Characteristics by Venue Type

The average connection time per charge session plotted against the average number of charging events per port per day show charging session characteristic differences by venue. Profile curves represent the connection utilization percentage. Stations at Business Offices and Multi-use Parking Garages/Lots have high utilization around 13% of the time, but at Business Offices these charge events are less frequent but longer, whereas charge events at Multi-use Parking Garages/Lots are more frequent, but shorter in duration.



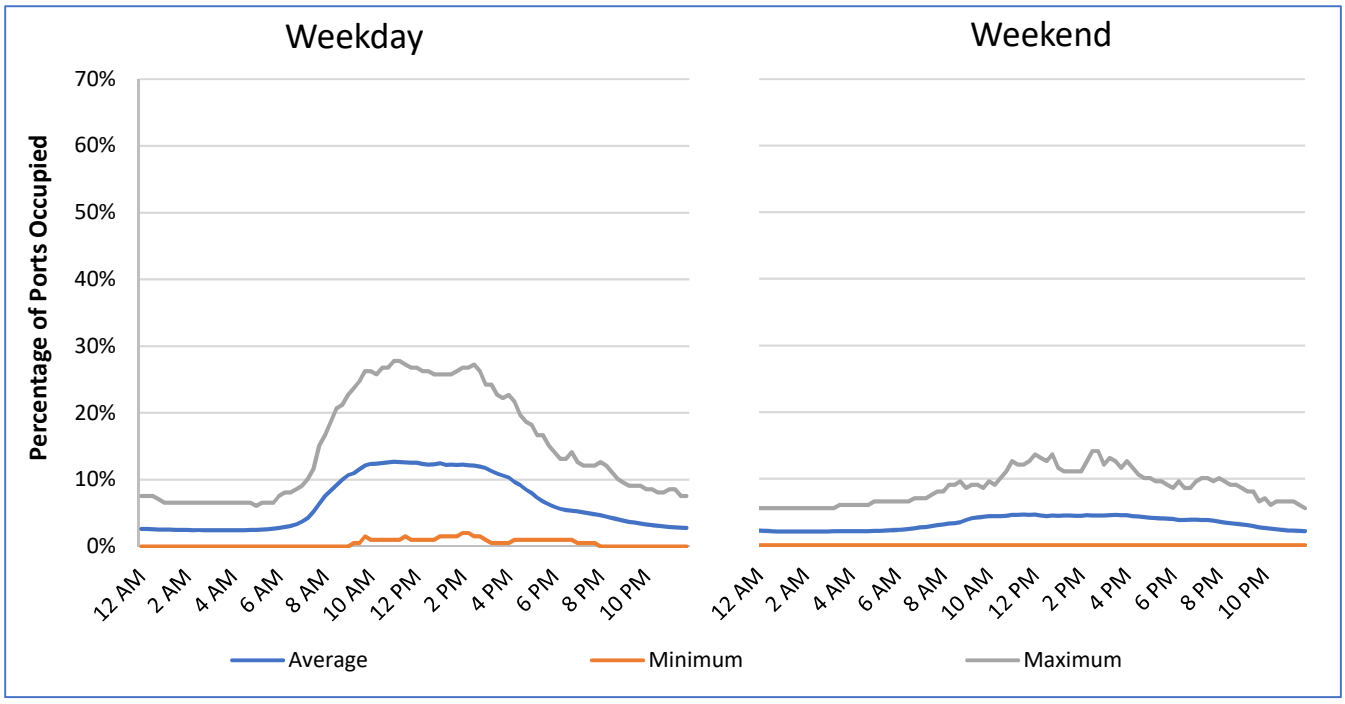
Level 2 Charging Event Start Times

A large portion of charging events at Business Offices start earlier in the day, around 7-9 am, most likely when employees arrive for work. Stations at other locations also have many charging events starting during the morning hours, but show flatter distributions, indicating charging events starting throughout the day. Charging events at Multi-unit Dwellings also apear to mostly start at the beginning of the day, but a limited number of installations currently might be skewing these results.

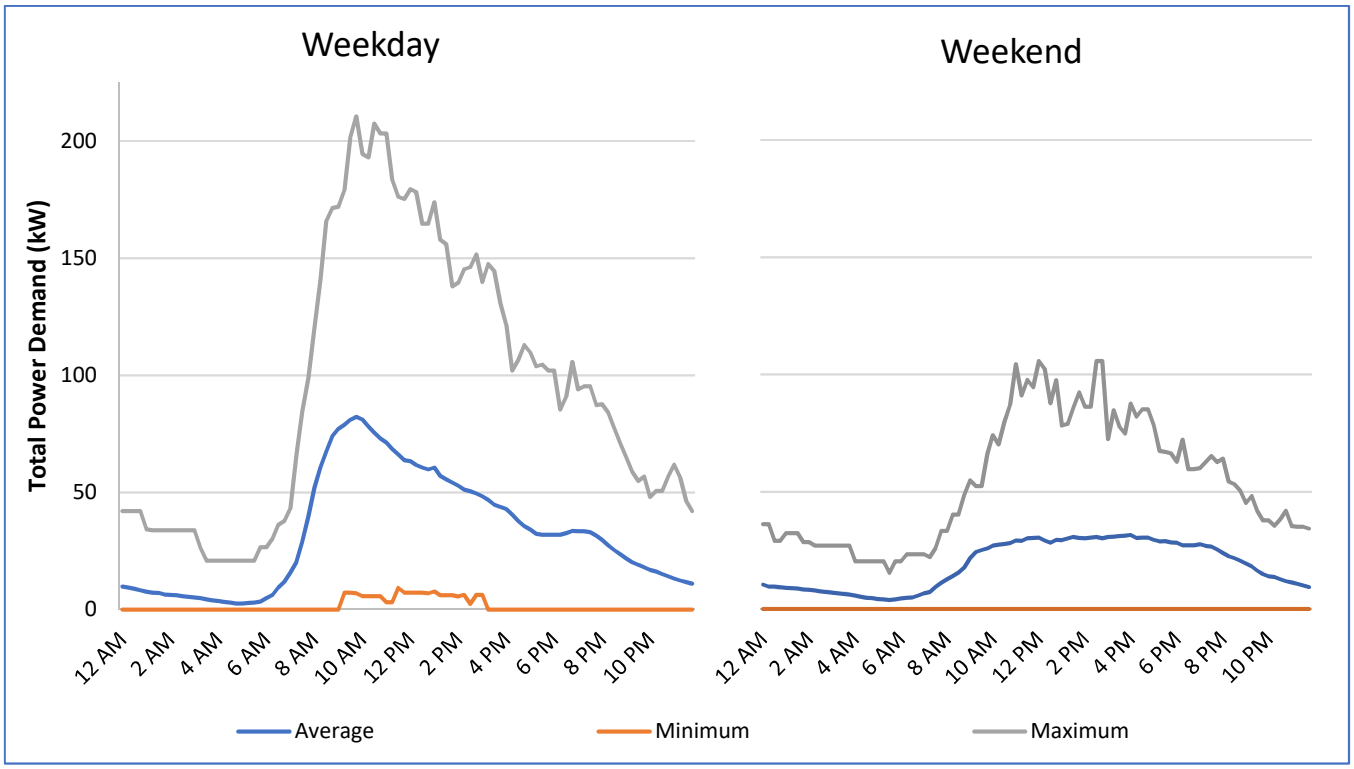


Level 2 Charging Impact on Power Grid - All Venues

Port Availability: Percentage of active charging ports in use across the time of day for weekdays and weekends. Utilization is considerably higher during weekdays.

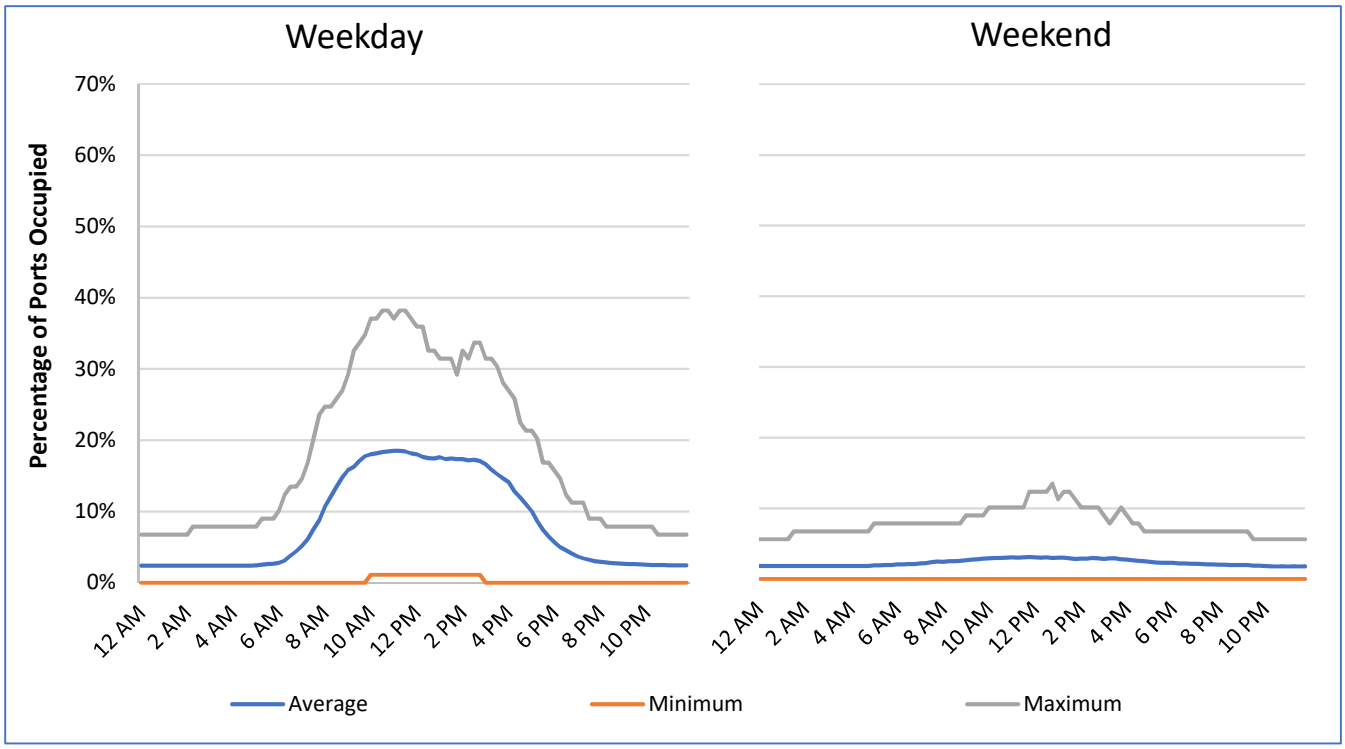


Estimated Total Charging Demand: Total power draw (calculated using average power per charging event for the charging duration) from all stations for weekdays and weekends. Weekday peak is during the late morning hours, whereas the weekend has a less defined peak with high periods around mid-day.

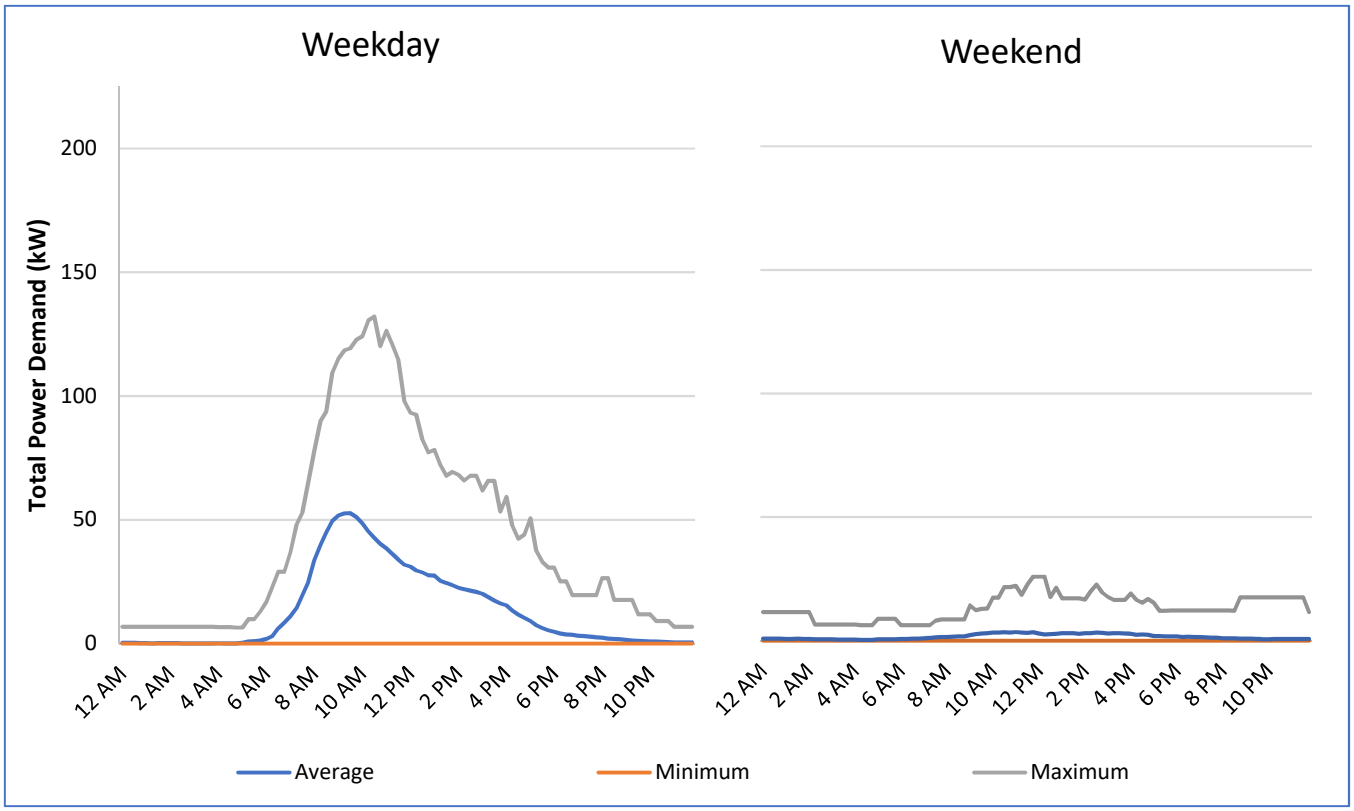


Level 2 Charging Impact on Power Grid - Business Offices

Port Availability: Percentage of active charging ports in use across the time of day for weekdays and weekends. Utilization is considerably higher during weekdays.

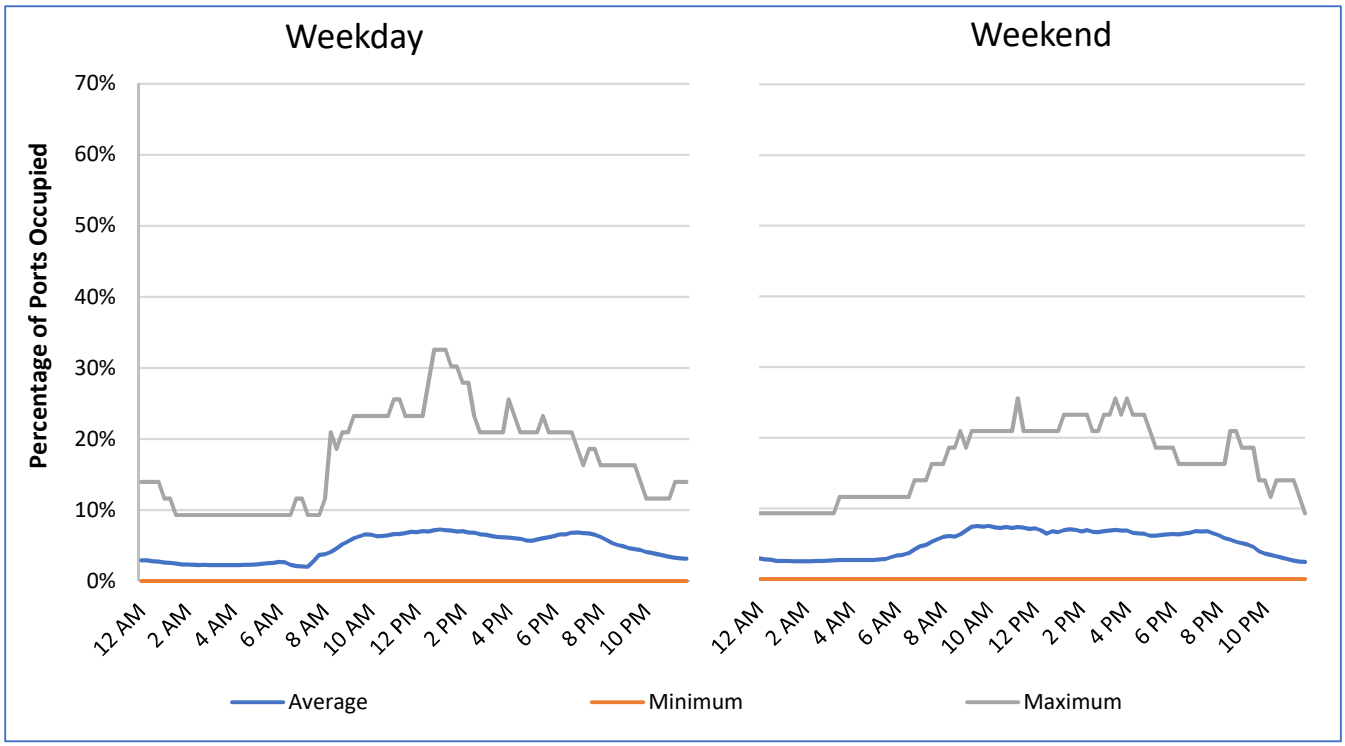


Estimated Total Charging Demand: Total power draw (calculated using average power per charging event for the charging duration) from all stations for weekdays and weekends.

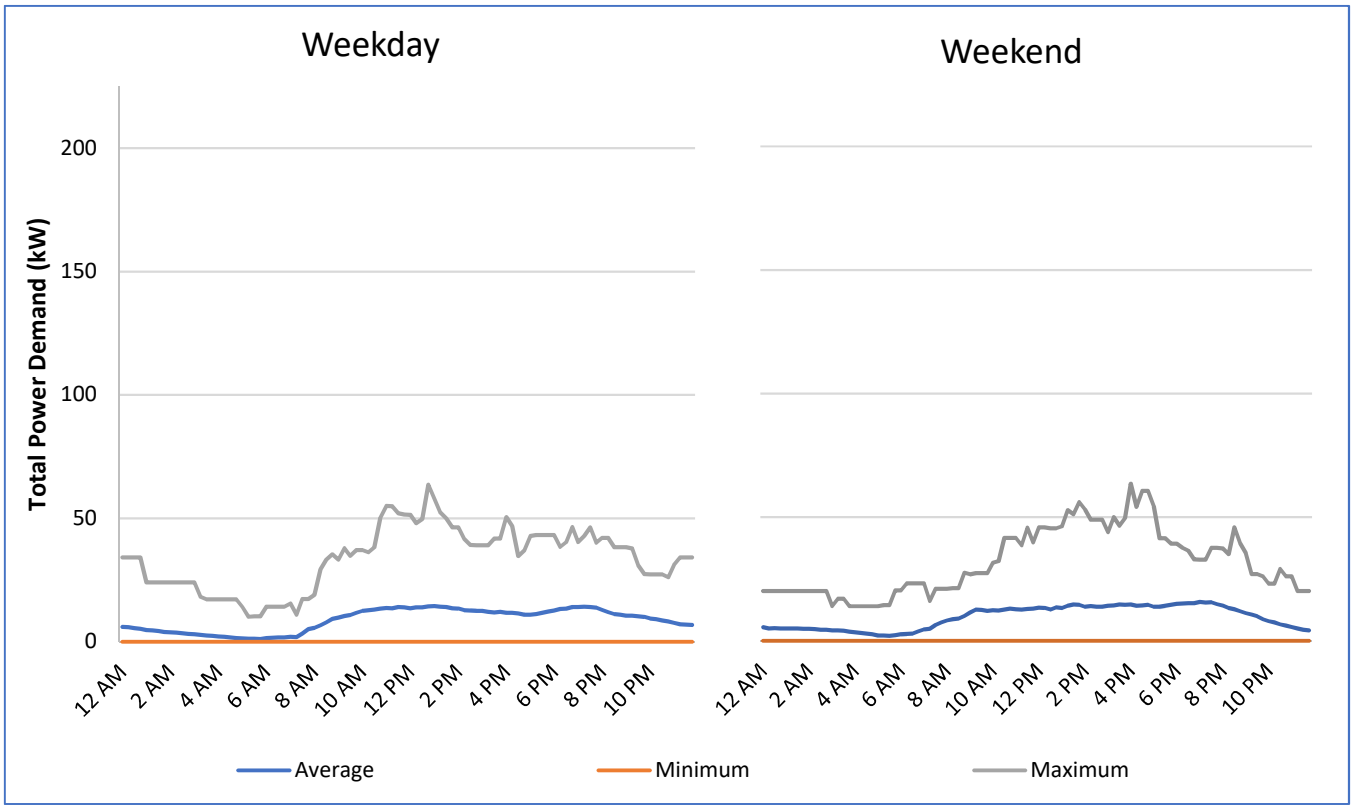


Level 2 Charging Impact on Power Grid - Multi-use Parking

Port Availability: Percentage of active charging ports in use across the time of day for weekdays and weekends. Utilization is similar during weekdays and weekends.

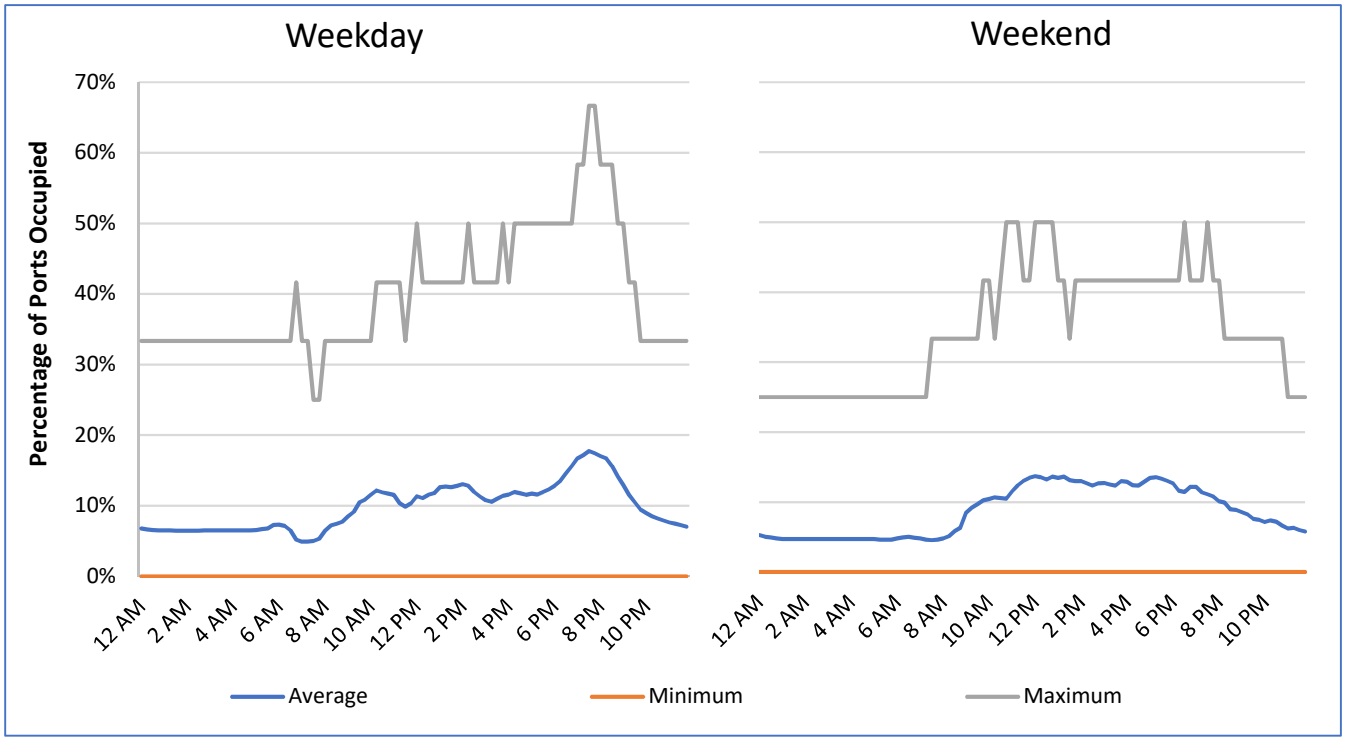


Estimated Total Charging Demand: Total power draw (calculated using average power per charging event for the charging duration) from all stations for weekdays and weekends.

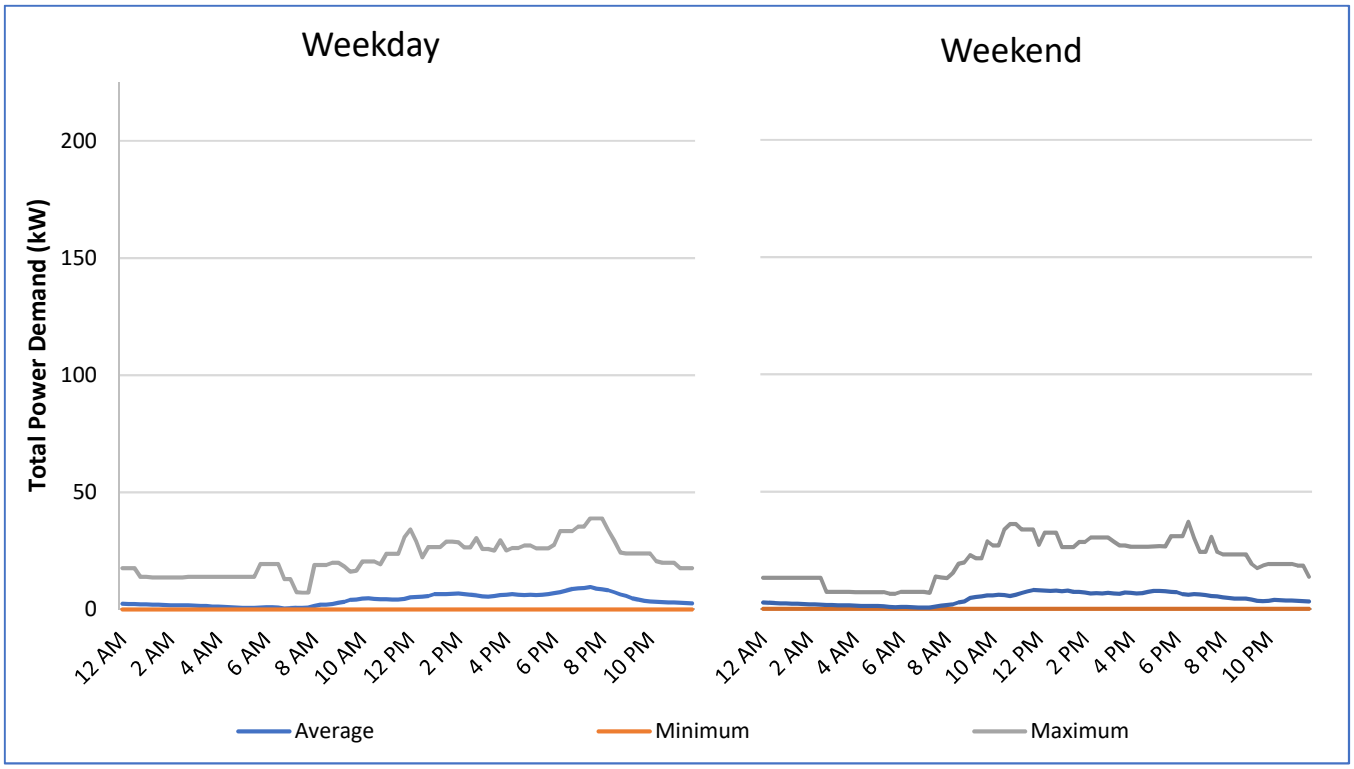


Level 2 Charging Impact on Power Grid - Municipal Buildings

Port Availability: Percentage of active charging ports in use across the time of day for weekdays and weekends. Utilization is slightly higher during weekday evenings, but overall stations at Municipal Buildings have higher utlitization than most other venues.

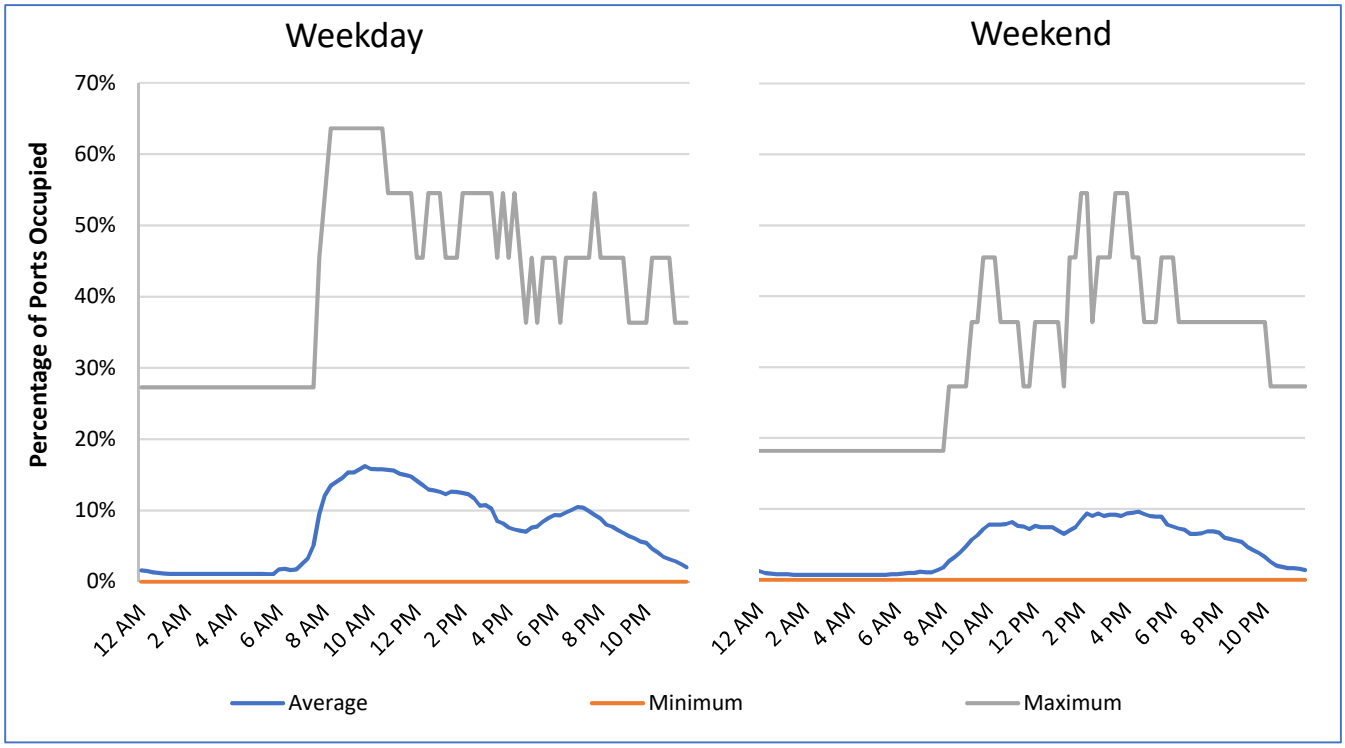


Estimated Total Charging Demand: Total power draw (calculated using average power per charging event for the charging duration) from all stations for weekdays and weekends.

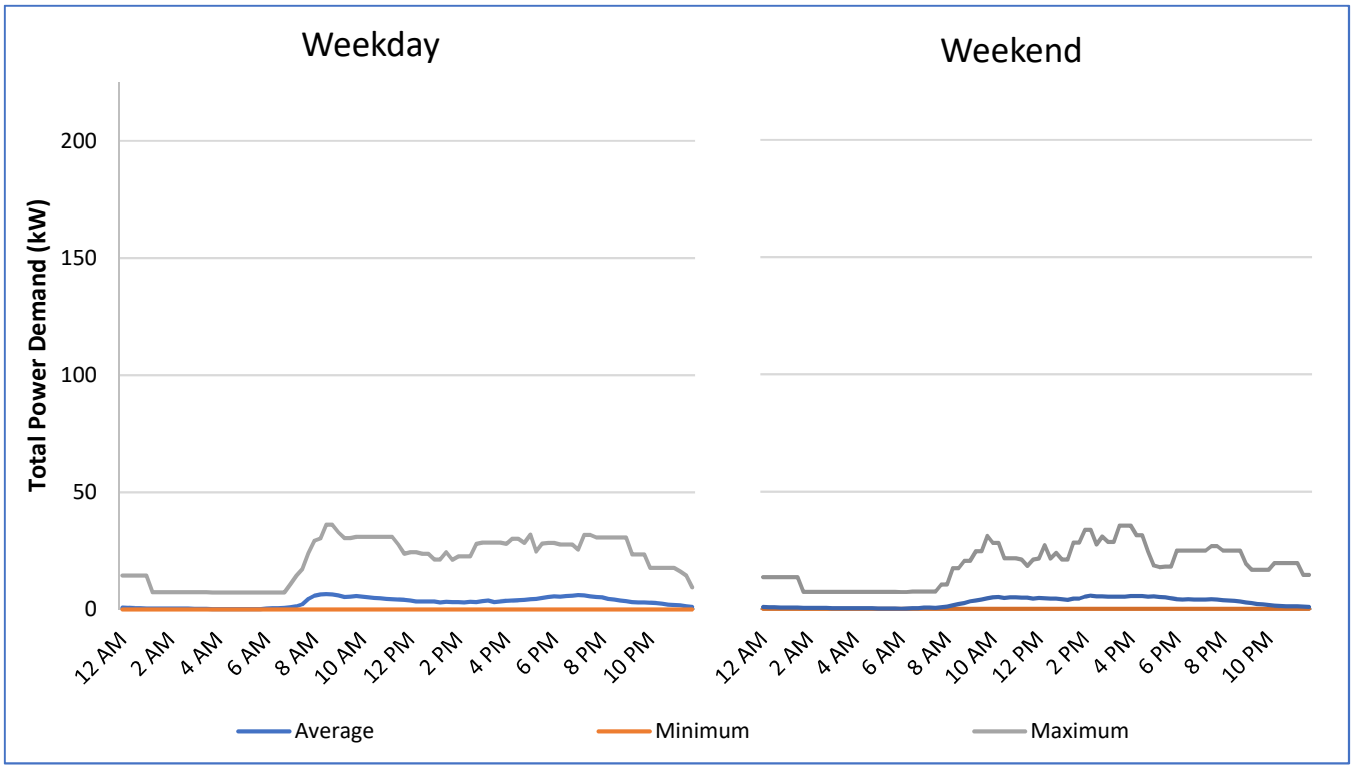


Level 2 Charging Impact on Power Grid - Medical/Educational

Port Availability: Percentage of active charging ports in use across the time of day for weekdays and weekends. Utilization is slightly higher during weekdays, but overall stations at Medical and Educational Campuses have higher utlitization than most other venues.

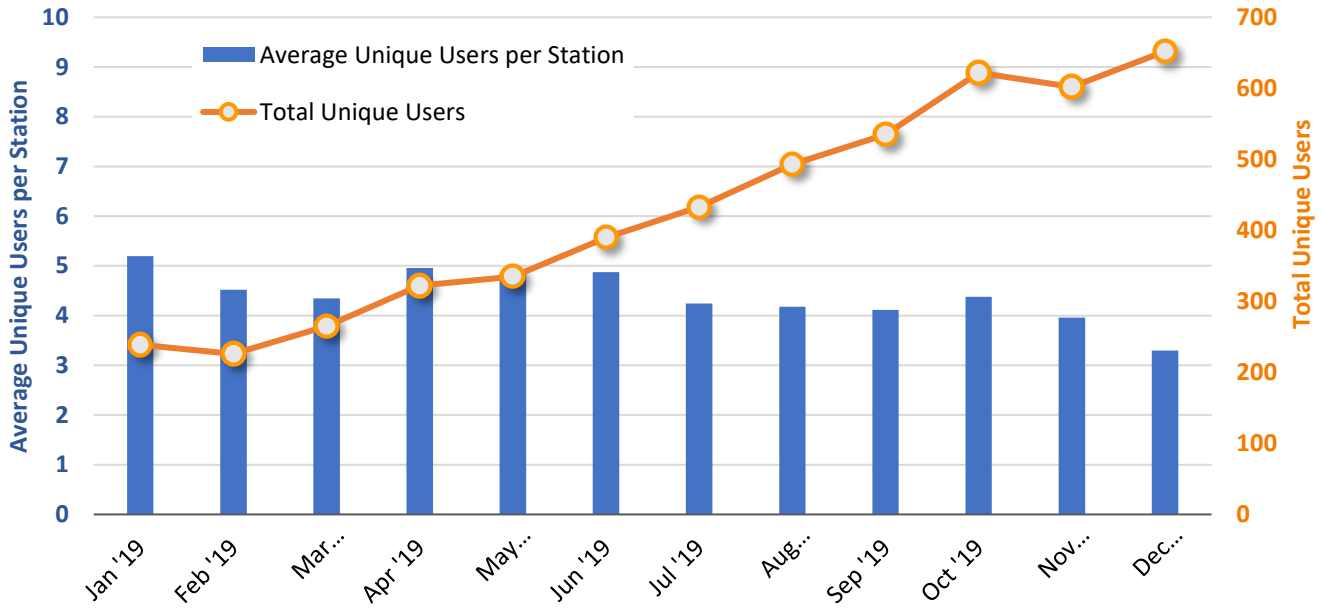


Estimated Total Charging Demand: Total power draw (calculated using average power per charging event for the charging duration) from all stations for weekdays and weekends.

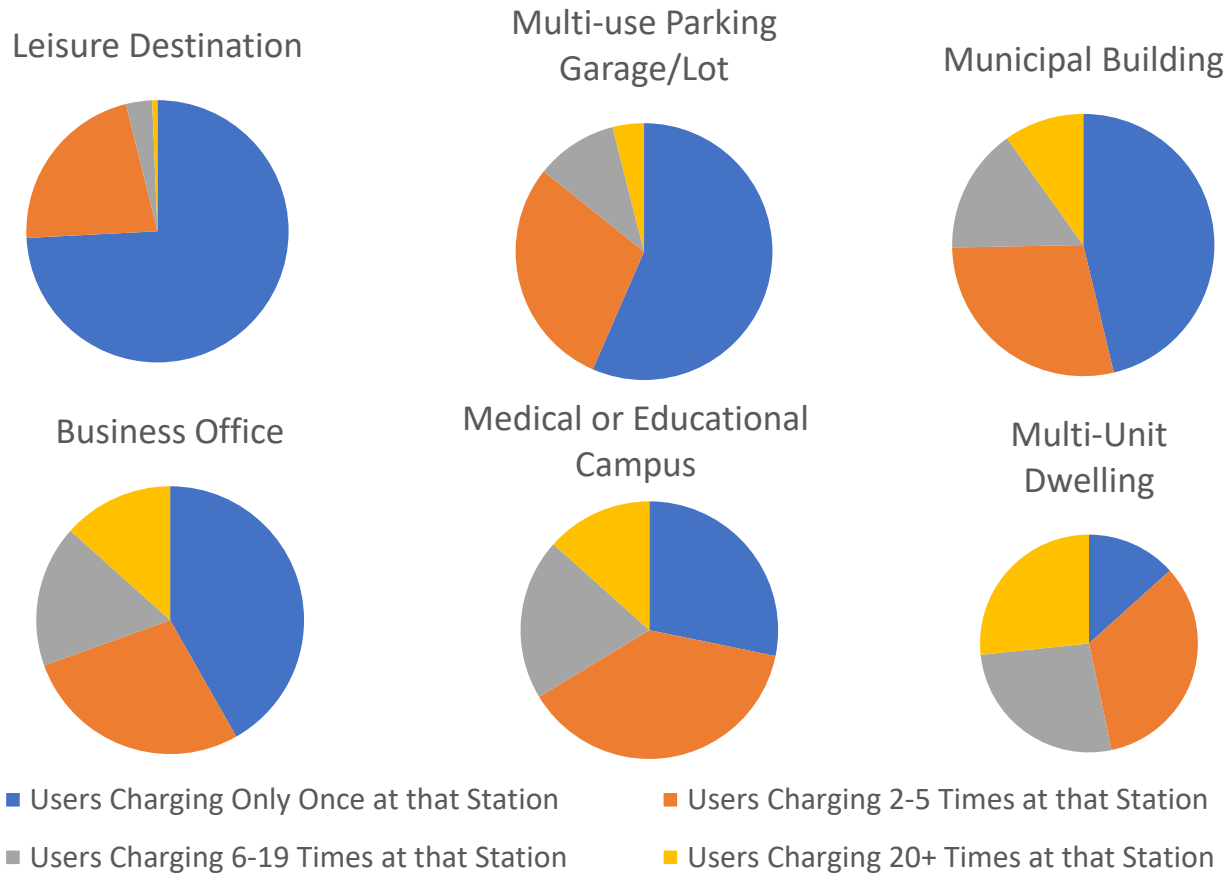


Unique EV Drivers Using the Program Charging Stations

Unique Users: The total number of unique users at Program charging stations consistently increased, but the rate of station installations was slightly higher so the average number of unique users per station decreased slightly throughout the year.



Average Portion of Frequent Users: Different charging station venues will be used by a variety of different users, many of which might only charged there once (i.e., Leisure Destination, Multi-use Parking), while other venues are used by the same EV drivers many times throughout the year (i.e., Multi-Unit Dwelling, Medical/Educational).



Detailed Level 2 Charging Station Usage Statistics

Venue Type	Ports	Total Days of Port Availability	Charging Events (CE)	Charging Events per day	Plug-in Time		Charging Time		% of Plug-in time charging	Total Energy (kWh)	Energy per CE (kWh)
					Hours	Hours per CE	Hours	Hours per CE			
Business Office	89	16,369	7,377	0.5	51,345	7.0	18,915	2.6	37%	88,188	12.0
Multi-use Parking Garage/Lot	43	5,955	6,225	1.0	18,193	2.9	13,873	2.2	76%	78,912	12.7
Municipal Building	12	3,456	2,935	0.8	9,989	3.4	6,485	2.2	65%	36,040	12.3
Medical or Educational Campus	11	2,475	2,047	0.8	6,333	3.1	4,269	2.1	67%	25,104	12.3
Multi-Unit Dwelling	9	1,893	662	0.3	4,816	7.3	2,618	4.0	54%	13,838	20.9
Fleet	2	730	395	0.5	4,600	11.6	1,031	2.6	22%	5,050	12.8
Leisure Destination	18	3,094	323	0.1	2,316	7.2	606	1.9	26%	3,214	10.0
Retail	10	132	16	0.1	27	1.7	25	1.6	92%	148	9.2
Transit Facility	4	526	8	0.0	84	10.5	29	3.6	34%	93	11.6
Hotel	0	0	0	0.0	0	0.0	0	0.0	0%	0	0.0

Region	Ports	Total Days of Port Availability	Charging Events (CE)	Charging Events per day	Plug-in Time		Charging Time		% of Plug-in time charging	Total Energy (kWh)	Energy per CE (kWh)
					Hours	Hours per CE	Hours	Hours per CE			
Boston Metro	128	22,966	16,378	0.7	81,277	5.0	40,364	2.5	50%	214,853	13.1
Western	54	8,586	2,116	0.2	10,146	4.8	4,884	2.3	48%	22,198	10.5
Southeast	16	3,078	1,494	0.5	6,280	4.2	2,604	1.7	41%	13,537	9.1

Land Use Type[4]	Ports	Total Days of Port Availability	Charging Events (CE)	Charging Events per day	Plug-in Time		Charging Time		% of Plug-in time charging	Total Energy (kWh)	Energy per CE (kWh)
					Hours	Hours per CE	Hours	Hours per CE			
Urban	168	27,517	18,137	0.7	92,224	5.1	44,406	2.4	48%	235,454	13.0
Rural	30	7,113	1,851	0.3	5,479	3.0	3,446	1.9	63%	15,133	8.2
Highly Rural	0	0	0	0.0	0	0.0	0	0.0	0%	0	0.0

[4] *Utilizes the US Census Bureau's definition for "Urban", "Rural" and "Highly Rural" (www.ruralhealth.va.gov/about/rural-veterans.asp)*
- Urban Area: population density of at least 1,000 people per square mile.
- Rural Area: Any non-urban or non-highly rural area.
- Highly Rural Area: An area having less than 7 people per square mile.