COMMONWEALTH OF MASSACHUSETTS

DEPARTMENT OF PUBLIC UTILITIES

DIRECT TESTIMONY OF JENNIFER A. SCHILLING

EXHIBIT ES-JAS-1

IN SUPPORT OF
NSTAR ELECTRIC COMPANY
d/b/a EVERSOURCE ENERGY

2022-2025 ELECTRIC GRID MODERNIZATION PLAN
OVERVIEW

July 1, 2021

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DIRECT TESTIMONY OF
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I. INTRODUCTION

Q. Please state your name and business address.

A. My name is Jennifer A. Schilling. My business address is 247 Station Drive, Westwood, Massachusetts.

Q. By whom are you employed and in what capacity?

A. I am the Vice President of Grid Modernization for the Eversource Energy operating companies, including NSTAR Electric Company d/b/a Eversource Energy ("Eversource" or the "Company"). As Vice President of Grid Modernization, I am responsible for Grid Modernization Plan ("GMP") investment portfolio management, as well as the coordination and implementation of the GMP investment programs. I am responsible for developing strategies to increase the capacity of the Company's distribution system to optimize the integration of distributed energy resources, while improving the safety, security, reliability, and cost-effectiveness of the system.

Q. Please describe your education and professional background.

A. I graduated with a Bachelor of Arts degree in environmental science and political science from Barnard College, Columbia University in 1995. In 2001, I earned a Master of Business Administration from Duke University.

From 2001 to 2008, I held several positions at Reliant Energy in Houston Texas, ending my tenure in the position of Director, Corporate Strategy. In 2008, I joined the Northeast Utilities System as the Director of Business Planning for Western Massachusetts Electric Company ("WMECO"). I subsequently accepted the role of Director, Asset Management for WMECO and then Director, Distribution Engineering for Eversource. From there, I became the Director of Grid Modernization before assuming my current role.

Q. Have you previously testified in regulatory proceedings before the Department?

A. Yes. I have sponsored testimony before the Department of Public Utilities (the "Department") in several dockets in relation to grid-modernization and distribution planning matters as part of different proceedings, including D.P.U. 17-05 and D.P.U. 15-122.

Q. Please explain the purpose of your testimony in this proceeding.

A. In this filing, Eversource is presenting its 2022-2025 GMP in accordance with the Department's decisions in Petition of NSTAR Electric Company and Western Massachusetts Electric Company, each d/b/a Eversource Energy for Approval by the Department of Public Utilities of their Grid Modernization Plan, D.P.U. 15-122 (May 20, 2018); and Grid Modernization – Phase II, D.P.U. 20-69-A (May 21, 2021).

My testimony is designed to introduce the Company's filing, including discussion of the various components of the 2022-2025 GMP and the approach and philosophy that Eversource has applied in developing the 2022-2025 GMP. Lastly, my testimony discusses

the implementation schedule for the 2022-2025 GMP ultimately approved by the Department.

Q. How is your testimony organized for this purpose?

A. Section I of my testimony is the introduction. Section II discusses the components of the Company's 2022-2025 GMP filing, as well as the overall approach and philosophy inherent in the 2022-2025 GMP. Section III discusses issues relating to the timeline for the Department's review of the 2022-2025 GMP, as well as the Company's implementation of the 2022-2025 GMP approved by the Department. Section IV is the conclusion.

Q. What is the overall structure in this filing in relation to presentation of the GMP?

A. The source document for the 2022-2025 Eversource Grid Modernization Plan is presented as Exhibit ES-JAS-2. The source document includes all components of the Company's 2022-2025 GMP, including a summary of lessons learned and progress to date relative to 2018-2021 GMP implementation. The material presented in the 2022-2025 GMP source document was developed by the Eversource grid modernization management team. Further, the Company is presenting a proposal for Advanced Metering Infrastructure ("AMI") investments and an implementation schedule for these investments. The Company's discussion on the AMI investments and implementation schedule are discussed in Exhibit ES-AMI-1, as well as associated exhibits.

II. GMP COMPONENTS

Q. What are the Department's stated objectives of grid modernization?

A. The Department's stated objectives for grid modernization are to achieve functionality falling into three broad areas: (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.

For the first objective, the Department has stated that the objective of reducing the effect of outages will be primarily met through the deployment of grid-facing technologies that enable companies to attain optimal levels of grid visibility, remotely command and control their grid assets, and have a self-healing grid. Id. at 100. The Department also found that, in addition to reducing the effect of outages, the deployment of grid-facing technologies will establish the foundation by which the Company can: (1) improve power quality; (2) facilitate the interconnection of distributed energy resources; (3) reduce system losses; (4) improve workforce productivity (e.g., by allowing a company to identify with greater certainty the location and cause of a fault on its system); and (5) improve asset utilization (e.g., by allowing a company to manage the loading of distribution assets such as transformers, thus allowing a company to extend the useful life of its existing distribution assets). Id. at 100-101.

For the second objective, the Department seeks the deployment of customer-facing technologies that will facilitate the reduction of peak demand by allowing customers to respond to price signals regarding the time-varying cost of electricity. Id. at 101. In addition to allowing consumers to lower their electric bills, price-responsive usage will provide system-wide benefits by reducing the need for investments in new generation, transmission, and distribution facilities. Id. at 101-102.

For the third objective, the Department found that grid modernization will enable the safe interconnection and full integration of greater quantities of intermittent DER, which is a key to achieving the Commonwealth's climate goals and requirements. Id. at 102. The Department also stated that, in a modern grid, DER will be able to interact with the distribution system to provide both supply and reliability benefits. Id. at 12-13.

Q. Are these objectives still consistent with circumstances present on the Eversource distribution system, even after the implementation of the 2018-2021 GMP?

A. Yes. The foundation the Company has developed as a result of 2018-2021 GMP implementation has been shaped by pursuit of the Department's grid modernization objectives. Outcomes resulting from 2018-2021 GMP implementation have placed the Company in the position to pursue new investments that will further these objectives throughout the 2022-2025 GMP and in future GMPs. Since 2018, many of the trends driving the need to modernize the distribution system consistent with the Department's

objectives have accelerated, increasing the sense of urgency associated with modernizing the distribution system.

Massachusetts continues to be at the forefront of policy initiatives that support the advancement of energy efficiency and clean energy resources. In the last few years, Massachusetts has established several aggressive clean energy initiatives that have set in motion an important transition to a cleaner energy future for the state. Programs such as the Solar Massachusetts Renewable Target ("SMART") and the Massachusetts Clean Peak Energy Standard will continue to drive deployment of small and large-scale solar and energy storage facilities. Also, on March 26, 2021, Governor Baker signed into law Chapter 8 of the Acts of 2021, An Act Creating a Next Generation Roadmap for Massachusetts Climate Policy ("Climate Act"). Among other things, the Climate Act establishes new interim goals for emission reductions and a commitment to achieve net zero greenhouse gas emissions by 2050. As a result, the urgency of grid modernization has grown rapidly due to these public policy initiatives and advancing technologies.

Transforming the grid to enable a cleaner energy future in line with policy goals, while maintaining safety, security, reliability, resiliency, and cost-effectiveness will require even more targeted investments aimed at addressing barriers to clean energy technologies. The increased imperative for distributed clean energy solutions is driving progress towards achieving the Department's grid modernization objectives. The Company has continued to experience an increase in its scale of solar deployment and increasing levels of DER

penetration on the distribution system. Additionally, the objective to optimize system performance by attaining optimal levels of grid visibility, command and control, and self-healing supports a more modular and flexible grid design that improves reliability despite the increased complexity of a distribution system characterized by two-way power flow.

Operational innovation and technological advancement continue to be necessary to make a significant step forward in achieving the efficiency, reliability, and accessibility of the modern distribution system. Within that context, ensuring system reliability is maintained as new uses and new climate-related issues emerge continues to be the Company's highest priority. This requires Eversource to focus on improving the basics of keeping the system safe and reliable while at the same time deploying new technology. Investments in grid modernization technology are improving system reliability and resiliency and reducing customer exposure to storm events. For instance, as a result of investments in advanced distribution automation, on average, there 10 percent fewer customers in each "self-healing" protective zone, reducing the probability that a weather event will affect customers.

However, since the Company's initial 2018-2021 GMP, key drivers of grid modernization have evolved to accommodate the Company's experiences with its 2018-2021 GMP, as well as the Commonwealth's priority to implement clean energy solutions. The key drivers include more aggressive clean energy targets, cost declines in DER technologies, and customer demand for reliability and resiliency is increasingly shaped by dependence on

electric devices, including electric vehicles ("EVs"). The Company's 2022-2025 GMP leverages investments and lessons learned from the 2018-2021 GMP to make additional important advances in clean energy solutions, like integrating solar and other DER, as well as increasing reliability and maximizing value to customers. There are tremendous opportunities to further modernize the grid by leveraging the currently implemented grid modernization technology and operating practices to continue to meet the goals of customers and the communities in which they reside. The 2022-2025 GMP is designed to utilize the lessons learned from the Company's previous 2018-2021 GMP and tap into further grid modernization opportunities to continue to develop a more resilient grid to the benefit of customers and the Commonwealth as a whole.

Q. What are the primary components of the Company's 2022-2025 GMP?

A. The Company's proposed 2022-2025 GMP will make additional advancements in achieving the Departments grid modernization objectives. In order to accomplish these objectives, the Company is proposing investments in the following categories: (1) Advanced Distribution Management System ("ADMS"); (2) Communications; (3) Monitoring and Control; (4) Volt VAR Optimization ("VVO"); (5) Advanced Load Flow; (6) Distributed Energy Management System ("DERMS"); (7) FERC Order 2222; and (8) Measurement, Verification and Support. The ADMS investment will complete implementation of the Distribution Management System ("DMS") project. The Communications investments consist of improvements to the Company's field area network ("FAN") and modernization of data transmission infrastructure. The Monitoring

and Control investments include substation relay upgrades and power quality monitoring. The VVO investments will expand the 2018-2021 GMP VVO program in western Massachusetts and add advanced inverter control. The Advanced Load Flow programs include interconnection automation, probabilistic power flow modeling and foundational investments in data analytics. DERMS investments will demonstrate technology capable of dispatching DER based on real time conditions as modeled by the DMS. FERC Order 2222 investments will increase capabilities required to successfully implement new responsibilities associated with enabling participation of aggregated DER in the wholesale market. The Measurement, Verification and Support investments will provide for on-going operational system support and maintenance, program management, and third-party measurement and verification.

In addition, the Company is also proposing to implement AMI investments, which are needed to provide benefits and meet the changing needs of customers and establish an additional foundation for the Company to continue to modernize its distribution system consistent with the Department's grid modernization goals and the Commonwealth's energy and environmental policies.

Q. What are the specific criteria that the Company has applied to develop its 2022-2025 GMP in furtherance of the Department's objectives?

A. In developing the 2022-2025 GMP, Eversource applied several criteria to determine the structure and approach of the 2022-2025 GMP. These criteria are:

(a) Achieve the Department's Grid Modernization Objectives

The Company has placed particular emphasis on technologies and investments that achieve multiple grid modernization objectives simultaneously, and each of the investments included in the 2022-2025 GMP satisfy multiple objectives to a certain extent.

(b) Maintain Focus on Customer Needs and Advancement in Customer Education

In keeping with its core focus, Eversource developed the 2022-2025 GMP by putting the customer at the center of its new grid modernization efforts. The Company's customers' key expectations are service reliability, shorter outage restoration times and lower, stable prices, and the Company continually strives to deliver these benefits. 2022-2025 GMP investments that improve reliability and resiliency, optimize demand, increase system efficiency, and integrate DER will provide these benefits to customers across the Eversource system.

(c) Implement Cost-Effective Investments to Maximize Value to Customers

Given the rate at which technology is advancing and the turnover on technologies, it is critical to identify and invest in technologies and programs that will deliver meaningful and sustainable benefits over the full life of the asset. The Company has identified those investments which have value to customers and will increase its ability to serve them in a safe, reliable, and cost-effective manner through an ever-changing distribution grid.

(d) Advance State Policy Goals

In developing the 2022-2025 GMP, Eversource sought to continue making a meaningful contribution to advancing state energy and environmental policy goals. As described

above, Massachusetts has been at the forefront of policy initiatives that support the advancement of energy efficiency and clean energy resources. Absent more accelerated investment to modernize the grid, it will become increasingly challenging to support customer demand and reduce environmental impact. Eversource is an active partner in achieving the Commonwealth's goal of increasing the penetration of DER. Many of the investments included in the 2022-2025 GMP are directly focused on making DER, inclusive of energy storage, an integral part of a dynamic grid optimized for two-way power flow.

(e) Leverage Grid Modernization Experience

Under its 2018-2021 GMP, Eversource successfully invested in a suite of grid modernization technologies designed to continue to advance achievement of the Department's grid modernization objectives. The best practices and lessons learned in connection with this initial GMP investments, influenced the development of the 2022-2025 GMP and allowed the Company to analyze new and emerging technologies based on a foundation grounded on practical experience.

(f) Adopt Transformational Technologies

The 2022-2025 GMP includes further deployment of transformational technologies that make a meaningful contribution to supporting innovation and finding new and smarter ways to deliver benefits to Eversource's customers. In the 2018-2021 GMP, the Company made significant advances in sensing, communication, and remote intelligence through the following programs: Advanced Sensing, Automated Feeder Reconfiguration, Urban

Underground Automation, Distribution System Network Operator and Communications. With further advances in sensing, communication, and remote intelligence, Eversource will be positioned to leverage newer technologies to deliver the benefits of an increasingly modernized grid. This is particularly important given the increasing complexity of the grid due to technological advancements in power distribution equipment and the proliferation of DER.

(g) Establish a Flexible Foundation for the Future

The 2018-2021 GMP was developed to set the groundwork for further advanced grid modernization using a common platform of investments. Each investment included in the 2018-2021 GMP has provided a strong foundation for the future evolution of the modern grid. For example, over the last three years, the Company has added over 1,400 devices on the system that provide remote visibility used to maintain reliability despite the increase in two-way power flow resulting from high penetrations of DER. The 2022-2025 GMP will build upon this foundation to further modernize the grid, providing benefits to customers and aligning with the clean energy initiatives in the Commonwealth. The proposed investments are designed to reliably integrate into the current system, but to also provide the needed flexibility to adapt to changes in the technology landscape to support further innovation over time.

Q. Has the Company completed any of the programs included in its 2018-2021 GMP?

A. Yes. Grid Modernization Completed Investments include authorized investments that have achieved their grid modernization objectives and will continue as needed as a part of the

Company's business as usual work plan. The investments that the Company has included as completed for Grid Modernization purposes are Distribution Line SCADA, Automated Feeder Reconfiguration, and Urban Underground Automation. These investments are further outlined in Exhibit ES-JAS-2.

Q. What are the investments previously deployed in the 2018-2021 GMP that the Company is proposing to continue in its 2022-2025 GMP?

A. The Company is proposing to continue the following six investments in its 2022-2025 GMP:

- DMS - Control room technology to model as-operated distribution system power flows based on real time field device telemetry. The DMS investment includes advanced applications that leverage the power flow model to increase the safety and reliability of the distribution system.

- Wireless Communications System Improvements - Augmentation of the Company's existing FAN to increase capacity for transmission of data from field devices to the Company's real time operational systems, including the DMS. This investment builds upon gains made with the deployment of wireless "nodes" as a part of the 2018-2021 GMP.

- Substation Automation - Continuation of programs to upgrade feeder relay technology in the Company's bulk substations and add feeder relays in

distribution substations. This program provides improved visibility and automation capabilities to critical substation assets.

- Power Quality Monitoring - Deployment of continuous monitoring devices on feeders and other substation equipment to provide detailed and granular data for infrastructure serving commercial and industrial customers with sensitive equipment.

- VVO - Expansion of existing program deployed in Western Massachusetts to reduce demand, increase system efficiency, and integrate DER with software and remotely operated distribution equipment that actively manages system voltage.

- Program Management and Measurement and Verification - Funding for resources responsible from managing grid modernization programs, including tracking and reporting. Investment also includes continuation of support for third-party measurement and verification activities.

These investments are further outlined in Exhibit ES-JAS-2.

Q. What are the new categories of investments the Company is proposing for inclusion in its 2022-2025 GMP?

A. Since the Company initiated its GMP, numerous developments have shaped the landscape for investments in people, process, and technology required to support reliability, resiliency, and clean energy objectives. New policies in the Commonwealth have

increased the sense of urgency around ensuring that the distribution grid can enable, rather than inhibit, the growth in renewable resources, EV, and other forms of beneficial electrification. To address these and other emerging developments, the Company is proposing the following eight new investments in its 2022-2025 GMP:

- DERMS - Control room tools to manage, monitor and dispatch DER based on real-time system conditions modeled in the Company's DMS. This investment includes development of operational forecasting capabilities to predict near-term (hour-ahead, day-ahead) load and generation impact on power flows based on weather conditions.
- Communications System Modernization - This program will initiate implementation of an end-to-end solution based on industry-standard protocols and data concentration tools is needed to ensure investments in the FAN will be supported by a completely robust and modern data path into the Company's real-time systems.
- Probabilistic Power Flow Modeling - In combination with other grid modernization investments in modeling and forecasting, the addition of tools for the robust study of various potential outcomes related to locational changes in load and generation.
- Analytics Platform – These foundational investments in data storage and processing will enable advanced analysis of extremely large data sets.
- Interconnection Automation - These investments include software tools that build upon advanced load flow and other planning tools to increase the efficiency of the DER impact study process.

- Congestion Management – These investments provide support for eventual implementation of programs to dispatch DER for multiple use cases, including the dispatch of aggregated small scale DER as contemplated by FERC Order 2222. These investments will include a state-wide investigation of approaches for optimizing dispatch based on real-time system conditions.

- System Support and Maintenance – This funding will provide engineering resources necessary to support control room systems with a focus on DMS model maintenance, optimization functions, including VVO, and system planning modeling and forecasting tool maintenance and improvements.

Each of these investments are further outlined in Exhibit ES-JAS-2.

Q. Is the Company including a revised GMP cost recovery tariff with its filing?

A. Yes. The Company is providing a revised Grid Modernization Factor ("GMF") cost recovery tariff to reflect the change from a three-year GMP to a four-year GMP. D.P.U. 20-69-A, at 28, 39. This revised tariff is being provided as Exhibit ES-JAS-3 (clean) and Exhibit ES-JAS-4 (redline).

III. TIMING OF DEPARTMENT REVIEW

Q. What is the Company's expectation regarding the scope and timing of the Department's review of the 2022-2025 GMP?

A. Eversource recognizes that electric grid modernization is a complex and multi-faceted undertaking that has engendered the continuing interest and participation of a broad range

of stakeholders. Eversource also recognizes that the Department will need time to thoroughly investigate the Company's filing (in conjunction with other grid modernization filings) and to render a final decision on the elements of the Company's 2022-2025 GMP plan.

However, the Company is proposing that several investment categories that have been previously preauthorized and deployed in the 2018-2021 GMP continue as part of its incremental Grid Modernization efforts in 2022 and beyond. The Department has directed the Company to identify any proposed investments in grid-facing technologies that have been previously deployed and/or preauthorized, including separate itemized budgets, testimony, and supporting documentation. D.P.U. 20-69-A, at 37. Because the Department has reviewed these investment categories before, the Department expects that its investigation of any previously deployed and/or preauthorized technologies can be streamlined. Id.

Therefore, the Company is requesting streamlined review of its previously deployed investment categories that are being proposed for implementation in 2022. Ideally, the Company would need a decision by December 2021 to avoid disruptions in the overall GMP implementation.

Q. What proposed investment categories to be implemented in 2022 were previously deployed in the Company's 2018-2021 GMP?

A. The Company is proposing to invest in multiple different programs that were deployed and preauthorized in the Company's 2018-2021 GMP. These include investments in DMS,

Wireless Communications, Substation Automation, Power Quality Monitoring, VVO, and Program Management and Measurement and Verification. These continuing investments are further outlined in Exhibit ES-JAS-2.

Q. Why is it important for the Department to streamline its review of the investment categories proposed in 2022 that were previously deployed in the Company's 2018-2021 GMP?

A. The Commonwealth of Massachusetts has worked incredibly hard over the past ten years to provide the impetus for a successful transition to a modernized electric grid characterized by systems that are designed to handle severe weather and robust interconnection of DER, among other goals. The Company's work through its approved 2018-2021 GMP to accommodate the amount of DER connected to or looking to connect to the Company's system is a fundamental prerequisite to the success of this vision. The Department's regulatory process to oversee and authorize grid modernization investments must align with the gravity, breadth, and complexity of the work currently underway by providing a stable and consistent funding process. Loss of funding or funding uncertainty for calendar year 2022 has the potential to disrupt the Company's ongoing GMP investments and would be highly detrimental to the interests of customers and others relying on the Company's grid modernization initiatives.

For example, loss of key contractor labor in project management would result in considerable costs and delays. The Company has engaged multiple contracted project management resources that have had to learn the Eversource processes and requirements

(at a cost). The experience and expertise that these individuals provide is vital to keep costs down and ensure projects are completed on schedule. Their knowledge of and familiarity with the Eversource system acquired over the previous two and a half years would be completely lost if they had to be re-assigned to other projects and the resources required to train new project management resources would be considerable.

Further, loss of key contractor labor in engineering and information technology ("IT") will substantially disrupt the continuation of the Company's GMP. Loss of contracted resources would increase costs required to re-bid contracts, on-board new resources and train them on Eversource policies and systems. In addition to the added financial cost, it would likely add over three months of demobilization and remobilization time.

Due to this, the delays in customer benefits would be substantial. If the VVO program is disrupted, for instance, the Company will not have resources to continue to expand the number of feeders under VVO control, delaying important benefits to customers. Further, projects expected to be completed by the end of 2022 that will bring substantially more benefits to customers will be delayed and may not be implemented until 2023.

For these reasons, the Company is seeking expedited review and approval of the investment categories outlined above to ensure continuity in its GMP and the seamless and uninterrupted provision of benefits to customers.

IV. CONCLUSION

Q. Does this conclude your testimony?

A. Yes, it does.

2021

2022-2025 Grid Modernization Plan

Docket No. D.P.U. 21-80

July 1, 2021

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I. INTRODUCTION

NSTAR Electric Company d/b/a Eversource Energy ("Eversource" or the "Company")[1] is presenting its 2022-2025 Grid Modernization Plan ("2022-2025 GMP" or the "Plan") for review and approval by the Department of Public Utilities (the "Department"). Eversource has always been, and continues to be, at the forefront of implementing new technologies to further improve service to customers and lessen/mitigate the impact of outages on customers. The Company has endeavored to be a catalyst for clean energy initiatives and supports the important public policy goals that are providing the strong impetus to modernize the electric grid, including goals designed to promote energy efficiency, clean transportation, energy-storage deployment and clean energy resources, among other initiatives. The Department's Grid Modernization investigation and subsequent approval of the Company's first Grid Modernization Plan ("GMP") through 2021 ("2018-2021 GMP")[2] has enabled the Company to further expand its efforts on behalf of 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 extended the 2018-2020 GMP through December 31, 2021, and subsequently approved the Company's petition for additional funding for the extension through 2021. Petition of NSTAR Electric Company and Western Massachusetts Electric Company, each d/b/a Eversource Energy for Approval by the Department of Public Utilities of their Grid Modernization Plan, D.P.U. 15-122-D, at 4 (2020)("D.P.U. 15-122-D"); NSTAR Electric Company d/b/a Eversource Energy, D.P.U. 20-74 (2020 Grid Modernization Program Extension and Funding Report at 6).

customers in making significant strides to achieve critical Massachusetts energy and environmental policies.

Recognizing the importance of grid modernization relative to the transition to a distributed clean energy future, Eversource placed a priority on planning and implementing its 2018-2021 GMP while ensuring no lapse in continuing its traditional grid-facing investments. Grid modernization implementation activities have been organized to ensure the Company maximizes value to customers while ensuring a balanced portfolio of initiatives that address each of the Department's grid modernization objectives. The Company has established a grid modernization program management structure that is focused on following efficient processes for planning, engineering, construction, and commissioning of grid modernization programs.

This program management structure also drives robust tracking and reporting procedures to ensure that progress relative to scope, schedule and budget are visible across the organization, including at the leadership levels. This dedication to tracking and reporting has enabled sound decision making with respect to ensuring efficient and maximum progress on the 2018-2021 GMP portfolio, while identifying areas of improvement for the Company's 2022-2025 GMP. By the end of 2021, Eversource is on track to meet or exceed most targets approved for the Company's current GMP through 2021 and will be prepared to begin the implementation of its 2022-2025 GMP proposed herein.

II. PROCEDURAL BACKGROUND

In October 2012, 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). The Company was an active and engaged partner in the Department's long-running investigation, bringing its expertise and innovation to bear on the effort. 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 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.[3] Petition of NSTAR Electric Company and Western Massachusetts Electric Company, each d/b/a Eversource Energy for Approval by the Department of Public Utilities of their Grid Modernization Plan, D.P.U. 15-122, at 106.

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.

On May 12, 2020, the Department issued a decision extending the 2018-2020 GMP through December 31, 2021 to provide the Distribution Companies with the flexibility to adjust their respective GMPs through 2020 and reschedule any planned deployments that were delayed through 2021 due to COVID-19, or other factors. Petition of NSTAR Electric Company and Western Massachusetts Electric Company, each d/b/a Eversource Energy for Approval by the Department of Public Utilities of their Grid Modernization Plan, D.P.U. 15-122-D, at 4 (2020) ("D.P.U. 15-122-D"). In its decision, the Department stated that, if the Distribution Companies experienced budget constraints related to authorized GMP investments as a result of the extension, they were authorized to petition the Department for an expansion of the Department approved 2018-2020 GMP budget. D.P.U. 15-122-D at 7.

On July 1, 2020, Eversource petitioned the Department for authorization of a budget extension of $56 million for the 2018-2021 GMP term, apportioned within the five investment categories previously authorized by the Department for Advanced Sensing, Automated Feeder Reconfiguration, Urban Underground Automation, Distribution System Network Operator and Communications. NSTAR Electric Company d/b/a Eversource Energy, D.P.U. 20-74 (2020 Grid Modernization Program Extension and Funding Report at 6). In support of its petition, the Company noted that it expected to successfully complete its authorized 2018–2020 GMP by the

end of 2020, having met or exceeded most targets and demonstrated progress relative to many of the ongoing metrics of grid modernization value and performance (id. at 5). Following its investigation, the Department approved, with certain modifications, the Company's petition. D.P.U. 20-74, at 41-42.

On July 2, 2020, the Department initiated the second phase of its inquiry into the modernization of the electric grid. Grid Modernization – Phase II, D.P.U. 20-69-A (the "Order"). In the Order, the Department provided directives and guidance on the investments that the Distribution Companies will incorporate into their next GMP filings. Id. at 1. The Department required each of the Distribution Companies to file a grid modernization plan on or before July 1, 2021, including the directives and guidance included in the Order. Id. at 55. In accordance with the Order, the Company hereby submits it 2022-2025 GMP.[4]

III. EVERSOURCE'S GRID MODERNIZATION PLAN OVERVIEW

A. State of the Grid

Massachusetts continues to be at the forefront of policy initiatives that support the advancement of energy efficiency and clean energy resources. In the last few years, Massachusetts has established several aggressive clean energy initiatives that have set in motion an important

[4] The Department will extended the three-year grid modernization plan investment term to include calendar year 2025. D.P.U. 20-69-A at 38.

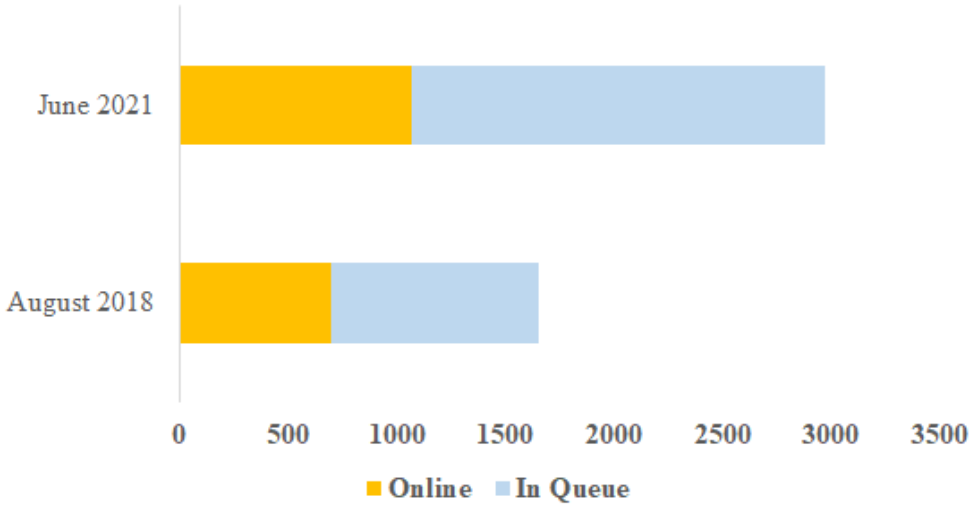
transition to a cleaner energy future for the state. Programs such as the Solar Massachusetts Renewable Target ("SMART") and the Massachusetts Clean Peak Energy Standard will continue to drive deployment of small and large-scale solar and energy storage facilities. Further, on March 26, 2021, Governor Baker signed into law Chapter 8 of the Acts of 2021, An Act Creating a Next Generation Roadmap for Massachusetts Climate Policy ("Climate Act"). Among other things, the Climate Act establishes new interim goals for emission reductions and a commitment to achieve net zero greenhouse gas emissions by 2050. As a result, the urgency of grid modernization has grown rapidly due to these public policy initiatives and advancing technologies.

The increased imperative for distributed clean energy solutions are driving the need for continued pursuit of the Department's grid modernization objectives. When implementing its 2018-2021 GMP, Eversource was actively engaged in driving progress relative to these objectives. The objective to optimize system performance by attaining optimal levels of grid visibility, command and control, and self-healing supports a more modular and flexible grid design that improves reliability despite the increased complexity of a distribution system characterized by two-way power flow. The Company has provided visibility and automation to almost 250 substation feeder breakers, added visibility to over 180 existing automation devices, increased visibility by installing over 150 line sensors and deployed 370 new automated switches to improve the self-healing capacity of both the overhead and underground system. With these advanced sensors and automation devices, the increasingly modern grid has provided much improved situational awareness for system operators, better positioning them to adapt and respond to real-time conditions. Eversource has also focused a significant portion of its grid-facing investment

portfolio on deploying a Volt VAR Optimization program ("VVO") on 26 feeders in its western Massachusetts service territory. These investments have improved system efficiency, reduced peak demand and line losses.

Additionally, the Company continues to experience an increase in its scale of solar deployment and increasing levels of distributed energy resource ("DER") penetration on the distribution system. Since August 2018, the Company has interconnected over 13,000 additional solar and solar plus battery generation facilities, for a total of 52,000 solar and solar plus battery generation facilities interconnected to the system. These facilities represent over 350 MW of incremental capacity. Further, the number of facilities waiting to interconnect to the system increased twofold. In August 2018, the Company had 690 MW of solar generation online and 950 MW in queue. By June 2021, this had increased to 1,066 MW online and 1,900 MW in queue.

Figure 1: MA Solar and Solar + Battery Online and In-Queue (Megawatts)



Therefore, since the Company's initial 2018-2021 GMP, key drivers of grid modernization have evolved to accommodate the Company's experiences with its first GMP, as well as the Commonwealth's priority to implement clean energy solutions. The key drivers include more aggressive clean energy targets, cost declines in DER technologies, and customer demand for reliability and resiliency is increasingly shaped by dependence on electric devices, including electric vehicles ("EVs"). The Company's second proposed Plan leverages investments and lessons learned from the 2018-2021 GMP to make additional important advances in integrating solar and other DER, maximizing value to customers by tapping into further grid modernization opportunities to continue to develop a more resilient grid to the benefit of customers and the Commonwealth as a whole. There are tremendous opportunities to further modernize the grid by leveraging the currently implemented grid modernization technology and operating practices to continue to meet the goals of customers and the communities in which they reside.

B. Key Guiding Principles

Eversource is committed to the Department's objective of achieving the cost-effective modernization of the electric distribution grid. Therefore, in developing the 2022-2025 GMP, Eversource was guided by several key principles.

1. Achieve the Department's Grid Modernization Objectives

Eversource developed its 2022-2025 GMP to continue to achieve the three grid-modernization objectives identified by the Department, which are to: (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 DER. D.P.U. 15-122, at 106.

Achieving advancements in these three objectives has provided benefits to the Company's customers through the 2018-2021 GMP and will continue to provide additional benefits into the future through the 2022-2025 GMP. Eversource fully supports these objectives and has relied on these objectives as the foundation for building its GMPs. In the process of developing the Plan, the Company placed particular emphasis on the evolving needs identified through lessons learned, as well as leveraging the technologies and investments already implemented in the 2018-2021 GMP to achieve multiple grid-modernization objectives simultaneously. In fact, all but two of the investments included in the Plan satisfy multiple objectives.

The Department's grid-modernization objectives were critical in successfully implementing the 2018-2021 GMP and the Company has developed the proposed 2022-2025 GMP with the same objectives in mind. New technologies have emerged, and the discrete and organized grid-modernization foundation the Company has developed has placed the Company in the position to pursue new investments that will further these objectives into the next Plan. Transforming the grid to enable a cleaner energy future, while maintaining safety, security, reliability, resiliency, and cost effectiveness will require more targeted investments aimed at addressing barriers to clean energy technologies. The 2022-2025 GMP provides the Company with the means to continue to modernize its distribution system while maintaining the flexibility to incorporate potential future technological advances and respond to evolving public policy goals. Such flexibility is critical to the success of the Company's endeavors on behalf of customers.

2. Focus on Customers and Advancement in Customer Education

In keeping with its core focus, Eversource developed the 2022-2025 GMP putting the customer at the center of its new grid-modernization efforts. Eversource is attuned to the fact that customers seek service reliability, shorter outage restoration times and lower, stable prices as their key energy expectations. Investments that improve reliability and resiliency; optimize demand; increase system efficiency; and integrate distributed energy resources will provide this benefit to customers across the Eversource system.

The Company developed its 2022-2025 GMP through utilizing these tools and advancements to continue improving its programs to meet customer needs both today and in the future. Eversource

has also tailored its 2022-2025 GMP programs to provide maximum value to customers by choosing investments designed to identify the lowest-cost solutions. Therefore, the Plan focuses on further technologies that modernize the grid and provide direct benefits to its customers while also controlling costs.

3. Implement Cost-Effective Investments to Maximize Value to Customers

Given the rate at which technology is advancing and the turnover on technologies, it is critical to identify and invest in technologies and programs that will deliver meaningful and sustainable benefits over the full life of the asset. The Company has identified those investment which have value to customers and will increase our ability to serve them in a safe and cost-effective manner in an ever-changing distribution grid.

Further, 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 to show cost-efficiency and customer benefits. 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 to illustrate customer benefits and cost containment.

In its "Grid Modernization Plan Statewide and Eversource-Specific Infrastructure Metrics Baselines and Targets" filing of August 2018, Eversource established infrastructure metrics, including targets for 15 categories of device deployment. Eversource has worked diligently since 2018 to meet or exceed these targets. With a continual focus on capturing opportunities to lower

costs and improve program efficiency, the Company has worked to keep unit costs in line with projections. The Company has also expanded on its proven methods for integrated planning and scheduling to integrate grid modernization programs with other infrastructure programs to maximize efficiency and maintain schedule targets for all grid-facing investments. Implementation of software programs, including the advanced load flow tool, have been characterized by similar levels of rigor with respect to maintaining scope, schedule, and budget.

The Company's performance metrics have also shown significant benefits for customers within budget. For each GMP year, the Company provides the Commonwealth's third-party measurement and verification ("M&V") consultant, Guidehouse, data supporting calculation of performance metrics and Guidehouse produces an evaluation outlining the results of the M&C, DA, Communications, and ADMS investment areas to show progress, benefits and cost-effectiveness. Thus far, the Company has demonstrated benefits in several performance metrics, including reducing the average zone size by close to ten percent and delivering the benefit of GMP-funded distribution automation devices to over 152,000 customers. This evaluation will continue for the Company's 2022-2025 GMP to illustrate that the final Plan is producing benefits for customers while being cognizant of the financial investment.

4. Advance State Policy Goals

Eversource has developed its 2022-2025 GMP to make further meaningful contributions to advancing state policy goals. As described above, Massachusetts has been at the forefront of policy initiatives that support the advancement of energy efficiency and clean energy resources.

Absent more accelerated investment to modernize the grid, it will become increasingly challenging to support customer demand and while reducing environmental impact. Eversource has been an active partner in achieving the Commonwealth's goal of increasing DER penetration. Many of the investments included in the 2022-2025 GMP are directly focused on making DER, an integral part of a dynamic grid optimized for two-way power flow. These include investments in the distribution management system, the DER management system, and dynamic DER interface technology. These investments will further the Commonwealth's clean energy policies and initiatives while meeting customer demands.

5. Leverage Grid Modernization Experience

Eversource has long been a national leader in grid modernization and has invested in technologies that provide greater awareness of system conditions and automation of the grid. The Company designed and implemented its 2018-2021 GMP to advance the Department's grid modernization objectives to produce tangible benefits for customers and the Commonwealth. As discussed in more detail below, there have been several lessons learned as a result of the 2018-2021 GMP that will inform success going forward. The Company utilized a programmatic framework when implementing the GMP, and the importance of this framework and the Company's top-to-bottom commitment to the program cannot be overstated. It was this framework that allowed for real-time tracking and timely identification of real, or potential, deployment and/or financial challenges and inaccuracies. The investments and experiences identified through this framework for the 2018-2021 GMP influenced the development of the 2022-2025 GMP and allowed the Company to analyze new and emerging technologies on a robust foundation. The Company will leverage its

2018-2021 GMP to enable the successful execution of its 2022-2025 GMP to further accelerate grid-modernization investments in some instances, and to invest in new and different technologies in others.

6. Adopt Transformational Technologies

The 2022-2025 GMP also includes further deployment of transformational technologies that make a meaningful contribution to supporting innovation and finding new and smarter ways to deliver benefits to Eversource's customers. In the Company's 2018-2021 GMP, the Company made significant advances in sensing, communication, and remote intelligence through the following programs: Advanced Sensing, Automated Feeder Reconfiguration, Urban Underground Automation, Distribution System Network Operator and Communications. The Advanced Sensing program investments provide additional telemetry to support the distribution management system ("DMS"), providing a higher fidelity system model to distribution operators. Through the Automated Feeder Reconfiguration program, the Company deployed over 250 distribution automation devices, and has made substantial progress towards its sectionalizing objectives on its overhead distribution system. As a result of the Urban Underground Automation program, approximately 140 antiquated oil-filled devices have been replaced with modern vacuum fault interrupting ("VFI") switches and the Company has invested significant engineering effort to develop an advanced auto-restoration scheme for the 4 kV underground.

The path to a truly modern grid will require continued investments programs to enhance the business of delivering electricity to end-use customers. With these previous advances in sensing,

communication, and remote intelligence, Eversource is now positioned to leverage these investments and incorporate new technologies to deliver more benefits of an increasingly modernized grid in its 2022-2025 GMP. This is particularly important given the increasing complexity of the grid due to technological advancements in power distribution equipment and the proliferation of DER.

7. Establish a Flexible Foundation for the Future

The 2018-2021 GMP was developed to set the groundwork for further advanced grid modernization using a common platform of investments. Each investment included in the 2018-2021 GMP has provided a strong foundation for the future evolution of the modern grid. The 2022-2025 GMP will build upon this foundation to further modernize the grid, providing benefits to customers and aligning with the clean energy initiatives in the Commonwealth. The proposed investments are designed to reliably integrate into the current system, but to also provide the needed flexibility to adapt to changes in the technology landscape to support further innovation over time.

C. Progress to Date

All the Company's 2018-2021 GMP investments have been designed, engineered, and implemented to maximize the value of work performed for customers. Working collaboratively across internal departments and with external stakeholders, the Company has developed numerous initiatives focused on prioritizing investments, increasing implementation efficiency, and delivering favorable outcomes based on robust tracking, reporting and risk management. As a result of these efforts, the Company met or exceeded most implementation expectations for the

first three years of the 2018-2021 GMP. The Company is also making steady progress toward its implementation goals for 2021. Actual device deployment through June 2021 and 2018-2021 device projections are shown in Table 1 below.

Table 1: Device Deployment

Investment Areas and Preauthorized Device Types	Units				
	2018-2020 Actual	2021 Actual (through June)	2018-2021 Actual	2021 Plan	2018-2021 Projection
Monitoring & Control (SCADA)	**435**	**69**	**504**	**125**	**560**
Microprocessor Relay	180	22	202	57	237
4kV Circuit Breaker SCADA	54	-	54	13	67
Recloser SCADA	59	-	59	-	59
Padmount Switch SCADA	59	-	59	-	59
Network Protector SCADA	83	8	91	21	104
Power Quality Monitors	-	39	39	34	34
Distribution Automation	**451**	**15**	**466**	**151**	**602**
OH DA	243	8	251	100	343
OH DA w/Ties	53	-	53	-	53
4kV Oil Switch Replacement	137	7	144	35	172
4kV AR Loop	18	-	18	16	34
Volt-Var Optimization	**577**	**-**	**577**	**624**	**1,201**
VVO - Regulators	96	-	96	48	144
VVO - Capacitor Banks	74	-	74	32	106
VVO - LTC Controls	8	-	8	4	12
VVO - Line Sensors	189	-	189	40	229
VVO - IT Work	N/A	-	N/A	-	N/A
Microcapacitors	99	-	99	200	299
Grid Monitoring Line Sensors	111	-	111	300	411
Advanced Distribution Management System (ADMS)	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**
Communications	**8**	**1**	**9**	**6**	**14**
Numbers of Nodes	8	1	9	6	14
Miles of Fiber	-	-	-	-	-
Total	**1,471**	**85**	**1,556**	**906**	**2,377**

The following is a summary of implementation progress as of June 2021:

1. Monitoring and Control:

Monitoring and control investments were successfully deployed in support of grid operations. The Microprocessor Relay and 4kV Circuit Breaker SCADA investment types were the most significant cost drivers in this category and have required a substantial onboarding effort from both engineering and project management support teams. Unit costs were higher than the original budget but through portfolio management, costs were redistributed to this important asset and taken as a whole, the Microprocessor Relay and 4kV Circuit Breaker SCADA investments met the committed unit targets.

The three remaining distribution SCADA investments were also successful. The Recloser and Padmount SCADA investments eliminated all possible locations where communications-only upgrades were possible, and for Recloser SCADA the Company implemented a strategy to find additional existing recloser locations with older, oil-filled equipment and replace the entire device with modern equipment. The Network Protector SCADA investment included the new deployment of the Digital Grid system which provides much more insight into the Company's networked system in western Massachusetts. This investment achieved its objective while remaining under budget, allowing the Company to deploy the Digital Grid system at an additional network.

Lastly, the pilot deployment of the Fisher Block power quality monitoring investment at a large substation serving commercial and industrial customers with sensitive equipment and processes

successfully demonstrated the efficacy of a new technology to continuously monitor system conditions on a sub-cycle basis. This was a new technology to the Company and the output results will be instrumental in understanding system perturbations and allow for fruitful conversations with the affected customers, as needed. The Company is still working through the new processes and protocols regarding how and when to communicate with affected customers so that collaboration can occur on timely basis.

2. Distribution Automation:

The Distribution Automation ("DA") investments were effectively managed and deployed, exceeding targets in most areas. The Overhead DA ("OH DA") and Overhead DA with Ties ("OH DA w/Ties") were very efficiently and effectively deployed, well in excess of original targets. The addition of reclosers (OH DA) on the distribution system both provides visibility and control for system operators but also reduces customer exposure by reducing the number of customers between automated switching devices. This investment lowers the isolation count of customers via devices that act autonomously. In addition to the new recloser locations, the Company automated many manual circuit ties (OH DA w/ Ties) so that the new tie-switches would coordinate with existing automation infrastructure and provide better reliability to customer and better insight and control to system operators. DA device deployments were prioritized to focus on locations with the greatest sectionalizing benefit, considering average zone size and historical reliability.

The Company also successfully replaced older, oil-filled 4kV switches, located mostly in the Boston and greater Boston area. This was a successful program that exceeded original targets, despite the inherent challenges that come with operating within the city, all while maintaining customer service. The acceleration of this important replacement program has provided boost to the work down plan that the Company has had in place.

The Company also worked to design and engineer new technology to automate several of its underground 4kV circuits. As a part of the 4kV Auto-restoration Loop project, the Company engaged many subject matter experts both within and outside of the Company. Though the principle for automating these loops is relatively straightforward, the practical deployment has been a challenge based chiefly on the ability to effectively and accurately communicate from the newly installed substation equipment, to the various underground switches, via cellular network. The Company will continue toward commissioning this project, including an assessment of lessons learned relative to automating this critical infrastructure.

3. Volt-Var Optimization:

The Volt-Var Optimization ("VVO") investment was a new technology deployment for the Company and included the installation of SCADA-enabled feeder head and end-of-line sensors, capacitor banks, regulators, and substation load tap changers ("LTCs"). The software platform that drives the VVO automation is the Yukon, integrated volt/var controller ("IVVC") by Eaton. The Company successfully deployed and commissioned all VVO assets in Q4 of 2020 and is still

in the nine to twelve-month measurement and verification process, via the oversight and tracking from Guidehouse. Preliminary reports that indicate the VVO system is operating as intended and providing autonomous voltage reductions on the affected feeders.

The successful implementation of the VVO investment has provided the Company with assurance that the system works and is a benefit to operations and customers. Additionally, lessons learned from the initial implementation will inform future deployments of the VVO technology. The Company plans to continue to deploy the VVO investment throughout other areas of the distribution system.

4. Communications:

The Communications investments have focused primarily on augmentation of the Company's existing private radio system with the addition of new wireless "nodes". The Company analyzed its existing infrastructure and reviewed a set of new locations in which an existing node was upgraded to a master or a new location was installed. New or upgraded master radios improved coverage and penetration to field devices in addition to connecting directly to a fiber optic backhaul, which further increases fidelity and reduces latency. The Company intends to continue the mix of 900MHz and 450MHz master node deployment.

5. Advanced Load Flow:

The Advanced Load Flow ("ALF") was a new software deployment to create detailed computer models of the Company's distribution system. In parallel, the data sources critical to the accuracy of the models were, and will continue to be, assessed, and enhanced as necessary to leverage the

advanced functionality of the software. For example, data cleaning activities were prioritized to focus on improving data quality for equipment types most likely to support model accuracy for both the planning load flow and the DMS model. This enhancement of model data sources is critical to the operation of other functions, including VVO and ADMS.

To date, the Company has significantly improved its distribution modeling capability. An automated model build process from the most recent GIS configuration, as well as other up to date, active data sources, improves the Company's ability to perform system planning studies across the entire distribution network. Engineers will spend less time assembling the models and more time assessing results from future changes and additions. This model build process will also be a key enabler of future automated analyses involving large numbers of circuits.

6. Performance and Implementation Metrics:

To date, the Company has made measurable progress toward its grid modernization objectives during the 2018-2021 GMP. This progress has been tracked and measured using the established performance and infrastructure metrics, along with the addition of case studies where GMP devices were involved in specific outage events. As mentioned in previous sections, The Company works with Guidehouse to measure and verify the effectiveness of GMP investments.

Clear progress has been made toward optimizing system performance through investments made under the OH DA programs during the 2018-2021 GMP. Circuits targeted for OH DA investments experienced an average zone size reduction of approximately 250 customers during the 2018-2021 GMP. The average customer zone size across the entire system decreased by about 10% during

the same time period. These decreases in average zone size can be attributed to the accelerated deployment of OH DA devices under the GMP. The Company estimates that almost 200,000 customers have benefited from these programs.

Measurable progress has also been captured through tracking the System Automation Saturation and Circuits with Installed Sensors metrics. The System Automation Saturation metric measures automation saturation levels for customers served by partially and fully automated devices. Since the baseline was recorded in 2018, the score has decreased from 247.1 to 170.8. This is an improvement of 76.3 over the baseline. The Company also measured a moderate increase in circuits with installed sensors.

The reliability impact of M&C and DA devices proved challenging to measure using the defined reliability metrics. The Company and Guidehouse determined that the effect of GMP devices was difficult to discern due to many external factors that affect reliability but are not GMP related. For example, storm activity, major event classification, and circuit reconfigurations vary from year to year, making it difficult to clearly measure reliability benefits directly from the GMP devices, at the circuit and system level. Because of this challenge, the Company worked with Guidehouse to perform case analyses on real outage events that involved GMP devices. The Company gathered and shared OMS data, one-line diagrams, SCADA data, switching orders, and any other relevant data for specific outage events that were selected by Guidehouse for their evaluation. The case studies were intended to help demonstrate whether the GMP device(s) added any value during the selected outage events. Guidehouse determined that the devices evaluated showed improvements

in reliability. Further details on each case study can be found in Guidehouse 2020 Evaluation Reports.

As noted earlier in this document, the Company's and Guidehouse's preliminary reports have shown realized benefits from the VVO investments. Early figures show the Company has realized energy savings and voltage reductions on feeders where VVO is enabled. Further details on these benefits are discussed within the VVO section of this document as well in Guidehouse's 2020 Evaluation Report.

D. Other Lessons Learned

The Company has derived many important lessons and insight from the execution of its 2018-2021 GMP. First and foremost, the Company has realized that following a disciplined planning and scheduling processes is essential to managing scope, schedule, and budget, which includes ensuring engineering and procurement of long-lead materials well in advance of construction to allow for optimal project execution. Further, the Company has found that developing effective communication at the outset, in departmental hand-offs for complex tasks, such as commissioning, supports more efficient deployments. Also, having defined and definitive completion milestones during project development is key to optimizing scheduling of internal and contracted field resources.

Additionally, the Company understands deployment of new technologies will inevitably involve unforeseen challenges that will stress schedule and budget. However, setting detailed requirements and statements of work up-front with technology vendors enables more rapid issue

resolution as concerns arise. Allowing the project team in charge of new technology deployments the ability to change their paradigm from a "design, then build" philosophy to an "iterative design, then build" process also produces creative resolutions.

Lastly, the complexities associated with information technology / operational technology ("IT/OT") projects require sufficient, and often extensive, lead time planning and up-front costs. Therefore, implementation of real-time systems used by System Operations are particularly challenging and have far-reaching consequences outside the control room, including the need for ongoing training and systems-maintenance. The Company plans to utilize this knowledge and the lessons learned from the 2018-2021 GMP to develop solutions to implement the 2022-2025 GMP more efficiently and seamlessly.

IV. Ten Year Vision

The Eversource vision for a modern grid contemplates improvements made over a ten-year time horizon that will transform the distribution grid of today with the technologies of tomorrow to provide a customer centric platform that enables the transition to a cleaner energy future while continuously improving customer engagement, and the safety, security, reliability, and cost effectiveness of the distribution grid. Grounded on the grid modernization objectives identified by the Department and supported by the Company, Eversource is committed to delivering a distribution grid that will:

- Create opportunities for active engagement by customers and stakeholders in the transition to the grid of the future

- Enable the levels of penetration of distributed energy resources required to support meaningful gains in clean energy objectives
- Allow for flexibility in timing and approach as technologies and policies evolve
- Optimize the use of assets to create value and minimize costs for all customers
- Support fair and equitable allocation of costs and benefits of modernization
- Complement the Eversource mission to improve customer satisfaction, employee engagement, community partnerships and clean energy leadership

The path to a modern grid will continue into the future. The investments completed as a part of the 2018-2021 GMP and those proposed in the 2022-2025 GMP set a strong foundation that Eversource will build upon as a part of its ten-year plan. Although specific investments through 2031 will be shaped by advances in technology and prevailing system conditions, the Company's focus on building a flexible foundation based on a wide range of capabilities in people, process, and technology is designed to maximize benefit to customers over both the near and long term.

The following is a summary of trends that will continue to shape the needs and opportunities for grid modernization over the ten-year horizon.

- Rapid advances in technology
- Support for clean energy objectives
- Threats to the electric power system requiring extreme diligence in physical and cyber security
- Increased proliferation of distributed clean energy resources
- Growing complexity of real-time distribution operations
- Planning uncertainties associated with EV penetration and dispatchable DER

- Need to optimize the value of DER to lower costs and reduce carbon emissions
- Demand for even more high-speed communication infrastructure
- Challenges associated with aging infrastructure
- Continued customer demand for safe, resilient, and reliable service

Addressing these trends as they emerge and evolve over the ten-year time horizon will require the Company to continue its modernization efforts beyond the 2022-2025 GMP term.

Several programs will require further investment to support continuous improvement beyond the 2022-2025 GMP to continue to drive necessary modernization outcomes through 2031.

Substation automation - Investments focused on increasing visibility and control at the Company's critical substation assets provide foundational capabilities that increase the Company's capacity to plan and operate an increasingly complex distribution system. Over the ten-year time horizon, the Company expects it will be able to substantially complete this important modernization program, with further substation automation enhancements transitioned to the base capital program.

Communications – Programs established as a part of the GMP for wireless communications improvements, communications system modernization and strategic fiber are essential enablers required to capture the full potential of grid modernization investments, including DMS, distribution automation, VVO and DERMS. Continuing to invest in communications modernization over the next ten years through both grid modernization and base capital programs will ensure the Company is able to maximize grid benefits into the future.

Additional investments in other categories will be required, although the pace and scope of deployment beyond 2025 will be highly dependent on the results experienced over the course of implementing the 2022-2025 GMP as well as outcomes relative to the trends identified above.

DERMS – The need for technologies, processes, and engineering resources to support centralized management and dispatch of DER for multiple use cases will be the centerpiece of grid modernization into the future. The electric power industry will continue to dedicate extensive resources to developing and improving DERMS technology. Building upon the 2022-2025 GMP demonstration and industry best practices the Company will continue to develop value-added DERMS capabilities over the next ten years.

Congestion Management – Initial efforts to develop mechanisms for DER optimization, and the need to enable implementation of FERC Order 2222 as it evolves over time, will continue to drive the Company's efforts to design and implement congestion management programs as an essential tool of the control room of the future.

VVO – The value proposition of VVO demonstrated as a part of the 2018-2021 GMP will continue to support further investment in VVO over the ten-year time horizon. Although components of the VVO program may become "business as usual" investments in recognition of the Company's commitment to clean energy and carbon reduction, the Company expects the industry will continue to develop and improve voltage management technologies that will be best demonstrated as a part of a focused modernization program.

Power Quality Improvements – As technology advances, the Company will seek out opportunities to improve area power quality for C&I customers with sensitive electronic equipment and processes.

Over the next ten years, Eversource customers will continue to benefit from modernization programs completed as a result of the Company's 2018-2021 and 2022-2025 GMP implementations. Programs considered "grid modernization complete" will serve as important foundational enablers of additional modernization efforts even beyond 2031.

Advanced Distribution Automation – The increased flexibility enabled by the addition of hundreds of sectionalizing distribution automation devices will improve reliability well into the future. As enablers of DMS-based "self-healing" schemes, these sectionalizing devices will isolate faults to small sections of the grid and facilitate re-supply of unaffected customers from other sources.

DMS – Completed as a part of the 2022-2025 GMP implementation, the DMS will serve as the foundation for transitioning towards the control room of the future over the next ten years. Among other benefits, the power flow model will serve as the basis for the integration of DER into real time operations based on as-operated system conditions, maximizing the value of new and existing clean energy assets deployed on the distribution system.

Advanced Load Flow – In recognition of the demands of planning the increasingly complex distribution system, since 2018, the Company has devoted significant resources towards the development of sophisticated tools to support robust modeling and forecasting for future scenarios

of load and generation. As additional data becomes available, the Company will have the tools and skilled engineering resources to ensure it is used to support cost-effective system capacity and reliability investments over the planning horizon.

In addition to the modernization investment categories identified above, over time, the Company will continue its efforts to seek out new innovative opportunities to increase its capacity to deliver the benefits of grid modernization to customers. Transforming the distribution grid to enable a clean energy future will require flexibility in approach to take advantage to advances in technology and industry best practices for cost effective modernization.

V. Five Year Plan

In the upcoming five years, the Company proposes to advance the Department's objectives for grid modernization through (1) targeted investments in grid-facing technology and energy storage; (2) deployment of Advanced Metering Infrastructure ("AMI"), and (3) continued assessment of the evolving needs of customers, the clean energy economy and the electric power system.

The Company's proposed grid-facing investments are substantially included in the four-year investment plan described later. Some of the investment initiatives included in the 2022-2025 GMP are likely to continue into 2026, while new initiatives will be informed by ongoing implementation of the four-year investment plan and other requirements the Company identifies to achieve the 10-year vision.

Eversource also continues to recognize that battery energy storage systems ("ESS") provide many potential benefits consistent with the objectives of grid modernization. In addition to potential applications that accommodate the growth of distributed generation and facilitate other important policy objectives, Eversource continues to recognize the potential for ESS to be deployed as an alternative to traditional distribution solutions as a non-wires alternative ("NWA") in appropriate circumstances. The Company agrees that any investments in ESS should be informed by detailed project descriptions and business assessments. Eversource looks forward to submitting such detailed ESS proposals for Department review and approval later in 2021.

Eversource's AMI implementation plan presented separately in this filing is another key component of the Company's five-year strategic plan. AMI represents a technology-driven evolution that will impact the services the Company offers its customers, the Company's operations, and its continued ability to meet the Department's grid modernization goals, as well as other critical Commonwealth energy and environmental policies. AMI systems that collect detailed usage data in granular increments via a wireless communications system provide a foundation for transformational customer and utility operating insights. The grid has evolved from the days where the Company only needed to contend with one-way power flows. The Company and its customers now exist in a world where the Company needs to contend with and effectively and safely manage two-way power flows, including all the communication that needs to accompany that responsibility.

Customer needs and expectations regarding their electric service are also expected to evolve with further adoption of customer-owned DER, purchase and use of EVs, exploration of battery storage, and participation in energy efficiency and load management programs, as well as a general desire to better manage electricity usage. AMI presents the only technological solution that can ensure that the Company is able to effectively and safely manage its distribution system and fully serve the needs of its customers.

The Company's 2022-2025 GMP, it's AMI implementation plan and forthcoming ESS proposals are the most defined components of Eversource's five-year strategic grid modernization plan, but they do not represent the full scope of the Company's grid modernization strategy for the coming five years. Eversource expects to continue to support similar and parallel goals through business activities that enable further growth of DERs; encourage EV adoption, charging infrastructure development and load optimization; and increase energy service options through aggregation activities and other customer offerings. The Company expects future grid modernization investments, both within the five-year strategic horizon and beyond, will be informed by these activities and ongoing evolution of the electric power system and markets.

VI. Four Year Investment Plan

A. Overview

The Company's four-year investment plan for the years 2022 through 2025 consists of a balanced portfolio of programs designed to work together to make meaningful contribution to the Commonwealth's grid modernization objectives of optimizing system performance, optimizing system demand and interconnecting and integrating DER. The 2022-2025 GMP reflects the

distribution system's need for continued modernization to enable the levels of penetration of EVs, renewable generation, energy storage and other technologies that will be needed to achieve the Massachusetts target of net zero emissions in a way that is equitable and cost-effective for all customers.

Over the prior four-year investment period from 2018 through 2021, the Company has made significant progress in developing the people, process and technology capabilities needed to maximize value and deliver on its grid modernization commitments. Hundreds of employees from numerous engineering, field operations and system operations disciplines have contributed to the delivery of grid modernization programs. With executive leadership support, the Company mobilized to execute an incremental grid modernization work plan with creativity and focused attention without sacrificing outcomes relative to other commitments to provide safe and reliable service to customers.

Over this time, the Company has seen meaningful changes in how the distribution system is planned, engineered, and operated. The integration of VVO technology into the operations of the East Springfield control center, for example, has demonstrated the value of widespread visibility and control. Extensive training and change management with system operators explained the purpose and impact of the technology, with a focus on ensuring "no harm" to the system as engineers started using the tool to gradually increase system efficiency. Once deployed, however, operators found several ancillary benefits of the widespread visibility and control provided by VVO field devices.

Implementing grid modernization programs has shown the value of dedicated focus on making step-change improvements in the penetration of existing visibility and control technologies. Prior to the grid modernization program, to replace aging underground oil switches with remotely operated vacuum fault interrupting switches, for instance, the rate at which the Company was able to modernize its underground 4-kV system in Boston and Cambridge would have required over 40 years to complete. The acceleration provided by the grid modernization program jump started the program resulting in a significant increase in automation for this critical part of the system. As described below, this effort has enabled the Company to define a path forward to complete oil switch replacements as a part of its base capital program going forward.

Another important lesson learned through grid modernization implementation is the value in dedicating attention on the design, development, training, and implementation of new technology. Absent focused attention on managing the unique challenges that emerge in deployment of operational technologies ("OT"), such as advanced load flow, for instance, there is often no near-term path forward.

These programs have a significant degree of complexity and require multi-disciplinary participation of subject matter experts from multiple engineering, operations, and information technology ("IT") disciplines. Increasingly, the grid of the future is dependent on data analytics and IT/OT projects that support optimization and support management of the complexity associated with designing and operating a distribution grid characterized by self-healing and automation; high penetration of DER; and two-way power flow. Over time, with proper training

and change management, OT tools developed as a part of the grid modernization portfolio are integrated into existing engineering and operations processes. The advanced load flow tool, for instance, is now a standard part of analysis for system planners in Massachusetts, increasing efficiency and effectiveness of analysis. New projects, such as energy storage, are developed by system planners using the tool to efficiently gain perspective on opportunities to use technology to address system needs.

The 2022-2025 GMP is an evolution from the 2018-2021 plan reflecting on lessons learned and developing an increased focus on deployment of tools to support system operations need to manage two-way power flows in real time and further integrate energy storage and other dispatchable resources as grid assets for multiple use cases.

2022-2025 GMP Summary

Table 2 provides a summary of the 2022-2025 GMP by investment category and investment type.

Table 2: 2022-2025 Budget by Investment Type

INVESTMENT CATEGORY	INVESTMENT TYPE	2022 Continuing	2022 New	2023	2024	2025	Total
ADMS	DMS	6,500	-	10,500	-	-	**17,000**
Communications	Wireless Communications Improvements	6,000	-	6,000	6,000	6,000	**24,000**
Monitoring & Control	Substation Automation	15,000	-	15,000	16,000	15,000	**61,000**
Monitoring & Control	PQ Monitoring	1,200	-	1,200	1,200	1,200	**4,800**
VVO	VVO	8,700	-	9,900	10,900	10,500	**40,000**
Measurement, Verification and Support	Program Management and M&V	900	-	900	900	900	**3,600**
Advanced Load Flow	Analytics Platform	-	500	2,000	1,500	1,000	**5,000**
Advanced Load Flow	Interconnection Automation	-	1,000	2,000	-	-	**3,000**
Advanced Load Flow	Probabilistic Power Flow Modeling	-	-	500	1,000	500	**2,000**
Communications	Communications System Modernization	-	2,000	4,000	4,000	4,000	**14,000**
DERMS	Dynamic DER Interface	-	800	1,300	1,900	2,000	**6,000**
DERMS	DERMS	-	1,000	2,500	3,500	3,000	**10,000**
Measurement, Verification and Support	Systems Support and Maintenance	-	200	1,400	1,400	1,400	**4,400**
Order 2222	Congestion Management	-	500	500	1,500	1,500	**4,000**
TOTAL		**38,300**	**6,000**	**57,700**	**49,800**	**47,000**	**198,800**

In total, the 2022-2025 GMP represents a portfolio approach aimed at making meaningful progress towards achieving the Commonwealth's grid modernization objectives. In addition, many of the investments included in the 2022-2025 GMP are designed to support eventual implementation of FERC Order 2222. Table 3 details the ways in which proposed investments support grid modernization objectives and Implementation of FERC Order 2222.

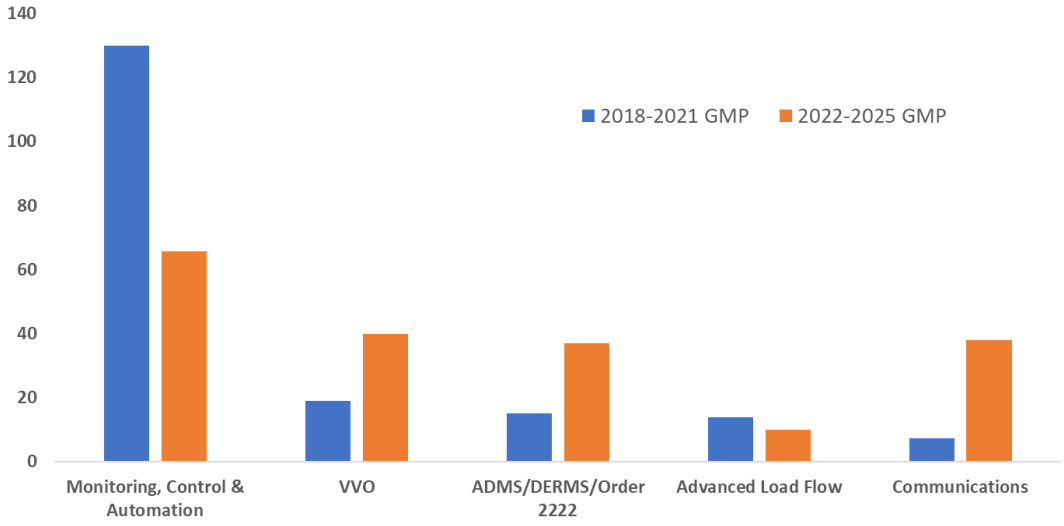
Table 3: Grid Modernization Objectives Support by Investment Type

		Grid Mod Objectives Enabled			
INVESTMENT CATEGORY	**INVESTMENT TYPE**	**Optimize System Performance**	**Optimize System Demand**	**Integrate DER**	**Enables Order 2222**
ADMS	DMS	✓	✓	✓	✓
Communications	Wireless Communications Improvements	✓	✓	✓	
Monitoring & Control	Substation Automation	✓		✓	
Monitoring & Control	PQ Monitoring	✓			
VVO	VVO	✓	✓	✓	
Measurement, Verification and Support	Program Management and M&V	✓	✓	✓	
Advanced Load Flow	Analytics Platform	✓			
Advanced Load Flow	Interconnection Automation			✓	✓
Advanced Load Flow	Probabilistic Power Flow Modeling			✓	✓
Communications	Communications System Modernization	✓	✓	✓	
DERMS	Dynamic DER Interface	✓	✓	✓	
DERMS	DERMS	✓	✓	✓	✓
Measurement, Verification and Support	Systems Support and Maintenance	✓	✓	✓	✓
Order 2222	Congestion Management			✓	✓

B. Four Year Plan Comparison

The 2022-2025 GMP is an evolution from the 2018-2021 GMP reflecting lessons learned and an increased focus on deployment of tools to support system operations need to manage two-way power flows in real time and further integrate energy storage and other dispatchable DER as grid assets used for multiple use cases. See Figure 2 for a comparison of the 2022-2025 GMP relative to the 2018-2021 GMP.

Figure 2: Four Year Plan Comparison ($ millions)



The 2022-2025 GMP can be considered in the following three categories relative to 2018-2021 GMP:

- **Grid Modernization Completed Investments.** Authorized investments that have achieved their grid modernization objectives and will continue as needed as a part of the Company's business as usual work plan.

- **Continuing Investments.** Authorized investments that are either (1) ongoing projects that will not be completed at the end of the 2018-2021 term; or (2) existing programs that have not yet achieved their grid modernization objectives.

- **New Investments.** Programs that are based on (1) a new need or opportunity that has emerged since 2018; and/or (2) lessons learned during the 2018-2021 implementation.

1. Grid Modernization Completed Investments

In its 2018-2021 GMP, the Company included several programs aimed at deploying technologies to increase visibility and automation of the distribution system. These foundational investments provide data on system performance to engineers, enabling them to conduct more granular and sophisticated analysis in support of reliability and resiliency planning. These investments also serve as critical tools available to system operators to reconfigure the system in response to faults or other system disturbances in real time. Further, investments in visibility and automation are leveraged to increase the effectiveness of DMS power flow and advanced applications; VVO; DERMS and forecasting tools. As shown in Figure 2, over the 2018-2021 term, the largest proportion of investment was dedicated to visibility and automation programs.

Although it is challenging to define the concept of "grid modernization complete" for specific investment categories, it is nevertheless important to attempt to define a level of deployment where additional investment with either significant diminishing returns for customers and/or future deployments can be incorporated into the Company's capital plan as a part of the business as usual process and budget. The following is a summary of the investments the Company considers complete relative to its grid modernization program.

- **Distribution Line SCADA.** The Company implemented programs to add supervisory control and data acquisition ("SCADA") to reclosers, padmount switches and network protectors. For the most part, this program added communication and control functionality to existing devices. This approach ensured that the value of existing assets in the field would be enhanced by remote communications and control. At the program inception, the Company identified the addressable population of devices in all three categories. As of the end of 2020, all devices in this population had been SCADA enabled. As a result, system operators can view the status and send control signals to virtually all reclosers and view status of the majority of network protectors in Massachusetts, enhancing safety and reliability of the system.

- **Automated Feeder Reconfiguration.** Although the Company has been investing in overhead distribution automation since the early 2000's, in 2018, significant opportunity remained to deploy automation to further sectionalize the system. The grid modernization automated feeder reconfiguration program placed a priority of deploying devices in locations that would limit the numbers customers that would be exposed by a fault on the system by automatically isolating faults to a small section of the grid and re-feeding the un-faulted sections from another source. In western Massachusetts, additional investments were made in creating new ties between feeders and deploying automation devices to increase the number of options to re-feed customers from alternate sources. At the end of 2021, the

Company expects that the level of sectionalization, as defined by the number of customers in a recloser zone, will meet its established targets. Going forward, additional sectionalization devices will be deployed as a part of the Company's business as usual work plan as needed to address specific reliability and resiliency opportunities.

- **Urban Underground Automation.** Prior to the grid modernization program to replace aging underground oil switches with remotely operated vacuum fault interrupting switches, the Company was replacing an average of 15 oil switches a year. With a total population of 676 oil switches at the end of 2017, continuing at that rate, it would have taken 45 years to reach the required level of modernization. With a focused grid modernization program, however the Company was able to accelerate the program and replace 172 over the four-year period, making meaningful gains in visibility and control of the underground system in the Boston and Cambridge areas. The acceleration provided by the grid modernization program, combined with the efficient processes established for design, engineering and construction has enabled the Company to remove the program from the grid modernization portfolio based on an assessment that the program can be effectively managed as a part of the base capital program.

2. Continuing Investments

As detailed in in Table 2, there are six investments included in the category of continuing investments. These investments represent $38.3 million in spending for 2022 and $150.4 million over the full 2022-2025 plan term.

The following is a summary of the need to continue these modernization programs.

- **Distribution Management System.** The DMS is an essential tool that will be used by system operators to manage two-way power flows on the distribution grid while improving safe and reliable service for customers. The DMS is an enabling investment for advanced tools to optimize DER on the system using VVO applications and DERMS. In its 2021 supplemental budget request, the Company established a three-year schedule for deployment of the DMS, starting in 2021. By the end of 2021, the Company expects over 40 internal and external resources will be actively engaged on the project, making any disruption in the work plan extremely detrimental.

- **Wireless Communications.** Over the last four years, the Company has confirmed the benefits of cost-effective investments in augmenting its existing wireless communications infrastructure. Analysis of DMS requirements for communications bandwidth and latency have further reinforced the need to invest in wireless communications. Maintaining continuity in the engineering and

deployment of this technology will minimize costs and ensure a comprehensive approach to prioritization of base station locations.

- **Substation Automation.** Adding sophisticated visibility and control capabilities to critical assets used to manage power flows is a key enabling investment of the modern grid. Engineering and construction of substation automation projects are complex and multi-disciplinary activities requiring significant lead time for site walk-downs, drawing preparation, outage scheduling and material procurement. On average, it takes 12-15 months from the time a substation location is confirmed to the time it is placed in service. Given the resource-intensive nature of these projects, it is difficult to implement multiple substation projects simultaneously. As a result, it is critical to maintain the project pipeline for engineering and construction over multiple years without disruption.

- **Power Quality Monitoring.** In 2021, the Company successfully completed its first demonstration of substation monitoring technology used to provide continuous data regarding power quality on feeders affecting large commercial and industrial customers with sensitive electronic and generating equipment. Since 2018, the Company's participation in the Energy Consortium working group has reinforced the fact that there are many large customers that have the potential to benefit from the use of this technology on their feeders. Continuing the program without

disruption will maintain momentum and support efforts to reduce costs and improve of methods for communication and coordination with affected customers.

- **Volt VAR Optimization.** Execution of the VVO program has begun the Company's transition towards active voltage management as an operational tool used to increase system efficiency and support the integration of DER. Efforts required to conceive, design, engineer, construct, and test VVO equipment and software over the past four years have been extensive, requiring participation by multiple engineering, field operations and system operations resources. In total, the Company has trained over 50 employees working out of the Springfield area work center on either field device operation and installation and/or control room operations. As a result, the Company has developed an efficient, well informed workforce set up to expand the program cost-effectively, including ongoing M&V of program results under different operating conditions. Delays in program expansion risk increasing program costs and deferral of benefits related to reduced energy and demand usage.

- **Program Management and Measurement and Verification.** The establishment of robust program management processes and tools has increased the efficiency and effectiveness of execution of the Company's grid modernization programs. Program management resources ensure all grid modernization projects are set up for success with respect to necessary labor and capital resources and support issue

identification and resolution. These resources track thousands of work orders to maintain accurate and timely reporting of project costs and outcomes. These efforts require daily diligence to ensure projects proceed successfully through the close-out stage. Measurement and verification of grid modernization outcomes and benefits is also an ongoing activity that will be negatively impacted by disruption. In addition to internal tracking and reporting activities, in collaboration with other EDCs, the Company has engaged Guidehouse to provide third-party M&V services. Data must be reviewed, verified, organized, and provided to Guidehouse on a regular and ongoing basis to enable a continuous and uninterrupted record of grid modernization outcomes across the Commonwealth.

The Commonwealth of Massachusetts has worked incredibly hard over the past ten years to provide the impetus for a successful transition to a modernized electric grid characterized by system that is designed to handle severe weather and robust interconnection of distributed generation, among other goals. The Company's work through the approved grid modernization program to accommodate the amount of distributed generation connected to or looking to connect to the Company's system is a fundamental prerequisite to the success of this vision. The Department's regulatory process to oversee and authorize grid modernization work must align with the gravity, breadth, and complexity of the work underway by providing a stable and consistent funding process. Loss of funding or funding uncertainty for calendar year 2022 has the potential to disrupt the Company's ongoing grid modernization programs and would be highly detrimental to the interests of customers and others relying on the Company's grid modernization initiatives.

Specifically, the Company would experience the following general impacts across all continuing investment categories:

Loss of Key Contractor Labor: Several specialized engineering and IT tasks are currently outsourced to contractors. These resources have also spent time learning the Eversource specifications and systems and, as a result, are now highly trained and efficient. If the grid modernization work were disrupted, the Company would need to terminate contracts that it is expecting to renew at the beginning of 2022. Loss of these resources would increase costs required to re-bid contracts, on-board new resources and train them on Eversource policies and systems. In addition to the added financial cost, it would likely add over three months of demobilization and remobilization time.

Re-Assignment of Dedicated Internal Grid Modernization Labor Resources: There are a number of internal labor resources who have been hired to support grid modernization programs on a fully dedicated basis the Company may be unable to maintain in their roles for the period of the delay in funding. This will present challenges in terms of the most efficient management of resources.

3. New Investments

Since the Company initiated its grid modernization program, many developments have shaped the landscape for investments in people, process, and technology required to support reliability, resiliency, and clean energy objectives. New policies in the Commonwealth have increased the sense of urgency around ensuring that the distribution grid can enable, rather than inhibit, the

growth in renewable resources, electric vehicles, and other forms of beneficial electrification. Every day, the complexity associated with automation and two-way power flow is driving greater need for real-time visibility and control of the distribution system. Optimization of resources at the grid edge is becoming a requirement for cost-effectively meeting clean energy goals and maximizing value to customers. At the same time, industry advances and lessons learned are creating new opportunities for the Company to accelerate its path towards its ten-year vision for an integrated grid of the future. In recognition of these new opportunities, the Company is proposing a handful of new programs that build upon modernization efforts pursued to date and while creating new pathways to grid optimization. The following is a summary of drivers supporting the addition of new investments in the 2022-2025 GMP.

- **Analytics Platform and Probabilistic Power Flow Modeling.** As a result of investments in advanced load flow and forecasting tools, the Company can use increasingly sophisticated techniques to plan the grid of the future. At the same time, however, system planning must address a growing degree of uncertainty at the regional and local levels. The challenges of planning for solar and other intermittent distributed generation whose output can be predicted by weather are relatively small compared to a grid characterized by energy storage, EV charging and other flexible load that will charge and discharge based on multiple use cases. Advanced data analytics and machine learning technologies are increasingly required to conduct probabilistic studies of the millions of potential power flow outcomes to assess the relative need for investments at the substation, along

distribution feeders, and down to pole-top transformers and secondary infrastructure connecting customers to the grid. Maximizing the value of distribution investments by prioritizing projects based on a more complete understanding of the impact (and value) of grid edge dispatchable resources.

- **Interconnection Automation.** Assessing the potential impact of DER on the system is an essential component of modern system planning. There is growing recognition in the electric power industry of the need to improve the efficiency and effectiveness of the study process to reduce time and lower costs for customers. The volume of applications and the complexity of analysis are increasingly stressing the limits of existing engineering resources and their current processes. These stresses are expected to grow as new drivers support the use small DER as aggregated resources that can be dispatched simultaneously in one area of the grid for a common objective. In recognition of these needs and limitations, in recent years, new software tools have been introduced to effectively automate portions of the study process. These tools increase capacity, reduce study time and free up high value resources to focus on more complex planning activities.

- **Communications System Modernization.** Although the Company has been and will continue to invest in expanding the capacity of its field area network ("FAN") to support the needs of the future grid, recent strategic analysis of the Company's existing infrastructure, including data concentration, interface with is Enterprise

Energy Control System ("eECS"), and use of communications protocols, has exposed the need for an expanded focus to ensure that the "path of a packet" of data from field device to control room is sufficiently secure, robust and flexible to meet the needs of the modern grid. Industry research and best practices confirm that an end-to-end solution based on industry-standard IP-based protocols and data concentration tools is needed to ensure investments in the FAN will be supported by a completely robust and modern data path into the Company's real time systems.

- **Distributed Energy Resource Management System.** The future of distribution operation and optimization will be increasingly characterized by the integration of DER for management and optimization based on real time system conditions. Although it has been technically possible for years for utilities, aggregators and other entities to dispatch DER remotely for various value streams, the full value of DER cannot be unlocked without the ability of system operators to monitor and control DER in response to real time system conditions based on a robust power flow model of the as-operated distribution system. Given its commitment to complete its DMS project by the end of 2023, inclusive of a power flow model of its entire system, the Company is well positioned to begin planning and demonstration of a model based DERMS integrated into control room operations.

- **Dynamic DER Interface.** The rapid increase in penetration of advanced inverters, energy storage, and other dispatchable resources is one of the most important trends

shaping the planning and operation of the distribution system. These resources present both a challenge of unpredictability and an opportunity to create substantial value through improved optimization for multiple use cases. As the grid operator, it is imperative for the Company to take an active leadership role in the development of tools and processes to support the use of dispatchable resources as grid assets. As these resources proliferate, communication and control capabilities for system operators, used in conjunction with DERMS and other control room optimization tools, will be essential prerequisites for power flow optimization. In recognition of this need, technologies to enable communication and control of stand-alone DER have advanced to the point where a future characterized by low-cost, efficient optimization of customer owned DER is increasingly within reach. Making this vision a reality will also require collaboration with other EDC's and Eversource customers to work towards the implementation of transparent and administratively efficient value sharing mechanisms. It is critical for the Company and its customers to start as soon as possible to demonstrate the feasibility and value proposition of widespread integration of DER as grid assets.

- **Congestion Management.** Working together as a part of one optimized electric power grid, flexible resources such as advanced inverters and energy storage can provide multiple sources of value. Opportunities exist to dispatch resources to lower transmission system peak load and local substation or feeder peak load, improve power quality, support VVO schemes, and increase hosting capacity.

Absent active coordination based on real time system conditions, these resources have the potential to work at cross purposes and worsen system constraints. Pending changes to the ISO-New England market to enable participation of aggregated small-scale DER in the wholesale market is one of the key near-term drivers of the need to invest in technology and process to increase coordination among resources in a way that improves reliability and increases overall value to the electric power system. Developing these capabilities will take years of dedicated focus and attention but starting to understand and build basic tools and methods will support the long-term vision of an optimized clean and flexible power system.

- **System Support and Maintenance.** Investments made to date in grid modernization systems, such as advanced load flow and forecasting, have served to increase capabilities and improve outcomes for customers. Going forward, as the Company shifts its modernization program to increase emphasis on operational software systems and related processes, the need for incremental engineering resources for ongoing support will grow. Technologies implemented without a dedication to continuous improvement will result in lost opportunity to capture the full potential created by the original investment. In its 2022-2025 GMP, the Company has allocated over $35 million in direct investment in control room technology, including DMS and DERMS. Without engineering resources for ongoing operations support, however, system operators will be challenged to make

full use of new tools to increase safety, reliability, and optimization activities. Similarly, implementation of advanced forecasting software will provide system planners with greatly enhanced capabilities for making investment decisions in the face of uncertainty. Dedicating engineering resources to enhancing the use of the tool over time with analysis, data management and training will increase the sophistication and applicability of forecasts used to make planning decisions.

C. Advanced Distribution Management System (ADMS)

1. Distribution Management System (DMS)

a. *Budget Summary*

<table>
<tr><td colspan="4">Continuing Investment</td></tr>
<tr><td>Optimize System Performance</td><td>Optimize Demand</td><td>Integrate DER</td><td>Enables Order 2222</td></tr>
<tr><td>✓</td><td>✓</td><td>✓</td><td>✓</td></tr>
<tr><td colspan="4">2022 Investment: $6.5 million
Total Four-Year Investment: $17 million</td></tr>
<tr><td colspan="4">Investments Enabled: VVO, Dynamic DER Interface, DERMS, Congestion Management
Enabling Investments: Communications, System Support & Maintenance, Substation Automation</td></tr>
</table>

b. *Overview*

Building on enabling investments in advanced sensing, automation, communications, data quality improvements and system planning resulting from the 2018–2021 GMP, Eversource will continue

with deployment of a DMS for all overhead and underground primary feeders in its Massachusetts service territory. In 2021, the Company began the planning phase of the project which is the first year of a three-year project to develop the DMS real time power flow and advanced functions such as fault location, isolation, and service restoration ("FLISR"), study mode and a training simulator. The remaining effort includes design, build, test, and commission for the entire service territory. These capabilities provided by the DMS will greatly enhance the ability of system operators to manage and optimize an increasingly complex distribution system characterized by high penetrations of DER and automation.

c. *Project Need*

Historically, system operators have relied on traditional control room tools designed to maintain safe and reliable service of a system characterized by relatively predictable customer loads and one-way power flow. These tools are no longer sufficient for operators to manage the complexity associated with high penetration of DER and automation. The presence of DER on the distribution system presents a challenge to the system operator when trying to understand where all the sources of energy are on a given circuit and under contingency operations. It is imperative that the distribution system operators have the ability to understand the dynamics of power flows to maintain safe and reliable service. Another primary challenge of the modern grid is the difficulty for operators to maintain situational awareness while processing massive amounts of data from a multitude of field devices.

As a result of the 2018–2021 GMP, an additional 1,000 remotely communicating devices will be available via the Company's ECS. Managing data and alarms from thousands of points on the system requires more sophisticated analytics and visualization tools. Today's control rooms are often high-stress environments where operators are challenged to make rapid decisions processing data from multiple systems simultaneously. Difficulties managing high volumes of data in the moment often drive additional conservatism in decision-making, which has the potential to affect customers. For instance, during high-load conditions, to avoid potential overloads, operators limit the transfer of load when the system is in an abnormal condition, increasing the potential for an outage event to affect more customers.

The modern grid has the potential to be characterized by sophisticated "self-healing" logic designed to process large amounts of data and recommend the optimal configuration to maximize reliability benefit. Currently, the system is characterized by first generation automation schemes with limited ability to react dynamically to system conditions. In eastern Massachusetts, auto-restoration schemes are static with only one option available to restore customers. In more complex outage situations, operators must step in to operate devices, restoring more customers but slowing restoration time relative to a fully automated solution. In western Massachusetts, loop schemes operate based on local system conditions. With no centralized logic based on real-time loading conditions, operators must disable loop schemes in high-load periods to avoid potential for overload, decreasing system reliability. With limited situational awareness, operators are unable to precisely direct field crews to the location of a fault, increasing the time to repair and restore.

d. *Project Description*

The DMS project will provide operators with an as-operated electrical model of the entire distribution system. The model will be based on asset information from the Company's GIS and other asset databases. Direct integration with the Company's Energy Control System will incorporate telemetry and control capabilities from all substation and field devices. Integration with the Company's outage management system ("OMS") will ensure all information associated with the as-operated condition of the distribution system is available to support efficient restoration activities. Operators will transition from limited situational awareness and significant amounts of data to a tool that provides a mathematical model of the distribution system that will run real-time load flow calculations of the distribution grid based on electrical characteristics and measured values. These will then be used to assess system conditions against operating limits, including voltage limits and normal and emergency limits of cable and equipment. Load flow calculations provide the current state of the system including voltages, currents, and power flow direction as well as warn of potential operating violations if another piece of equipment is lost. The same load flow can be used to model future state configurations which are useful for operational and long-term planning. The DMS will have the ability to accept and process data more efficiently and effectively than human operators. With substation, feeder and other equipment alarms, conditional system limits, filtering and forecasting the DMS will aid in avoiding the potential for information overload, allowing the Company to operate equipment with greater efficiency and proactively respond to emerging problems.

The DMS project will require three years to complete. In 2021, Eversource will establish the foundational DMS architecture and demonstrate the ability to produce the real-time load flow capability for a small geographic region in a pre-production environment, prior to deploying in the control room. This work will include deployment of DMS software and associated hardware in a configuration that incorporates disaster-recovery protocols for redundant onsite and remote backup capabilities. Significant effort will focus on building upon data quality improvements made as a result of the 2018–2021 GMP Advanced Load Flow project with further data remediation activities. The Company will also complete a GIS database mapping effort to ensure the DMS model build is based on an efficient and sustainable process to extract GIS data that is reflective of current system conditions.

In the Company's long-term vision for the control room, technologies such as DMS, load and generation forecasting, VVO, and distributed energy resource management systems ("DERMS") will provide powerful capabilities to support optimization of the system, utilizing customer and Company-owned DER as powerful and important grid assets. Transitioning from a control room focused exclusively on providing safe and reliable service to one that ensures all assets are used to support system optimization for multiple variables will require the addition of an engineering optimization function to support operators as the complexity and responsibilities of real-time operations grows over time. The System Support and Maintenance section below provides more information on operations support requirements.

Work completed in 2021 will enable the Company to deliver DMS capability to Massachusetts control rooms in a staggered regional deployment over the course of 2022 and 2023. The work in 2022 and 2023 will include continued support for data engineering and remediation for assets across Massachusetts to ensure model accuracy. Capabilities introduced into the control room will include distribution system power flow and FLISR. Operators will also have access to a study mode feature that will enable more efficient and effective contingency analysis and a training simulator used to train operators based on review and analysis of prior events.

Over the three-year implementation period, significant effort will focus on process improvement and organizational change management. Training and change management efforts will enable a seamless transition from current control room processes to those based on automated updates of the as-operated distribution system model. Robust operating procedures will be designed to support consistent use of DMS capabilities. Process improvements will focus on the ongoing model build process aimed at ensuring field changes are reflected in the as-operated model in real time.

e. *Benefits and Outcomes*

Implementation of DMS technology in the control room will provide tools necessary to greatly improve situational awareness, leverage extensive monitoring and control capabilities to make gains in reliability performance, deliver a more effective training environment to build operator proficiency under multiple operating scenarios, and serve as a foundation for greater optimization

of system conditions with wide-spread VVO capability and ultimately DERMS capability to enable use of DER as grid assets.

A distribution load flow model providing real time visibility into current and voltage conditions relative to equipment ratings will provide system operators with tools to pro-actively configure the distribution system based on large volumes of data processed automatically to support effective and efficient decision- making. The DMS will provide a "study mode" functionality to evaluate the impact of a proposed switching action to identify potential adverse consequences on an hourly basis (e.g., voltage problems, equipment overload, protection system issues). Sophisticated data processing and analytics will allow for the identification of opportunities to pro-actively mitigate risks of operating in contingency conditions. Multiple actions such as load transfers and temporary back-up equipment can be considered quickly and accurately.

The value of situational awareness is compounded by the prevalence of solar and other forms of DER on the system. The DMS will improve operators' ability to configure the system and plan for high and low load conditions disaggregating the impact of generation from load. Analytical tools will provide for the ability to study the impact of large generators going off-line and coming back on-line in order to determine if DER can remain on-line following feeder reconfiguration. Processing high volumes of data with analytical tools will reduce the need for conservatism in deciding whether DER must be curtailed in contingency conditions.

The DMS will provide an important next step in reliability benefit for customers. Improved fault location will shorten outage duration. Advanced analysis will use pre-fault loading conditions to

calculate restoration steps ensuring protection schemes work as designed accounting for DER output and masked load. Modeling the system with real time load data will eliminate the need to disable auto restoration loop schemes based on conservative worst-case scenarios improving the utilization of switching devices to reduce the impact of outages. DMS intelligence will also prevent automatic switching into faulted circuit segments reducing a potential safety concern.

Achieving the modern grid will require system operators to process massive volumes of data, utilizing advanced analytics to support efficient, intelligent decision-making, optimizing system conditions for multiple variables. The DMS will serve as the platform for optimization. Without a real-time model of the system based on the power flow of load and generation on the as-operated model, options to use DER to capture meaningful locational value are limited. Utilizing DER to solve real-time problems on the grid requires a DERMS solution paired with the DMS load flow.

In the future, the DMS will identify a fault condition and use FLISR to automatically sectionalize and re-supply unaffected sections. If closing a tie would cause an overload condition, a model based DERMS solution would be able to dispatch energy storage to avoid the overload condition in the affected circuit segment, enabling the restoration scheme to proceed. If the revised circuit configuration caused a voltage concern, the model based DERMS could change settings on advanced inverters to maintain system stability. Similarly, model-based DERMS solution integrated with the DMS will increase the ability of sophisticated VVO schemes to achieve energy and demand savings in the presence of high-penetration of DER, utilizing advanced inverters as another tool to support optimization.

f. *Leveraging 2018-2021 GMP*

The DMS project will build upon many of the 2018–2021 GMP initiatives. In 2021, the DMS project has been initiated to start the planning, design, and initial build of the IT environments. This work also includes the initial model build of one region. This work is the first steps in the deployment of the DMS at Eversource. All this work in 2021 is part of the 3-year plan for DMS implementation and is critical to the effort defined in the 2022-2025 Grid Modernization plan.

In addition, the accuracy of the load flow model is dependent on the penetration of monitoring and control devices feeding into the ECS. The step-change in monitoring and control devices, strategically placed, enabled by the 2018-2021 GMP, will support the DMS model accuracy. The advanced load flow project was an important precursor to the DMS project. Building a planning model based on GIS data and other supporting databases required significant data remediation and database design that will reduce time and cost for the DMS project. Improvements in GIS data were also enabled by the GIS survey project.

Strategy efforts completed as a result of the 2018–2021 GMP will also inform the DMS project, including a DMS requirements analysis and a GIS strategy effort to understand the lowest cost option to address GIS and DMS interface planning.

Finally, wireless communications improvements will support future projects to augment existing infrastructure to provide the communications system capacity and latency required to support the near real time DMS model.

Lastly, the Company identified key training and change management activities that are necessary to successfully deploy new technology to a control room environment. The VVO project provided the opportunity to work with system operators on training content, schedule, and deliverables such as job aids. These experiences will translate well to deploying the DMS in a similar environment.

D. Volt VAR Optimization

1. Budget Summary

Continuing Investment			
Optimize System Performance	Optimize Demand	Integrate DER	Enables Order 2222
✓	✓	✓	
2022 Investment: $8.7 million **Total Four-Year Investment:** $40.0 million			
Enabling Investments: DMS, Substation Automation, Dynamic DER Interface, DERMS, Analytics Platform			

2. Overview

In the 2022-2025 GMP, the Company will expand the current VVO program, including the ENGO micro-capacitor deployment, to additional substations and feeders in western Massachusetts and transition device commissioning into the ECS control system for eventual integration with the DMS.

The Company will also enhance its current VVO approach by adding control of advanced inverters at an Eversource-owned solar site in Southampton to provide Volt/Var support in coordination with VVO operations and set points. The addition of advanced inverters into a VVO scheme will

demonstrate the opportunity to increase the cost-effectiveness of VVO going forward with the use of new and existing inverter capacity on the distribution system.

Finally, the Company will deploy a similar program in eastern Massachusetts to equip substation and feeder assets with remote communication and control capability integrated into the Company's DMS and supervised by the local System Operations Center (SOC) dispatchers.

3. Project Need

Opportunities exist throughout the Eversource service territory to continue optimizing system efficiency and power quality. Advanced technology that allows for improved monitoring and control makes it feasible to optimize system operations in real-time across varying system conditions just as managing voltage and reactive power flow becomes increasingly important due to the following opportunities:

1. Ensuring that distribution voltages remain within prescribed ranges and are not fluctuating rapidly as additional DER, characterized by intermittent output, is added to the system.

2. Identifying opportunities for conservative voltage reduction ("CVR") to reduce peak demand and energy consumption.

3. Improving system efficiency and reducing line losses through optimized reactive power dispatch to reduce greenhouse gas emissions.

4. Alleviating the voltage and power quality concerns that may otherwise limit the interconnection of new renewable energy resources through active voltage management and mitigation.

The increasing reliance on distributed inverter-based generation to meet demand is causing new challenges for the transmission and distribution system. In periods when distributed solar provides a bulk of the regional supply, transmission operators increasingly require distribution devices to provide voltage and reactive power support. Grouping, monitoring, coordinating, and dispatching such assets (Capacitor banks, Regulators, and DER Inverters) at a regional level is not feasible today due the lack of communication and integration between those devices.

The VVO system is currently operated based on feedback from devices on the circuits, creating an inherently reactive response. Transitioning to a model-based control system enables VVO to proactively address voltage and power reduction.

4. Project Description

In western Massachusetts, this project will continue expanding VVO to an additional 5-7 substations by upgrading additional load tap changers with remote control capability; installing remotely controlled voltage regulators and capacitor banks; and deploying additional feeder head and end-of-line sensors. This deployment will also include deployment of ENGO micro-capacitors on all feeders fed by these substations.

The VVO system which is currently hosted on a dedicated platform will eventually be transitioned to the model based DMS system. DMS brings all dispatch and control entities within a single

scheme that expands the utility of individual devices across multiple functions. For example, VVO will be able to use interval measurements from reclosers and sectionalizers that would primarily feed the FLISR functions. Equally, FLISR will now be able to use data from voltage control equipment to inform its restoration algorithm. The ENGO micro-capacitors will also be integrated into the DMS system so that the setpoints of each of those devices is coordinated within the appropriate zone in the VVO hierarchy.

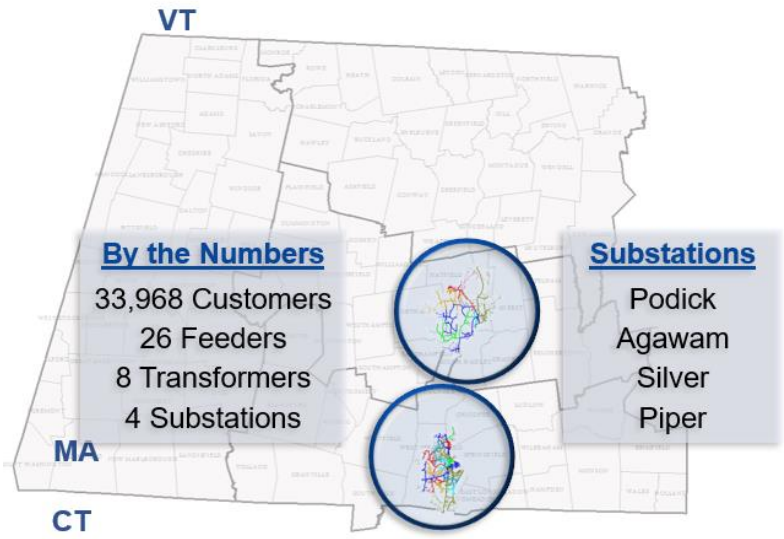
All inverters at the Eversource-owned PV DER facility in Southampton, MA will be replaced and commissioned into the VVO module within DMS. The upgraded inverters and the ability to integrate with the VVO system will be analyzed for additional locations as well.

In eastern Massachusetts, the Company will leverage the experience in western Massachusetts to introduce VVO to a regional control room as well as 4-6 substations and feeders within that jurisdiction. This deployment will be commissioned into the eECS and DMS platform as those technologies are being deployment in parallel. The eastern Massachusetts VVO deployment will be similar to the western Massachusetts, including ENGO micro-capacitors.

5. Benefits and Outcomes

Eversource deployed VVO at four stations in Western MA (Figure 3) with a total peak demand of 146 MW and 575,900 MWh of annual energy consumption. Participating feeders represent a diversity of urban and rural areas; residential, commercial, and industrial load; and varying levels of DER penetrations.

Figure 3: Footprint of VVO Deployment 2018-2021



Preliminary results from the VVO deployment at the four stations are in line with Eversource's expected reductions in demand (1.8%) and energy use (2.2%). The estimated energy savings amount to 12,600 MWh annually, which represents 9.8 kilotons of CO_2 emissions offset or about 230 passenger cars taken off the road.

The VVO system is successfully working to flatten and lower voltage profile at the station and feeder level. Figure 4 shows the impact of VVO ON vs OFF on a single feeder during the course of a day. Voltages grouped closer together reflect a "flatter" voltage profile along the feeder. With coordinated control and feedback from line sensors, VVO enables more flattening (reduced losses) and reduction in voltage (power and energy savings) along the length of the feeder. Figure 5 shows that trend over several days of ON/OFF testing.

Figure 4: Voltage Profile along a Feeder (VVO ON vs OFF)

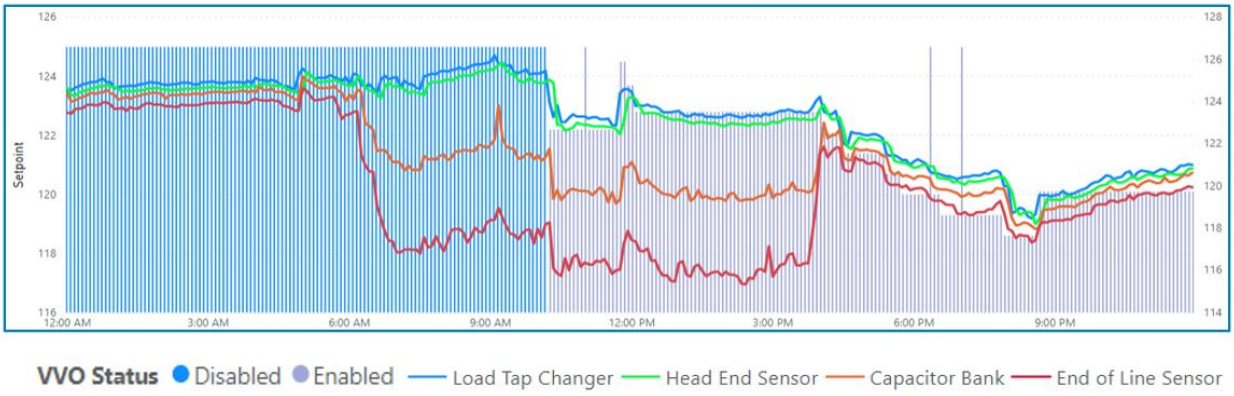
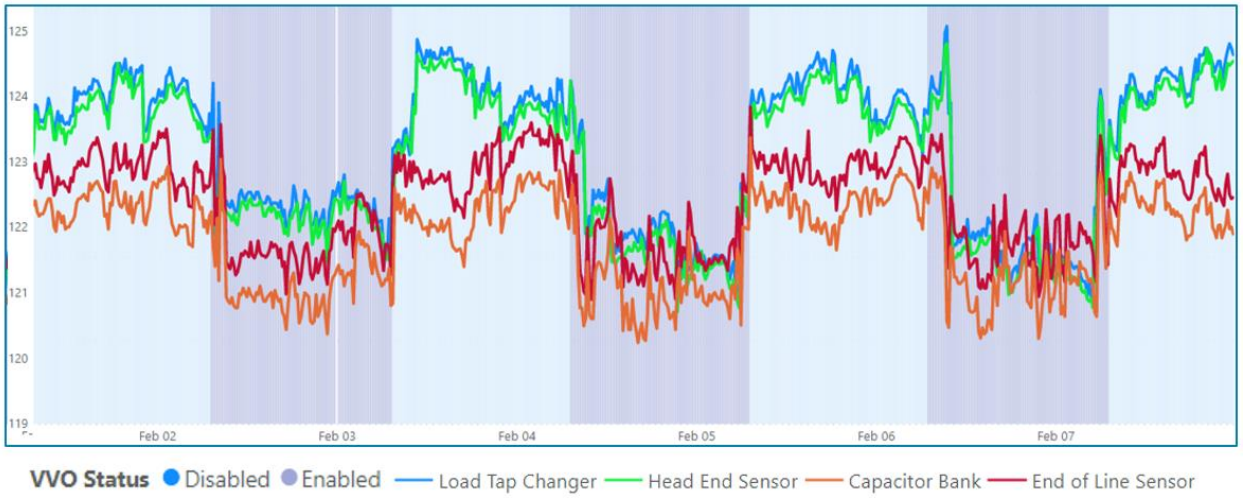
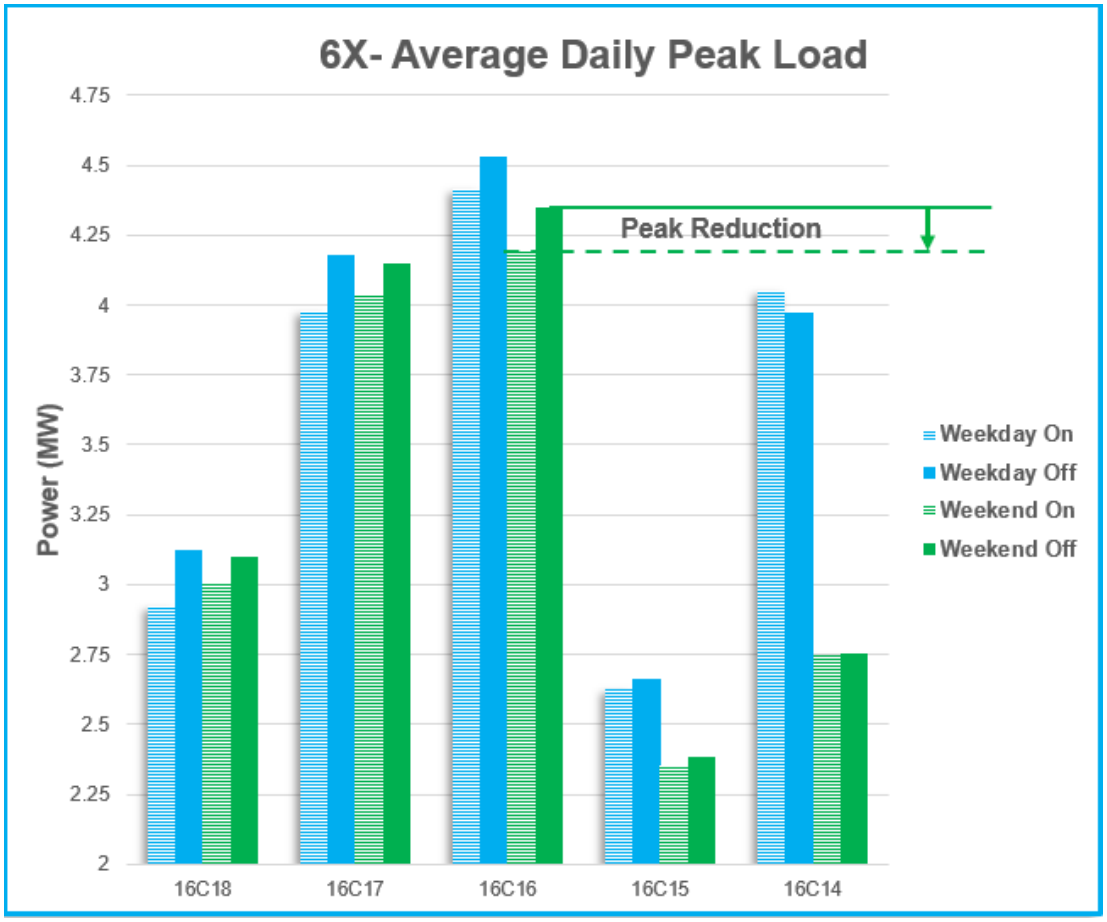


Figure 5: Voltage trend over several days of ON/OFF cycling



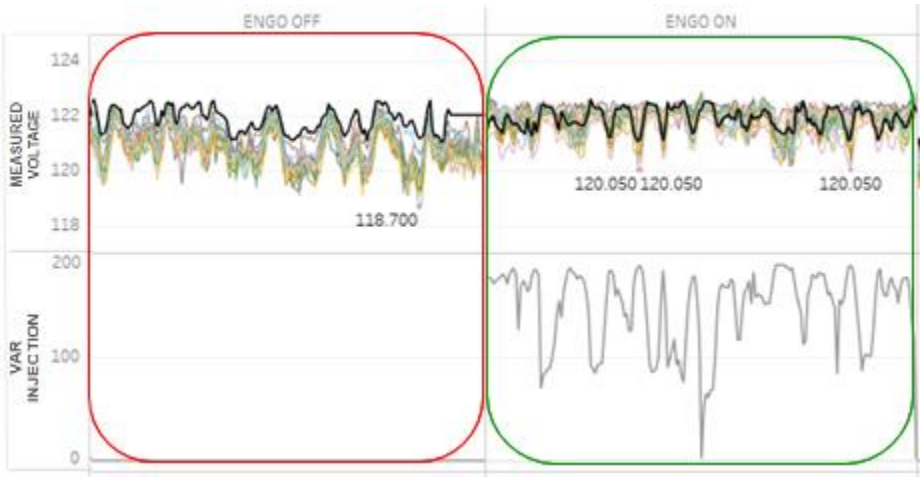
Preliminary assessments of the impact on feeder demand (and energy) suggest a reduction in net load across most feeders (Figure 6). As the ON/OFF testing progresses through multiple seasons and generates a larger sample size that smooths out daily fluctuations, we expect to glean more insight into the relative impact of VVO on different load types and feeder characteristics that will enable further optimization.

Figure 6: Impact on Feeder Demand (VVO ON vs OFF)



The ENGO micro-capacitor deployment, in tandem with VVO, is providing a distributed solution to address pockets of low voltage that may otherwise limit VVO benefits. Figure 7 shows the wide variation in voltage levels at the micro-capacitor locations (red box) when they are disabled vs the green box that shows a more consistent voltage level clustered around the primary system voltage (solid black line) when they are enabled and injecting reactive power to support voltage levels.

Figure 7: Microcapacitor results when disabled (red) vs enabled (green)



6. Leveraging 2018-2021 GMP

The VVO program planned for 2022-2025 is based largely on experience gained developing and implementing the 2018–2021 GMP. For each station evaluated, all electrical load and geographical characteristics were tabulated and normalized to each other- the points tabulated included annual energy usage (MWh), peak demand (MW), existing voltage and reactive support (Capacitors and Regulators), existing and in-queue distributed generation (DG), feeder lengths, load unbalance, and industrial load (aggregate and as a percentage of peak demand). Based on load flow studies and engineering judgment, each category was assigned a weighting factor to reflect its respective favorability to and potential savings from VVO investments.

Following completion of the station assessment and ranking, the Company reviewed the list to eliminate stations that are not currently attractive candidates for VVO based on additional factors including age of substation equipment; available communications options; and proposed capital projects and overlapping outages.

Challenges associated with installing large, platform-mounted voltage regulators in various locations in our communities has highlighted the need for a more distributed, easy-to-install alternative. This has prompted the identification of technologies like the ENGO micro-capacitors and DER inverters for deployment and integration to mitigate the need for voltage regulators where possible.

E. Monitoring & Control

1. Substation Automation

a. *Budget Summary*

Continuing Investment			
Optimize System Performance	Optimize Demand	Integrate DER	Enables Order 2222
✓		✓	
2022 Investment: $15.0 million **Total Four-Year Investment:** $61.0 million			
Investments Enabled: DMS, PQ Monitoring, VVO, DERMS **Enabling Investments:** Communications			

b. *Overview*

One of the most important characteristics of the modern grid is the proliferation of advanced sensing technology to provide visibility and control to the grid edge. Widespread visibility into system conditions is the foundation upon which all advanced intelligence and real-time response

depends. These investments will provide additional telemetry to support the DMS, providing a higher fidelity system model to distribution operators.

The goal is to continue this program to increase the penetration of advanced remote telemetry devices in substations. These devices provide system operators with remote visibility and control of power flows on the grid required to optimize system conditions regardless of local penetrations of load and generation. The scope of work for 2022-2025 will prioritize locations that will provide telemetry to increase the accuracy of DMS power flow calculations.

c. *Project Need*

In many areas of the grid, system operators lack adequate visibility and control required to optimize the modern grid. In bulk substations, many feeders still rely on older electromechanical relay technology that does not allow for remote operations, such as application of fast-trip and lock-out settings for worker safety or changes in protection settings. These older relays are not capable of remote interrogation for engineering analysis, requiring a crew to visit the substation to collect the necessary data to diagnose power quality events. In distribution substations in eastern Massachusetts, several critical 4 kV substations remain without any remote telemetry at all. Although these stations are among the most heavily loaded on the system, operators must dispatch crews to collect basic loading information.

Plans to deploy a DMS are amplifying the importance of real-time telemetry. A DMS provides operators with a system-wide load flow model updated multiple times every hour and provides insight into opportunities to optimize system conditions, including advanced automated feeder

reconfiguration reflecting current loading conditions. Without enough strategically placed telemetry, DMS model accuracy will be insufficient to support calculations such as fault location.

d. *Project Description*

The Substation Automation program has two components. First, the Company will continue its program to replace older relay technology with current microprocessor relay technology for 190 additional feeders at bulk substations across Massachusetts. These relays will be equipped with incremental remote monitoring capability to enable more timely engineering analysis of system events. Second, the Company will continue its program to add relays with remote telemetry to 55 high priority 4 kV feeders in eastern Massachusetts.

e. *Benefits and Outcomes*

Advanced sensing technology is a critical enabling investment supporting the transition to the modern grid. High penetrations of telemetry support an accurate DMS model that will improve operators' ability to identify opportunities to optimize system conditions and improve reliability with sophisticated FLISR schemes. Microprocessor relays enable next generation analysis and control, including adaptive protection and predictive outage detection. Increased penetration of devices with remote monitoring capabilities will reduce inefficiency and delays associated with the need to travel to substations to collect system measurements. System operators will have the information needed to address emerging issues, such as high heat driven loading concerns or reverse flow overload concerns in areas of high solar penetration.

f. *Leveraging 2018-2021 GMP*

The increase in penetration of remote monitoring and control is a significant accomplishment of the 2018 – 2021 GMP. By the end of 2020, the Company added advanced relays to close to over 250 feeders in high priority substations across Massachusetts. Over the course of this program, the Company has learned important lessons enabling it to increase efficiency and minimize per-unit costs. Some of those major lessons are:

1. Forward review of required substation work, in addition to Grid Modernization work, allows for a coordinated deployment of resources that reduces the overhead costs of both the GMP and non-GMP work. Careful cost tracking allows this type of efficient work plan to be executed, while still retaining appropriate cost allocations.

2. Implementation of a longer planning horizon for this type of work allows for sufficient time to solicit and onboard external resources, when and where needed.

3. Retaining the same project management team throughout the entire 2018-2021 plan allowed for relationships to be formed and area-to-area nuances to be understood and built into execution plans, which ultimately drove efficiency into the process.

4. The process of "kitting" common components will be explored as an opportunity to increase efficiency and costs on projects. "Kitting" involves

soliciting pre-packaged sets of common material/equipment that are delivered ahead of project construction.

5. Emphasis on the pre-construction review, known as "walk-downs" is always a key component to efficient project execution. Eversource has worked to expand these walk-downs to gather as much information as possible to mitigate unforeseen conditions during construction.

2. Industrial Customer Power Quality

a. *Budget Summary*

Continuing Investment			
Optimize System Performance	Optimize Demand	Integrate DER	Enables Order 2222
✓			
2022 Investment: $1.2 million **Total Four-Year Investment:** $4.8 million			
Enabling Investments: Communications, Substation Automation			

b. *Overview*

The Power Quality Monitoring initiative provides remote access and storage of continuous power quality data, so that detailed information from disturbance events can be evaluated by Eversource Distribution Engineering, System Planning and Protection and Controls Engineering to determine root causes and potential remediation needs. This information can be shared by Eversource, in a collaborative effort with affected commercial and industrial customers, to provide appropriate

situational awareness and/or develop mitigation strategies for disturbances that occur outside of predefined thresholds as appropriate.

c. *Project Need*

The electric utility system operating characteristics have changed over the years and will continue to evolve. DER penetrations are increasing, automated system reconfiguration devices are being deployed extensively and customers are utilizing equipment and processes that are more sensitive to system disturbances, than in the past. The Company strives to create a distribution system that provides electricity that meets the needs of all customers, ranging from residential customers whose load is relatively insensitive to power quality disruptions to larger industrial customers who can be more impacted by changes in operating conditions. The Company recognizes that modern equipment and processes are increasingly sensitive to small disturbances. While customers have responsibility to design their equipment and systems to withstand the majority of these types of disturbances, the Company is committed to working collaboratively to identify cost effective solutions to minimize the consequences of these disturbances.

The modern distribution system will effectively utilize and accommodate DERs and continue to support the various automation devices and systems that will allow for further visibility and command and control of the system to reduce customer interruptions through increased reliability. However, some of the causal effects of DER and system automation is the potential to create voltage transients that have the potential to impact customer experience.

As an example, The Energy Consortium ("TEC"), which is made up of leading education, research, and manufacturing members, has engaged with Eversource on challenges that occur to their facilities upon certain disruptions to the electric power system. It is important to note that these commercial and industrial customers often own and maintain their own electrical distribution system which then have distinct locations that directly interface with Eversource's electrical distribution system. Each of these systems have the potential to affect the other. Some customer-owned systems operate at stringent tolerance levels due to their respective operations, such as: pharmaceutical production testing and research; precision manufacturing production runs; and, cutting-edge/advanced-technology experimentation. Disruptions to these operations can have significant cost and schedule impacts.

Discussions on how best to monitor and analyze the electric power system disruptions began as part of D.P.U. 17-05 and the Department has authorized a pilot program for Eversource to develop and deploy a power quality monitoring system to enable circuit output monitoring of all circuits fed from a particular substation, down to the sub cycle time interval. As a result of the technology, Eversource has the ability to receive alerts when user-defined thresholds are exceeded and the ability to remotely download information for analysis.

The principle behind this investment is to demonstrate a monitoring system that allows Eversource to better understand electric distribution system disturbances to determine whether an event:

- Originates on the Company-owned portion of the system and is within industry-established operating specifications and tolerances and does not impact customers; or

- Originates on the Company-owned portion of the system and is within industry-established operating specifications and tolerances but is impactful to customers; or

- Originates on the company-owned portion of the system and is not within industry-established operating specifications and tolerances;

- Originates on customer-owned equipment.

Eversource recognizes that the project duration, inclusive of development, engineering, design, and construction exceeded Company and TEC expectations. Given the up-front effort required for this first deployment, including initial time to verify and validate the power quality monitoring system operations, the Company expects a significantly easier deployment on future substations. However, Eversource's intentions will be to be more communicative with the TEC and/or other commercial and industrial customers throughout the process.

With the challenges of several commercial and industrial customers with sensitive equipment and processes, and Eversource's need for additional situational awareness on parts of the electric power system, several substations feeding large commercial customers in Eastern Massachusetts have been identified as having insufficient access to feeder disturbance information due to being

equipped with analog metering and/or electromechanical relays that lack data storage and remote access capability. Absent this new monitoring technology, Eversource is often not aware of small disturbances that have the potential to affect customers and the Company does not have sufficient information to fully analyze the event.

d. *Project Description*

Eversource intends to implement the power quality monitoring system at four to five additional locations. The general scope of work that would occur at each location is identified below:

1. Installation of new Fischer block devices which will be mounted on existing test switches with minimal effort (the device will replace the existing dust covers on the ABB FT test switch, which is wired to the existing panel meters).

2. Installation of new fiber cables and fiber run innerduct to new communications cabinet installed within the Station control house (via ethernet communications cable installed within Fischer Block SMART Bolt).

3. Installation of split core CT's to be placed over existing secondary circuit wires behind the panel (via CT port within Fischer Block SMART Bolt).

4. Minimal outage work is anticipated as the Fischer Block Test Switch device is designed to measure the appropriate voltage and currents with no drilling or modification to the existing panel.

5. Installation of new communications cabinet that will contain all required supporting equipment including the PoE (Power over Ethernet) switch and expansion module that powers each device, local data concentrators, and SMART Data Storage Unit.

6. Installation of high-speed fiber connection point through JMUX

7. Vendor Support of Wave IQ software and IT Support for integration of software with any required network security firewalls.

8. Supporting station upgrades including potential additions/expansion of AC/DC power supply and modifications to support the new equipment

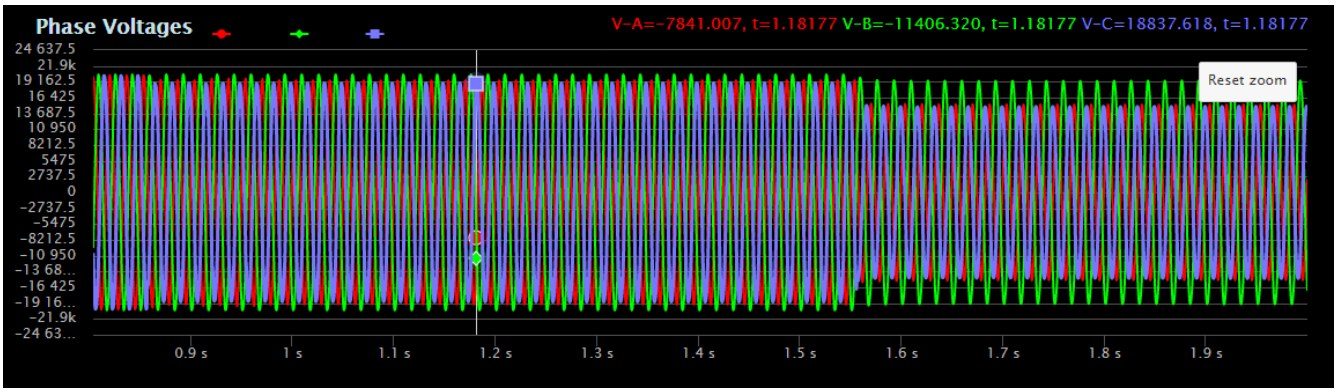
e. *Benefits and Outcomes*

Industrial customers with sensitive loads will benefit from power quality metering that will support proactive identification and analysis of power quality events. This information will inform the potential need for future system improvements to reduce these types of events without reducing overall system reliability.

To-date, the aforementioned power quality metering has been implemented at a substation in the Cambridge. The system is still in the final stages of protocol and communications development but has successfully detected anomalies on the electric distribution system. A sampling of the output data from the power quality monitoring system after a faulted underground cable is shown in Figure 8. From these data, Eversource was able to discern on which phase the fault occurred

and how it propagated. These data allow for sub-cycle monitoring and recording of events and Eversource is currently in the process of setting up the IT infrastructure and the appropriate triggering thresholds so that when disturbances occur outside of those thresholds, automatic notification is sent to the subject matter expert personnel for both awareness and analysis. The benefits behind this automated infrastructure will provide Eversource with the information needed to effectively communicate with, and/or have responses for, affected customers on the system.

Figure 8: Voltage Waveform Indicates the Reduction at the Substation



The availability of insights resulting from the this power quality monitoring technology will improve the Company's ability to work collaboratively with customers to understand and address power quality disturbances as appropriate.

f. *Leveraging 2018-2021 GMP*

Ongoing discussions with industrial customers in recent years highlight the need to address the power quality disruptions that characterize the modern grid. Improved metering was determined as the next step towards developing solutions that will ultimately improve conditions for these customers. In early 2021, Eversource successfully deployed a power quality monitoring system

within a strategic substation, feeding an industrial customer with highly sensitive needs. The installation and commissioning of this new technology has provided a proven path forward for replication at additional substations with sensitive customer loads.

The initial development and deployment of this first power quality system has positioned Eversource to much more quickly and efficiently deploy additional power quality investments. Additionally, through discussions with TEC, Eversource will further develop a communications strategy to ensure there is mutually agreed upon conditions and protocols on information transfer.

F. Communications

1. Wireless Communications Improvements

a. *Budget Summary*

Continuing Investment			
Optimize System Performance	Optimize Demand	Integrate DER	Enables Order 2222
✓	✓	✓	
2022 Investment: $6.0 million **Total Four-Year Investment:** $24.0 million			
Investments Enabled: DMS, Substation Automation, PQ Monitoring, VVO, Dynamic DER Interface, DERMS			

b. *Overview*

The Company is striving to build a grid that can meet the requirements of its grid management systems during all events and especially during severe weather events that can cause wide-spread

outages in the region. This has led to a growing importance of a robust, resilient, reliable communications network that can be called upon when needed most. To that effect, the Company has worked to develop a comprehensive field area network ("FAN") telecommunications strategy that builds upon its existing network infrastructure. The FAN must also be flexible such that it can adjust to the ever-changing conditions on the distribution network and the central control systems that are used to manage it. The growing complexity of the distribution system is driving the need for grid-edge visibility and grid management systems. The Company's development of a DMS and DERMS will depend on communications infrastructure that can support more frequent, high bandwidth communications from more devices on the grid. This communications network will be the foundation for future operations as we shift from a reactive, prescribe state to more proactive optimized operation. The benefits of optimal operations are only achieved if data from the distribution network is provided in near real time from across the entire network.

c. *Project Need*

The Company recently completed a refresh of its FAN strategy, in an effort to assess its current state of telecommunications capabilities across its service territories and to develop recommendations for future upgrades that can meet the increased data requirements of a modern grid. The Company developed five guiding principles to shape the development of this strategic effort. The five guiding principles are interoperability and standardization, cybersecurity and safety, reliability and resiliency, cost-effectiveness and feasibility, and technology obsolescence and risk mitigation. The FAN strategy identified areas of improvement consistent with the guiding principles. First, the modernization of the grid requires newer control room technology (e.g.,

SCADA, DMS, OMS, DERMS) that provide real-time status of the grid to operators and facilitate effective automation in response to real-time conditions. These systems are centralized and rely on a communications network to connect their central logic to the field devices. Currently, the Company's private communications network and its supporting infrastructure are unable to meet the full demands of these newer control room technologies. Significant quantities of remote field units do not have the connectivity to support these centralized systems. They lack the bandwidth, latency, and frequency of data communications required to enable these systems to operate in real-time conditions. The current state of the communications network also lacks the ability to provide end-to-end monitoring of network traffic, leaving the Company unable to optimize the network and a potential cybersecurity vulnerability. Exacerbating the issue, field units cannot be accessed remotely and any required adjustments of distribution device setpoints or troubleshooting requires a physical visit by technician. In many cases, these coverage deficiencies in the Company's private communications network drives decision to commission new distribution devices on public carrier cellular networks. This has led to a suboptimized network, with sections of the grid having disparate connectivity performance between distribution devices in the same coverage area.

Lastly, a variety of technologies that are in use to support FAN communications are approaching their end-of-life and require replacement. Equipment nearing end-of-life include distribution SCADA radios which support the Company's Enterprise Energy Control System (eECS) and future DMS.

d. *Project Description*

The FAN strategy generated several recommendations with the aim to enable cost effective and reliable solutions for the set of challenges specific to the Company. Consistent with this strategic effort, the Company will continue to focus on the build out of a sub-1GHz private radio network, purpose built for its SCADA and other distributed automation requirements. A purpose-built network addresses the needs of the SCADA network, aligns with Eversource's guiding principles and provides a pathway to achieve the future state. This proposed network will be designed to improve the communications network connectivity, improve bandwidth, and meet the increased frequency of data communications to remote units as required by the Company's real-time systems.

As recommended by the FAN strategy, the Company will design a comprehensive network for data communications in eastern and western Massachusetts, which includes selection of base radio frequency, antenna locations and configuration of radios. The design will include the identification of geographic locations for base radios and receive proper approvals for Eversource to build at these locations. The Company expects the new network design will require new base radios and infrastructure to be built in both Eastern and Western Massachusetts. The Company will soon issue a request for proposal ("RFP") that will focus on the engineering design, procurement, and construction of this comprehensive network, starting in eastern Massachusetts. The selected engineering, procurement, construction ("EPC") contractor will deliver a turn-key network that meets the Company's technical specifications and is constructed, integrated and tested in accordance with the Company-approved construction drawing and coverage acceptance

verification. In parallel and once the design is finalized, the Company will work to implement this network in western Massachusetts. The build out of this new network infrastructure will include the replacement or upgrading of remote radios in field devices. In addition, it will also include the commissioning of approximately 24 new base radios enabling approximately 50 related remote terminal units ("RTUs") per base station. The network design will identify specific locations for base radios, and the EPC will acquire the proper siting, permitting approvals. The EPC will install and configure the base radio, and as part of the commissioning process, will also reconfigure any existing field units that will utilize this new base radio for its communications.

The proposed network will improve the Company's ability to monitor communications network traffic, which in turn enable the optimization of the network and efficient identification and mitigation of communications issues that can adversely impact the real systems. It will also be capable of providing remote access to distribution devices, allowing for remote monitoring and adjustment of setpoints of these devices. In addition, improvements to the private communications network provides the opportunity to transition some of the public carrier cellular-connected devices to the newly improved network, if it is determined that this will improve the connectivity performance and reliability of the device.

e. *Benefits and Outcomes*

To date, the Company has deployed nine new nodes on its system expanding the coverage of the Company's existing 450MHz and 900MHz private radio network For example, in the Pelham and Pocumtuck areas, in alignment with the Company's strategic goals, this expansion adds more

capacity to allow for current cellular and Tait radio system devices be transferred into the Company's radio system, with the latter currently being at the end of its useful life. The expansion allowed the addition of several of the new volt-var optimization ("VVO") and recloser devices into the Company's communication infrastructure with higher fidelity. This expansion has improved the capacity of the wireless communications network, providing more devices with better connectivity that can support the latency, bandwidth and frequency of data required by the new centralized technologies in the control room. In addition, the expansion has also improved the Company's ability to conduct remote monitoring, troubleshooting and control of the network and distribution field devices. Additional projects currently under development will further enhance the Company's wireless communications system capacity. For example, a project is underway to add a master radio node in downtown Boston that is expected to significantly improve network capacity, as shown in Figures 9 and 10. An increase in the "green" color indicates the Received Signal Strength Indicator "RSSI" is better, which allows for increased coverage.

Figure 9: Radio Coverage BEFORE 450MHz Master Radio Deployment

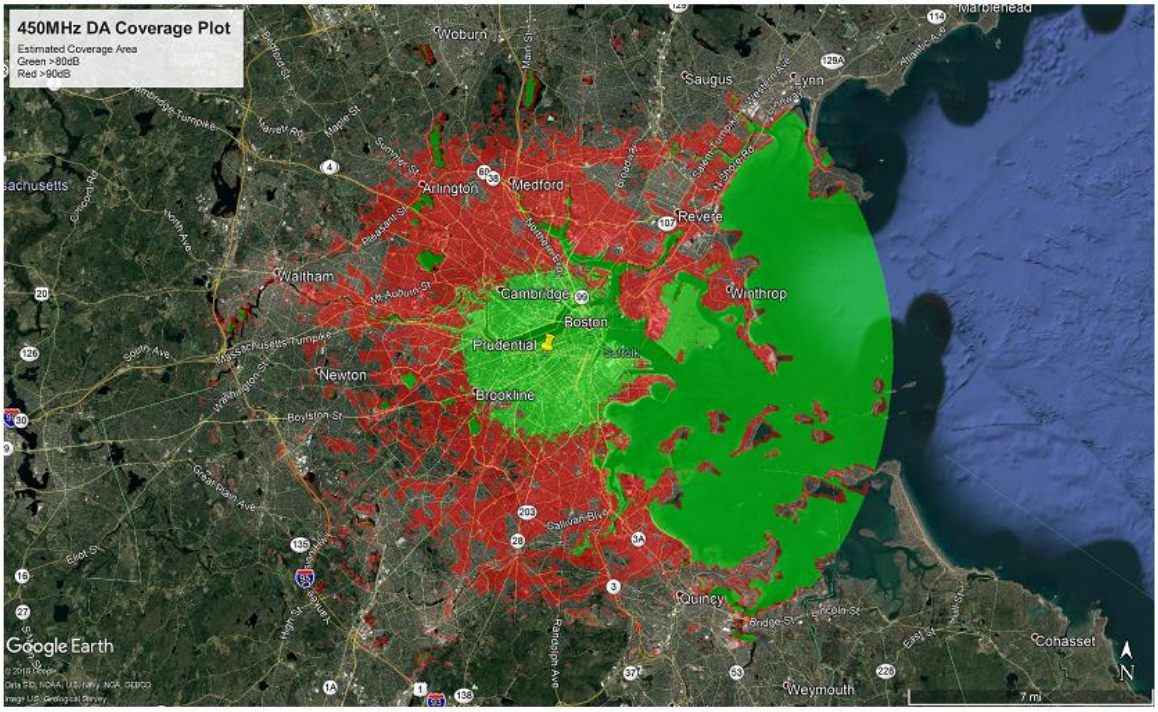
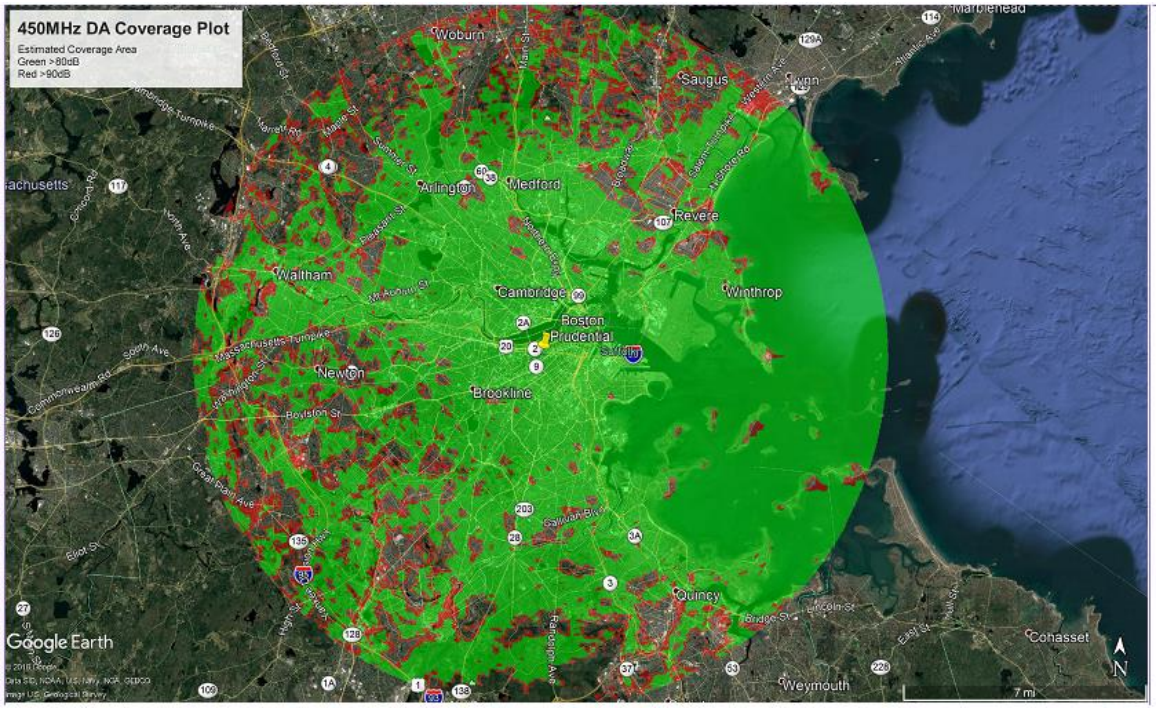


Figure 10: Radio Coverage AFTER 450MHz Master Radio Deployment



f. *Leveraging 2018-2021 GMP*

There have been several lessons learned as a result of the 2018-2021 GMP communications plan that will inform success going forward. First, the Company has demonstrated that its strategy of augmenting its existing wireless communications infrastructure is a cost-effective option to ensure increased throughput of data transmission using 450MHz licensed spectrum. The Company plans to continue maintaining its existing 900MHz licensed and unlicensed spectrum radio network and migrating devices on this radio network to the new 450MHz radio network as its capacity increases. Second, the Company observed during the execution of the nodes program an underestimation of the required field resources required, particularly with the deployment of the new radio frequency. Going forward, the Company will now know the proper number of field resources required for an increased efficiency in the deployment of new radio infrastructure. The Company has also gained an improved understanding of the breadth of opportunities to add wireless nodes to cost-effectively augment existing infrastructure has informed the strategy to focus on primarily on improving the capacity of radio networks.

2. Communication System Modernization

a. *Budget Summary*

New Investment			
Optimize System Performance	Optimize Demand	Integrate DER	Enables Order 2222
✓	✓	✓	
Four Year Investment: $14.0 million			
Investments Enabled: DMS, Substation Automation, PQ Monitoring, VVO, Dynamic DER Interface, DERMS			

b. *Overview*

The Company continues to find ways to modernize the existing communications infrastructure where it is cost effective and prudent to do so. Its recent FAN telecommunications strategy identified several recommendations that the Company can act upon as part of its comprehensive telecommunications strategy. The Company will begin planning the transition to internet protocol ("IP") on its FAN and eliminate data concentrators along the communications path in order to improve the resiliency and reliability of the data path from field devices to the Company's Enterprise Energy Control System (eECS). Building out an IP-based communications network will establish a modern communications path for the transmission of data on the distribution system.

c. *Project Need*

One of the critical components of the Company's recent FAN strategy effort included a current state assessment of the Company's distributed communications systems across the enterprise. This

effort is referred to as the ‘path of a packet”, and its intention is to represent how data moves between field devices and enterprise control systems. By mapping this movement, risks, redundancies, and other issues were identified. Connectivity between the eECS system and field devices was documented visually for more than 20 unique paths across all services and territories. Several issues and risks were identified, including single points of failure, and obsolete or end of life technology.

Specific to the Company’s Massachusetts electric service territories, the “path of the packet” assessment identified that the majority of its end-device connections use serial communications protocols (see Figures 11 and 12 below). This represents a risk, due to serial communications protocols being antiquated and limits the Company’s ability to remotely troubleshoot and monitor serial-connected devices. The development of serial communications hardware by manufacturers is stagnant and is at risk of obsolescence in the industry. In addition, serial connected devices limit the interoperability of field devices because it is a one to one relationship between the device and the master station. This prevents interoperability between centralized systems. A serial communication network also lacks modern security monitoring capability of network activity. Although there is minimal risk of a cybersecurity attack due to the non-routable nature of serial communications, serial protocols prevent the Company from using active security tools on its network. Finally, the lack of monitoring deprives the Company of the capability to perform remote troubleshooting of the communications network, requiring physical field visits to multiple locations to investigate network issues.

The "path of the packet" assessment also identified areas to improve the redundancy of equipment in that path. The Company's Eastern MA ECS data path uses data concentrators to collect data at stops along the way before the final destination. In particular, in the last step in the path prior to connection with the ECS front end processor, complex centralized data concentration devices (referred to in the Figure 11 as "GE D200 Data Concentrator") require extensive configuration when they are commissioned and introduce another potential point of failure. These 16 centralized data concentrators are antiquated technology and no longer supported by manufacturers. Enabled by the newly deployed ECS technology, the Company's current strategy calls for elimination of the centralized data concentrators in favor of directly connecting FAN traffic into the front-end processor.

Figure 11: E-MA Electric SCADA Current State Path of the Packet

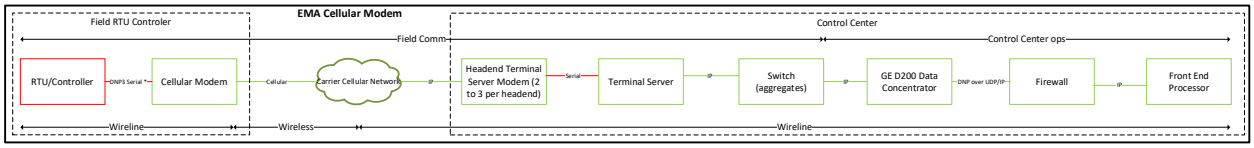
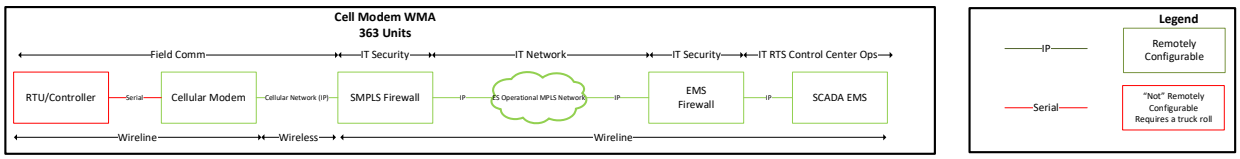


Figure 12: W-MA Electric SCADA Current State Path of the Packet

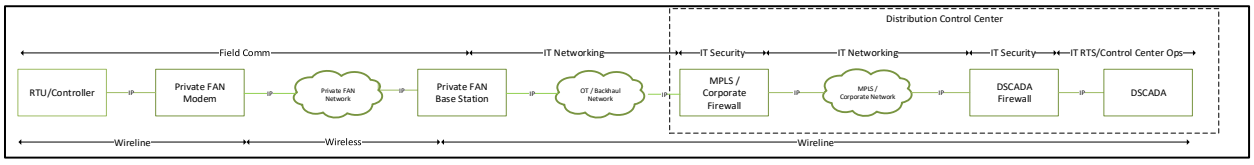


d. *Project Description*

The Company's serial to IP migration plan will replace serial-connected field devices with an IP-based distributed network protocol (DNP) connection. These connections are represented on the left-hand side of Figures 11 and 12 above. The "RTU/Controller" box will need to be re-programmed to be configured properly with new IP settings at approximately 150 locations. In order to maximize cost-effectiveness, identification of these locations will be coordinated with deployment of new base stations as a part of the wireless communications program to enable retirement of at least one centralized data concentration device.

These setpoints are what establish the connection between the "RTU/Controller" and the ECS. Work is also required on the ECS side of the communications path to align with the new configuration being implemented in the remote devices. The ECS system is defined in Figures 11 and 12 as the far-right box. Once complete, the "path of a packet" will reflect the representation in Figure 13 below.

Figure 13: Future State Path of the Packet



The desired future-state is end-to-end IP connections, which will enable the simplification of the path of the packet and eliminate potential single points of failure represented by data concentrators (see Figure 13 above). The migration to IP based communications also will be implemented in the

Company's investments in its private radio system. This transition will require the replacement of obsolete or end of life remote terminal units ("RTUs") and controllers. Although a detailed migration program will be required, given the need to convert over 4,000 devices the Company expects this transition will take several years to complete.

The Company envisions the future state for its SCADA network is well represented in Figure 13 above: an end-to-end IP-based secured network that enables the remote troubleshooting and configuration at the grid edge, with all data traffic monitored in real-time.

e. *Benefits and Outcomes*

The Company expects several benefits will be enabled by this project. The migration from serial protocol to IP will enable remote access to field devices for engineering review and corrective actions (e.g., remotely changing distribution device set points). Remotely troubleshooting field equipment presents opportunities to reduce trouble resolution time, enable earlier identification of issues and enhance flexibility for the Company to remotely adjust setpoints on thousands of devices, reducing maintenance costs. This flexibility will better allow these devices to stay current with an ever-changing distribution system. A modern end-to-end IP-based FAN network will require increased cybersecurity measures and protocols, including a constant monitoring of network activity. The adoption of IP for use in the FAN, inherently enables remote end-to-end monitoring, configuration and troubleshooting of all IP-connected devices. An end-to-end IP-based FAN network will be protected with enhanced cybersecurity measures like authentication and data encryption and provide 24/7 monitoring of the network and connected devices.

Implementation of this plan will also reduce the risk of technology and workforce skillset obsolescence, as IP and DNP3 are protocols that have been universally adopted by the industry. Overall, this project will align with the Company's FAN strategy guiding principle to future proof technology, removing the risk of technology and skillset obsolescence.

f. *Leveraging 2018-2021 GMP*

The Company will leverage the lessons learned since the implementation of its grid mod plan beginning in 2018. The Company will continue building upon its 450MHz wireless radio node investments. The Company's current and future state assessments of its radio network and the SCADA-connected devices it supports has identified the need for a complete, end-to-end private radio network solution that is supplemented with public carrier cellular connectivity where it is deemed prudent.

G. Advanced Load Flow

1. Interconnection Automation

a. *Budget Summary*

New Investment			
Optimize System Performance	Optimize Demand	Integrate DER	Enables Order 2222
		✓	✓
Four Year Investment: $3.0 million			
Investments Enabled: DERMS **Enabling Investments:** Analytics Platform			

b. *Overview*

Driven largely by state policy incentives, distributed generation interconnection requests have been increasing rapidly in Massachusetts since 2010 and are expected to continue increasing for the foreseeable future. To facilitate the interconnection process, as a part of its 2018-2021 GMP, Eversource has invested in tools and solutions including Synergi Electric, Hosting Capacity Maps. Additional tools used in the interconnection process include PSCAD and Power Clerk,. However, the recent exponential increase in interconnection applications as well as engagements with developers through filings in the Department's inquiry into distributed generation interconnection in docket D.P.U. 19-55 have shown that there is a need for more and better information, flexible interconnection processing for storage, and a faster turnaround for interconnection requests. In an effort to learn and understand how other utilities and jurisdictions approach this issue, Eversource has conducted a wide-ranging review of market technologies from North American and Europe as well as benchmarking discussions with peer utilities. Eversource found that in all cases, the key to improving and speeding up the interconnection review process is a unified software platform to combine and streamline relevant tools and processes. This software platform is intended to integrate with the modeling/simulation tools (Synergi, PSCAD), the customer interconnection portal (Power Clerk), and provide an end to end solution for case management, impact studies, automation of process steps, reporting, and data ownership management. In addition, the platform would enable more granular, relevant information to be rapidly published on hosting capacity maps.

c. *Project Need*

Massachusetts has seen a significant increase in interconnections for solar and storage applications, both residential and utility scale over the past years. Currently, the Company has over 8,000 interconnections representing over 2,000 MW of nameplate capacity. The majority of the capacity in queue is associated with applications for large (standard) projects in saturated areas that require more complex engineering analysis, mitigation measures and cost estimation. This has led to an extensive backlog of projects in the application queue. Furthermore, the significant increase of solar plus storage applications has brought up the question, through filings in docket D.P.U. 19-55, of how co-sited storage can help mitigate interconnection constraints. This requires developers to receive more detailed information about the point of interconnection as well as utility control and monitoring capabilities.

Delays in interconnection studies, as well as the limited capability to account for load management through storage, has impacted customer satisfaction and the financial profile of many projects. Consequently, Eversource sees an opportunity to improve the interconnection process, while also improving customer satisfaction and the possibly mitigating financial risk for developers.

Customer Information: Currently, hosting capacity maps offer limited insights into actual limitations of interconnections, especially if storage systems are involved. Furthermore, information is presented statically, no recommendations are made, and the maps can be up to one month out of date.

Case Management: The volume of information required to process interconnections often leads to process inefficiency and reduced transparency. Clear tracking and management of all interconnections, from start to finish, including study results, power flow data, network models, is essential for the company to ensure a seamless process.

Automation of Process Steps: While not all steps within an interconnection study can and will be automated, and beyond a certain size of interconnecting resource more engineering interaction will be required, Eversource realizes that specific steps in the study process can be automated, such as model preparation or conversion of models to PSCAD. The steps that can benefit from automation will be identified as part of this effort.

Network Model Management: With multiple departments using the Synergi and PSCAD network models, it is vitally important to ensure consistent and up to date network models with visibility and traceability of all changes made. Significant preparation time is needed today for a study to ensure the models available are the current and most accurate forms.

Data Ownership: In some cases, supporting studies, models and customer data are exchanged with vendors to and from Company servers. The proposed solution would allow vendors to use the platform to conduct their studies without network or customer data ever leaving Eversource secured environments.

Improved Granularity: Today not all interconnections are studied in full detail and below a certain size and feeder loading conditions an expedited process is typically used. However, actual conditions might not always be representative of those generalized assumptions and problems can

go unnoticed until a larger interconnection is studied on a given circuit. Here, by improving speed and automation of the interconnection process, the intention is to run even smaller applications through a basic simulation to determine if thresholds are approached in the hopes of identifying issues early on.

d. *Project Description*

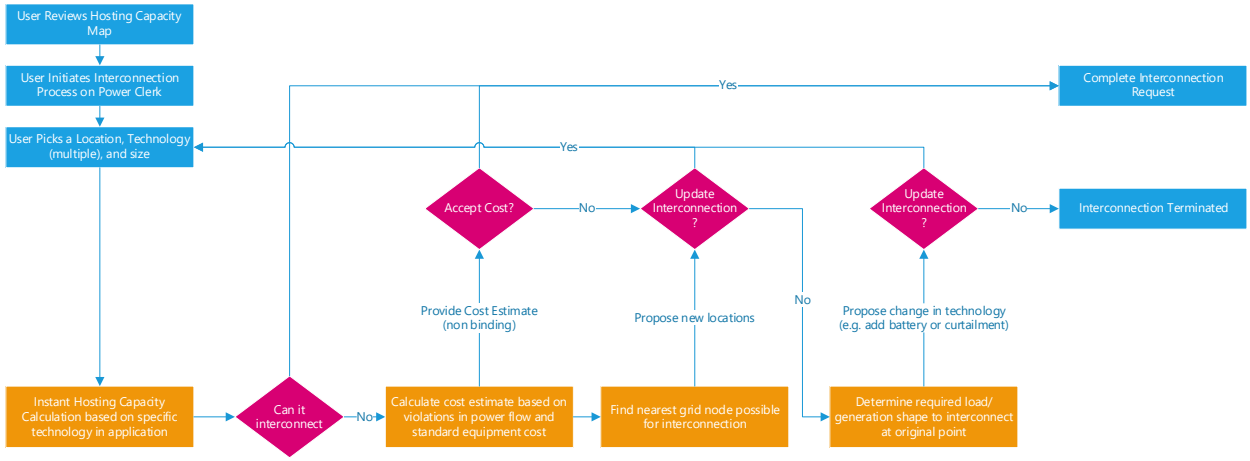
In support of increasing the efficiency and effectiveness of the interconnection application study process, Eversource is proposing to procure a software solution to enhance the Company's capabilities to quickly and accurately assess interconnection impacts in order to safely and reliably interconnect as much DER as possible to support the State's 2030 and 2050 clean energy policy objectives. In addition, efforts will be made with existing vendors for Power Clerk, PSCAD, and Synergi to integrate these tools into the proposed platform and increase functional capabilities.

Procurement of Software Solution: Eversource intends to purchase a software solution using the experience gain from previous vendor interactions. The intention is to provide a dedicated and specifically tailored solution to DER planners while leveraging investments made into Synergi, PSCAD and Power Clerk by increasing integration and automation between the tools. The Solution will be specifically tailored to the Massachusetts interconnection process.

Improvements to Customer Provided Data: By merging hosting capacity information into the interconnection platform, and providing users the ability to interact with the hosting capacity data, users will be able to evaluate different options (location, curtailment, active management, storage, etc.) directly during the interconnection process. Specifically, the interaction with customers as

they evaluate their interconnection before filing it will provide more clarity on the potentially associated cost and risk of the interconnection, and potentially reduce the time to process the interconnection request.

Figure 14: Schematic representation of a possible customer interaction



Pending completion of the currently ongoing D.P.U. 20-75 docket, information on group studies, size of groups, queue length and more, could also be displayed to customers.

e. *Benefits and Outcomes*

Improvements to Hosting Capacity Calculations: A key component of the proposed solution is the active engagement with customers through a portal environment, providing easy access to guidance on improvements to their interconnection, which is based on the ability to compute ad-hoc hosting capacity calculations. In addition to this ad hoc capability, hosting capacity calculations must be time series based to allow for the evaluation of specific operating modes and dispatch patterns.

Customer User Flow: Customers will have the ability to actively engage with the interconnection portal and receive direct feedback on possible constraints of their application. While this will not replace an interconnection study, modifying the interconnection to better fit the available grid capacity significantly reduces the risk of associated interconnection cost. Furthermore, it will provide developers with more information on options to utilize storage assets or other measures to actively reduce their possible cost to interconnect.

Interconnection Turn Around Time: Through automation of all feasible study steps and an improved case management, Eversource expects a reduction of effort, and consequently time, required to study the interconnection request. The result will manifest itself with faster turnaround times for interconnecting customers, which directly results in reduced risk to projects.

f. *Leveraging 2018-2021 GMP*

The proposed effort heavily relies on investments made to implement the Synergi Advanced Load Flow tool, by utilizing the tool and improvements made to the tool through script automation and the forge process. The cost and time to implement the Interconnection Automation project will also be reduced by improvements made to the hosting capacity capabilities in 2021. Specifically, efforts to calculating hosting capacity will ensure a running start for this project as processes for model creation, cleaning, and automation of the simulation are already in place through previous projects.

2. Analytics Platform

a. *Budget Summary*

New Investment			
Optimize System Performance	Optimize Demand	Integrate DER	Enables Order 2222
✓			
Four Year Investment: $5.0 million			
Investments Enabled: PQ Monitoring, VVO, Probabilistic Power Flow Modeling			

b. *Overview*

The last decade has seen significant reductions in the cost of computation and data storage all the while improving computing speeds and efficiencies. At the same time, advances in distribution utility sensor technologies and availability of low-cost system sensors, is driving an inflection point with respect to availability of data. This data can help utilities become more agile in responding to customer requirements. In normal operation, data can be used to uncover new opportunities to add capacity, new ways to build resiliency and enhance service quality to customers. Additionally, data can help pinpoint incipient faults even before they result into outages, or in storm events, help locate and diagnose fault conditions faster than traditional means. To best utilize the data, modern data processing and intelligence tools are necessary. These tools allow the ability to process billions of rows of data in fractions of a second and provide actionable intelligence to the system operators. These tools also allow the elimination of expensive manual

process of both getting to and cleaning the information for use in analytics that can provide valuable information and insights into the grid and our customers. Thus, the addition of these new data tools can help the Company better serve customers.

c. *Project Need*

Eversource uses different IT systems to store data associated with various types of field devices. In addition to the system performance data, which is archived in the Company's data historian environment, Eversource maintains asset history and maintenance logs in a separate asset management system. To support various DER use cases, Eversource also relies on other types of datasets, such as 15-minute solar irradiance at 1 square km interval. These sources are used by all business areas. For example: the distribution engineering team looks at the circuit performance data to find root causes of reliability issues; the GIS group does periodic inventory updates of the asset database; the asset management team calculates useful remaining life of the assets and determines replacement candidates; the planning group studies load growth to plan future projects; and substation technical engineering looks at signatures to investigate equipment failures and identify root causes. To facilitate these tasks, Eversource engineers collect, clean, slice and dice the information on an as needed basis.

The process is manual, laborious, time consuming and in some cases, not possible. Data retrieval from remote servers is often slow and limited by design to prevent server overload. Combining information from multiple sources poses the next challenge. Different systems of record maintain their unique primary keys, making information association for the same piece of equipment

challenging. Once the information is made available, engineers must spend hours to days cleaning and sanitizing the dataset wherever necessary to remove missing values, corrupted entries, and erroneous data entries to make the data useful. Due to the inherent limitations of the Windows operating system and engineering laptop computers, our engineers can only process data using their PCs to a certain limit. Beyond a certain file size and complexity, the data cannot be analyzed on local machines. Lastly, the use of local computation environment prevents Eversource from using the latest machine learning and statistical analyses tools to support their work.

The implementation of advanced metering infrastructure ("AMI") will make thousands of additional data streams available. This data requires modern distributed computing tools for analysis. AMI data, when combined with other data sources, such as, OMS, GIS and customer systems can help uncover valuable insights into grid operations.

The Analytics Platform project is intended to facilitate ease of data analysis. The project will harness the power of cloud computing and allow the Company to leverage infinitely scalable storage and computation capabilities. At the same time, the Company will be able to use the latest artificial intelligence tools to help solve the problem statements at hand.

d. *Project Description*

The project covers two key enablement areas. The first part will establish the cloud infrastructure to support the software solutions. In this first part, the Company will add storage, compute, web services, private endpoints, virtual networks, and data routes in development, test, and production environments.

Appropriately sizing environments, will allow data scientists at Eversource to design and build data-first solutions in development, deploy the solutions in the test environment for verification and finally deploy intelligence-ready products in the production environment. Security components in this buildout will protect Eversource data and maintain secured communication between several system of records mentioned earlier and the data analytics solutions.

The second component, a cloud intelligence platform, will provide a data orchestration solution hosted in the cloud infrastructure described above. The cloud intelligence platform will enable Eversource to analyze large volumes of data coming from disparate systems, study inter-relationships, and develop statistical models for forecasting and early warning. The platform supports large scale automated machine learning.

The Analytics Platform project will empower employees with latest machine learning tools and help build solutions at scale. Examples include:

1. with the maintenance logs, system signatures, and past failure history, Eversource engineers can build machine learning models to predict future equipment failure;

2. the platform can analyze system signatures in near real-time to spot anomalies and detect outages in near-real time;

3. looking at protection and control system operation, the software can help determine root causes of momentary outages;

4. it will set the Company up for the future AMI integration where ability to crunch billions of rows of data every day will be crucial to fully realize the potential; and

5. deployment of these models will serve a variety of business functions, ultimately improving reliability and quality of service to customers.

e. *Benefits and Outcomes*

The project will alleviate some of the key pain points that the Company experiences today around data analytics including access to data, speedy data cleaning and processing, and automated machine learning. The infrastructure will enable engineers to combine data from a variety of data sources in the cloud, and stage the data for analytics in the cloud. This will reduce the burden on the on-premises resources. As a secondary effect, the Company will observe improvement in runtime for queries and overall performance improvement in analytics.

Second, as discussed above, the software platform will help reduce the time it takes to clean and sanitize data. It will also support automated extract transform and load ("ETL") routines to periodically re-run cleaning routines as required by the analytics.

In addition, the software platform will empower resident data scientists with state-of-the-art auto-machine learning tools. These tools can train several machine learning algorithms and determine best model and parameters algorithmically. They are "fire and forget" solutions which require very little to no manual intervention to build machine learning models. The software will enable non-data scientists to solve data-driven problems with more ease and speed.

The work will deliver a cloud environment equipment with all necessary components to install and operate a machine learning software tool, including but not limited to storage, computation, and networking functionality. The data science software will enable Eversource to develop models to perform key tasks, for example, detect equipment failure in advance, incorporate data driven insights into system planning, and improve storm response.

f. *Leveraging 2018-2021 GMP*

The previous GMP scope allowed Eversource to incorporate advanced sensing equipment in several substations as a part of the Substation Automation project. This equipment produces an unprecedented amount of data and visibility into system operations. Engineers have the data to observe electrical quantities that we did not before.

The Analytics Platform project will allow engineers to leverage data newly available as a result of GMP investments in sensing to demonstrate VVO system effectiveness as well as help shape decision making around operating points for existing and future developments.

Similarly, the platform will facilitate analysis of continuous monitoring data provided by power quality monitoring systems and enable near-real time failure analysis and detecting anomalous patterns using feeder current and bus voltage data. Lastly, these analytics tools will work in tandem with ongoing Synergi development. It will support running scenario analysis in Synergi as well as preparing data that will make Synergi models better, for example, accurate solar insolation profile, load history and forecasts.

3. Probabilistic Power Flow Modeling

a. *Budget Summary*

New Investment			
Optimize System Performance	Optimize Demand	Integrate DER	Enables Order 2222
		✓	✓
Four Year Investment: $2.0 million			
Investments Enabled: VVO, DERMS, Congestion Management **Enabling Investments:** Analytics Platform, System Support & Maintenance			

b. *Overview*

A critical part of the system planning process, distribution system load forecasts are becoming increasingly challenging to produce. As a result of factors including, uncertainties in localized adoption rate forecasts for DERs and EVs; increasing complexity of grid operations and distribution automation; growth in dispatchable resources and flexible load driven by customer incentives and behavior; and increased penetration of aggregations, projecting a future grid state is increasingly uncertain. Forecasting the distribution system of the future is increasingly forcing engineers to ask the question, how do we plan for a system with so many unknowns?

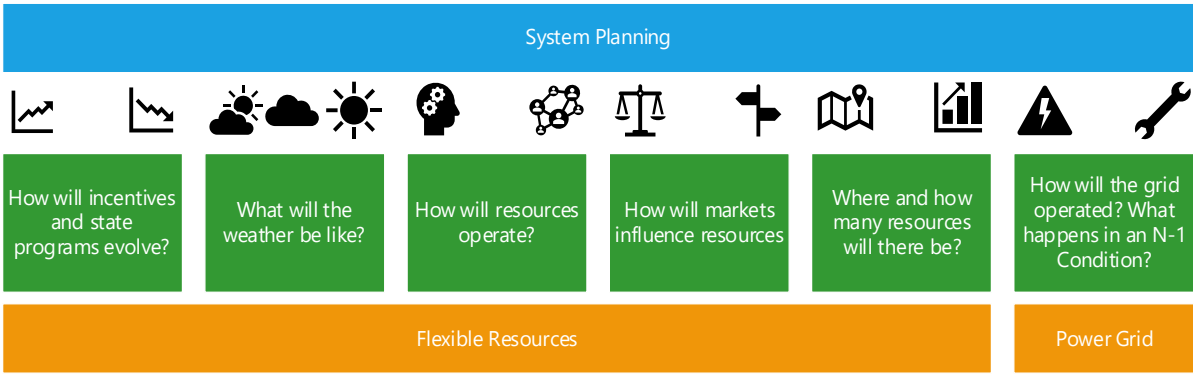
For system planning, this poses a challenge, as no conclusive decision can be made using tried and proven approaches, such as 90/10 forecasts for load peaks. Historically, this was a prudent and sound approach as there was only one variable to determine the system load, temperature.

However, with the adoption of new technologies the number of uncertain input variables increases, so do the scenarios, exponentially. For example, with the addition of solar generation, weather (cloud) cover was introduced as a new variable resulting in the simulation of not only a peak load, but also a minimum load condition, which is reflected in in the Company's current distribution planning guide. Understanding these uncertainties (when, how, what, …) and how they might impact the power system years in advance is the next big challenge facing distribution planning.

c. *Project Need*

Complexity on the distribution system is on the rise with the rapid adoption of new technologies; uncertain forecasts of localized adoption and dispatch behavior; customer optimization through co-sited storage; as well as the introduction of resource aggregation for market participation through FERC Order 2222. With so many degrees of uncertainty, developing a single or even a handful of stand-in scenarios for future grid conditions is an increasingly inadequate method to address growing complexities and provide an accurate representation of future system conditions.

Figure 15: Uncertainties in modeling reliable system planning scenarios



As represented in Figure 15, today's systematic approach of considering a system's worst condition no longer holds up if the number of variables defining the system condition increases from a handful to 'x' (adoption rate forecasts, resource locations, control modes, aggregation, customer behavior, ISO energy markets, etc.). All of these variables will significantly impact the outcome of a power system study, but which are not necessarily independent of each other.

Concepts for managing these issues in the system planning process have long been studied in academic circles. Recently, however, with the wide-spread availability of large-scale processing capabilities, previously theoretical solutions are becoming mainstream applicable. In order to successfully model the future power system, a probabilistic power flow model is required. By simulating every possible variance of an uncertain input variable (Monte Carlo Method) the complex interplay of the variant input parameters can be understood. These processes, however, not only require powerful computation capabilities to run thousands of iterations with different scenarios, but also advanced data analytics to evaluate the results of these analysis and draw the right conclusions.

Without such simulation capabilities, adequate tools, and processes to evaluate the results, distribution system planning will find itself faced with an insurmountable number of possible scenarios and no ability to evaluate them in a feasible manner.

Lastly, by shifting to a risk-based system assessment, new process and planning criteria must be established that takes into consideration the inherent change in evaluating power systems. Best practices are required to inform capital plans based on the probability of certain scenarios happening.

The need can therefore be summarized in two key points, the ability to use probability distributions of uncertain input variables to run a Monte Carlo simulation model in a probabilistic power flow model, as well as the technical capabilities to evaluate the results using advanced data analytics and decision making processes.

d. *Project Description*

The Probabilistic Power Flow Modeling project will implement improvements to distribution modeling capabilities and support investments in enhancing necessary data analytics solutions.

As a part of the 2018-2021 GMP, the Company has already invested in automating the process of retrieving models, preparing them for analysis, running load allocation, and performing hosting capacity analysis. The Company will build upon these investments and advance automation capabilities to include probabilistic load flow calculations. As shown in Figure 16, the specific components in this process are:

Define Baseline Forecast Model. As an initial step, based on advanced forecasts; the most up to date network model; and generalized customer behavior assumptions, the Company will develop a baseline model from which input parameters will be varied.

Define uncertain input variables and their probability distributions. Review all input variables, such as customer behavior, adoption propensity, energy market prices, or asset locations on the grid and define probability distributions for each.

Create scenarios using a Monte Carlo Simulations. Create a Monte Carlo simulation environment which will allow the creation of thousands of randomized scenarios based on the probability distributions of the uncertain input variables. Each of these scenarios will contain specifics on adoption rate, user behavior, or locations of assets.

Automatically update network models. Provide automated capabilities to update the baseline model for each of the thousands of scenarios providing individual models for each, including different DG locations, weather conditions, and customer behavior profiles.

Perform Power Flow analysis. Upgrade existing capability to enable running thousands of power flows autonomously, and ideally in parallel.

Store Data in Analytics Environment. Direct the results from the thousands of power flow simulation to a cloud storage application which will provide easy access for advanced analytics.

Advanced Data Analytics. Develop capabilities to digest large quantities of power flow results. New methods for reviewing power flow results will be required for engineers to review and analyze thousands of scenarios in an organized manner.

New Decision-Making Processes. New processes will be required as results from probabilistic simulations no longer provide a binary recommendation, but an association of each possible scenario outcome on a probability scale. New processes must be implemented which allow investment decision making using risk-based assessments, including updated to Eversource's distribution planning guide.

e. *Benefits and Outcomes*

Driven by the propagation of new technologies and the resulting increasing complexity of the distribution system, the need for powerful planning capabilities has never been more pressing. By developing the proposed probabilistic simulation tools, Eversource will gain capabilities which will help address the challenges of a decentralized generation infrastructure. In addition, Eversource is expecting to improve modelling of the interplay of systems such as VVO with distributed resources.

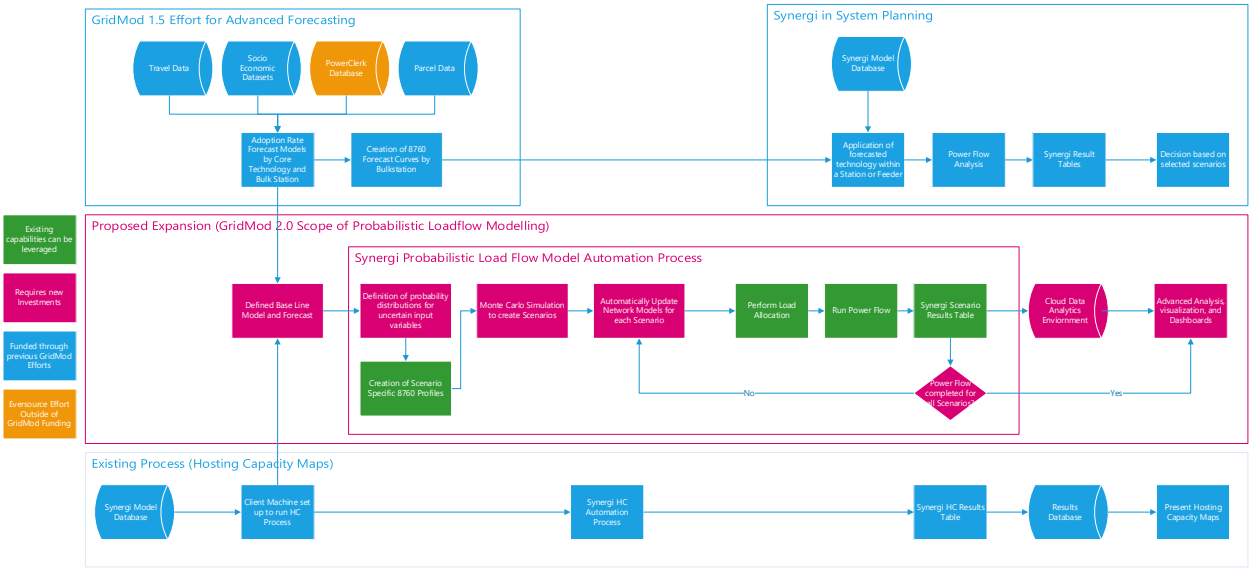
By developing a risk-based assessment for distribution planning, scenarios and projected grid conditions can be evaluated based on their probability to occur, informing investment decisions and prioritization. This will also advance the use case for alternative solutions to system constraints, as all scenarios causing the constraint can be identified and very targeted programs created to address these constraints.

With a specific focus on FERC Order 2222, the Probabilistic Power Flow Modeling project will also allow Eversource to simulate of thousands of scenarios for bulk energy market participation of aggregated resources, a capability that Eversource currently does not have.

f. *Leveraging 2018-2021 GMP*

The proposed project fits within two previous Grid Mod investments, namely, it will build on investments made to implement the Synergi and the Advanced Forecasting projects. Figure 16 shows the interaction with the in this projected proposed process and the existing processes.

Figure 16: Schematic interaction of proposed investments with existing processes



H. DERMS

1. DERMS

a. *Budget Summary*

New Investment			
Optimize System Performance	Optimize Demand	Integrate DER	Enables Order 2222
✓	✓	✓	✓
Four Year Investment: $10.0 million			
Enabling Investments: DMS, Communications, Dynamic DER Interface, Substation Automation			

b. *Overview*

System operators are challenged daily to monitor and control power flow on the distribution system in the presence of DER. The impact of the growing penetration of DER requires a Distributed Energy Resource Management System (DERMS) to assist operators in managing these assets. The DERMS is a software platform that can manage DER to deliver grid services and provide operators a tool to balance demand with supply on the distribution network. This investment is the inception of capabilities for system operators to incorporate behind the meter and utility scale DERs into the overall solution that will be used to solve for distribution system operational needs. To achieve the optimal use of distribution system assets, the DERMS will organize connected assets and provide critical operational data for each asset to be a data input into the DMS. The DER data stored in DERMS will be used for both near term forecasting and real time operations. Near-term forecasting capability is critical to understand the day-ahead

output and operating parameters of DER to balance load and generation and to safely plan maintenance activity on the distribution system. The DERMS will also act as the system from which the system operator will be able to issue commands to the DER to guarantee the safe and reliable operation of the distribution system in real time. Another expected enhancement in this area is to build IT infrastructure to support the interoperability of the DERMS with other real time systems. It is critical to future growth to be able to share data efficiently between systems and having the IT infrastructure in place to improve interoperability will be critical. The Company does expect to progress this capability over time and is planning to start with a targeted deployment to include different types of assets within a specific geographic region of its service territory.

c. *Project Need*

Distributed energy resources play a key role in achieving clean energy goals and provide an opportunity to shift how the distribution system is operated to a more optimal state. This begins with establishing a way to monitor in real time, multiple types of DER including energy storage, solar, smart thermostats, smart water heaters, etc. Monitoring of DER today is limited to utility owned equipment installed at the interconnection point for large scale DER. This provides basic high-level summary data but does not provide detailed data related to the specifics of a DER such as inverter level voltage and power output.

To go beyond monitoring and to take full advantage of these assets, there are many areas of need that are required to be addressed. To begin, the adoption of IEEE 1547-2018 requires DERs to be capable of active voltage regulation, disturbance ride through, and frequency response. These

requirements advanced the functionality of DER but also necessitates the collection of data for each asset and to build them into the model of the distribution system to effectively manage them. DER assets' nameplate data and operational setpoints don't reside in an operational system today. The DER type, model, output capability, site connection is critical information to know how to model these assets as part of the steady state model. In addition, control of operational modes and setpoints such as voltage, Volt/VAR, watt/frequency will be predicated on collecting the "as-left" settings and including those details in the model of the asset.

Today, there is no such system that has this data and can translate it into operational use for system operators to be able to act on local distribution conditions. Furthermore, if DER begins to be aggregated for multiple use cases, there will be a need to know how that aggregation is intending to use each asset and layer that data point on top of the individual asset information. An example of this is the potential impact FERC Order 2222 will have by establishing a path to the regional market for aggregated DERs which may compete with local distribution operating conditions. This complex situation of individual use versus aggregated use requires a system to manage the local, global, and contractual constraints that each DER potentially are subject to.

In addition to the operating tool, building out information system architecture that is interoperable and efficient to manage the sharing of data between operational systems is needed to enhance the capability. As information technology advances, the Company also needs to establish a more agile architecture to make adoption more "plug and play" in nature.

Another area of need is to be able to accurately predict output of DER to ensure reliable grid operations. The forecast needs to be defined for the day ahead and also intra-day as the distribution system can potentially change drastically due to outage events, system maintenance, and power flow conditions. It also needs to be presented as actionable information to system operators. Due to the complexity of each DER's operating state, a system is required to take in multiple data points and be able to supply that information into the distribution management system to present it to operators as a clear decision that will not sacrifice the safety and reliability of the distribution system.

d. *Project Description*

The Company investment in DERMS is an implementation of a system that is inclusive of the IT environment, operational control software and forecasting tools that will enable the monitoring and control of DER on the distribution system.

The main system to be deployed will connect a database of DER assets with specific operating parameters to the model-based distribution management system. The Company will perform data gathering and cleaning to support DERMS control capability regarding specific DER operating setpoints (MW/MVAR output, PF settings, volt/watt curves, frequency/watt curves). This data gathering activity will be focused on one operational area within Eversource's service territory to prove out functionality before scaling up the effort for the remaining service territory beyond 2025.

There will also be effort to consolidate the Company's existing Connected Solutions program, which includes customer owned assets, into one complete set of DER to be available for monitoring and control in the DERMS.

Once the DERMS platform is established, an interface will be built to the Company's distribution management system so that a system operator can perform study cases and real time actions that will send commands to DERs that are participating. The commands include open and close, changing local operational modes, and specific set point control.

In addition to real time monitoring and control, the Company will also build near term forecasting capability in system operations that will predict load and generation on the distribution system in the day ahead to week ahead time frame. Forecasting results will be used to inform the Company's existing operational planning activities on the distribution system. This capability will be established in the same operational area as the DERMS described above.

As part of this investment, the IT environment will include building upon the Company's approach to enterprise service bus which is the framework for Eversource applications to share data using a standard set of integration capabilities. The initial set of integrations will be focused on enabling DERMS and interoperability with other real time systems such as DMS. The Company will continue to monitor industry developments and adjust as necessary for changes in markets, policies, technology, and customer preferences that will influence the DERMS technology available in the market.

e. *Benefits and Outcomes*

The DERMS system presents the Company and customers multiple benefits to further modernize the distribution grid. The DERMS system will be the tool that will provide the Company's system operations center with the capability to monitor and control the distribution systems power flow while maintaining safe and reliable power. Balancing load and generation using DER connected to the distribution system depends on what type of DER (energy storage, solar, smart thermostats, smart water heaters, etc.…) is participating and its associated operating parameters and contracts. With this specific data for different types of DER, operating decisions can be made with more precision.

The data associated with the DER will also be more efficiently shared between systems because of the common integration platform being implemented and also supported by a more modern and scalable information technology architecture. Moreover, each type of DER will have different use cases and using the DERMS as a central control system will be critical to successfully managing the distribution system for multiple use cases. These multiple use cases at times contradict each other and so the DERMS will be the key to unlocking this complexity and to produce an optimal solution.

The DERMS also enables the continued growth and adoption of DER on the distribution network by creating the capability to optimize DER output for specific system conditions. Understanding the system conditions from DMS and the DER assets managed within DERMS, provide the complete picture from which a system operator can operate the distribution system.

f. *Leveraging 2018-2021 GMP*

The DERMS project will utilize lessons learned from project deployment as well as utilize basic DER data that was collected for the Company's Advanced Load Flow ("ALF") and DMS projects in the 2018-2021 GMP. The Company's understanding of complexity of a real time system has grown and will be drawn upon when detailed project planning and execution starts. This includes organizing the project around an agile methodology, identifying the right resources, and ensuring change management tools are in place to make a smooth transition from installation to maintenance. Both the DMS and ALF investments have set the foundation for organizing data to be used for a major system like DERMS. The DERMS system will utilize the data architecture that is in place to be more efficient when expanding for its own uses. The Company will also be leveraging forecasting experience that was developed from the advanced forecasting project. Although the forecasting project focused on long term forecasting of load and generation, those same data points can also be used to inform the day ahead projections.

2. Dynamic DER Interface

a. *Budget Summary*

New Investment			
Optimize System Performance	Optimize Demand	Integrate DER	Enables Order 2222
✓	✓	✓	✓
Four Year Investment: $6.0 million			
Investments Enabled: VVO, DERMS **Enabling Investments:** Communications			

b. *Overview*

This investment will upgrade the existing communication and control capability at Eversource and customer-owned large inverter-based DER facilities. These enhancements will enable the DER assets to be commissioned and integrated into the Company's eECS/DMS/DERMS control platform to provide real-time monitoring and control capabilities to system operators in support of VVO and other optimization algorithms.

This deployment will be used to (1) study and document the efficacy and feasibility of this technology as a standard interconnection interface; and (2) identify the best value sharing mechanism for incentivizing wider adoption and participation. The intent is to demonstrate the technology first at an Eversource owned facility and then test different scenarios with a select group of customers whose input and insights will be critical to the success of the study.

c. *Project Need*

As regulatory and environmental mandates accelerate the adoption of renewable DER resources, the need for monitoring and controlling the output of those resources becomes increasingly important. This is especially true for intermittent resources like solar PV arrays which can adversely impact the power flow and voltage profile on the feeders and substations where they are interconnected. Monitoring the status and output of the DER allows for accurate modeling within DMS to proactively identify voltage or capacity violations as well as opportunities for optimizing system configuration or conservative voltage reduction. The current lack of ability to throttle the output or change the operating mode of the DER inverters over-the-air (i) limits the interconnection of additional renewable DER resources; and (ii) for existing resources, sometimes

results in extended curtailment periods following automatic tripping due to a power quality violation.

As existing DERs interconnect using a wide variety of vendors and technology, there is no common or standardized interface to efficiently scale their integration into the EDCs SCADA/DMS/DERMs platform to enable such monitoring and control. This lack of a simple and transparent mechanism for providing dynamic voltage and reactive support (in addition to active power and energy output) to minimize required system modifications or provide incremental value to the distribution system makes it difficult for interested customers to take full advantage of the inherent flexibility and capability of their resource.

d. *Project Description*

Upgrade the existing monitoring and control capabilities at approximately 24 Eversource- and customer-owned DER sites to demonstrate dynamic dispatching capabilities of the inverter resources. Demonstrating the technology at customer-owned sites will entail recruiting interested customers and establishing agreements to participate in the project.

The main component of the implementation is a programmable controller and integrator which hosts a library containing several ready-to-use programmable modules for controlling the point of interconnection ("POI") between the utility grid and the inverter generation resource. At most sites, this allows for the implementation of several operating modes including Voltage, VAR, and Power Factor control. The interconnection protocols and standards will rely on the recommendations of

the Massachusetts Technical Standards Review Group's ("TSRG") Communications Subcommittee.

In addition to DMS, Eversource will also explore integrating these resources into the DERMS platform (including an IT Security review) and develop processes for grouping assets and dispatching based on varying criteria (day-ahead and near-erm forecasts, real-time system conditions, etc.

The EDCs have agreed to collaborate and work together to align in determining increased value created through monitoring, controlling, and utilizing non-utility owned DER assets in a variety of different use cases beyond those in operation today (e.g., demand response). Together, the EDCs will explore the value and compensation mechanisms to the DER owners that can be implemented across the state for these incremental DER managed use cases. Eversource and the other EDCs intend to leverage the collective knowledge and experience from DER integration demonstrations as an input to this collaborative effort.

e. *Benefits and Outcomes*

A programmable controller at the POI provides an Eversource-defined standard integration platform for commissioning into the ECS/DMS system, regardless of the configuration or inverter vendor installed at the DER location. This enables the efficient scalability of this capability at other Eversource or customer owned DER locations as expansions are planned and approved. As these will be based on TSRG requirements and recommendations, this will create a consistent standard across participating EDCs in Massachusetts.

We expect that the ability to use the DER assets as grid management resources will lower the burden of DER interconnection requirements and increase hosting capacity by incorporating the advanced dispatching capabilities to mitigate their system impact.

f. *Leveraging 2018-2021 GMP*

The advanced load flow (ALF) and hosting capacity analyses approved and implemented in 2018-2021 GMP will support the identification of locations and assets best suited for this demonstration as well as the operating modes and setpoints to iteratively implement. The PI Asset Framework (AF) model implemented in 2021 will be used to archive the interval data at these sites along with the data at the respective feeders and substations to support the benefits analysis of the project. The VVO and DMS platforms that have and will be deployed will provide the platform to commission, integrate, and control these DER resources.

I. Congestion Management (FERC Order 2222)

1. Budget Summary

New Investment			
Optimize System Performance	Optimize Demand	Integrate DER	Enables Order 2222
		✓	✓
Four Year Investment: $4.0 million			
Enabling Investments: Probabilistic Power Flow Modeling, DMS, DERMS, Analytics Platform			

2. Overview

With the issuance of FERC Order 2222, distribution system operators are anticipating an additional challenge of ensuring safe and reliable grid operations while managing the impact of coordinated dispatch of aggregated DER participating in wholesale markets. Although the specific guidelines and processes for implementation of FERC Order 2222 in the ISO-New England market are still under development, the Company recognizes that the future of the distribution system will be characterized by dispatchable resources, including batteries and flexible load, playing an increasing role in shaping power flows based on evolving use cases. Active dispatch for energy markets of both large stand-alone as well as aggregated smaller facilities connected to the distribution system has the potential to add value to the transmission and distribution grid. Uncoordinated and unmanaged, however, the use of these resources will increase the complexity of real time distribution operations, impacting operators' ability to maintain power quality and reliability. Ensuring dispatchable resources are able to maximize their value to the market and grid in multiple use cases at the same time will require new tools, processes and skill sets to coordinate dispatch based on the as-operated status of the grid, including reflecting the impact of unplanned network conditions such as an N-1 events on power flows.

Ultimately, coordination of DER dispatch will involve multiple components, including the ability to identify constraints on the system, determine an optimal mix of resources required to manage constraints, and communicate dispatch instructions to DER resources and aggregators. With these capabilities, the Company's coordination of resources will allow for bulk market participation while taking into consideration distribution constraints and value creating opportunities.

3. Project Need

With the expected exponential growth in the number and type of DER actively dispatched for various use cases on the electric power system, the Company will need systems and processes to support analysis of distribution system constraints and needs and communication with resources and aggregators to ensure successful implementation of FERC Order 2222 and other future programs aimed at DER dispatch for system support.

Without these capabilities, at the least, the electric system will not realize the full value creation potential of these resources. In the worst case, uncoordinated dispatch between aggregators/DERs and the EDCs could affect power flows in a way that impacts the safe and reliable operation of the power grid.

Although specific requirements for FERC Order 2222 implementation remain under consideration, the Company anticipates it will need to address the following operational needs in advance of full implementation. These needs are applicable for all types of DER dispatch, including use of DER assets to address distribution system constraints.

1. The Company must have sufficient information regarding dispatch schedules to conduct operational load forecasts used to inform switching operations, maintenance, or respond to anticipated critical events such heat waves.

2. Dispatch decisions must be informed by an awareness of anticipated system constraints, planned outages, and other events that might limit access to

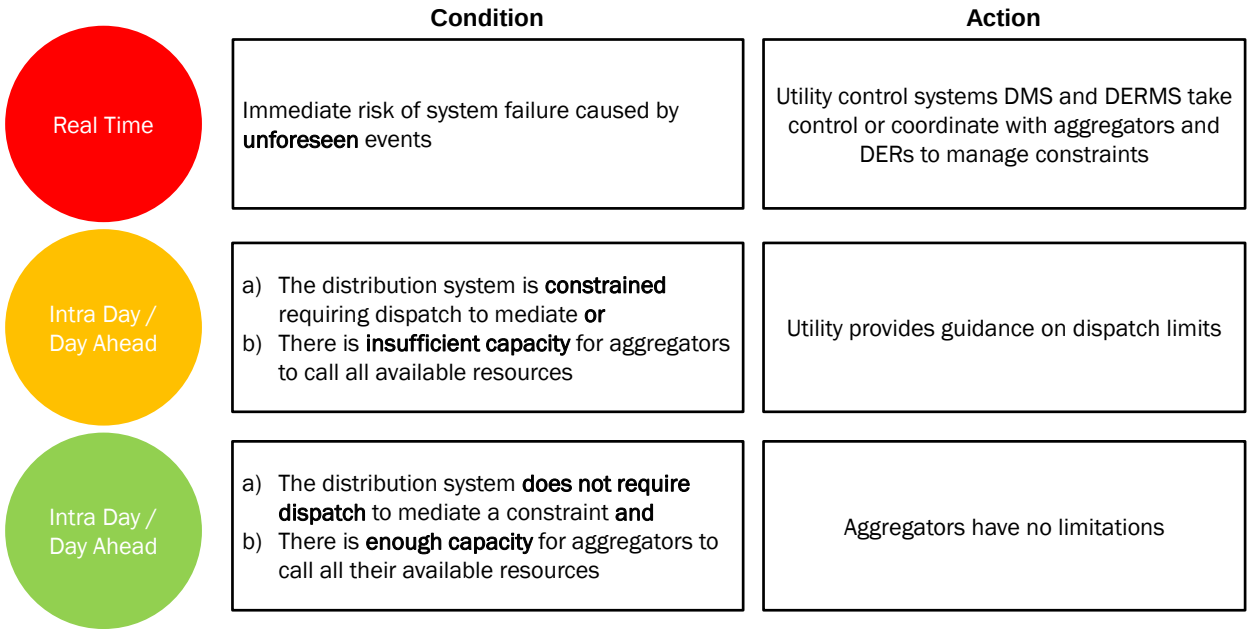
resources before final plans are established. Absent this awareness there may be a need for curtailment of DERs by the EDCs based on real time system conditions.

3. Absent coordinated dispatch for wholesale and distribution use cases, the Company will have no avenue for providing additional incentives for resource dispatch to address real time congested systems, potentially requiring incremental system investments.

4. During critical system events such as N-1 conditions (e.g., outages, faults, storm events), real time communication between aggregators and utilities is essential as system conditions change rapidly, requiring an adjustment of dispatch.

Analysis and communication of grid conditions with the potential to affect DER dispatch may be facilitated by categorization of system constraints based on their level of severity. In its initial planning relative to DER dispatch, the Company has adopted an abstracted version of a grid "traffic light" concept established by a European Association of Energy and Water Industries, BDEW. This nomenclature is based on the definitions of "green", "yellow" and "red" phases as summarized in Figure 17.

Figure 17: Overview System Conditions and Actions



The global electric power industry is in the early phases of establishing best practices with respect to technology and processes for dispatch of aggregated and stand-alone DER for multiple use cases. Several approaches have been attempted in demonstrations or limited deployments. Although a more thorough assessment of these different approaches is likely to produce valuable insights to inform programs in Massachusetts, the following are common areas where needs have been identified.

- Communication interface/portal/API for communication regarding dispatch schedules and forecasted system constraints.

- Congestion management tools and processes to forecast constraints and determine optimal dispatch schedules, DLMP, or capacity bands.

- Coordination of dispatch between aggregators, DERMS, and DMS to ensure optimal system conditions.

The dispatch of aggregated and stand-alone DER for multiple use cases on the transmission and distribution grid is driving the need for new tools, processes and skill sets to ensure that distribution system operators are able to support optimization while maintaining their obligation to provide safe and reliable service.

Although there are many factors related to policies, technology, markets and customer preferences that will shape the future of DER participation as grid assets, it is clear that the demand for maximizing the value of DER for multiple use cases will grow considerably over the next four years. With respect to FERC 2222, the Company must be prepared to support implementation based on final program guidelines as they are established, such as and refined over the next four years.

4. Project Description

The Company proposes a project to study, simulate and test technologies and processes to address the needs and opportunities associated with coordinated DER dispatch of aggregated DER will add knowledge and capabilities to help ensure that the Company is prepared to support development and implementation of FERC Order 2222 and other emerging markets or programs to capture the full value of DER on the transmission and distribution systems.

Over the four-year GMP term, the Company proposes to conduct a three phase project to evaluate and test best practices for enabling the participation of aggregated DER in the wholesale market based on real time grid conditions as required by the final ISO-New England guidelines for FERC 2222 implementation. This project will include consideration of opportunities to dispatch DER as distribution grid assets and incorporate concepts related to optimization of resources for multiple use cases, using tools such as direct control, price signals or operating bandwidth guidelines.

In recognition of the emerging nature of the needs, opportunities and solutions associated with dispatch of aggregated DER based on real time system conditions, a coordinated approach among Massachusetts EDCs will avoid duplicative efforts and support development of one common approach to DER value optimization in the Commonwealth.

Based on preliminary discussions between Eversource, National Grid and Unitil subject matter experts, the following represents a consistent three-phase approach. The EDCs expect to collaborate for a common deliverable in Phase 1 and share data and outcomes throughout Phase 2 and Phase 3.

- Phase 1 – Investigation. Develop state-wide report on industry best practices for DER valuation and dispatch programs and methods
- Phase 2 – Simulation. Conduct computer simulation of proposed programs and methods

- Phase 3 – Field Trial. Field test with simulated constraints in zero risk environment

During the Phase 1 Investigation, the EDCs will work with external advisors to (a) assess state-of-the-art methodologies and technologies based on review of relevant literature and programs; (b) rank each approach based on pre-identified criteria and select the most attractive approaches for Massachusetts EDCs and; (c) develop a proposal and scope for Phase 2 simulations and the Phase 3 field trials. The funding requests outlined in each company's filing reflect the proposed respective contribution by the utility towards this phase.

Among other items, as part of Phase 1, the EDCs will explore contract mechanisms and associated DER compensation schemes that could be used to manage distributed resources and communicate with aggregators regarding the status of grid congestion. EDCs will look at international models such as the Grid Traffic Light, capacity bands, distribution locational marginal pricing (DLMP), and other models evaluated domestically and internationally on similar topics. The EDCs will also use Phase 1 to develop a more complete understanding of how or why certain models and technologies may be better or worse suited to serve the customers in Massachusetts. Lastly, Phase 1 will focus on the interaction between different utility systems, ISO-New England, customers, and aggregators.

The Phase 2 Simulation and the Phase 3 Field Trial will be conducted independently by each EDC given the differences in each company's operating systems. The precise scope for these latter phases will be shaped by the findings in Phase 1. The EDCs will collaborate during Phase 1 to

determine collectively which approaches should be further evaluated in Phase 2 and 3 to ensure that the companies are not conducting duplicative studies.

The Simulation Phase proposed by Eversource will include the procurement of software solutions which will enable the simulation of congestion management solutions identified in Phase 1. This procurement will be informed by projects previously completed by other utilities, including National Grid, Southern California Edison, Ameren, ComEd and AusNet in Australia. While using real time telemetry and grid conditions, customer responses will be simulated to mimic behavior and study the impacts on the system. This will allow Eversource to assess the impact of such approaches in a controlled Sandbox environment. During this phase, adjustments can be made to approaches defined in Phase 1. Phase 2 will act as the dry run for the field trial phase.

In the Field Trial Phase, Eversource proposes to identify a region (e.g., a substation) in which it can work with interested customers to test concepts successfully simulated in Phase 2. Participating customers will be provided the communications, access to a portal, control, and metering infrastructure required for the trial. To ensure safe operations and reliable power supply to all our customers, Eversource will conduct any trials in a region with sufficient capacity available at all times. Constraints on the system will be simulated by modifying field measurements to ensure, at all times, safe operations of the system

5. Benefits and Outcomes

Uncoordinated, dispatch of aggregated small scale and stand-alone large scale DER will drive increased volatility of power flows on the electric power system. The Congestion Management program represents an important step forward in establishing and testing feasible approaches to enable coordination of DER dispatch that maximize value to on both bulk and distribution systems.

Benefits of the Congestion Management program include:

- Ensuring that aggregators and DER operators are dispatched based on an advance understanding of any system constraints.
- Increasing opportunities for aggregators and DER to provide distribution services in congested systems increasing their value proposition.
- Protecting distribution system from unstable operating conditions through a detailed information exchange and coordination methods.

6. Leveraging 2018-2021 GMP

Several 2018-2021 GMP investments will support the Congestion Management program. The Advanced Load Flow and Advanced Forecasting investments have increased the Company's ability to model distribution system power flows and will inform Phase 2 simulation activities. The DMS will result in a real-time load flow tool for system operators that will be a foundational enabling investment for coordinated DER dispatch.

In addition, the proposed Congestion Management program scope is related to many of the efforts Eversource is proposing in the 2022-2025 GMP. Probabilistic Power Flow Modelling enables system planning to understand all possible scenarios which can arise from differing dispatch models. Investments in Dynamic DER Interface and DERMS solutions will provide the real time DER management support, especially in the "red phase" but also during "yellow phases" of coordinated dispatch.

J. Measurement, Verification & Support

1. Program Management Resources and Portfolio Measurement and Verification

a. *Budget Summary*

Continuing Investment			
Optimize System Performance	Optimize Demand	Integrate DER	Enables Order 2222
✓	✓	✓	
2022 Investment: $0.9 million **Total Four-Year Investment:** $3.6 million			
Investments Enabled: DMS, Wireless Communications, Substation Automation, PQ Monitoring, VVO, Analytics Platform, Interconnection Automation, Probabilistic Power Flow Modeling, Communications System Modernization, Dynamic DER Interface, DERMS, Congestion Management			

b. *Overview*

The Grid Modernization Plan can only be successful with the appropriate amount of internal program management ("PM") execution oversight, and an objective external M&V process. The following subsections are broken down to discuss both GMP PM and M&V activities.

Program Management:

The GMP requires dedicated management and oversight of multiple programs that include a high volume of work within a relatively short period of time. Having a dedicated management team is essential to ensuring implementation stays on track and is accurately reported at multiple intervals. The PM team provides coordination and facilitation across multiple departments within the Company to make sure that all teams that are performing GMP work have all tools and information needed for their tasks and are tracking the progress of the work in the field so that is captured and reported on internally in a timely manner. The team also leads all efforts related to the GMP annual reporting process so that the requirements for that reporting are met.

Measurement and Verification:

Eversource expects that the existing third-party measurement and verification vendor, Guidehouse, will continue to evaluate the Company's progress toward GMP objectives and the results of the infrastructure and performance metrics. This will include the evaluation for both continuing and new investments in the distribution system as identified in the GMP. Eversource has included a budget item in this filing to accommodate the costs associated with the third-party evaluation process. The PM team works with internal stakeholders and Guidehouse to provide all information

needed for these metrics and consolidates and finalizes all information provided in the M&V process.

c. *Project Need*

Program Management:

Eversource 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. The focus on tracking and reporting also supports robust performance reporting and active engagement in the M&V process. For the 2018-2021 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.

This team of employees has worked to layer the GMP into Eversource's existing business practices and leveraged the existing capabilities, processes, procedures, departments, and personnel within the Company's ecosystem. Administratively, to support the GMP integration, the team developed a process framework to evaluate, analyze, align and mange cross-functional responsibilities. These steps represent critical foundational steps that were developed and deployed to ensure that all GMP investments were undertaken in a deliberate and efficient manner. This framework was utilized during the execution of the 2018-2021 GMP and will be used for future GMPs.

Measurement and Verification:

Similar to the 2018-2021 GMP, the Company expects there to be a need for third party evaluation of both the continuing and the new GMP investments of the 2022-2025 GMP. The formal evaluation process, which was required by the DPU for the 2018-2021 GMP, has played a critical role in ensuring uniform and accurate reporting across the EDCs and in evaluating investment effectiveness. To-date, Guidehouse, in conjunction with the three EDC's has worked diligently to develop effective processes, methods and level of content details that are required to enable Guidehouse to make their assessments of the GMP and report on them to the department.

Additionally, Guidehouse offers the benefit of having industry-wide knowledge that can be drawn upon when it comes to the evaluation process and identifying opportunities for the Company to consider for changes or improvements in the future. Having an external measurement and verification resource also enhances the credibility and transparency of the GMP in reporting progress on the plan to the department in a consistent and effective manner.

d. *Leveraging 2018-2021 GMP*

Program Management:

The dedicated management team of personnel, who were newly hired as part of the 2018-2021 GMP, have been able to establish a platform of processes and procedures, tailored to the needs of the portfolio. This has allowed the various GMP programs/investments to be successfully implemented, while maintaining thorough reporting content and accuracy. Eversource will continue to utilize these personnel for future GMP deployments.

This team works to provide continuous process improvement and when needed, make changes to the data collection and review, types of reporting, engagement with stakeholders, and real-time analysis of the over-all portfolio so that adjustments among various investments could be made while retaining the GMP intent and budget authorization. The changes made throughout the process have helped the broader team become more cohesive and to achieve a greater efficiency relative to the GMP inception. It is Eversource's intention to continue to utilize these management personnel to continue the GMP execution in the future.

Measurement and Verification:

An evaluation plan will need to be constructed for the 2022-2025 GMP at the direction of the Department. If the evaluation plan adopted for the 2022-2025 GMP is similar to the evaluation plan for the 2018-2021 GMP, the existing framework and processes would be leveraged for the 2022-2025 GMP.

The processes developed with Guidehouse, since the start of the 2018-2021 GMP, are expected to continue seamlessly for continuing investments. For new investments, a portion of the existing evaluation framework can be utilized, but new processes will have to be created for the measurement and reporting of any new performance metrics. The Company meets with Guidehouse and the other EDCs on a regular basis to discuss all measurement and verification related items. The Company has also spent significant time developing and improving data gathering, consolidation, and data sharing processes that work for all stakeholders. These general

reporting processes and communications channels that were set up for the 2018-2021 GMP will support the measurement and verification of the 2022-2025 GMP.

2. Systems Support & Maintenance

a. *Budget Summary*

New Investment			
Optimize System Performance	Optimize Demand	Integrate DER	Enables Order 2222
✓	✓	✓	✓
Four Year Investment: $4.4 million			
Investments Enabled: Probabilistic Power Flow Modeling, DMS, DERMS, Congestion Management			

b. *Overview*

Going forward, as the Company shifts its modernization program to increase emphasis on operational software systems and related processes, the need for incremental engineering resources for ongoing support will grow. Technologies implemented without a dedication to continuous improvement will result in lost opportunity to capture the full potential created by the original investment.

In its 2022-2025 GMP, the Company has allocated over $35 million in direct investment in control room technology, including DMS and DERMS. Without engineering resources for ongoing operations support, however, system operators will be challenged to make full use of new tools to increase safety, reliability, and optimization activities. Similarly, implementation of advanced

forecasting software will provide system planners with greatly enhanced capabilities for making investment decisions in the face of uncertainty. Dedicating engineering resources to enhancing the use of the tool over time with analysis, data management and training will increase the sophistication and applicability of forecasts used to make planning decisions.

c. *Project Need*

The need for operational support of control room systems will be significant. Although implementation of DMS is expected to increase the efficiency of many control room activities, such as switch order writing and contingency analysis, the need for power flow model maintenance will be largely incremental to current operations. Currently, operations support activities focus on maintaining the eECS system, ensuring operators have visibility and control of field devices. Following DMS deployment, system operators will be making decisions based on a power flow model that is built by layering data from GIS and additional engineering and asset data sources together with telemetry from field devices from the eECS. Accurate data on asset attributes, equipment settings and system connectivity are required to ensure the model provides a true representation of system conditions. Absent daily monitoring and maintenance of model build statistics to correct errors, the ability of operators to make use of the DMS power flow and the advanced applications it enables will severely limited.

As control room systems expand beyond the DMS to include VVO, DERMS and operational forecasting capabilities, additional engineering resources will be required to support system operators with optimization functions. Currently, the mission of system operations is to ensure

safe and reliable service to customers. Activities designed to drive value through optimized integration of DER are incremental responsibilities that will require support from engineers trained in data analytics and power systems. The need for operations support to ensure the cost-effective development of DERMS technology and optimization processes will continue to grow over time with the increased penetration of dispatchable DER resources.

Investments made in system planning tools, including advanced forecasting and probabilistic modeling, will require incremental resources dedicated to administering, maintaining, providing training, and identifying opportunities to optimize use of advanced functions and features. Dedicated engineers will be required to ensure maximum value is derived from the inclusion of additional robust and complex data sets for planning parameters such as solar generation and electric vehicles. These engineers will be needed to provide detailed forecasts to support probabilistic load flow activities performed by existing system planners.

d. *Project Description*

The Systems Support and Maintenance investment category will provide funding for the following resources dedicated to providing support for grid modernization systems. These resources will be incremental labor to the Company's existing workforce.

- DMS Model Maintenance – Two full time engineers to maintain the DMS power flow model, ensuring timely updates and accurate results on a daily basis.
- Optimization Support – Two full time engineers to support system operations with implementation of optimization functions, including VVO schemes, use

case management for Company-owned energy storage, DER dispatch, and operational forecasting.

- System Forecasting – Two full time engineers to provide system planners with detailed long-term forecasts of load (including electric vehicles), energy storage, demand response and distributed generation to support probabilistic modeling activities used to plan distribution system upgrades.

e. *Benefits and Outcomes*

Incremental engineering resources supporting grid modernization systems and processes will ensure that the Company realizes the full value from its investments in operational technology. Dedicated daily attention to maintaining the DMS power flow model will ensure that results seen by system operators are accurate reflections of the as-operated condition of the distribution system. An accurate power flow model is a fundamental prerequisite to deliver outcomes from DMS-enabled applications that improve safety and reliability on the distribution system, such as FLISR, switch order management and contingency analysis. Engineering resources focused exclusively on supporting real time optimization activities will increase the magnitude of benefits associated with use of VVO schemes and DER to reduce regional and local peak demands; increase system efficiency; increase hosting capacity and decrease the need for costly distribution infrastructure upgrades. Robust forecasts of load and generation used in system planning will shape the allocation of resources dedicated to capacity-related distribution system upgrades to accommodate growth in load and generation. Dedicated attention focused on representing the potential trajectory

of changes in power flow dynamics over the planning horizon will inform investment decisions from substations to local distribution feeders.

f. *Leveraging 2018-2021 GMP*

Resources dedicated to maintenance and support for real time operations and system planning tools will increase the value of investments in technology implemented in the 2018-2021 GMP and the 2022-2025 GMP. The DMS project initiated in 2021 is expected to be placed in service in 2023. The project team responsible for building the DMS tool will provide training and guidance for incremental resources hired to assume DMS model maintenance responsibilities. Having successfully incorporated the Synergi advanced load flow tool into their standard work flow, system planners have many of the capabilities required to make use of forecasts provided by support resources needed to incorporate a more thorough picture of the impact of DER on future distribution power flows.

VII. METRICS

A. Background on Metrics/Current Metrics

In D.P.U. 12-76-B, the Department of Public Utilities (the "Department") directed NSTAR Electric Company d/b/a Eversource Energy ("Eversource"), 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") (individually, the "Company" and collectively, the "Companies") to include in their Grid Modernization Plans ("GMPs") two types of company-specific metrics: (1) infrastructure metrics that track the implementation of grid modernization technologies and systems; and (2) performance metrics that measure progress towards the

objectives of grid modernization. D.P.U. 12-76-B, at 30. In addition to the company-specific metrics, the Department directed the Companies to jointly propose a common list of statewide metrics to be included in each GMP. Id., at 31. Furthermore, the Department directed the Companies to solicit stakeholder input in developing both statewide and company-specific metrics. Id., at 33.

Infrastructure Metrics:

As part of D.P.U. 15-120/15-121/15-122 the Department approved the Companies' proposed statewide and company-specific infrastructure metrics. Id., at 198-201. The Department ordered the Companies to establish baselines by which the grid-facing performance metrics will be measured against and to file them within 90 days of the Order. Id., at 203. On August 15, 2018 Eversource filed the "*Grid Modernization Plan Statewide and Eversource-Specific Infrastructure Metrics Baselines and Targets*". The Company does not recommend changing infrastructure metrics at this time.

Performance Metrics:

Regarding the performance metrics proposed by the Companies, the Department determined that additional work was needed to develop metrics that appropriately track the quantitative benefits associated with pre-authorized grid-facing investments, and progress toward the Grid Modernization objectives. Id., at 95-106. The Department ordered the 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 July 11, 2019, the Companies jointly submitted revised performance metrics, "*Grid Modernization Performance Metrics, Revised July 11, 2019*" and on July 25, 2019, the Companies received the stamp-approved copy of this document, without changes to the original submission. The performance metrics have been reviewed and are generally unchanged except for VVO metrics. The original VVO metrics were developed prior to engagement by Guidehouse or before the system was fully deployed and operational. Guidehouse has since collected significant data and started their data analysis. The revised VVO performance metrics were amended to resemble the methods Guidehouse utilized in their evaluation. These changes were also outlined in the revised Stage 3 Evaluation plans submitted on December 1, 2020 and also as responded to in information requests DPU-EP-1-1 (submitted February 6, 2020), DPU-EP-1-8 (submitted January 30, 2020), and DPU-EP2-1 and 2-4 (submitted on April 28, 2020). The performance metrics document can be found in Attachment A, "*DPU 15120 15121 15122 Performance Metrics FINAL redlined*" , with suggested changes made in a redlined format.

Additionally, as described above, new investment types have been included in the 2022-2205 GMP and therefore additional performance metrics are being proposed to measure progress towards the objectives of grid modernization. The Companies have jointly collaborated to propose two new state-wide performance metrics and Eversource specifically has proposed two additional

performance metrics. All four proposed performance metrics are summarized below and are elaborated in Attachment B, "*DPU 21-80 GMP Proposed Performance Metrics (FINAL)*".

B. Proposed Metrics

Proposed Statewide Performance Metrics:

Distributed Energy Resource Management System ("DERMS") Demonstration: This metric will be utilized to monitor the number and percentage of DER sites enrolled in each Company's DERMS system and the associated dispatched kilowatts ("kW").

FERC Order No. 2222 Customer Participation Metric: This metric will demonstrate the number of customers (*customer count*) and the corresponding total number of total kilowatts (kW) for customers participating in the ISO-New England wholesale market programs developed as a result of FERC Order 2222.

Proposed Eversource-Specific Performance Metrics:

Eversource Load Forecasting – Milestone Completion: This metric is designed to demonstrate progress towards establishing the full complement of load forecasting capabilities proposed by the Company from adoption propensity models to probabilistic scenario modelling.

Eversource Power Quality Monitoring: This metric will provide transparency regarding data acquired as a result of the power quality monitoring project and the classification of events recorded on the system. Equally as important is the need to communicate with impacted customers

quickly, efficiently, and accurately to maintain a partnership and cooperation that will positively affect electric delivery.

Grid Modernization Plan
Performance Metrics
Revised July 11, 2019

Massachusetts Department of Public Utilities
D.P.U. 15-120, 15-121, 15-122

1 INTRODUCTION

In D.P.U. 12-76-B, the Department of Public Utilities (the "Department") directed NSTAR Electric Company d/b/a Eversource Energy ("Eversource"), 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") (individually, the "Company" and collectively, the "Companies") to include in their Grid Modernization Plans ("GMPs") two types of company-specific metrics: (1) infrastructure metrics that track the implementation of grid modernization technologies and systems; and (2) performance metrics that measure progress towards the objectives of grid modernization. D.P.U. 12-76-B, at 30. In addition to the company-specific metrics, the Department directed the Companies to jointly propose a common list of statewide metrics to be included in each GMP. Id., at 31. Furthermore, the Department directed the Companies to solicit stakeholder input in developing both statewide and company-specific metrics. Id., at 33.

Pursuant to the directives from the Department, each Company filed a GMP that included a list of proposed statewide and company-specific metrics for both infrastructure and performance. On May 10, 2018, the Department issued its Order regarding the individual GMPs filed by Eversource, National Grid and Unitil, respectively. In the Order, the Department preauthorized grid-facing investments over three-years (2018-2020) for the Companies and adopted a three-year (2018-2020) regulatory review construct for preauthorization of Grid Modernization investments. D.P.U. 15-120/15-121/15-122, at 137-173. The Department recognized that achievement of its Grid Modernization objectives[1] is a complex, long-term, and evolving endeavor and that, in the early stages of Grid Modernization, it is reasonable to expect that significant changes will take place associated with the introduction of new technologies and the costs associated with existing and new technologies. Id., at 107-108. Furthermore, the Department found that it is reasonable to expect that the Companies' understanding of how best to deploy Grid Modernization technologies to optimize their performance will evolve over time. Id.

As part of its decision regarding the Companies' GMPs, the Department approved the Companies' proposed statewide and company-specific infrastructure metrics. Id., at 198-201. In approving the infrastructure metrics, the Department found that the purpose of the metrics will be to record and report information: the metrics will not, at present, be tied to incentives or penalties. Id., at 197. The Department ordered the Companies to establish baselines by which the grid-facing performance metrics will be measured against and to file them within 90 days of the Order. Id., at 203. To assist in the development of these baselines, the Department directed each of the Companies to develop and maintain information on its system design, operational characteristics

[1] The Department approved a modified set of Grid Modernization objectives, specifically: (1) optimizing system performance; (2) optimizing system demand; and (3) facilitating the interconnection of distributed energy resources. Id., at 95-106.

(e.g., voltage, loading, line losses), and ratings prior to any deployment of preauthorized grid-facing technologies. Id. Additionally, the Department directed the Companies, when developing the proposed baselines to use, to the extent possible, information reported in the annual service quality filings, as well as other publicly available information. Id.[2]

Regarding the performance metrics proposed by the Companies in the GMPs, the Department determined that additional work was needed to develop metrics that appropriately track the quantitative benefits associated with pre-authorized grid-facing investments, and progress toward the Grid Modernization objectives. Id., at 95-106. The Department ordered the 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.

Consistent with the Department's directives, the Companies worked closely and collaboratively to develop a set of proposed performance metrics. This document describes the statewide, as well as company-specific, performance metrics that the Companies propose to use for evaluating their progress towards the Grid Modernization objectives. This document will also identify how the baseline for each metric is calculated and reported. Due to the complexity and data intensive nature of these metrics, the Company has not yet had the opportunity to calculate a baseline for all metrics. Additionally, the Company is undertaking the detailed design and planning analysis necessary to implement its GMP, which will necessarily inform several of the infrastructure metric baselines. Prior to undertaking the detailed data analysis necessary to develop the baselines, the Companies wanted to engage with the Department and stakeholders in the stakeholder process to determine if refinements to the proposed metrics were necessary, as well as receive final approval for the metrics. Following the Department's approval of a final set of performance metrics, the Companies will undertake the data analysis and report on the baselines in their respective initial annual GMP filings.

The chart below provides the complete set of metrics, both approved infrastructure metrics and proposed performance metrics, that the Companies will be utilizing to track and report on their progress under their individual GMPs, as well as their progress in achieving the Department's Grid Modernization goals.

[2] The infrastructure metrics baselines are being filed separately by each Company.

Metric Type	Metric	Investment Category					
		Monitoring and Control	Distribution Automation	VVO	ADMS	Communications	Advanced Load Flow*
Performance	Volt Var Optimization (VVO) Baseline			X			
Performance	VVO Energy Savings			X			
Performance	VVO Peak Load Impact			X			
Performance	VVO Distribution Losses w/o AMF (Baseline)			X			
Performance	VVO Power Factor			X			
Performance	VVO – GHG Emissions			X			
Performance	Increase in Substations with DMS Power Flow and Control Capabilities				X		
Performance	Control Functions Implemented by Circuit				X		
Performance	Numbers of Customers that benefit from GMP funded Distribution Automation Devices		X				
Performance	Grid Modernization investments' effect on outage durations	X	X				
Performance	Grid Modernization investments' effect on outage frequency	X	X				
Performance	Advanced Load Flow - Percent Milestone Completion						X
Infrastructure	Grid Connected Distribution Generation Facilities						X
Infrastructure	System Automation Saturation	X	X				
Infrastructure	Number/ Percentage of Circuits with Installed Sensors	X					
Company Infrastructure	Number of devices or other technologies deployed	X	X	X		X	
Company Infrastructure	Cost for deployment	X	X	X		X	
Company Infrastructure	Deviation between actual and planned deployment for the plan year	X	X	X	X	X	X
Company Infrastructure	Projected deployment for the remainder of the three year term	X	X	X	X	X	X

On August 15, 2018, the Companies filed the proposed performance metrics as required by the Department following its approval of the Companies' modified GMPs. Each Company also filed baseline and target information for the statewide and Company-specific infrastructure metrics approved by the Department. D.P.U. 15-120/15-121/15-122 at 198-201. Following this submission, the Companies responded to information requests issued by the Department, the Department of Energy Resources ("DOER") and the Cape Light Compact ("CLC") consistent with the procedural schedule included in the September 28, 2018 Procedural Memorandum ("Memorandum") issued by the Department.

Additionally, the Department's Memorandum scheduled a technical session on the Companies' August 15, 2018 performance metrics filing. The Companies participated in the technical session, including presenting on the proposed performance metrics.[3] Following the technical session, the Department issued a Memorandum that set out required revisions to the August 15, 2018 performance metrics, as well as directed the Companies to develop additional performance metrics ("Metrics Revision Memorandum"). The Metrics Revision Memorandum set April 2, 2019 as the

[3] The Companies' February 13, 2019 technical session presentation can be found at https://fileservice.eea.comacloud.net/FileService.Api/file/FileRoom/10379369

deadline for the Companies to file the revised and new performance metrics, with initial comments on the Companies' filing due on April 16, 2019 and reply comments due on April 23, 2019. Consistent with the directives contained in the Metrics Revision Memorandum, the Companies provided on April 9, 2019the required revisions to the initial set of performance metrics, as well as the new metrics required by the Department. Following further directives from the Department, the Companies filed additional revisions on June 6, 2019. National Grid made further revisions to its company-specific reliability performance metric located in Appendix C, pursuant to a Department directive, on July 11, 2019.

2 STATEWIDE PERFORMANCE METRICS

The Companies worked collaboratively to develop a list of statewide performance metrics for each Company to use to measure progress towards grid modernization. These statewide performance metrics were developed using many different resources. The Companies started by reviewing the metrics filed in each of their respective GMPs. In addition, Eversource had developed a comprehensive listing of potential metrics in its recent base rate case, D.P.U. 17-05, which included input from a large and varied group of stakeholders. Lastly, the Companies also reviewed performance metrics that other utilities throughout the country have used to measure their progress towards grid modernization.

Under their individual service quality plans, most recently revised in D.P.U. 12-120, the Companies are currently required to report on their performance in relation to numerous service quality metrics. The statewide performance metrics developed by the Companies in relation to their GMPs, as detailed below, are designed to be in addition to and not duplicate or modify the service quality metrics.

2.1 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.

2.1.1 Type of Metric

Statewide Performance Metric

2.1.2 Objective

Establish an ~~baseline~~ impact factor for each VVO enabled circuit which will be used to quantify the peak load, energy savings, and greenhouse gas ("GHG") impact measures.

2.1.3 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.

2.1.4 Calculation Approach

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

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

As part of the baseline data capture, each VVO circuit will, at a minimum, 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

2.1.5 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.

2.1.6 Baseline

The baseline will be calculated through M&V after each circuit and/or substation is placed into service. The baseline will be constructed using data collected when VVO is off during the VVO M&V period. The Company recommends that each VVO/CVR circuit ~~will~~ undergo a nine- to twelve~~three to six~~-month M&V period~~rocess~~ to capture one winter, one summer, and either the fall or spring shoulder seasons.~~,~~ T~~t~~he results from ~~of~~ this M&V process ~~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 VVO 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.

2.2 VOLT VAR OPTIMIZATION (VVO) ENERGY SAVINGS

2.2.1 Type of Metric

Statewide Performance Metric

2.2.2 Objective

This metric is designed to quantify the energy impact VVO/CVR has on the system with the intent of optimizing system performance~~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~~.

2.2.3 Assumptions

Once a circuit has VVO enabled, a M&V ~~measurement and verification~~ 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 energy baseline and energy savings~~a circuit level VVO impact and baseline~~ will be created.

2.2.4 Calculation Approach

The follow~~ing ing data~~ data will be tracked and reported upon on a ~~substation~~ system and circuit basis after the VVO M&V process is complete:

a. ~~Annual energy delivered in kilowatt hours ("kWh") for 2015, 2016, and 2017.~~ VVO Energy Savings: Net energy savings (kWh), calculated by estimating the observed difference in load profiles for each circuit between the VVO enabled and VVO disabled states during the M&V period. This difference in load profiles is estimated via statistical analysis.

b. VVO Energy Baseline: Counterfactual energy usage (kWh), derived using statistical models constructed to estimate VVO energy savings and data collected when VVO is disabled during the M&V period. The VVO energy baseline assumes that VVO is disabled for the entirety of the M&V period.

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

2.2.5 Organization of Results

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

2.2.6 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. The pre-investment baseline of energy delivered will not be used to calculate VVO energy savings. Baseline for VVO energy savings is kWh observed during VVO disabled state during the M&V period and will be reported in the first annual report after the VVO M&V process is complete. ~~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.~~

2.3 VVO PEAK LOAD IMPACT

2.3.1 Type of Metric

Statewide Performance Metric

2.3.2 Objective

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

2.3.3 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 5 years will be used.

~~2.3.4~~ Calculation Approach

~~**2.3.5 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**~~

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

a. VVO Peak Load Reduction: Net peak load reduction (kW), calculated by estimating the observed difference in load profiles for each circuit between the VVO enabled and VVO disabled states during peak hours during the VVO M&V period. This difference in load profiles is estimated via statistical analysis.

~~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~~ peak load reduction ~~reduction~~ attributed to VVO/CVR will be aggregated, resulting in the statewide estimated peak load reduction.

~~2.3.6~~2.3.4 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.

~~2.3.7~~2.3.5 Baseline

VVO-related pre-investment baseline of annual peak load in million-volt ampere ("MVA") will be provided for each ~~feeder~~ circuit and substation within the service territory for the years 2015, 2016, and 2017. The pre-investment baseline of annual peak load will not be used to calculate VVO peak load reductions. Baseline for VVO peak load reductions is kW observed during VVO disabled state during system peak hours during the VVO M&V period and will be reported in the first annual report after the VVO M&V process is completed.

2.4 VVO – DISTRIBUTION LOSSES WITHOUT AMF (BASELINE)

2.4.1 Type of Metric

Statewide Performance Metric

2.4.2 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. Electrical loss can also be investigated using amperage interval data and EDC-specific assumptions surrounding resistance. ~~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.~~

2.4.3 Assumptions

There are many elements that contribute to ~~differences between circuit load data and the hourly measurements.~~distribution losses. These factors include:

- Unmetered load, such as street lights
- Electricity theft

• Circuit line losses

2.4.4 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.

2.4.5 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.

2.4.6 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.

2.5 VVO POWER FACTOR

2.5.1 Type of Metric

Statewide Performance Metric

2.5.2 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 in power factor 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.

2.5.3 Assumptions

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

2.5.4 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 to calculate power factor improvement.

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

a. VVO Power Factor: Power factor improvement, calculated by estimating the observed difference in power factor for each circuit between the VVO enabled and VVO disabled states during the VVO M&V period during hours corresponding to greater than 75 percent of a circuit's peak annual demand. This difference in power factor is estimated via statistical modeling for each circuit. 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 aA system power factor performance will be calculated, weighted by the by weighting circuit-level power factor estimates by the peak demand of each respective circuit.

2.5.5 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.

2.5.6 Baseline

The baseline will be is power factor observed during VVO disabled state during the VVO M&V period during hours corresponding to greater than 75 percent of a circuit's peak annual load 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 report after the measurement and verification VVO M&V process is completed.

2.6 VVO ESTIMATED VVO/CVR ENERGY AND GHG IMPACT

2.6.1 Type of Metric

Statewide Performance Metric

2.6.2 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.

2.6.3 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.

2.6.4 Calculation Approach

This metric will use the following data:

- Circuit level M&V estimated VVO Energy Savings~~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 respecti~~ the ~~ve M&V~~ energy reduction (MWh) ~~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.

$$CO_2\ Emissions\ (tons) = Energy\ Savings\ (MWh) * CO_2\ Emissions\ Factor\ (tons/MWh)$$

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

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.

2.6.5 Organization of Results

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

2.6.6 Baseline

The baseline for this metric will be reported in the first annual report after the ~~measurement and~~ VVO M&V process ~~verification~~ is completed.

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

2.7.1 Type

Statewide Performance Metric

2.7.2 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.

2.7.3 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.

2.7.4 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.

2.7.5 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.

2.7.6 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.

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

2.8.1 Type

Statewide Performance Metric

2.8.2 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.

2.8.3 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.

2.8.4 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.

2.8.5 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.

2.8.6 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.

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

2.9.1 Type

Statewide Performance Metric

2.9.2 Objective

This metric will show the progress in the Distribution Automation investment by tracking the numbers of customers that have benefitted from the installation of Distribution Automation 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.

2.9.3 Assumptions

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

2.9.4 Calculation Approach

This metric will track and report on the following:

Circuit number
Number of customers impacted

2.9.5 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.

2.9.6 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.

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

2.10.1 Type

Statewide Performance Metric

2.10.2 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.

2.10.3 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 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.

2.10.4 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.

2.10.5 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.

2.10.6 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[4] 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.

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

2.11.1 Type

Statewide Performance Metric

2.11.2 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.

2.11.3 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.

2.11.4 Calculation Approach

This metric will track and report on the following:

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[4] 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 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.

2.11.5 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.

2.11.6 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.

2.12 VVO RELATED VOLTAGE COMPLAINTS PERFORMANCE METRIC AND BASELINE

2.12.1 Type of Metric

Statewide Performance Metric

2.12.2 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.

2.12.3 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~~2022-2025 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~~four-year plan (2022~~1~~-2023~~5~~).

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 GMP circuits targeted as VVO/CVR in its service territory into the baseline for this performance metric for the 2022~~1~~-2025~~3~~ GMP.

Eversource and National Grid propose to update the baseline for this metric with respect to the 2021~~2~~-2023~~5~~ GMPs to include all GMP circuits targeted as VVO/CVR circuits within their respective service territories.

2.12.4 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

2.12.5 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 DPU an opportunity to assess the effectiveness of the VVO investments while minimizing the introduction of new customer impact.

2.12.6 Baseline

Utilizing the assumptions discussed above, the Companies will calculate the 2015 through 2017 baseline to use to measure ~~process~~ progress 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 GMP Annual Reports.

APPENDIX A

Eversource-Specific Performance Metrics

~~App.A.1.0 EVERSOURCE ADVANCED LOAD FLOW – PERCENT MILESTONE COMPLETION~~

~~App.A.1.0.1 Type~~

~~Eversource-specific Performance Metric~~

~~App.A.1.0.2 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.~~

~~App.A.1.0.3 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.~~

~~App.A.1.0.4 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 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.~~

~~**App.A.1.0.5 Organization of Results**~~

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

~~**App.A.1.0.6 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.~~

App.A.2.0 EVERSOURCE CUSTOMER OUTAGE METRIC

App.A.2.1 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.

App.A.2.2 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.

App.A.2.3 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.

App.A.2.4 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.

App.A.2.5 Baseline

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

APPENDIX B
Unitil-Specific Performance Metric

App.B.1.0 UNITIL RELIABILITY-RELATED COMPANY-SPECIFIC PERFORMANCE METRIC (CP-1)

App.B.1.0 Type of Metric

Company-Specific Performance Metric

App.B.1.0.1 Objective

The objective of this metric is to track the customer minutes saving per outage on each feeder.

App.B.1.0.2 Assumptions

Outages and their impact are typically situational in nature. However, certain projects are designed to shorten the duration of the outage by improving the initial response to the outage.

App.B.1.0.3 Calculation Approach

The following data will be tracked and reported upon on an individual outage basis:

a. Time of first notification from AMI to OMS
b. Time of first customer call from IVR to OMS
c. Outage duration
d. Feeder and substation level CAIDI for the years 2015, 2016 and 2017

(Time of first notification from AMI to OMS) - (Time of first customer call from IVR to OMS) = number of minutes saved

Number of minutes saved * number of customers affected = customer minutes saved\

AVERAGE (‘Circuit CAIDI 2015’+’ Circuit CAIDI 2016’+’ Circuit CAIDI 2017’) - ‘Circuit CAIDI Year n’ = if greater than 0, positive impact.

App.B.1.0.4 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.

This metric is a study of the overall duration of outages and the number of customer minutes saved based upon grid modernization investments. Data will be provided in a tabular basis by feeder and substation.

App.B.1.0.5 Baseline

The pre-investment baseline of a static three-year average circuit level CAIDI in 2015, 2016, and 2017 shall be provided for each feeder within the service territory. The metric will use the circuit three-year CAIDI average covering the years 2015-2017 as the baseline for this metric. It will compare the CAIDI results of the GMP plan year to the circuit's 2015-2017 three-year historic average.

App.B.1.0.6 Target

Unitil estimated that the grid modernization projects would save on average 5 minutes per outage.

APPENDIX C
National Grid-Specific Performance Metric

App.C.1.0 NATIONAL GRID RELIABILITY-RELATED COMPANY-SPECIFIC PERFORMANCE METRIC

App.C.1.0.1 Type of Metric

Company-Specific Performance Metric

App.C.1.0.2 Objective

This metric is designed to measure the impact of Advanced Distribution Automation (ADA) investments on the customer minutes of interruption (CMI) for main line interruptions.

App.C.1.0.3 Assumptions

The Company intends to rely on existing classifications for mainline interruptions to provide the customer minutes of interruption for both the baseline and to measure the future years CMI for ADA enabled circuits only.

App.C.1.0.4 Calculation Approach

The following information will be tracked and reported for ADA investment at the substation and circuit level where appropriate:

a. Historical customer minutes of interruption for mainline interruptions
b. Calendar year customer minutes of interruption for mainline interruptions

App.C.1.0.5 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. The metric will be reported upon at the substation and circuit level where ADA is enabled.

App.C.1.0.6 Baseline

The pre-investment baseline of a static three-year average customer minutes of interruption from mainline interruptions in 2015, 2016 and 2017 shall be provided for each feeder within the Company's service territory. The metric will use the circuit three-year CMI average covering the years 2015-2017 as the baseline for this metric. The Company will compare the CMI results of the GMP plan year to the circuit's 2015-2017 three-year historic average.

APPENDIX D

Hosting Capacity Status Reporting

In their initial Grid Modernization Plans ("GMPs"), each Distribution Company described, and in some cases proposed investments related to, the development of hosting capacity maps. D.P.U. 15-120/15-121/15-122, at 42, 86. The Department of Public Utilities (the "Department"), in limiting GMP investments to grid-facing investments, did not authorize the inclusion of hosting capacity map-related investments in the GMPs. Id. at 134, nt. 70. Instead, the Department noted that it would open a separate proceeding into the investigation of cost-effective deployment of customer-facing grid modernization investments. Id. at 135. Accordingly, the Distribution Companies, following the issuance of the order, shifted their attention and resources to implementing their approved grid modernization investments.

Following the March 14, 2019 technical session on the proposed Grid Modernization Annual Report templates, the Department issued a Memorandum on March 19, 2019 requiring the Distribution Companies to make certain revisions to the grid modernization performance metrics as originally filed on August 15, 2018. As part of the performance metric reporting in the Annual Grid Modernization Reports, the Department also required the Distribution Companies to provide details of their hosting capacity analyses, including the feeder hosting capacity data, for each feeder and substation within their service territories in 2018, 2019, and 2020. Memorandum at 6.

Given that the Distribution Companies' proposed hosting capacity investments were not approved as part of the 2018-2020 GMPs, the Distribution Companies have not progressed hosting capacity analyses as part of this docket. Investments planned over the course of the 2018-2020 GMPs in system visibility and load flow model capabilities are required in order for the Distribution Companies to calculate detailed hosting capacity values. In addition, the Distribution Companies need to work collaboratively with the stakeholders to develop common assumptions and establish load flow and hosting capacity calculation methodologies. This is required so stakeholders that are using the hosting capacity calculations have a common understanding of the approach as they interpret the information provided by the Distribution Companies (see Distribution Companies' responses to DPU-PM-2-1; DPU-PM-2-2 and DPU-PM-3-2).

The Distribution Companies propose to provide the Department and stakeholders with an update on the status of hosting capacity within their respective Grid Modernization Annual Reports. The narrative status update would be supported with a schedule of when each substation and feeder is projected to be ready for a hosting capacity analysis. The Distribution Companies would propose to include the hosting capacity value for those feeders where the models and data is available. The Distribution Companies would also submit a schedule of when they would be able to provide a hosting capacity value for those feeders where the models and data to calculate hosting capacity does not currently exist.

As was clear from the discussion at the March 19, 2019 technical session, the Distribution Companies, the Department, the DOER and other stakeholders are interested in developing robust, comprehensive and useful hosting capacity maps to assist in the interconnection of DG facilities in Massachusetts. To that end, the Distribution Companies look forward to actively participating in the separate proceeding on the deployment of customer-facing grid modernization investments. This separate proceeding will allow for a more comprehensive and efficient approach to

developing customer-facing tools and capabilities. Additionally, the Distribution Companies note that the separate proceeding could address the requirement to file heat maps as directed by St. 2018, c. 227.[5]

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

1. Metric Name – **DERMS SOFTWARE**

    a. Type of Metric

        i. Statewide Performance Metric

    b. Objective

        i. This metric is intended to track and monitor the execution of the Distributed Energy Resource Management System ("DERMS") through the number of sites with DER that are managed by DERMS and the quantity of dispatchable kilowatts ("kW") that the utility can dispatch.

    c. Assumptions

        i. Distributed Energy Resources ("DER") nameplate and operational parameters are provided by customers to the Company in a timely manner.

        ii. DER assets will be added to the DERMs database via direct I.T. platform interface or manual entry.

        iii. The Company intends to include existing Demand Response ("DR") customers and their specific use-cases into the DERMS.

            1. All prior DR data will be re-baselined to zero. See "Baseline" section below.

            2. It is currently unknown if the DERMS functionality can match the existing DR customer use cases.

    d. Calculation Approach

        i. The following metrics will be used to monitor the participation rate and dispatched kilowatts for DER assets.

            1. ***Number of Participating Sites:*** This metric will be a direct number of sites being managed by DERMS.

            2. ***Total kW of Dispatchable DER that is managed by DERMS:*** This metric will be a number of kW nameplate capacity of DER that are managed by DERMS for a given period.

3. ***Number of Instances[1] Sites are Dispatched:*** This metric will be a direct number of instances, per site, that are dispatched as part of the DERMS program, for a given period.

e. Organization of Results

i. This data will be provided on an annual basis with the Grid Modernization Annual report, for the year prior. Data will be arranged by the following:

1. ***Number of Participating Sites:*** The number of participating sites will be presented by feeder.

2. ***Total kW of Dispatchable DER that is managed by DERMS:*** A single kW value will be provided for total DER managed by DERMS.

3. ***Number of Instances Sites are Dispatched:*** A direct number will be provided, for each specific site, by feeder.

f. Baseline

i. Because the Company has not had the ability to allow customers to participate in this type of DER system management before, the baselines for these metrics will be zero. This is inclusive of any existing DR assets that will be migrated into the DERMS from the Company's existing Demand Response Management System (DRMS).

2. Metric Name – **FERC ORDER NO. 2222 CUSTOMER PARTICIPATION METRIC**

a. Type of Metric

i. Statewide Performance Metric

b. Objective

i. This metric will demonstrate the number of the Company's customers (customer count and total kw of DER) participating in the DER aggregation models in ISO-NE resulting from FERC O2222. The Company's investments related to FERC O2222 included in this filing should help improve market

[1] "Instances" is to mean the number of days in a given period that a site received any centrally communicated dispatch by DERMS.

access for DER aggregations by improving the ease and speed of certain distribution utility functions critical to FERC O2222 including those related to the DER aggregation registration and review, metering and settlement, and operational coordination processes. The pace and scale of wholesale market participation by DER aggregations, however, will be dependent on a variety of external factors beyond distribution utility control that may shape the economic viability of market participation.

c. Assumptions

i. Reporting information for this metric assumes that ISO-NE's proposed compliance filing for FERC O2222 is submitted to FERC, approved by FERC, and implemented as operational in ISO-NE. For years prior to implementation all values for this metric will be zero or considered non-applicable.

d. Calculation Approach

i. This metric will track and report on the following:

At the end of the calendar year how many (1) customers and (2) associated kWs of DER are enrolled as part of aggregated DER resources in the ISO-NE wholesale market.

e. Organization of Results

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

f. Baseline

i. The baseline for this metric will start at zero since ISO-NE has not implemented the new DER aggregation participation models that will result from FERC O2222. A chart with the total number of customer participants and associated kw of DER enrolled each year will be provided to support the tracking of this metric.

3. Metric Name – **EVERSOURCE LOAD FORECASTING – MILESTONE COMPLETION:**

a. Type of Metric

i. Company-Specific Performance Metric

b. Objective

i. The metric is designed to demonstrate progress towards the final completion of the advanced forecasting workflow from adoption propensity models to probabilistic scenario modelling. The metric will measure percent completion relative to a final deliverable of advanced forecasting capabilities used by Eversource system planning engineers to perform scenario analysis for all non- secondary network circuits of the distribution system.

c. Assumptions

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

d. Calculation Approach

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

1. ***Bulk Station Adoption Propensity Models:*** Ability to create an adoption propensity for each MA-Bulk Station for Solar, Storage, and Electric Vehicles allows the allocation of state level objectives on a bulk station level across Eversource's Service Territory. Ability to analyze results at an individual circuit level - for new load, for DG pre-application screening, fault analysis, high/low voltage complaint investigations.

2. ***Bulk Feeder Adoption Propensity Models:*** Ability to create an adoption propensity for each MA-Bulk Feeders for Solar, Storage, and Electric Vehicles allows the allocation of state level objectives on a bulk feeder level across Eversource's Service Territory.

3. ***Scenario Generation:*** Using the adoption propensity models, state climate targets, as well as company load forecasts, randomized scenarios can be created automatically using a Monte Carlo method.

4. ***Automated Scenario Model Creation***: Based of the ALF process, the baseline models can now be automatically modified to reflect the scenarios created under 2) and 3) in a way that they are power flow ready

5. **Result Analysis**: The scenario models can be automatically queued, and power flow run on them. The generated results are pushed to a DB where they can be analyzed further. Analysis can be performed using cloud-based analytics capabilities.

e. Organization of Results

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

f. Baseline

i. The baseline is inclusive of the completion of the initial Grid Modernization plan, 2018-2021.

1. 100 percent of bulk stations meeting the adoption propensity model as well as the scenario generation metric

2. 60 percent of bulk station feeders meeting the adoption propensity model as well as the scenario generation metric

3. Scenario Generation, Automated Scenario Model Creation and Result Analysis will all have a zero baseline.

4. Metric Name – **EVERSOURCE POWER QUALITY MONITORING**

b. Type of Metric

i. Company-Specific Performance Metric

c. Objective

i. Provide Eversource and the commercial and industrial customers that this investment supports, objective measurements of the degree to which the electric power system is operated within specified thresholds to ensure proper performance of customer equipment.

ii. Address the importance of data sharing and communication by measuring the time required to provide customers with final root cause analysis for events that impact them.

d. Assumptions

i. Disturbances, such as voltage sags and momentary outages, can be categorized as follows:

1. Event occurs on the Company-owned portion of the system and is within predefined thresholds and do not impact customers; or

2. Event occurs on the Company-owned portion of the system and is within predefined thresholds but are impactful to customers; or

3. Event occurs on the company-owned portion of the system and is not within predefined thresholds; or

4. Event occurs on the customer-owned equipment.

ii. "Industry-established" end use equipment performance criteria will be used to assess distribution system performance.

e. Calculation Approach

Working collaboratively with customers, the Company will define a "Triggering Event" as a disturbance that is outside of a set of predetermined thresholds(s) [2] For the purposes of this metric, we propose to use the Information Technology Industry Counsel ITIC (CBEMA) curve[3].

The Company will calculate the following in a calendar year:

1. ***Number of Triggering Events:*** The number of times power quality events were outside established thresholds, and event was triggered as measured by the power quality monitoring equipment installed on the Company's system as a part of the Grid Modernization program.

2. ***Days to Provide Root Cause Analysis:*** The average number of days from recording of Triggering Event by

[2] . A "Triggering Event" is an anomaly and does not necessarily mean that system was operating outside of acceptable specification and tolerances.

[3] The ITIC (formerly Computer Business Equipment Manufacturers Association "CBEMA" curve was established to define withstand criteria that equipment manufacturers use to ensure acceptable equipment operation during typical power system performance.

power quality monitoring system to delivery of a final root cause analysis presentation to affected customer(s).

f. Organization of Results

i. Results will be organized in accordance with the following:

1. ***Number of Triggering Events:*** This metric will be monitored as a direct number, over a specified period (e.g., week/month/year/inception-to-date).

2. ***Days to Provide Root Cause Analysis:*** This metric will be monitored as an average number of all events, over a specified period (e.g., week/month/year/inception-to-date).

g. Baseline

i. The baseline for this newly deployed technology will begin at zero for the elements identified in the Calculation Approach section above.

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GRID MODERNIZATION FACTOR

1.0 APPLICABILITY

This Grid Modernization Factor tariff ("GMF tariff") provides for the recovery of incremental costs associated with the Company's Grid Modernization Plan ("GMP") approved by the Department of Public Utilities (the "Department"). To be eligible for recovery, GMP costs must: (1) be preauthorized by the Department; (2) be incremental relative to the Company's current investment practices or new types of technology for capital investments; (3) be incremental to those costs that the Company currently recovers through its base distribution rates for operation and maintenance ("O&M") expenses and solely attributable to preauthorized grid modernization investments; (4) be prudently incurred; (5) have aggregate total expenditures for preauthorized Eligible GMP Projects less than the four-year expenditure cap determined by the Department; and (6) be recorded as in-service by December 31 of each GMP Investment Year.

The Company's rates for retail Delivery Service are subject to adjustment to reflect the operation of this GMF tariff. The Grid Modernization Factor ("GMF"), as defined herein, shall be applied to all retail delivery service kilowatt-hours ("kWhs") as determined in accordance with the provisions of Section 3.0 below. The GMF shall be determined annually by the Company, subject to the Department's review and approval. The operation of this GMF tariff is subject to Chapter 164 of the General Laws.

2.0 DEFINITIONS

2.1 Accumulated Deferred Income Taxes (ADIT) means the accumulated deferred income taxes associated with cumulative Eligible GMP Investments as of the end of the respective GMP Investment Year. For the year in which the Eligible GMP Investment was placed into service, the accumulated deferred income taxes will be determined on a monthly basis. The accumulated deferred income taxes for subsequent years shall be calculated based upon the average of the beginning and ending calendar year balances.

2.2 Accumulated Reserve for Depreciation (ARD) means the Accumulated Reserve for Depreciation, including net salvage, associated with cumulative Eligible GMP Investments as of the end of the respective GMP Investment Year. For the year in which the Eligible GMP Investment was placed into service, the Accumulated Reserve for Depreciation will be determined on a monthly basis. The Accumulated Reserve for Depreciation for

GRID MODERNIZATION FACTOR

subsequent years shall be calculated based upon the average of the beginning and ending calendar year balances.

2.3 Allowed O&M Expense (O&M) is the incremental O&M expense that is incurred by the Company as a result of implementing its GMP and is solely attributable to preauthorized grid modernization investments, including incremental GMP development and evaluation costs, the cost of which is not being recovered in base distribution rates or through another cost recovery mechanism. Eligible O&M costs are the actual monthly GMP-related O&M expenses incurred in the GMP Investment Year prior to the Recovery Year. Allowed O&M Expense will exclude all overhead and burdens O&M expenses, including pension and post-retirement benefits other than pension costs recovered through any other reconciling mechanism.

2.4 Depreciation Expense (DEPR) is the annual depreciation expense associated with the average annual cumulative Eligible GMP Investments placed into service through the end of the calendar year prior to the Recovery Year. For the year during which the Eligible GMP Investment is placed into service, the Company shall calculate depreciation expense for use in the GMP Revenue Requirement by (1) dividing the annual depreciation accrual rates, determined in the Company's most recent distribution rate case, by 12, and (2) applying the resulting rate to the average monthly plant balances during the year. Depreciation expense for subsequent years may be calculated based on the average of the beginning and end of year plant balances.

2.5 Eligible GMP Investments are the cumulative capitalized costs of Eligible GMP Projects recorded as in-service, including net salvage, and are used and useful at the end of the GMP Investment Year that is prior to the GMP Recovery Year.

2.6 Eligible GMP Project is a project contained in the Company's GMP and preauthorized by the Department to be eligible for cost recovery as a project which contributes towards achieving the Department's grid modernization objectives to: (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.

GRID MODERNIZATION FACTOR

2.7 GMF is the Grid Modernization Factor that recovers the annual GMP Revenue Requirement approved by the Department.

2.8 GMP is the Company's five-year Grid Modernization Plan which includes a four-year short-term investment plan consisting of Eligible GMP Projects, plus a five year strategic plan outlining how the Company intends to meet the Department's grid modernization objectives.

2.9 GMP Investment Year is the annual period beginning on January 1 and ending on December 31.

2.10 Recovery Year is the 12-month period for which the GMF is in effect beginning on July 1 and ending on June 30 of each year.

2.11 GMP Revenue Requirement is the revenue requirement associated with GMP plant-in-service for each GMP Investment Year prior to the Recovery Year, plus Allowed O&M Expense. For the year in which an Eligible GMP Investment is placed into service, the GMP Revenue Requirement will be calculated on a monthly basis. The GMP Revenue Requirement for subsequent years shall be calculated based upon the average of the beginning and ending calendar year balances. The GMP Revenue Requirement will be calculated to recover (1) the monthly revenue requirement for Eligible GMP Investments placed into service in the GMP Investment Year immediately prior to the Recovery Year; (2) the average annual revenue requirement for the calendar year ending December 31 of the GMP Investment Year immediately prior to the Recovery Year, for cumulative Eligible GMP Investments placed into service in GMP Investment Years two years prior to the Recovery Year; and (3) Allowed O&M Expense.

2.12 Gross Plant Investments are the capitalized costs of Eligible GMP Investments recorded on the Company's books for Eligible GMP Investments. Actual capitalized cost of Eligible GMP Investments shall include applicable overhead and burden costs subject to the test provided in Section 4.0.

2.13 Pre-Tax Rate of Return (PTRR) shall be the after-tax weighted average cost of capital established by the Department in the Company's most recent general rate case, adjusted to

GRID MODERNIZATION FACTOR

a pre-tax basis by using currently effective federal and state income tax rates applicable to the period for which the GMP Revenue Requirement is calculated.

2.14 Property Tax Expense (PTE) means the property taxes calculated based on Eligible net GMP Investments multiplied by the Property Tax Rate. Property taxes will be excluded in the GMP Revenue Requirement in the first Recovery Year following the GMP Investment Year in which the eligible taxable plant went into service. Property taxes will be included in the GMP Revenue Requirement beginning in the second Recovery Year at 50% of the annual property tax amount. In subsequent years, the GMP Revenue Requirement will reflect a full year of property taxes.

2.15 Property Tax Rate is the Company's composite property tax rate determined in the Company's most recent general rate case, calculated as the ratio of total annual property taxes paid to total taxable net plant in service.

2.16 Rate Base (RB) is the investment value upon which the Company is permitted to earn its authorized rate of return.

3.0 GRID MODERNIZATION FACTOR ("GMF")

3.1 Rate Formula

$$GMF_c = \frac{(GMR + PPRA) \times DRA_c}{FkWh_c}$$

Where:

c Designates a separate factor for each rate class group.

GMF_c The Grid Modernization Factor, by rate class, as defined in Section 2.7.

GMR The GMP Revenue Requirement as defined in Section 2.11.

PPRA The Past Period Reconciliation Amount defined as the difference between (a) the amount authorized to be recovered through the prior year's GMFs as approved by the Department and (b) the actual revenue billed through the

GRID MODERNIZATION FACTOR

applicable GMFs. Interest calculated on the average monthly balance using the customer deposit rate, as outlined in 220 CMR 26.09, shall also be included in the PPRA.

DRA_c The Distribution Revenue Allocator representing the percentage of final revenue requirement allocated to each rate class group as determined in the Company's most recent general rate case as follows:

Service Territory/Area	Rate Classes	Distribution Revenue Allocator
All	R-1/R-2	41.145%
All	R-2/R-3	4.575%
Greater Boston	G-1/T-1	3.446%
Greater Boston	G-2/T-2	27.907%
Greater Boston	G-3/WR	7.998%
Cambridge	G-0/G-1/G-6	0.829%
Cambridge	G-2	1.329%
Cambridge	G-3/SB1	0.856%
Cambridge	G-4	0.012%
Cambridge	G-5	0.018%
South Shore, Cape Cod, Martha's Vineyard	G-1/G-7	3.930%
South Shore, Cape Cod, Martha's Vineyard	G-2	1.088%
South Shore, Cape Cod, Martha's Vineyard	G-3	0.610%
South Shore, Cape Cod, Martha's Vineyard	G-4	0.008%
South Shore, Cape Cod, Martha's Vineyard	G-5	0.053%
South Shore, Cape Cod, Martha's Vineyard	G-6	0.008%
Western Massachusetts	23/24/G-0/T-0	2.626%
Western Massachusetts	G-2/T-4	1.159%
Western Massachusetts	T-2	1.495%
Western Massachusetts	T-5	0.498%
Eastern Massachusetts	S-1/S-2	0.315%
Western Massachusetts	S-1/S-2	0.095%
Total		100.000%

GRID MODERNIZATION FACTOR

FkWh$_c$ The forecasted kWh to be delivered to the Company's retail delivery service customers.

3.2 Request for GMFs

The Company shall submit annually to the Department its proposed GMFs by May 15 to become effective for usage on and after July 1.

3.3 Application of GMFs on Customer Bills

The GMF shall be calculated to the nearest one one thousandth ($0.00001) of a cent per kWh and will be applied to the monthly kWh sales. In the Eastern Massachusetts territory, the GMF will be included with the distribution kWh charge on customers' bills.

4.0 OVERHEAD AND BURDEN ADJUSTMENTS

For purposes of GMF calculations, the actual overhead and burdens shall be reduced to the extent that actual O&M overhead and burdens in a given year are less than the amount included in base distribution rates as determined in its most recent general rate case. Such reduction shall be the difference between the actual O&M overhead and burdens and the amount included in base distribution rates. In addition, the percentage of capitalized overhead and burdens assigned to GMF projects shall be set equal to the ratio of GMF to non-GMF direct costs in any given year.

5.0 FILINGS WITH THE DEPARTMENT

5.1 GMP Term Filing

The Department preauthorized the Company's first short-term investment plan Eligible GMP Projects and spending cap in D.P.U. 15-122 (2018), establishing four years of GMP spending for the GMP Investment Years 2018 through 2021 (first authorization term) and the second short-term investment plan Eligible GMP Projects and spending cap in D.P.U. 21-80 (2021), establishing four years of GMP spending for the GMP Investment Years 2022 through 2025 (second authorization term). The operation of this GMF tariff is applicable to Eligible GMP Investment and Allowed O&M Expense associated with the first two GMP terms (2018 through 2021, and 2022 through 2025).

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GRID MODERNIZATION FACTOR

5.2 Annual GMP Cost Recovery Filing

The annual GMP cost recovery filing shall be submitted to the Department by May 15 and include, but not be limited to:

(1) Full project documentation of all Eligible GMP Projects' capital investment recorded as in-service during the Prior GMP Investment Year and documentation of Allowed O&M Expense, with narrative providing justification that the costs meet the cost recovery eligibility requirements in Section 1.0;

(2) Supporting documentation demonstrating that the costs sought for recovery are preauthorized, incremental, prudently incurred, in service, and used and useful (where applicable);

(3) Any cost variances as defined in the Company's capital authorization policies;

(4) A demonstration that the proposed factors are calculated appropriately;

(5) Bill impacts; and

(6) Demonstration that aggregate total of expenditures for preauthorized Eligible GMP Projects is under the four-year expenditure cap determined by the Department. This information shall also be included in the Term Report indicated below.

5.3 Grid Modernization Annual Report

The Grid Modernization Annual Report shall be submitted to the Department by April 1 following the completion of the GMP Investment Year.

5.4 Grid Modernization Term Report

The Grid Modernization Term Report shall be submitted to the Department by April 1 following the completion of the four-year, short-term investment plan.

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GRID MODERNIZATION FACTOR

1.0 APPLICABILITY

This Grid Modernization Factor tariff ("GMF tariff") provides for the recovery of incremental costs associated with the Company's Grid Modernization Plan ("GMP") approved by the Department of Public Utilities (the "Department"). To be eligible for recovery, GMP costs must: (1) be preauthorized by the Department; (2) be incremental relative to the Company's current investment practices or new types of technology for capital investments; (3) be incremental to those costs that the Company currently recovers through its base distribution rates for operation and maintenance ("O&M") expenses and solely attributable to preauthorized grid modernization investments; (4) be prudently incurred; (5) have aggregate total expenditures for preauthorized Eligible GMP Projects less than the ~~three~~four-year expenditure cap determined by the Department; and (6) be recorded as in-service by December 31 of each GMP Investment Year.

The Company's rates for retail Delivery Service are subject to adjustment to reflect the operation of this GMF tariff. The Grid Modernization Factor ("GMF"), as defined herein, shall be applied to all retail delivery service kilowatt-hours ("kWhs") as determined in accordance with the provisions of Section 3.0 below. The GMF shall be determined annually by the Company, subject to the Department's review and approval. The operation of this GMF tariff is subject to Chapter 164 of the General Laws.

2.0 DEFINITIONS

2.1 Accumulated Deferred Income Taxes (ADIT) means the accumulated deferred income taxes associated with cumulative Eligible GMP Investments as of the end of the respective GMP Investment Year. For the year in which the Eligible GMP Investment was placed into service, the accumulated deferred income taxes will be determined on a monthly basis. The accumulated deferred income taxes for subsequent years shall be calculated based upon the average of the beginning and ending calendar year balances.

2.2 Accumulated Reserve for Depreciation (ARD) means the Accumulated Reserve for Depreciation, including net salvage, associated with cumulative Eligible GMP Investments as of the end of the respective GMP Investment Year. For the year in which the Eligible

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GMP Investment was placed into service, the Accumulated Reserve for Depreciation will be determined on a monthly basis. The Accumulated Reserve for Depreciation for subsequent years shall be calculated based upon the average of the beginning and ending calendar year balances.

2.3 Allowed O&M Expense (O&M) is the incremental O&M expense that is incurred by the Company as a result of implementing its GMP and is solely attributable to preauthorized grid modernization investments, including incremental GMP development and evaluation costs, the cost of which is not being recovered in base distribution rates or through another cost recovery mechanism. Eligible O&M costs are the actual monthly GMP-related O&M expenses incurred in the GMP Investment Year prior to the Recovery Year. Allowed O&M Expense will exclude all overhead and burdens O&M expenses, including pension and post-retirement benefits other than pension costs recovered through any other reconciling mechanism.

2.4 Depreciation Expense (DEPR) is the annual depreciation expense associated with the average annual cumulative Eligible GMP Investments placed into service through the end of the calendar year prior to the Recovery Year. For the year during which the Eligible GMP Investment is placed into service, the Company shall calculate depreciation expense for use in the GMP Revenue Requirement by (1) dividing the annual depreciation accrual rates, determined in the Company's most recent distribution rate case, by 12, and (2) applying the resulting rate to the average monthly plant balances during the year. Depreciation expense for subsequent years may be calculated based on the average of the beginning and end of year plant balances.

2.5 Eligible GMP Investments are the cumulative capitalized costs of Eligible GMP Projects recorded as in-service, including net salvage, and are used and useful at the end of the GMP Investment Year that is prior to the GMP Recovery Year.

2.6 Eligible GMP Project is a project contained in the Company's GMP and preauthorized by the Department to be eligible for cost recovery as a project which contributes towards achieving the Department's grid modernization objectives to: (1) optimize system performance by attaining optimal levels of grid visibility, command and control, and self-

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healing; (2) optimize system demand by facilitating consumer price-responsiveness; and (3) interconnect and integrate distributed energy resources.

2.7 GMF is the Grid Modernization Factor that recovers the annual GMP Revenue Requirement approved by the Department.

2.8 GMP is the Company's five-year Grid Modernization Plan which includes a ~~three~~four-year short-term investment plan consisting of Eligible GMP Projects, plus a five year strategic plan outlining how the Company intends to meet the Department's grid modernization objectives.

2.9 GMP Investment Year is the annual period beginning on January 1 and ending on December 31.

2.10 Recovery Year is the 12-month period for which the GMF is in effect beginning on July 1 and ending on June 30 of each year.

2.11 GMP Revenue Requirement is the revenue requirement associated with GMP plant-in-service for each GMP Investment Year prior to the Recovery Year, plus Allowed O&M Expense. For the year in which an Eligible GMP Investment is placed into service, the GMP Revenue Requirement will be calculated on a monthly basis. The GMP Revenue Requirement for subsequent years shall be calculated based upon the average of the beginning and ending calendar year balances. The GMP Revenue Requirement will be calculated to recover (1) the monthly revenue requirement for Eligible GMP Investments placed into service in the GMP Investment Year immediately prior to the Recovery Year; (2) the average annual revenue requirement for the calendar year ending December 31 of the GMP Investment Year immediately prior to the Recovery Year, for cumulative Eligible GMP Investments placed into service in GMP Investment Years two years prior to the Recovery Year; and (3) Allowed O&M Expense.

2.12 Gross Plant Investments are the capitalized costs of Eligible GMP Investments recorded on the Company's books for Eligible GMP Investments. Actual capitalized cost of Eligible

GRID MODERNIZATION FACTOR

GMP Investments shall include applicable overhead and burden costs subject to the test provided in Section 4.0.

2.13 Pre-Tax Rate of Return (PTRR) shall be the after-tax weighted average cost of capital established by the Department in the Company's most recent general rate case, adjusted to a pre-tax basis by using currently effective federal and state income tax rates applicable to the period for which the GMP Revenue Requirement is calculated.

2.14 Property Tax Expense (PTE) means the property taxes calculated based on Eligible net GMP Investments multiplied by the Property Tax Rate. Property taxes will be excluded in the GMP Revenue Requirement in the first Recovery Year following the GMP Investment Year in which the eligible taxable plant went into service. Property taxes will be included in the GMP Revenue Requirement beginning in the second Recovery Year at 50% of the annual property tax amount. In subsequent years, the GMP Revenue Requirement will reflect a full year of property taxes.

2.15 Property Tax Rate is the Company's composite property tax rate determined in the Company's most recent general rate case, calculated as the ratio of total annual property taxes paid to total taxable net plant in service.

2.16 Rate Base (RB) is the investment value upon which the Company is permitted to earn its authorized rate of return.

3.0 GRID MODERNIZATION FACTOR ("GMF")

3.1 Rate Formula

$$GMF_c = \frac{(GMR + PPRA) \times DRA_c}{FkWh_c}$$

Where:

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c Designates a separate factor for each rate class group.

GMF_c The Grid Modernization Factor, by rate class, as defined in Section 2.7.

GMR The GMP Revenue Requirement as defined in Section 2.11.

PPRA The Past Period Reconciliation Amount defined as the difference between (a) the amount authorized to be recovered through the prior year's GMFs as approved by the Department and (b) the actual revenue billed through the applicable GMFs. Interest calculated on the average monthly balance using the customer deposit rate, as outlined in 220 CMR 26.09, shall also be included in the PPRA.

DRA_c The Distribution Revenue Allocator representing the percentage of final revenue requirement allocated to each rate class group as determined in the Company's most recent general rate case as follows:

Service Territory/Area	Rate Classes	Distribution Revenue Allocator
All	R-1/R-2	41.145%
All	R-2/R-3	4.575%
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Greater Boston	G-2/T-2	27.907%
Greater Boston	G-3/WR	7.998%
Cambridge	G-0/G-1/G-6	0.829%
Cambridge	G-2	1.329%
Cambridge	G-3/SB1	0.856%
Cambridge	G-4	0.012%
Cambridge	G-5	0.018%
South Shore, Cape Cod, Martha's Vineyard	G-1/G-7	3.930%
South Shore, Cape Cod, Martha's Vineyard	G-2	1.088%
South Shore, Cape Cod, Martha's Vineyard	G-3	0.610%
South Shore, Cape Cod, Martha's Vineyard	G-4	0.008%
South Shore, Cape Cod, Martha's Vineyard	G-5	0.053%
South Shore, Cape Cod, Martha's Vineyard	G-6	0.008%

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Western Massachusetts	23/24/G-0/T-0	2.626%
Western Massachusetts	G-2/T-4	1.159%
Western Massachusetts	T-2	1.495%
Western Massachusetts	T-5	0.498%
Eastern Massachusetts	S-1/S-2	0.315%
Western Massachusetts	S-1/S-2	0.095%
Total		100.000%

$FkWh_c$ The forecasted kWh to be delivered to the Company's retail delivery service customers.

3.2 Request for GMFs

The Company shall submit annually to the Department its proposed GMFs by May 15 to become effective for usage on and after July 1.

3.3 Application of GMFs on Customer Bills

The GMF shall be calculated to the nearest one one thousandth ($0.00001) of a cent per kWh and will be applied to the monthly kWh sales. In the Eastern Massachusetts territory, the GMF will be included with the distribution kWh charge on customers' bills.

4.0 OVERHEAD AND BURDEN ADJUSTMENTS

For purposes of GMF calculations, the actual overhead and burdens shall be reduced to the extent that actual O&M overhead and burdens in a given year are less than the amount included in base distribution rates as determined in its most recent general rate case. Such reduction shall be the difference between the actual O&M overhead and burdens and the amount included in base distribution rates. In addition, the percentage of capitalized overhead and burdens assigned to GMF projects shall be set equal to the ratio of GMF to non-GMF direct costs in any given year.

5.0 FILINGS WITH THE DEPARTMENT

GRID MODERNIZATION FACTOR

5.1 GMP Term Filing

The Department preauthorized the Company's first ~~three-year~~ short-term investment plan Eligible GMP Projects and spending cap in D.P.U. 15-122 (2018), establishing ~~three~~ four years of GMP spending for the GMP Investment Years 2018 through ~~2020~~ 2021 (first authorization term) and the second short-term investment plan Eligible GMP Projects and spending cap in D.P.U. 21-80 (2021), establishing four years of GMP spending for the GMP Investment Years 2022 through 2025 (second authorization term). ~~By July 1, 2020, the Company shall submit its next GMP term filing that shall include a second three-year short-term investment plan for GMP Investment Years 2021 through 2023 (second authorization term) plus a five-year strategic plan through 2026 identifying how the Company intends to achieve the grid modernization objectives.~~ The operation of this GMF tariff is applicable to Eligible GMP Investment and Allowed O&M Expense associated with the first two GMP terms (2018 through ~~2020~~2021, and ~~2021~~ 2022 through ~~2023~~2025).

5.2 Annual GMP Cost Recovery Filing

The annual GMP cost recovery filing shall be submitted to the Department by May 15 and include, but not be limited to:

(1) Full project documentation of all Eligible GMP Projects' capital investment recorded as in-service during the Prior GMP Investment Year and documentation of Allowed O&M Expense, with narrative providing justification that the costs meet the cost recovery eligibility requirements in Section 1.0;

(2) Supporting documentation demonstrating that the costs sought for recovery are preauthorized, incremental, prudently incurred, in service, and used and useful (where applicable);

(3) Any cost variances as defined in the Company's capital authorization policies;

(4) A demonstration that the proposed factors are calculated appropriately;

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(5) Bill impacts; and

(6) Demonstration that aggregate total of expenditures for preauthorized Eligible GMP Projects is under the ~~three~~four-year expenditure cap determined by the Department. This information shall also be included in the Term Report indicated below.

5.3 Grid Modernization Annual Report

The Grid Modernization Annual Report shall be submitted to the Department by April 1 following the completion of the GMP Investment Year.

5.4 Grid Modernization Term Report

The Grid Modernization Term Report shall be submitted to the Department by April 1 following the completion of the ~~three~~four-year, short-term investment plan.