Massachusetts Grid Modernization Program Year 2020 Evaluation Report: Advanced Distribution Management System/Advanced Load Flow (ADMS/ALF)

Massachusetts Electric Distribution Companies

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Introduction

As part of the Grid Modernization Plan (GMP), the Massachusetts Electric Distribution Companies (EDCs) are investing in advanced distribution management systems (ADMS) and advanced load flow (ALF). ADMS/ALF is a software platform investment fundamental to a modernized grid. ADMS consists of supervisory control and data acquisition (SCADA), outage management systems (OMSs), distribution management systems (DMSs), and advanced applications including operational power flow, conservation voltage reduction (CVR), Volt/VAR optimization (VVO), fault location isolation and service restoration (FLISR), and distributed energy resource management systems (DERMSs). An ADMS's capabilities are key to delivering on all of the Massachusetts Department of Public Utilities' (DPU's) grid modernization objectives. These objectives include the ability to control devices for system optimization, provide support for advanced distribution automation (ADA) and VVO, and serve as an enabling platform to support a high penetration of distributed energy resources (DER). ALF investments are tightly coupled with ADMS investments at Eversource, the only Electric Distribution Company (EDC) with a separate investment plan for ALF.

The evaluation focuses on the progress and effectiveness of the DPU's preauthorized ADMS/ALF investments for each EDC toward meeting the DPU's grid modernization objectives for Program Year (PY) 2020.

Table 1 summarizes the preauthorized ADMS/ALF investments for the EDCs in the Program Year (PY) PY2018 to PY2021 timeframe.

Table 1. ADMS/ALF Investments

EDCs	Description
Eversource	Implementation of ADMS supported by implementation of ALF
National Grid	Implementation of DMS integrated with SCADA
Unitil	Implementation of ADMS for VVO enablement

Source: Guidehouse review of 2019 GMP Annual Reports and EDC Data

Evaluation Process

The DPU requires a formal evaluation process (including an evaluation plan and evaluation studies) for the EDCs' preauthorized GMP investments. Guidehouse (formerly Navigant Consulting, Inc.)[1] is completing the evaluation to help ensure a uniform statewide approach and to facilitate coordination and comparability of evaluation results. The evaluation process assesses the progress and effectiveness of the DPU preauthorized ADMS and ALF investments for each EDC to help meet the DPU's grid modernization objectives.[2]

[1] Guidehouse LLP completed its acquisition of Navigant Consulting, Inc, in October of 2019. The two brands are now combined as one Guidehouse.

[2] DPU Order, May 10, 2018, p.106

The original Evaluation Plan developed by Navigant Consulting (now Guidehouse) was submitted to the DPU by the EDCs in a petition for approval on May 1, 2019. Modifications to this original Evaluation Plan were made to 1) request changes to the reporting schedule to accommodate Performance Metrics data availability timing, as discussed in response to DPU EP-1-1 submitted on February 6, 2020[3], and 2) to extend the Grid Modernization term period from the original 3 year term to a 4 year term as ordered by the DPU in its May 12, 2020 Order.[4] Modifications to the original Evaluation Plan were submitted to the DPU by the EDCs in a petition for approval on December 1, 2020. The company-specific GMP budget caps did not change with the term extension. The modified Evaluation Plan has been used to develop the analysis and evaluation provided below in this document.

The evaluation process guides the investments' contribution to meeting all three DPU objectives:

1) Optimize system performance by attaining optimal levels of grid visibility, command and control, and self-healing
2) Optimize system demand
3) Interconnect and integrate DER

ADMS is an enabling technology that has the potential to significantly enhance a utility's ability to meet DPU objectives. ALF enables ADMS and supports all three of the DPU's objectives, including improved modeling of the distribution system's current and future states. ALF is tightly coupled with the ADMS investment for Eversource—the geographic information system (GIS) and other system data cleanup components of ALF enable engineering load flow in Synergi and are necessary for operational load flow, and other ADMS functions in Eversource's future ADMS investment. GIS data cleanup is a component of each of the ADMS/ALF investments and is addressed differently at each EDC.

Guidehouse's evaluation of the ADMS/ALF investments consists of four tasks:

- **Task 1. Evaluation Plan:** Define overall study goals and identify metrics, including a round of plan refinement and coordination with the EDCs prior to finalization.
- **Task 2. Data Assimilation and Collection:** Distribute written data requests to each EDC semiannually, with each EDC providing the data specified and Guidehouse conducting follow-up data review meetings.
- **Task 3. Analysis and Presentation:** Analyze data following data collection tasks, producing a year-end draft presentation for each EDC to review. Outputs from Task 3 feed directly into preparation for Task 4.
- **Task 4. Reporting:** Provide interim draft reports following the yearly analysis review meetings with the EDCs and incorporate feedback into this final evaluation report. Evaluation reports are provided to the EDCs to incorporate into filings and reports to the DPU.

[3] Submitted to Massachusetts DPU 15-120, 15-121, 15-122

[4] Order (1) Extending Current Three-Year Grid Modernization Plan Investment Term; and (2) Establishing Revised Filing Date for Subsequent Grid Modernization Plans; DPU 15-120, DPU 15-121, DPU 15-122; May 12, 2020.

Data Management

The objective of data management is to collect planning and cost information. Data management tracks enabled power flow and control capabilities at regular intervals with each EDC based on the approved evaluation plan. It includes defining details on the data to be collected, identifying the timing of data collection, and designating owners at each EDC for the ADMS data as well as owners at Eversource for ALF data.

The evaluation strategy for the implementation of ADMS components is followed by the progression of functional realization of each EDC's ADMS. This progression means that the data helps identify the progress each EDC has made to establish the functionality of its ADMS. This process starts with evaluating the foundational prerequisites, moves to basic ADMS software, and finishes with advanced application functionality. These steps include integrating OMS and distribution SCADA (DSCADA) components if needed, cleaning the data, and enabling functionality (including load flow on circuits and substations) and advanced functionality, potentially including VVO, FLISR, and DERMS.

For Eversource's ALF investment, the data helps identify Eversource's progress toward establishing the functionality of the ALF, starting with foundational prerequisites, basic Synergi software, integrating Synergi to GIS and other systems, and cleaning up data in GIS and other systems.

Table 2 summarizes data sources used throughout the ADMS/ALF evaluation in PY2020. Sections 3.1.1 and 4.1.1 detail each of the data sources.

Table 2. ADMS/ALF Data Sources

Data Source	Description
2019 Grid Modernization Plan Annual Report[5,6,7]	Planned device deployment and cost information from each EDC's Supplement to the 2019 GMP Annual Report (filed April 1, 2020). Data was used as the reference to track progress against the GMP targets and are referred to as the GMP Plan in summary tables and figures throughout the report.
EDC Device Deployment Data Template	Captures planned and actual device deployment and spend data. Actual device deployment and cumulative spend information were provided by work order ID and specified at the feeder- or substation-level as appropriate. Planned device deployment information and estimated spend for PY2021 were provided at the most granular level. Data is referred to as EDC Data in summary tables and figures throughout the report.

[5] Massachusetts Electric Company and Nantucket Electric Company d/b/a National Grid, Grid Modernization Plan Annual Report 2019. Submitted to Massachusetts DPU on April 1, 2020 as part of DPU 15-120
[6] NSTAR Electric Company d/b/a Eversource Energy, Grid Modernization Plan Annual Report 2019. Submitted to Massachusetts DPU on April 1, 2020 as part of DPU 15-122
[7] Fitchburg Gas and Electric Light Company d/b/a Unitil, Grid Modernization Plan Annual Report 2019. Submitted to Massachusetts DPU on April 1, 2020 as part of DPU 15-121

Eversource's 2021 DPU-Filed Plan[8]	Eversource's GMP Extension request, which was approved by the DPU on February 4, 2021. Includes budgets for PY2021 deployment at the Investment Area level. This data source is included in the EDC Plan for Eversource planned spend at the Investment Area level.
ADMS/ALF Supplemental Data Template	Includes additional information unique to the ADMS/ALF Investment Area spanning inputs required for the Infrastructure Metrics and the Performance Metrics. Data covers actual versus planned ADMS/ALF implementation, data cleanup, schedule, and cost. Information was requested at the feeder- and substation-level where possible.

Source: Guidehouse analysis

Guidehouse reviewed all data provided upon receipt. The team conducted detailed quality assurance/quality control (QA/QC) of data inputs used in the analysis of Infrastructure and Performance Metrics. These QA/QC steps included checks to confirm each of the required data inputs are accounted for and can be incorporated into analysis.

After receiving the data, Guidehouse provided status update memos that summarized the QA/QC to the EDCs, confirming receipt of the datasets and indicating quality. Additional follow-up based on standing questions was required to confirm all EDC-provided data could be used in analysis.

Findings and Recommendations

The EDCs realize that IT/operational technology (OT) applications, including ADMS/ALF, are different from device-centric investments and require a different approach to planning, budgeting, and monitoring. Guidehouse found that estimates for the ADMS/ALF investments were initially high level and the EDCs refined them as they progressed through the evaluation period. The EDCs have refined the capital and operational components of the ADMS/ALF investment plans as those plans have progressed through the first 2 years of their GMPs.

Eversource's enhanced semiautomatic ALF implementation was completed in PY2020 and cost less than planned; ADMS implementation is planned for PY2021. National Grid's ADMS deployment milestones are on track following a multistep ADMS data cleanup process in PY2020; National Grid plans to implement an initial release of ADMS within control center operations in PY2021. Unitil has accelerated the schedule of its ADMS investment to use ADMS as the platform for VVO deployment; the various elements of ADMS remain on track.

Table 3 presents the Infrastructure Metric results through PY2020 for all EDCs. Additional detail surrounding findings for each Infrastructure Metric are provided in Section 3.2. Although Infrastructure Metrics are the same across all Investment Areas, ADMS/ALF investments are not tracked by device. Instead, ADMS/ALF investments are tracked by technology or software implementation. Throughout this report, the term technology or software implementation is used instead of device deployment.

[8] Grid Modernization Program Extension and Funding Report. Submitted to Massachusetts DPU on July 1, 2020 as part of DPU 15-122

Table 3. ADMS/ALF Infrastructure Metric Summary

Infrastructure Metrics			Eversource	National Grid	Unitil
GMP Plan Total, 2018-2020		Devices	N/A	N/A	N/A
		Spend, $M	$34.55*	$23.22	$0.40
EDC Data Total, 2018-2021		Devices	N/A	N/A	N/A
		Spend, $M	$28.97	$21.08	$0.60
IM-4	Number of Devices or Other Technologies Deployed through PY2020	# Devices Deployed	N/A	N/A	N/A
		% Devices Deployed	N/A	N/A	N/A
IM-5	Cost for Deployment through PY2020	Total Spend, $M	$15.97	$11.89	$0.17
		% Spend	86%	51%	43%
IM-6	Deviation Between Actual and Planned Deployment for PY2020	% On Track (Devices)	N/A	N/A	N/A
		% On Track (Spend)	72%	48%	43%
IM-7	Projected Deployment for the Remainder of the GMP Term	# Devices Remaining	N/A	N/A	N/A
		Spend Remaining, $M	$13.00	$9.19	$0.43

IM = Infrastructure Metric

*Includes the Eversource planned spend for PY2021, set forth in the *GMP Extension and Funding Report*, filed on July 1, 2020 and approved on February 4, 2021.

Source: Guidehouse analysis of 2019 GMP Annual Reports, GMP Extension and Funding Report, and 2020 EDC Data

Table 4 presents the progress of the Performance Metrics across the state's three EDCs.

Table 4. ADMS/ALF Performance Metrics Progress

Performance Metrics		Eversource*		National Grid†		Unitil	
		Circuits	Substations	Circuits	Substations	Circuits	Substations
PM-1	Increase in Circuits and Substations with DMS Power Flow and Control Capabilities	-	-	-	-	11	1
PM-2	Control Functions Implemented by Circuit and Substation	-	-	-	-	11	1
PM-3	ALF – Percent of Milestone Completion	100%	100%	N/A	N/A	N/A	N/A
Other	Distributed Generation (DG) Interconnection Queue Wait Time	N/A	N/A	N/A	N/A	N/A	N/A

PM = Performance Metric

*Eversource ADMS implementation begins in PY2021. Eversource ALF was enabled in Q4 PY2020, DG Interconnection Queue Wait Time is a future PM for when there is sufficient data to evaluate.

† National Grid ADMS deployment is planned for 2021; work to-date has been preliminary data cleanup and is not shown here.

Source: EDC data

Eversource

Eversource's ADMS/ALF progress is in line with its 2019 GMP Annual Report and was under budget, which allowed unspent funds to be reallocated to other GMP investments. The ALF implementation plan was completed on target for enabling basic semi-automatic and enhanced semi-automatic ALF in PY2020. Eversource placed the ALF project in-service once the enhanced semi-automatic level was considered enabled. Additional software implementation, a load forecasting tool, Synergi upgrades, and a PI asset framework were added to this Investment Area plan to better support operation of the ALF investment moving forward. These software are initiatives planned for PY 2021.

National Grid

National Grid's ADMS deployment of the monitor and inform phase is planned for 2021; work to-date has been preliminary data cleanup. National Grid is targeting the manage and control phase of ADMS and DSCADA system implementation (and supporting GIS modernization) within the next plan period to support the increased number of distribution devices (FLISR,

CVR/VVO, telecommunications, and feeder monitors) proposed in the GMP (along with supporting more interconnected DER) to meet grid modernization requirements.

Unitil

Unitil's ADMS progress is ahead of its 2019 GMP Annual Report, given the updates to the evaluation period extension (i.e., inclusion of 2021 in the estimate). ADMS implementation is on track, with the schedule realigned to allow using ADMS as a platform for VVO, another Investment Area. Total ADMS spend is less than originally planned for the 2018-2020 evaluation period. Additionally, Unitil completed the upgrade to the GIS-ADMS integration engine and implemented the VVO control function via ADMS on planned circuits at the Townsend substation.

Statewide Conclusions and Recommendations

Throughout the PY2019 to PY2020 period, Guidehouse worked with the EDCs on the evaluation process. Guidehouse' conclusions and recommendations are listed as follows.

Conclusions:

- Moving circuits from cleaned to operational takes more steps than the EDCs thought. They have to clean the data multiple times before they can put the data in operation. Once the data is initially cleaned, it is ready for a final cleaning.
    - The process of implementation of ADMS depends heavily upon the input data. Multiple steps of cleaning, augmenting, and testing are required prior to enabling the ADMS to go into production with the circuit model.
    - For example, Unitil is using a multi-step process to clean, augment, and test the input GIS (and other system data) prior to creating the circuit model in ADMS and testing that load flow converges.
    - If there are data problems that prevent clear visibility, switching support, and inability for load flow to converge then system operations will have low confidence in the system, slowing or preventing adoption of the technology.
    - Taking a measured and deliberate approach to cleaning data is prudent to support long-term adoption and usage of ADMS.
- EDCs had flexibility in budgeting ADMS/ALF and supporting tasks and moved money from one task to another as needed. This approach is working but has introduced variance to the plan. The variance to plan is not material to the progress the EDC made in its ADMS/ALF deployment (i.e., the ADMS/ALF deployment was initially over-budgeted).
- Performance Metrics preliminarily indicate that the EDCs are working towards supporting the DPU's primary objectives of optimizing system performance, demand, and interconnection of DER. However, the EDCs still have work to do before seeing mature ADMS/ALF performance on circuits and substations.

Recommendations:

- Continue progressing circuits into go-live status (i.e., full operation) within ADMS/ALF to confirm complete understanding of the challenges, barriers, and costs associated with

fully operationalizing ADMS/ALF. Guidehouse found that as each EDC gets to closer to operationalization of the ADMS/ALF, more challenges and unknowns appear. Getting visibility into these early can help ensure that EDC plans remain on track.

- As the EDCs see more mature ADMS/ALF performance on circuits and substations, it will be important to have full clarity on data that supports enhanced system performance. For Eversource, this means ensuring clarity on where ALF optimizes the DG interconnection queue process, and being able to show that within the publicly available data[9].

- The EDCs should work to explicitly track how this process is helping better achieve DER integration (e.g., lower costs or faster queue times).

    - For ALF Eversource, Guidehouse recommends to:

        - Expand the ALF development to include an external website where DER developers can log in and determine location and size of interconnections that are possible (similar to what is being done in Eversource Connecticut).

        - Track as a metric, how many individuals (i.e., customers, developers)are accessing the website for feeder information.

        - Perform a survey both internal to the company (Eversource) and external DER developers on the effectiveness and recommended changes to the ALF.

    - For ADMS Eversource, Guidehouse recommends to:

        - Conduct extensive pilot testing of the ADMS software prior to any cut-over or go live.

        - Conduct a survey of other users (Utilities) that have cut over to an ADMS for lessons learned.

[9] MassDGIC: Interconnection in Massachusetts, https://sites.google.com/site/massdgic/home/interconnection.

1. Introduction to Massachusetts Grid Modernization

This section includes a brief background to the Grid Modernization Evaluation process and an overview of the ADMS/ALF Investment Area and specific ADMS/ALF evaluation objectives. Subsequent sections address the evaluation processes and findings.

1.1 Massachusetts Grid Modernization Plan Background

On May 10, 2018, the Massachusetts Department of Public Utilities (DPU) issued its Order[10] regarding the individual Grid Modernization Plans (GMPs) filed by the three Massachusetts Electric Distribution Companies (EDCs): Eversource, National Grid, and Unitil.[11,12] In the Order, the DPU preauthorized grid-facing investments over 3 years (2018-2020) for each EDC and adopted a 3-year (2018-2020) regulatory review construct for preauthorization of grid modernization investments. On May 12, 2020, the DPU issued an Order[13] extending the 3-year GMP investment term to a 4-year term, including 2018-2021. The company-specific GMP budget caps did not change with the term extension. On July 1, 2020, Eversource filed a request for an extension of the budget authorization associated with grid modernization investments.[14] The budget extension, approved by the DPU on February 4, 2021, included $14 million for ADA, $16 million for ADMS/ALF, $5 million for Communications, $15 million for M&C, and $5 million for VVO.

The preauthorized GMP investments should advance the achievement of the DPU's grid modernization objectives:

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

As part of the GMPs, the DPU determined that a formal evaluation process for the preauthorized GMP investments, including an evaluation plan and studies, was necessary to help confirm the benefits are capitalized on and achieved with greater certainty.

The grid modernization investments were organized into six Investment Areas to facilitate understanding, consistency across EDCs, and analysis:

- Monitoring and Control (M&C)
- Advanced Distribution Automation (ADA)

[10] Massachusetts DPU 15-120; DPU 15-121; DPU 15-122 (Grid Modernization) Order issued May 10, 2018

[11] On August 19, 2015, National Grid, Unitil, and Eversource each filed a grid modernization plan with the DPU. The DPU docketed these plans as DPU 15-120, DPU 15-121, and DPU 15-122, respectively.

[12] On June16, 2016, Eversource and National Grid each filed updates to their respective grid modernization plans

[13] Massachusetts DPU 15-120; DPU 15-121; DPU 15-122 (Grid Modernization) Order (1) Extending Current Three-Year Grid Modernization Plan Investment Term; and (2) Establishing Revised Filing Date for Subsequent Grid Modernization Plans (issued May 12, 2020)

[14] Grid Modernization Program Extension and Funding Report. Submitted to Massachusetts DPU on July 1, 2020 as part of DPU 15-122

- Volt/VAR Optimization (VVO)
- Advanced Distribution Management Systems/Advanced Load Flow (ADMS/ALF)
- Communications/IoT
- Workforce Management (WFM)

This report focuses on the ADMS/ALF Investment Area. Similarly structured evaluation reports have been developed for each of the other Investment Areas.

1.1.1 Investment Areas

Table 5 summarizes the preauthorized GMP investment.

Table 5. Overview of Investment Areas

Investment Area	Description	Goal/Objective
Monitoring and Control (M&C)	Remote monitoring and control of devices in the substation for feeder monitoring or online devices for enhanced visibility outside the substation.	Enhance grid visibility and control capabilities, reliability increase
Advanced Distribution Automation (ADA)	Isolation of outage events with automated backup for unaffected circuit segments.	Reduce the impact of outages
Volt/VAR Optimization (VVO)	Control of line and substation equipment to optimize voltage, reduce energy consumption, and increase hosting capacity.	Optimize distribution voltage to reduce energy consumption and demand
Advanced Distribution Management Systems/Advanced Load Flow (ADMS/ALF)	New capabilities in real-time system control with investments in developing accurate system models and enhancing Supervisory control and data acquisition (SCADA) and outage management systems to control devices for system optimization and provide support for distribution automation and VVO with high penetration of DER.	Enable high penetration of DER by supporting the ability to control devices for system optimization, ADA, and VVO
Communications/IoT	Fiber middle mile and field area communications systems.	Enable the full benefits of grid modernization devices to be realized
Workforce Management (WFM)	Investments to improve workforce and asset utilization related to outage management and storm response.	Improve the ability to identify damage after storms

Sources: Grid Mod RFP – SOW (Final 8-8-18).pdf; Guidehouse

The Massachusetts DPU preauthorized budget for grid modernization varies by Investment Area and EDC. Eversource originally had the largest preauthorized budget at $133 million, with ADA and M&C representing the largest share ($44 million and $41 million, respectively). National Grid's preauthorized budget was $82.2 million, with ADMS/ALF representing over 50% ($48.4 million). Unitil's preauthorized budget was $4.4 million and VVO makes up 50% ($2.2 million).

On July 1, 2020, Eversource filed a request for an extension of the budget authorization associated with grid modernization investments.[15] The budget extension, approved by the DPU on February 4, 2021,[16] includes $14 million for ADA, $16 million for ADMS/ALF, $5 million for Communications, $15 million for M&C, and $5 million for VVO. These values are included in the Eversource total budget by Investment Area in Table 6.

Table 6. 2018-2021 GMP Preauthorized Budget, $M

Investment Areas	Eversource	National Grid	Unitil	Total
ADA	$58.00	$13.40	N/A	**$71.40**
ADMS/ALF	$33.00	$48.40	$0.70	**$79.10**
Communications	$23.00	$1.80	$0.84	**$25.60**
M&C	$56.00	$8.00	$0.35	**$64.75**
VVO	$18.00	$10.60	$2.22	**$30.80**
WFM	$0.00	$0.00	$0.30	**$1.00**
2018-2021 Total	**$188.00**	**$82.20**	**$4.41**	**$272.65**

Sources: DPU Order, May 10, 2018, and Eversource filing GMP Extension and Funding Report, July 1, 2020

The DPU allowed flexibility in these budgets based on changing technologies and circumstances. For example, EDCs can shift funds across the different preauthorized investments if a reasonable explanation for these shifts is supplied. The following subsections discuss these evaluation goals, objectives, and the metrics to be used.

1.1.2 Evaluation Goal and Objectives

The DPU requires a formal evaluation process (including an evaluation plan and evaluation studies) for the EDCs' preauthorized GMP investments. Guidehouse (formerly Navigant) is completing the evaluation to ensure a uniform statewide approach and to facilitate coordination and comparability. The evaluation's objective is to measure the progress made toward the achievement of the DPU's grid modernization objectives. The evaluation uses the DPU-established Metrics to help determine if the investments are meeting the DPU's GMP objectives.

1.1.3 Metrics for Evaluation

The DPU-required evaluation involves Infrastructure Metrics and Performance Metrics for each Investment Area. Selected case studies have been added for some Investment Areas (e.g., M&C) to help facilitate understanding of how the technology performed in specific instances (e.g., in remediating the effects of a line outage).

1.1.3.1 Infrastructure Metrics

Infrastructure Metrics were designed to evaluate the deployment of the GMP investments. Table 7 summarizes the Infrastructure Metrics.

[15] Grid Modernization Program Extension and Funding Report. Submitted to Massachusetts DPU on July 1, 2020 as part of DPU 15-122

[16] Massachusetts DPU 20-74 Order issued on February 4, 2021.

Table 7. Infrastructure Metrics Overview

Metric		Description	Applicable IAs	Metric Responsibility
IM-1	**Grid-Connected Distribution Generation Facilities**	Tracks the number and type of distributed generation facilities in service and connected to the distribution system.	ADMS/ALF	EDC
IM-2	**System Automation Saturation**	Measures the quantity of customers served by fully or partially automated devices.	M&C, ADA	EDC
IM-3	**Number and Percentage of Circuits with Installed Sensors**	Measures the total number of circuits with installed sensors that will provide information useful for proactive planning and intervention.	M&C	EDC
IM-4	**Number of Devices Deployed and In Service**	Measures how the EDC is progressing with its GMP from an equipment or device standpoint.	All IAs	Evaluator
IM-5	**Cost for Deployment**	Measures the associated costs for the number of devices or technologies installed; designed to measure how the EDC is progressing under its GMP.	All IAs	Evaluator
IM-6	**Deviation Between Actual and Planned Deployment for the Plan Year**	Measures how the EDC is progressing under its GMP on a year-by-year basis.	All IAs	Evaluator
IM-7	**Projected Deployment for the Remainder of the 4-Year Term**	Compares the revised projected deployment with the original target deployment as the EDC implements its EDC.	All IAs	Evaluator

IM = Infrastructure Metric, IA = Investment Area

Source: Guidehouse review of Infrastructure Metric filings

1.1.3.2 Performance Metrics

Table 8 summarizes the Performance Metrics, which are used to evaluate the performance of the GMP investments.

Table 8. Performance Metrics Overview

Metric		Description	Applicable IAs	Metric Responsibility
PM-1	**VVO Baseline**	Establishes a baseline impact factor for each VVO-enabled circuit, which will be used to quantify the peak load, energy savings, and greenhouse gas (GHG) impact measures.	VVO	All

Metric		Description	Applicable IAs	Metric Responsibility
PM-2	**VVO Energy Savings**	Quantifies 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.	VVO	All
PM-3	**VVO Peak Load Impact**	Quantifies the peak demand impact VVO/conservation voltage reduction (CVR) has on the system with the intent of optimizing system demand.	VVO	All
PM-4	**VVO Distribution Losses without Advanced Metering Functionality (AMF) (Baseline)**	Presents the difference between circuit load measured at the substation via the SCADA system and the metered load measured through advanced metering infrastructure (AMI).	VVO	All
PM-5	**VVO Power Factor**	Quantifies the improvement that VVO/CVR is providing toward maintaining circuit power factors near unity.	VVO	All
PM-6	**VVO – GHG Emissions**	Quantifies the overall GHG impact VVO/CVR has on the system.	VVO	All
PM-7	**Voltage Complaints**	Quantifies the prevalence of voltage-related complaints before and after deployment of VVO investments to assess customer experience, voltage stability under VVO.	VVO	All
PM-8	**Increase in Substations with Distribution Management System (DMS) Power Flow and Control Capabilities**	Examines the deployment and data cleanup associated with deployment of ADMS/ALF, primarily by counting and tracking the number of circuits and substations per year.	ADMS/ ALF	All
PM-9	**Control Functions Implemented by Circuit**	Examines the control functions of DMS power flow and control capabilities, focused on the control capabilities including VVO/CVR and fault location isolation and service restoration (FLISR).	ADMS/ ALF	All
PM-11	**Numbers of Customers that Benefit from GMP-Funded Distribution Automation Devices**	Shows the progress of ADA investments by tracking the number of customers that have benefitted from the installation of ADA devices.	ADA	ES, NG

Metric		Description	Applicable IAs	Metric Responsibility
PM-12	**Grid Modernization Investments' Effect on Outage Durations**	Provides insight into how M&C investments can reduce outage durations (CKAIDI). Compares the experience of customers on GMP M&C-enabled circuits as compared to the previous 3-year average for the same circuit.	M&C, ADA	All
PM-13	**Grid Modernization Investments' Effect on Outage Frequency**	Provides insight into how M&C investments can reduce outage frequencies (CKAIFI). Compares the experience of customers on M&C-enabled circuits as compared to the prior 3-year average for the same circuit.	M&C, ADA	All
PM-ES1	**Advanced Load Flow – Percent Milestone Completion**	Examines the fully developed ALF capability across Eversource's circuit population.	ADMS/ ALF	ES
PM-ES2	**Protective Zone: Average Zone Size per Circuit**	Measures Eversource's progress in sectionalizing circuits into protective zones designed to limit outages to customers located within the zone.	ADA	ES
PM-UTL1	**Customer Minutes of Outage Saved per Circuit**	Tracks time savings from faster AMI outage notification than customer outage call, leading to faster outage response and reduced customer minutes of interruption.	M&C	UTL
PM-NG1	**Main Line Customer Minutes of Interruption Saved**	Measures the impact of ADA investments on the customer minutes of interruption (CMI) for main line interruptions. Compares the CMI of GMP ADA-enabled circuits to the previous 3-year average for the same circuit.	ADA	NG
PM*	**Distributed Generation (DG) Interconnection Queue Wait Time**	Estimates the difference in queue wait time between circuits with and without ALF based on publicly filed data.	ALF	ES

PM = Performance Metric, IA = Investment Area, ES = Eversource, NG = National Grid, UTL = Unitil
*This Performance Metric was added as an evaluation metric to help better understand the investment's ability to meet one of the three DPU grid modernization objectives: "Interconnect and integrate distributed energy resources (DER)." However, it is not one of the DPU Stamped Approved Metrics. Eversource ALF was enabled in Q4 PY2020, DG Interconnection Queue Wait Time is a future PM.

Source: Stamp Approved Performance Metrics, July 25, 2019

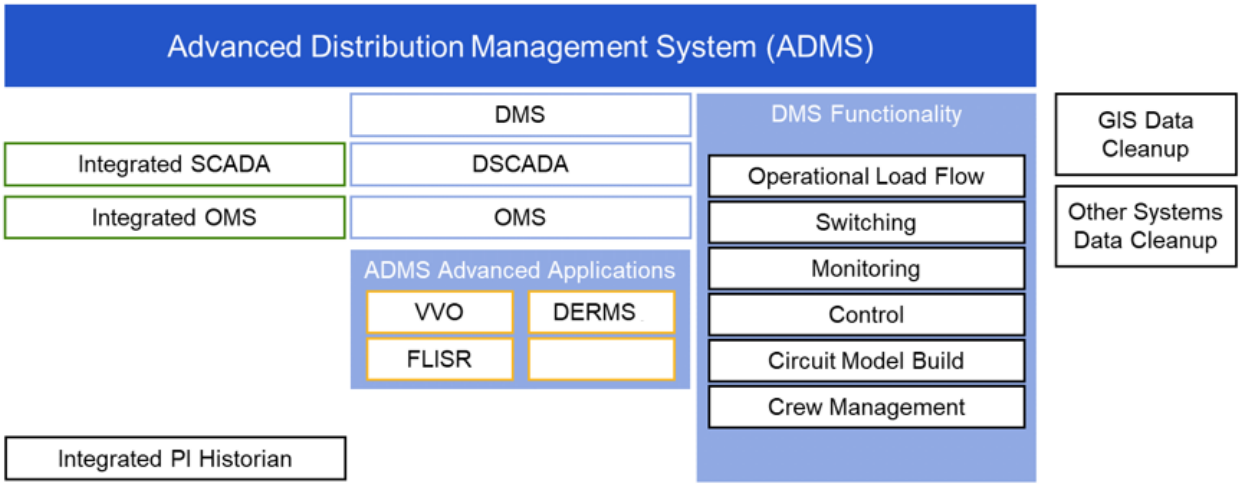
Performance Metrics that pertain specifically to the ADMS/ALF Investment Area are discussed in this report.

1.2 Introduction to ADMS/ALF

ADMS/ALF is a software platform investment fundamental to a modernized grid. ADMS consists of a combination of SCADA, outage management systems (OMSs), DMSs, and advanced applications including operational power flow, VVO, FLISR, and DER management systems (DERMSs). The capabilities of ADMS are key to delivering on all three of the DPU's grid modernization objectives. These objectives include the ability to control devices for system optimization, provide support for ADA and VVO, and serve as an enabling platform to support a high penetration of DER.

Figure 1 shows the typical components of an ADMS. This diagram shows the intrinsic and integrated components of an ADMS and a functionality stack related to the DMS component of the ADMS. The components and functionality are foundational to the industry status of ADMS and serve as the consistent picture for evaluating ADMSs at the EDC. Each of the EDCs are implementing solution components, integration, and functionality and are supporting data cleanup with different plans and timeframes in response to the Investment Area and their needs.

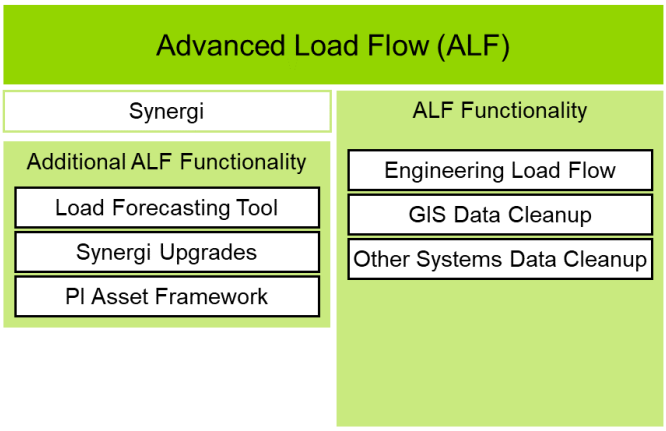
Figure 1. ADMS Evaluation Components and Functionality



Source: Guidehouse

The ALF context is shown in Figure 2. This diagram shows Synergi and a functionality stack related to the data cleanup component of ALF. The components and functionality shown in the figure are foundational to the industry status of ALF and serve as the consistent picture for evaluating ALF at Eversource. In PY2020, Eversource added three components to its ALF investment plan for PY2021: a load forecasting tool, Synergi upgrades, and a PI asset framework.

Figure 2. ALF Evaluation Components and Functionality



Source: Guidehouse

1.3 ADMS/ALF Evaluation Objectives

This evaluation focuses on the progress and effectiveness of the DPU preauthorized ADMS and ALF investments for each EDC toward meeting the DPU's grid modernization objectives.[17] Table 9 and Table 10 illustrate the key metrics on which the evaluation reports, including two Infrastructure Metrics and three Performance Metrics.

Table 9. ADMS Evaluation Metrics

Metric Type	ADMS Evaluation Metrics	ES	NG	UTL
IM	Deviation between actual and planned deployment for the plan year	✓	✓	
IM	Projected deployment for the remainder of the 4-year term	✓	✓	
PM	Increase in circuits and substations with DMS power flow and control capabilities	✓	✓	
PM	Control functions implemented by circuit and substation	✓	✓	
Other[18]	DMS implementation (planning, procurement, development, deployment, go-live)	✓	✓	✓
Other	Distribution SCADA (DSCADA) implementation or integration (planning, procurement, development, deployment, go-live)	✓	✓	✓
Other	OMS implementation or integration (planning, procurement, development, deployment, go-live)	✓	✓	✓
Other	Cleanup of geographic information system (GIS) data by circuit, substation, and region		✓	
Other	Cleanup of other data by circuit, substation, and region		✓	

IM = Infrastructure Metric, PM = Performance Metric, ES = Eversource, NG = National Grid, UTL = Unitil

[17] DPU Order, May 10, 2018, p.106.

[18] The "Other" metric type applies to metrics not specifically outlined by the DPU but that will be measured to understand all aspects of ADMS/ALF for a comprehensive evaluation. See Guidehouse Stage 3 Evaluation Plan filed December 1, 2020.

Source: Guidehouse Stage 3 Evaluation Plan filed December 1, 2020; Stamp Approved Performance Metrics, July 25, 2019

Table 10. ALF Evaluation Metrics

Metric Type	ALF Evaluation Metrics	ES	NG	UTL
IM	Deviation between actual and planned deployment for the plan year	✓		
IM	Projected deployment for the remainder of the 4-year term	✓		
PM	Advanced load flow – percent milestone completion	✓		
Other[19]	Data cleanup of GIS and other systems by circuit, substation, sub-region, and region	✓		
Other	Use of load flow tools for engineering (e.g., CYME, Synergi) by percentage of service territory	✓		
Other	Percentage of region and sub-region using automated scripting on a monthly basis	✓		
Other	Use of near-real-time system telemetry in load flow analysis	✓		
Other[20]	Percentage of DG interconnection requests that use advanced load flow investment	✓		
Other	Comparison of reduction in average DG interconnection request between ALF-enabled vs. non-ALF-enabled feeders	✓		

IM = Infrastructure Metric, PM = Performance Metric, ES = Eversource, NG = National Grid, UTL = Unitil

Source: Guidehouse Stage 3 Evaluation Plan filed December 1, 2020; Stamp Approved Performance Metrics, July 25, 2019

The EDCs provided the data supporting the Infrastructure Metrics to the evaluation team. The Performance Metrics are based on statistical analyses performed by the evaluation team using data provided by each EDC. The results from the analysis of Infrastructure Metrics and Performance Metrics are included in Sections 3.2 and 4.2, respectively.

The scope of the ADMS/ALF evaluation includes tracking the ADMS/ALF software implementation against plan, data cleanup progress, and cost. Table 11 presents the research questions associated with the ADMS/ALF evaluation objectives.

[19] The "Other" metric type applies to metrics not specifically outlined by the DPU but that will be measured to understand all aspects of ADMS/ALF for a comprehensive evaluation. See Guidehouse Stage 3 Evaluation Plan filed December 1, 2020

[20] This PM has been added as an evaluation metric to help better understand the investment's ability to meet one of the 3 DPU grid modernization objectives: "Interconnect and integrate distributed energy resources (DER);" However, it is not one of the DPU Stamped Approved Metrics. Eversource ALF was enabled in Q4 PY2020, DG Interconnection Queue Wait Time is a future PM.

Table 11. ADMS/ALF Evaluation Objectives and Associated Research Questions

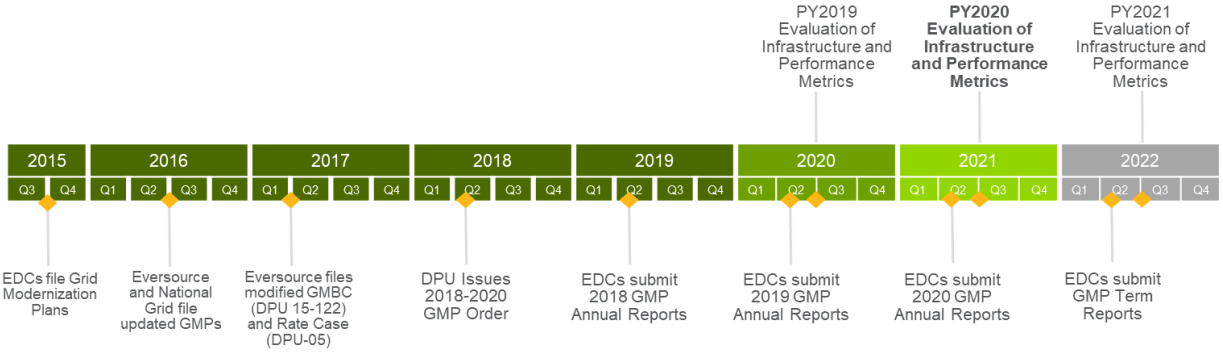
ADMS/ALF Evaluation Objective	Associated Research Questions
Software Implementation	• How do the ADMS and ALF investments align with optimizing system performance, optimizing system demand, and enabling interconnection and integration of DER? • What is each EDC's specific investment plan strategy for ADMS and ALF implementation (components and timeframes) during the preauthorized investment period, 2018-2021? • What does each EDC plan to leverage as a baseline ADMS and ALF application/component stack (GIS, PI Historian, DSCADA, OMS, Synergi, other systems, or other)? • What does each EDC plan to do related to ADMS functionality, including operational load flow, VVO, FLISR, and DERMS? • What does each EDC plan to do related to ALF functionality, including static analysis, semiautomated analysis, and fully automatic analysis? • What is the specific timing of ADMS implementation, integration with supporting systems, and data cleanup in GIS and other systems?
Data Cleanup	• What is the specific timing of ALF investment components including GIS data cleanup, other system data cleanup, and Synergi implementation?

Source: Guidehouse

2. ADMS/ALF Evaluation Process

This section summarizes Guidehouse's methodologies for evaluating Infrastructure Metrics and Performance Metrics, which were the focus of this PY2020 ADMS/ALF evaluation. ADMS/ALF data cleanup and planning are ongoing, and the use of ADMS/ALF functionality has begun. Figure 3 highlights the filing background and timeline of the GMP order and the evaluation process.

Figure 3. ADMS/ALF Evaluation Timeline



Source: Guidehouse review of the DPU orders and GMP process

2.1 Infrastructure Metrics Analysis

Guidehouse annually assesses the progress of each of the EDCs toward enabling ADMS/ALF on their feeders and substations. Table 12 highlights the Infrastructure Metrics that were evaluated. Although Infrastructure Metrics are the same across all Investment Areas, ADMS/ALF investments are not tracked by device. Instead, ADMS/ALF investments are tracked by technology or software implementation. Throughout this report, the term technology or software implementation is used instead of device deployment, which is more pertinent to some of the other Investment Areas.

Table 12. Infrastructure Metrics Overview

Infrastructure Metrics			Calculation
IM-4	Number of devices or other technologies deployed thru. PY2020	# Devices Deployed[21]	$\sum_{PY=2018}^{2020}(Devices\ Commissioned)_{PY}$
		% Devices Deployed	$\frac{\sum_{PY=2018}^{2020}(Devices\ Commissioned)_{PY}}{\sum_{PY=2018}^{2019}(Devices\ Commissioned)_{PY}+(Planned\ Devices)_{PY2020}}$
IM-5	Cost through PY2020	Total Spend, $M	$\sum_{PY=2018}^{2020}(Actual\ Spend)_{PY}$

[21] For ADMS/ALF, the IMs evaluate "technology implementation" rather than "devices deployed" in other Investment Areas.

		% Spend	$\frac{\sum_{PY=2018}^{2020}(Actual\ Spend)_{PY}}{\sum_{PY=2018}^{2019}(Actual\ Spend)_{PY} + (Planned\ Spend)_{PY2020}}$
IM-6	Deviation Between Actual and Planned Deployment for PY2020	% On Track (Devices)	$\frac{(Devices\ Commissioned)_{PY2020}}{(Planned\ Devices)_{PY2020}}$
		% On Track (Spend)	$\frac{(Actual\ Spend)_{PY2020}}{(Planned\ Spend)_{PY2020}}$
IM-7	Projected Deployment for 2021	# Devices Remaining	$(Devices\ Planned)_{PY2021}$
		Spend Remaining, $M	$(Planned\ Spend)_{PY2021}$

Source: Guidehouse

Section 3 provides the results from the evaluation of Infrastructure Metrics. To evaluate Infrastructure Metrics, Guidehouse:

- Reviewed the EDC data provided to ensure the information provided accurately reflected progress through PY2020 (see Section 3.1.2).
- Interviewed representatives from each EDC to understand the status of the ADMS/ALF investments, including:
    - Updates to their planned ADMS/ALF investments.
    - Reasons for deviation between actual and planned deployment and spend.

2.2 Performance Metrics Analysis

Performance Metrics were evaluated for each of the three EDCs. The EDCs have proposed to score and then count the number of substations with fully implemented and successful ADMS power flow analysis and the number of circuits with the specified control functions implemented. For ALF, Eversource proposed a metric designed to demonstrate progress toward the final completion of a fully automated modeling tool. Table 13 describes the Performance Metrics evaluated for PY2020.

Table 13. Performance Metrics Overview

PM	Performance Metrics	Description

PM-1	**Increase in Circuits and Substations with DMS Power Flow and Control Capabilities**	• Increase in circuits and substations with DMS power flow and control capabilities. • Primary Performance Metric to examine the deployment and data cleanup associated with ADMS deployment (situational awareness, basic power flow, switching, restoration capabilities). • The assumption is that data must be ready and fully clean prior to ADMS deployment, allowing converging power flow on specific circuits and substations. Counting and tracking the number of circuits and substations per year is the primary component of this Performance Metric.
PM-2	**Control Functions Implemented by Circuit and Substation**	• Control functions implemented by circuit and substation. • Secondary Performance Metric to examine implementation of advanced applications (e.g., automated capabilities, VVO, CVR, FLISR)
PM-3	**Advanced Load Flow – Percent Milestone Completion**	• Percent milestone completion of circuits with ALF capabilities. • Addresses Eversource narrowly and examines the fully developed ALF capability across its circuit population. This includes components of the hosting capacity maps that Eversource is now addressing.
Other	**DG Interconnection Queue Wait Time**	• Comparison of reduction in average DG interconnection queue wait time between ALF-enabled vs. non-ALF-enabled feeders.* Reduction in average timing of DG interconnection requests for all EDCs across Massachusetts. • Eversource ALF was enabled in Q4 PY2020, DG Interconnection Queue Wait Time is a future PM for when there is sufficient data to evaluate.

PM = Performance Metric

Note: Potential metrics in the future would be to assess the implementation and functionality of ADMS-based advanced applications such as ADMS-based VVO and ADMS-based FLISR.

*Depending on availability of appropriate data.

Source: Stamp Approved Performance Metrics, July 25, 2019

3. ADMS/ALF Infrastructure Metrics

Guidehouse presents findings from the Infrastructure Metrics analysis for ADMS/ALF in Section 3.2. Tables and figures highlight high level findings, with key findings presented thereafter.

3.1 Data Management

Guidehouse worked with the EDCs to collect data to complete the ADMS/ALF evaluation for the assessment of Infrastructure Metrics and Performance Metrics. The following sections highlight the evaluation team's data sources and data quality assurance/quality control (QA/QC) processes used to evaluate the Infrastructure Metrics.

3.1.1 Data Sources

Guidehouse used a consistent methodology (across Investment Areas and EDCs) to evaluate the data and illustrate EDC progress toward the GMP metrics. The data sources are summarized as follows.

3.1.1.1 2019 Grid Modernization Plan Annual Reports

Guidehouse used the planned device deployment and cost information from the EDCs' 2019 GMP Annual Reports, which were filed on April 1, 2020. Additionally, the team included Eversource's planned spending for PY2021 by Investment Area as filed in the *2021 Grid Modernization Program Extension and Funding Report*, which was approved by the DPU on February 4, 2021.[22] These filings served as the sources for planning data in this report and are referred collectively as the GMP plan for each EDC in summary tables and figures.

Table 14 provides a legend of the different planned and actual quantities reviewed and specifies the color/shade used to represent each in the remainder of the report.

Table 14. Deployment Categories Used for the EDC Plan

Representative Color	Data	Description
	2021 Plan	Projected 2021-unit deployment and spend
	2020 Plan	Projected 2020 unit deployment and spend
	2019 Actual	Actual reported unit deployment and spend in 2018
	2018 Actual	Actual reported unit deployment and spend in 2018

Source: 2021 Plan (Applicable to Eversource only) is sourced from the 2021 Grid Modernization Program Extension and Funding Report, filed July 1, 2020; other plan and actual data is sourced from the EDCs' 2019 GMP Annual Report Appendix 1 filed April 1, 2020

3.1.1.2 EDC PY2020 Device Deployment Data Template

Guidehouse collected device deployment data using standardized data collection templates (e.g., the All Device Deployment workbook file) for all EDCs in January-February 2021. The

[22] The plan filed did not provide data at the device type level, only at the aggregate Investment Area level. This data is only included in the GMP plan when the totals by Investment Area are presented.

data collected provides an update of planned and actual deployment, in dollars and device units, through the end of PY2020. Data from this source is referred to as EDC Data in summary tables and figures throughout the report. Table 15 summarizes the date of file version receipt used for the evaluation. The collected data was compared to the data submitted by the EDCs to the DPU in the 2020 Grid Modernization Plan Annual Reports and associated Appendix 1 filings.[23,24,25] The evaluation team confirmed the consistency of the data from the various sources and reconciled any differences.

Table 15. All Device Deployment Data File Versions for Analysis

EDC	File Version
Eversource	Received 2/18/2021
National Grid	Received 2/24/2021
Unitil	Received 1/21/2021

Source: Guidehouse

The EDC device deployment data (collected primarily in the All Device Deployment workbook) captured planned and actual device deployment and spend data. Actual device deployment and cumulative spend information was provided by work order ID and specified at the feeder- or substation-level, as appropriate.

The evaluation team also collected the current implementation stage of the work order (commissioned, in-service, construction, or design/engineering), the commissioned date (if applicable), and all cumulative costs associated with the work order. The EDCs provided planned device deployment information and estimated spend for PY2021 at the most granular level (circuit or substation) where available. Table 16 summarizes the categories used for the planned and actual deployment and spend from the EDC Data and specifies the color and pattern used in bar graphs to represent each in the remainder of the report.

[23] Massachusetts Electric Company and Nantucket Electric Company d/b/a National Grid, Grid Modernization Plan Annual Report 2020. Submitted to Massachusetts DPU on April 1, 2021 as part of DPU 21-30

[24] NSTAR Electric Company d/b/a Eversource Energy, Grid Modernization Plan Annual Report 2020. Submitted to Massachusetts DPU on April 1, 2021 as part of DPU 21-30

[25] Fitchburg Gas and Electric Light Company d/b/a Unitil, Grid Modernization Plan Annual Report 2020. Submitted to Massachusetts DPU on April 1, 2021 as part of DPU 21-30

Table 16. EDC Device Deployment Data

Representative Color	Data	Description
Spend Data		
	2021 Plan	Projected 2021 spend
	2020 Actual	Actual 2020 spend[26]
	2019 Actual	Actual 2019 spend[27]
	2018 Actual	Actual 2018 Spend

Source: Guidehouse analysis

Guidehouse also collected ADMS/ALF-specific data at the feeder-level using standardized data collection templates for all EDCs. This data source is also referred to as EDC Data in summary tables and figures throughout the report. Table 17 summarizes the file versions used for the evaluation.

Table 17. EDC ADMS/ALF-Specific Data Received for Analysis

Company	ADMS/ALF Supplemental Data Template
Eversource	Received 1/29/2020
National Grid	Received 1/26/2020
Unitil	Received 1/20/2020

Source: Guidehouse

3.1.2 Data QA/QC Process

Guidehouse reviewed all data provided for the Infrastructure Metrics and Performance Metrics analysis upon receipt. The following section details the data QA/QC processes adopted for the two analysis areas.

3.1.2.1 Infrastructure Metrics Data QA/QC

To ensure accuracy, Guidehouse conducted high level QA/QC of all deployment data received. This review involved following up with the EDCs for explanations regarding the following:

- Potential errors in how the forms were filled out (e.g., circuit information provided in the wrong field)
- Missing or incomplete information

[26] With the exception of GIS Survey, the 2020 actual costs shown in the tables and figures include only capital spending and do not include operations and maintenance (O&M) spending. This has been done to maintain consistency and comparability with the EDC's 2020 Annual GMP Filings (Appendix 1 required format). O&M spending information is included separately in Section 3.2.1. Because the GIS Survey investment represents a large portion of the total budget for ADMS/ALF, it is included in tables and figures to help provide an understanding of spending on this investment area, even though it is categorized as O&M spending..

[27] The 2019 and 2018 spending reported by the EDCs in the Annual Reports (and in the Appendix 1) included the associated O&M costs as well as Capital costs. With the exception of GIS Survey, the O&M costs are small relative to the capital costs for ADMS/ALF so were not removed from the analysis.

- Differences between the number of circuits ALF supported on in PY2020 and projected to be addressed in PY2021
- Deviation between 2019 GMP Annual Report (filed April 1, 2020) and actual deployment and spend

3.2 Deployment Progress and Findings

3.2.1 Statewide Comparison

This section discusses statewide ADMS/ALF investment progress through PY2020 and projected PY2021 progress.

Table 18 presents the Infrastructure Metric results through PY2020 for all EDCs. Additional detail surrounding findings for each Infrastructure Metric are provided in the other subsections. Although Infrastructure Metrics are the same across all Investment Areas, ADMS/ALF investments are not tracked by device. Instead, ADMS/ALF investments are tracked by technology or software implementation. Throughout this report, the term technology or software implementation is used instead of device deployment.

Table 18. ADMS/ALF Infrastructure Metrics Summary

Infrastructure Metrics			Eversource	National Grid	Unitil
GMP Plan Total, 2018-2020		Devices	N/A	N/A	N/A
		Spend, $M	$34.55*	$23.22	$0.40
EDC Data Total, 2018-2021		Devices	N/A	N/A	N/A
		Spend, $M	$28.97	$21.08	$0.60
IM-4	Number of Devices[28] or Other Technologies Deployed through PY2020	# Devices Deployed	N/A	N/A	N/A
		% Devices Deployed	N/A	N/A	N/A
IM-5	Cost for Deployment through PY2020	Total Spend, $M	$15.97	$11.89	$0.17
		% Spend	86%	51%	43%
IM-6	Deviation Between Actual and Planned Deployment for PY2020	% On Track (Devices)	N/A	N/A	N/A
		% On Track (Spend)	72%	48%	43%
IM-7	Projected Deployment for the Remainder of the GMP Term	# Devices Remaining	N/A	N/A	N/A
		Spend Remaining, $M	$13.00	$9.19	$0.43

IM = Infrastructure Metric
*Includes the Eversource planned spend for PY2021, set forth in the *GMP Extension and Funding Report*, filed on July 1, 2020 and approved on February 4, 2021.

[28] For ADMS/ALF, the IMs evaluate “technology implementation” rather than “devices deployed” in other Investment Areas.

Source: Guidehouse analysis of 2019 GMP Annual Reports and 2020 EDC Data

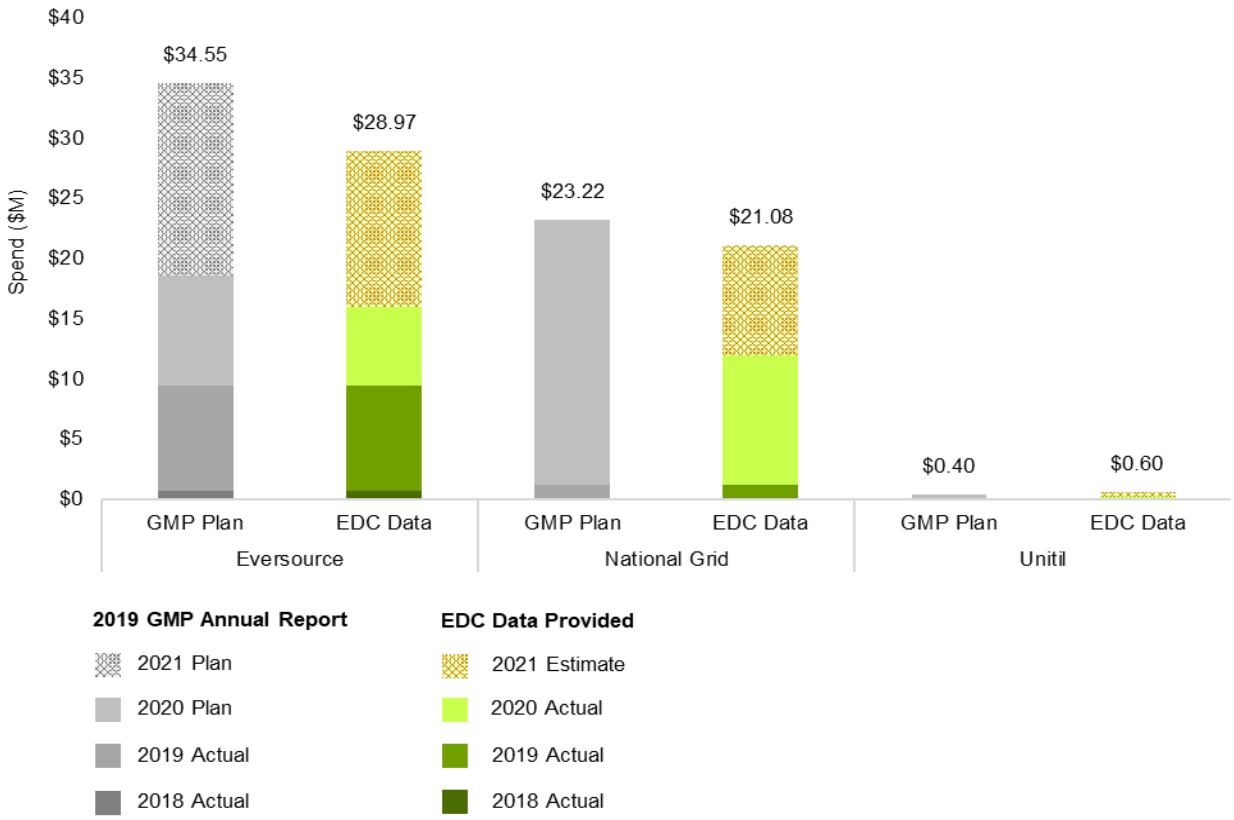
All three EDCs have operating territories that include Massachusetts and surrounding states. The ADMS/ALF programs include investments in Massachusetts as evaluated in this report.

Regions that contain feeders with planned ADMS/ALF investments include the following within the evaluation period:

- **Eversource:** All Massachusetts operating territory
- **National Grid:** All Massachusetts operating territory
- **Unitil:** Cities/towns of Fitchburg, Townsend, and Lunenburg

Figure 4 highlights planned versus actual spend in ADMS/ALF for each of the three EDCs. The EDC-specific results sections detail the differences between planned and actual spend.

Figure 4. ADMS/ALF Spend Comparison (2018-2021, $M)



Note: Includes the Eversource Planned spend for PY2021, set forth in the *GMP Extension and Funding Report*, filed on July 1, 2020 and approved on February 4, 2021.

Source: Guidehouse analysis of 2019 GMP Annual Reports and EDC Data

For Eversource and National Grid, O&M spending toward the GIS Survey[29] investment is included in the tables and figures. In addition to the PY2020 capital costs and GIS survey costs shown in Figure 4, Eversource incurred approximately $0.54 million toward Administration and Regulatory costs across the GMP investments in PY2020. National Grid incurred approximately $1.18 million in O&M costs toward the ADMS/ALF Investment Area in PY2020. National Grid incurred approximately $1.79 million toward Administration and Regulatory costs across the GMP investments in PY2020. Unitil incurred approximately $12,000 toward Administration and Regulatory costs across the GMP investments in PY2020.

3.2.1.1 Key Findings

Infrastructure Metric findings for PY2020 show that the EDCs are, for the most part, where they anticipated in their 2019 GMP Annual Reports.

- The Eversource ALF implementation completed in PY2020 cost less than planned. With the evaluation period extended to 2021, Eversource ADMS implementation is now included in the plan for PY2021.
- National Grid ADMS deployment milestones are on track, following a multistep data cleanup process to implement the ADMS monitor and inform phase within control center operations in 2021.
- Unitil is continuing its ADMS investment, with an accelerated schedule to use ADMS as the platform for the VVO investment.

3.2.2 Eversource

This section discusses Eversource's ADMS/ALF investment progress through PY2020 and its projected PY2021 progress as compared to the 2019 GMP Annual Report.

3.2.2.1 Overview of GMP Deployment Plan

Table 19 presents the GMP objectives that Eversource aims to achieve with its ADMS/ALF implementation.

[29] For Eversource, GIS Survey is also referred to as GIS Verification.

Table 19. Eversource ADMS/ALF GMP Objective Summary

Company	GMP Objective	Software Implementation
Eversource	Implement ALF and ADMS throughout the region to: • Increase visibility • Enhance the grid for DER customers • Increase DER hosting capacity	ADMS • Partial ADMS implementation planned for PY2021.
		ALF • Enhanced semiautomatic ALF completed by the end of 2020. • Deploy ALF on 2,242 circuits across 246 substations. • Software chosen is Synergi.
		Load Forecasting Tool[30] • Improve capability for long-term load forecasting. • Add new capability for long-term DER forecasting.
		Synergi Upgrades[31] • Evolution and refinement of the ALF tool capability to build upon what has been implemented. • Initial step in producing a precise hosting capacity value on the Massachusetts distribution network.
		PI Asset Framework[32] • Data analytics tool to provide insight into the impact of DER on system operations and establish a more uniform data model for historical data.

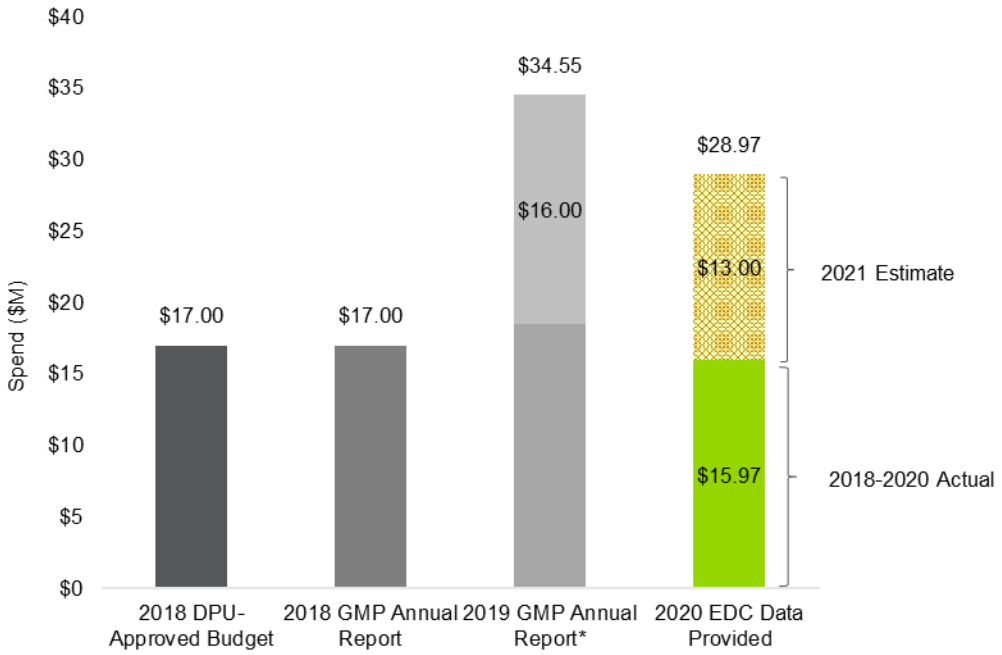
Source: Guidehouse analysis of 2019 GMP Annual Reports and EDC Data

3.2.2.2 ADMS/ALF Deployment Plan Progression

Figure 5 presents the total cost, planned and actual, for Eversource's ADMS/ALF investment over the GMP evaluation period. With the GMP evaluation period extension, Eversource's ADMS investment is now included in the expanded evaluation period, reflected in the figure below. Overall, Eversource has spent less in 2018-2020 than originally planned.

[30] New device investment added in 2021: load forecasting tool.
[31] New device investment added in 2021. Synergi upgrades.
[32] New device investment added in 2021. PI asset framework.

Figure 5. Eversource ADMS/ALF Planned and Actual Spend Progression, $M



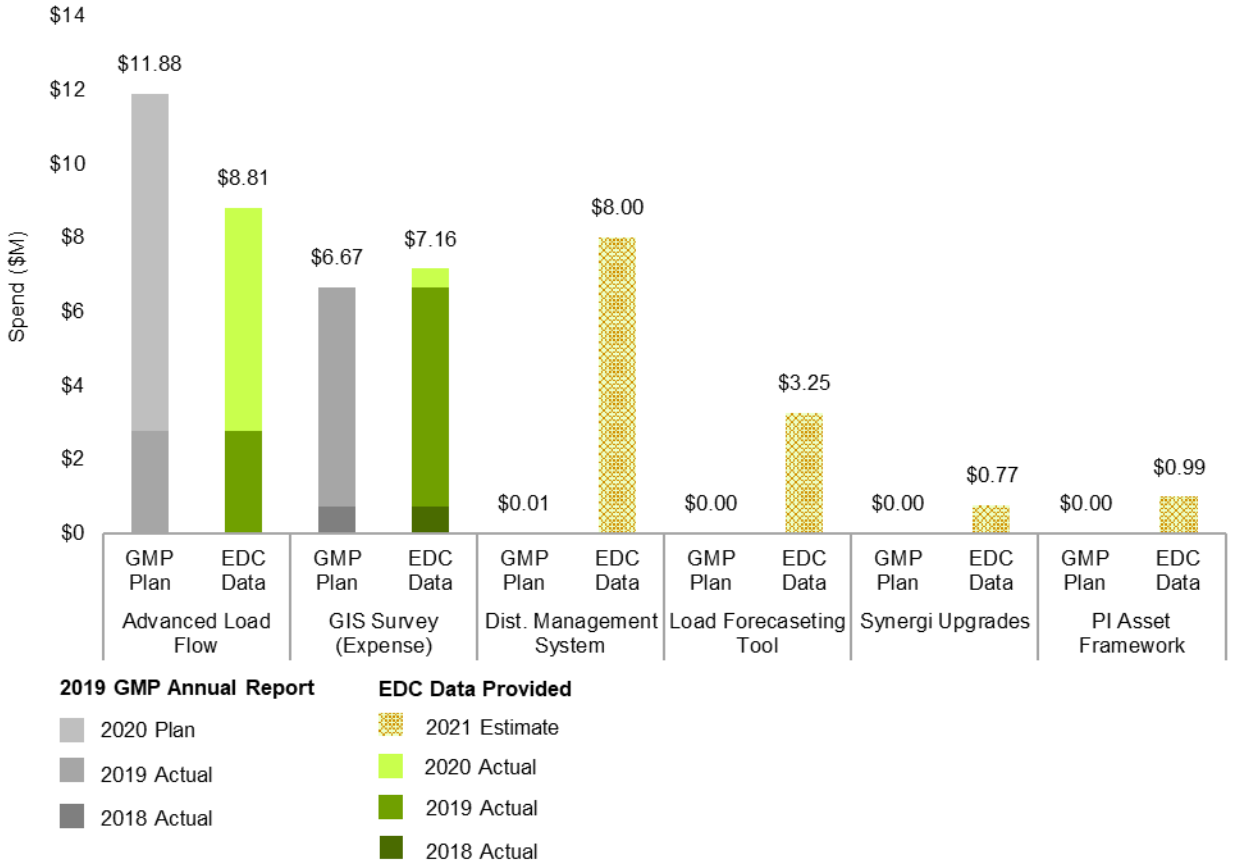
Notes: GIS survey is O&M spending, but is included in this figure as it makes up a significant portion of the total spending.
*Includes the Eversource plan for 2021, set forth in the *GMP Extension and Budget* filing on July 1, 2020.
Source: Guidehouse analysis of DPU Order (May 10, 2018), 2019 GMP Annual Reports, GMP Extension and Budget filing (July 1, 2020), and EDC Data

3.2.2.3 ADMS/ALF Progress through PY2020

Eversource's ADMS/ALF investment is on track with its revised plan.

Overall ALF implementation is on schedule and ADMS is planned for PY2021. Although GIS survey spending is categorized as O&M spending, it is included as part of the ADMS/ALF Investment Area for Eversource because it makes up a significant portion of the ADMS/ALF budget. Figure 6 summarizes the planned and actual technology implementation progress for Eversource's ADMS/ALF investment.

Figure 6. Eversource ADMS/ALF Spend Comparison (2018-2021, $M)



Notes: GIS survey is O&M spending, but is included in this figure as it makes up a significant portion of the total spending.
The Eversource plan for 2021, set forth in the *GMP Extension and Budget* filing on July 1, 2020, did not provide device or spend data at the device type level, only at the aggregate Investment Area level. The numbers shown in the figure reflect the 3-year plan.

Source: Guidehouse analysis of 2019 GMP Annual Reports and EDC Data

Table 20 presents the total planned and actual spend for Eversource's ALF/ADMS investment during the evaluation period.

Table 20. Eversource ADMS/ALF Plan and Actual Spend (2018-2021, $M)

	Advanced Load Flow	GIS Survey (Expense)	Dist. Management System	Load Forecasting Tool	Synergi Upgrades	PI Asset Framework
2018-2021 Total	**$8.81**	**$7.16**	**$8.00**	**$3.25**	**$0.77**	**$0.99**
PY2021 Estimate	$0.00	$0.00	$8.00	$3.25	$0.77	$0.99
PY2020 Actual	$6.03	$0.49	$0.00	$0.00	$0.00	$0.00
PY2019 Actual	$2.78	$5.96	$0.00	$0.00	$0.00	$0.00
PY2018 Actual	$0.00	$0.71	$0.00	$0.00	$0.00	$0.00

Source: Guidehouse analysis EDC Data

3.2.2.4 Infrastructure Metrics Results and Key Findings

Table 21 presents the Infrastructure Metrics results through PY2020 for Eversource.

Table 21. Eversource ADMS/ALF: Infrastructure Metrics Summary

Infrastructure Metrics			Advanced Load Flow	GIS Survey (Expense)	Dist. Management System	Load Forecasting Tool	Synergi Upgrades	PI Asset Framework
GMP Plan Total, 2018-2020*		Devices	N/A	N/A	N/A	N/A	N/A	N/A
		Spend, $M	$11.88	$6.67	$0.01	-	-	-
EDC Data Total, 2018-2021		Devices	N/A	N/A	N/A	N/A	N/A	N/A
		Spend, $M	$8.81	$7.16	$8.00	$3.25	$0.77	$0.99
IM-4	Number of Devices or Other Technologies Deployed through PY2020	# Devices Deployed	N/A	N/A	N/A	N/A	N/A	N/A
		% Devices Deployed	N/A	N/A	N/A	N/A	N/A	N/A
IM-5	Cost for Deployment through PY2020	Total Spend, $M	$8.81	$7.16	-	-	-	-
		% Spend	74%	107%	-	N/A	N/A	N/A
IM-6	Deviation Between Actual and Planned Deployment for PY2020	% On Track (Devices)	N/A	N/A	N/A	N/A	N/A	N/A
		% On Track (Spend)	66%	N/A	-	N/A	N/A	N/A

Infrastructure Metrics			Advanced Load Flow	GIS Survey (Expense)	Dist. Management System	Load Forecasting Tool	Synergi Upgrades	PI Asset Framework
IM-7	Projected Deployment for the Remainder of the GMP Term	# Devices Remaining	N/A	N/A	N/A	N/A	N/A	N/A
		Spend Remaining, $M	-	-	$8.00	$3.25	$0.77	$0.99

IM = Infrastructure Metric

*The Eversource Plan for 2021, set forth in the *GMP Extension and Budget* filing on July 1, 2020, did not provide device or spend data at the device type level, only at the aggregate Investment Area level. The numbers shown here reflect the 3-year plan.

Source: Guidehouse analysis of 2019 GMP Annual Reports and 2020 EDC Data

Guidehouse's review of Eversource's ADMS/ALF progress confirmed that Eversource is in line with where it expected to be in its 2019 GMP Annual Report and is under budget, which allowed unspent funds to be reallocated to other GMP investments. Key findings related to Eversource's progress include the following:

- Implementation plan for ALF was completed on target for enhanced semiautomatic ALF by the end of PY2020.
- Internal tracking of ALF progress broken out by western and eastern Massachusetts as ALF models are built by region—not broken out by circuit or substation—resulting in difficulty in tying ALF progress to specific substation and circuits.
- Limited ADMS implementation was planned for 2018-2020. With the GMP evaluation period extension to 2021, $8 million of planned ADMS investment is now included in the evaluation.
- Total spend to-date is less than planned for ALF.
- Total spend overall is less than planned for ALF.
- ALF is complete and in-service.
- Additional software implementation, a load forecasting tool, Synergi upgrades, and a PI asset framework were added to this Investment Area plan to better support operation of the ALF investment moving forward. These software are initiatives planned for PY 2021.

3.2.3 National Grid

This section discusses National Grid's ADMS investment progress through PY2020 and projected PY2021 progress as compared to the 2019 GMP Annual Report.

3.2.3.1 Overview of GMP Deployment Plan

Table 22 presents the GMP objectives that National Grid aims to achieve with its ADMS implementation. In 2020, the ADMS investment moved forward with a three-phase approach, beginning with Phase 1, monitor and inform, and entering Phase 2, manage and control, by the end of 2020.

Table 22. National Grid Summary

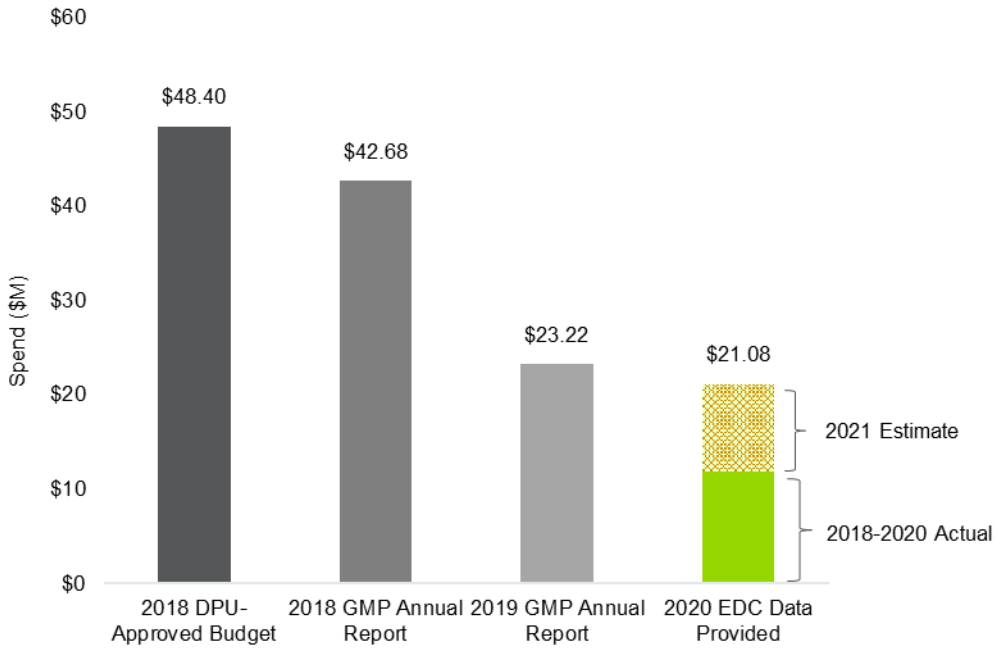
Company	GMP Objective	Software Implementation
National Grid	Using ADMS to optimize: • Performance • Demand • DER integration ADMS also helps reach the overall reliability and customer experience objectives.	ADMS • 196 circuits planned across 46 substations • Three-phase implementation approach: – Monitor and inform – Manage and control – Implement DERMS

Source: Guidehouse analysis of 2019 GMP Annual Reports and EDC Data

3.2.3.2 ADMS Deployment Plan Progression

Figure 7 presents the total cost, planned and actual, for National Grid's ADMS investment over the GMP evaluation period. National Grid has spent less on their ADMS investment than originally planned.

Figure 7. National Grid ADMS Planned and Actual Spend Progression, $M



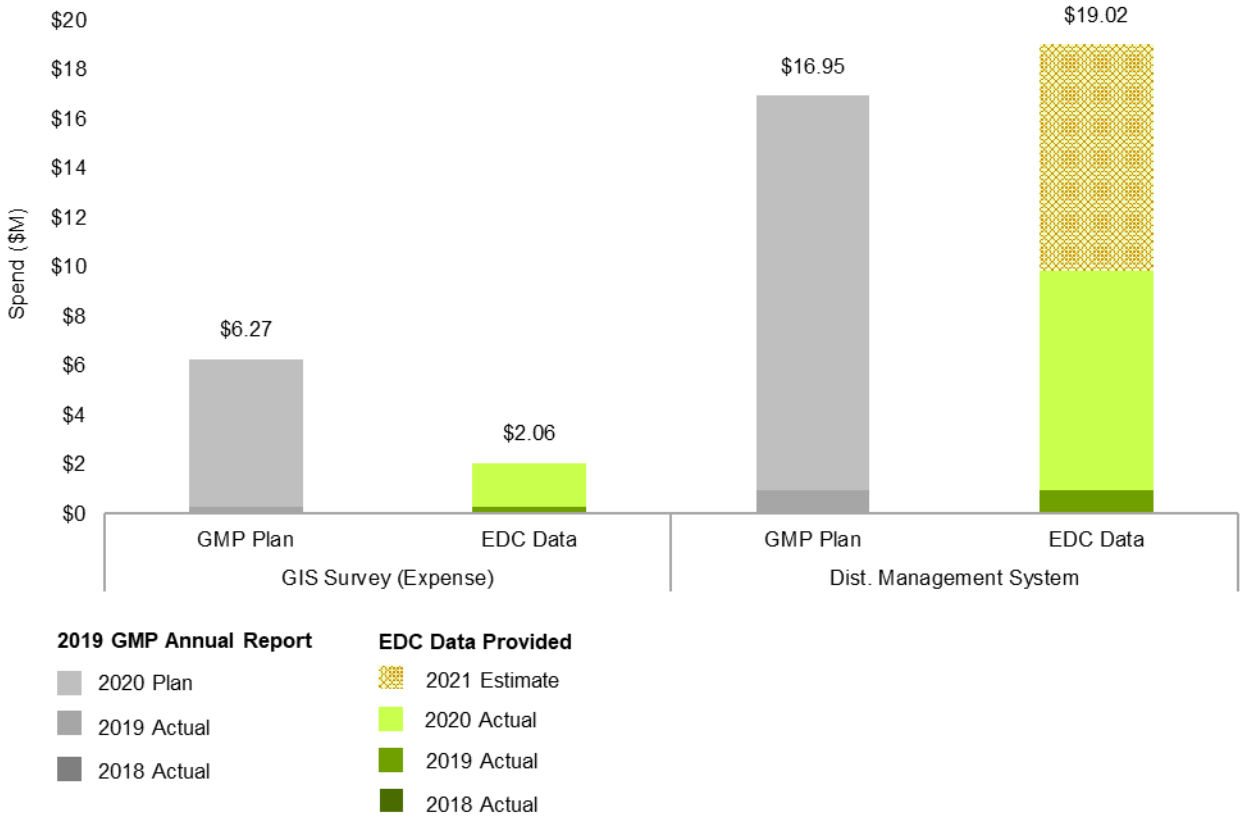
Notes: GIS survey is O&M spending, but is included in this figure as it makes up a significant portion of the total spending.

Source: Guidehouse analysis of DPU Order (May 10, 2018), 2019 GMP Annual Reports, GMP Extension and Budget filing (July 1, 2020), and EDC Data

3.2.3.3 ADMS Progress through PY2020

Figure 8 summarizes the total spend for National Grid's ADMS investment over the 3-year evaluation period. ADMS spending is estimated to be less than planned.

Figure 8. National Grid ADMS Spend Comparison (2018-2021, $M)



Notes: GIS survey is O&M spending, but is included in this figure as it makes up a significant portion of the total spending.

Source: Guidehouse analysis of 2019 GMP Annual Reports and EDC Data

Table 23 presents the total planned and actual spend for National Grid's ADMS investment during the evaluation period.

Table 23. National Grid ADMS Plan and Actual Spend (2018-2021, $M)

	GIS Survey (Expense)	Dist. Management System
2018-2021 Total	**$2.06**	**$19.02**
PY2021 Estimate	$0.00	$9.19
PY2020 Actual	$1.79	$8.88
PY2019 Actual	$0.27	$0.95
PY2018 Actual	$0.00	$0.00

Source: Guidehouse analysis EDC Data

National Grid follows a multistep process for ADMS data cleanup. This process is designed to align with go-live activities within ADMS and is commonly used in the industry for ADMS implementation. The data cleanup can only be taken so far prior to specific circuits progressing to go-live status in ADMS, and this process reflects practical realities of ADMS implementation. Process steps consist of the following:

- No data prep for circuits
- Circuit retirement/renaming
- Initial data prep for circuits for base ADMS
- Final data prep for circuits for base ADMS
- Go-live of ADMS with circuits
- Additional circuit cleanup (post go-live)

3.2.3.4 Infrastructure Metrics Results and Key Findings

Table 24 presents the Infrastructure Metrics results through PY2020 for National Grid.

Table 24. National Grid ADMS: Infrastructure Metrics Summary

Infrastructure Metrics			GIS Survey (Expense)	Dist. Management System
GMP Plan Total, 2018-2020		Devices	N/A	N/A
		Spend, $M	$6.27	$16.95
EDC Data Total, 2018-2021		Devices	N/A	N/A
		Spend, $M	$2.06	$19.02
IM-4	Number of Devices or Other Technologies Deployed through PY2020	# Devices Deployed	N/A	N/A
		% Devices Deployed	N/A	N/A
IM-5	Cost for Deployment through PY2020	Total Spend, $M	$2.06	$9.83
		% Spend	33%	58%
IM-6	Deviation Between Actual and Planned Deployment for PY2020	% On Track (Devices)	N/A	N/A
		% On Track (Spend)	30%	56%
IM-7	Projected Deployment for the Remainder of the GMP Term	# Devices Remaining	N/A	N/A
		Spend Remaining, $M	-	$9.19

IM = Infrastructure Metric

Source: Guidehouse analysis of 2019 GMP Annual Reports and 2020 EDC Data

Guidehouse's review of National Grid's ADMS progress confirmed that National Grid has moved forward with the ADMS investment in PY2020 but spent less than its original plan. Key findings related to its progress include the following:

- Internal tracking of ADMS progress is comprehensive, and it is treated as a large software project.
- National Grid has 196 circuits identified for initial deployment.
- ADMS deployment milestones are on track—plan is to have the ADMS platform, specifically the "monitor and inform phase" components, within control center operations by May 2021.
- GIS data cleanup is progressing as planned.

- National Grid is following a multistep process for data cleanup by feeder. Preliminary data prep is largely complete, with additional work planned for 2021.

3.2.4 Unitil

This section discusses Unitil's ADMS investment progress through PY2020 and projected PY2021 progress compared to the 2019 GMP Annual Report.

3.2.4.1 Overview of GMP Deployment Plan

Table 25 presents the GMP objectives that Unitil aims to achieve with its ADMS implementation.

Table 25. Unitil Summary

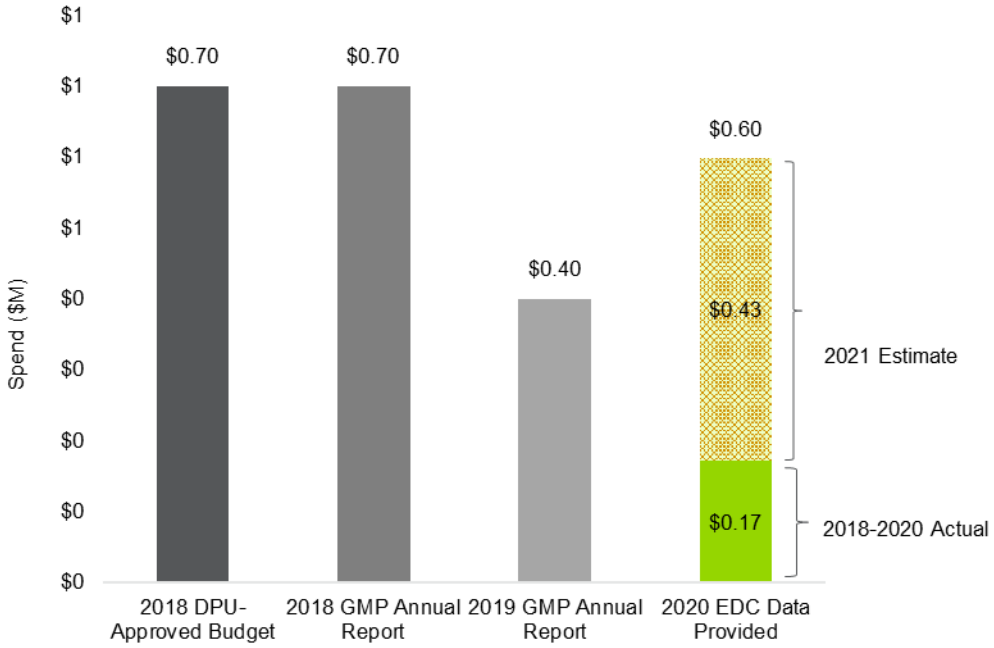
Company	GMP Objective	Software Implementation
Unitil	• Improve reliability • Use current SCADA system more effectively • Use ADMS as the platform for VVO, providing the most customer savings • *Future application*: DERMS, increasing M&C of DER on the system	ADMS • Accelerating the ADMS project to go hand in hand with other investments – Original plan was to have no ADMS spending in first 3 years – As VVO investment developed, ADMS was chosen as platform for VVO • Actual spending on ADMS was under budget in PY2020 – $400,000 planned spending from 2019 GMP Annual Report changed to $170,000 actual spend.

Source: Guidehouse analysis of 2019 GMP Annual Reports and EDC Data

3.2.4.2 ADMS Deployment Plan Progression

Figure 9 presents the total cost, planned and actual, for Unitil's ADMS investment over the GMP evaluation period. Unitil accelerated ADMS to support VVO, and the ADMS project is overall under budget based on the original plan. With the evaluation period extension, they have planned to spend a total of $0.6M by end of 2021.

Figure 9. Unitil ADMS Planned and Actual Spend Progression, $M

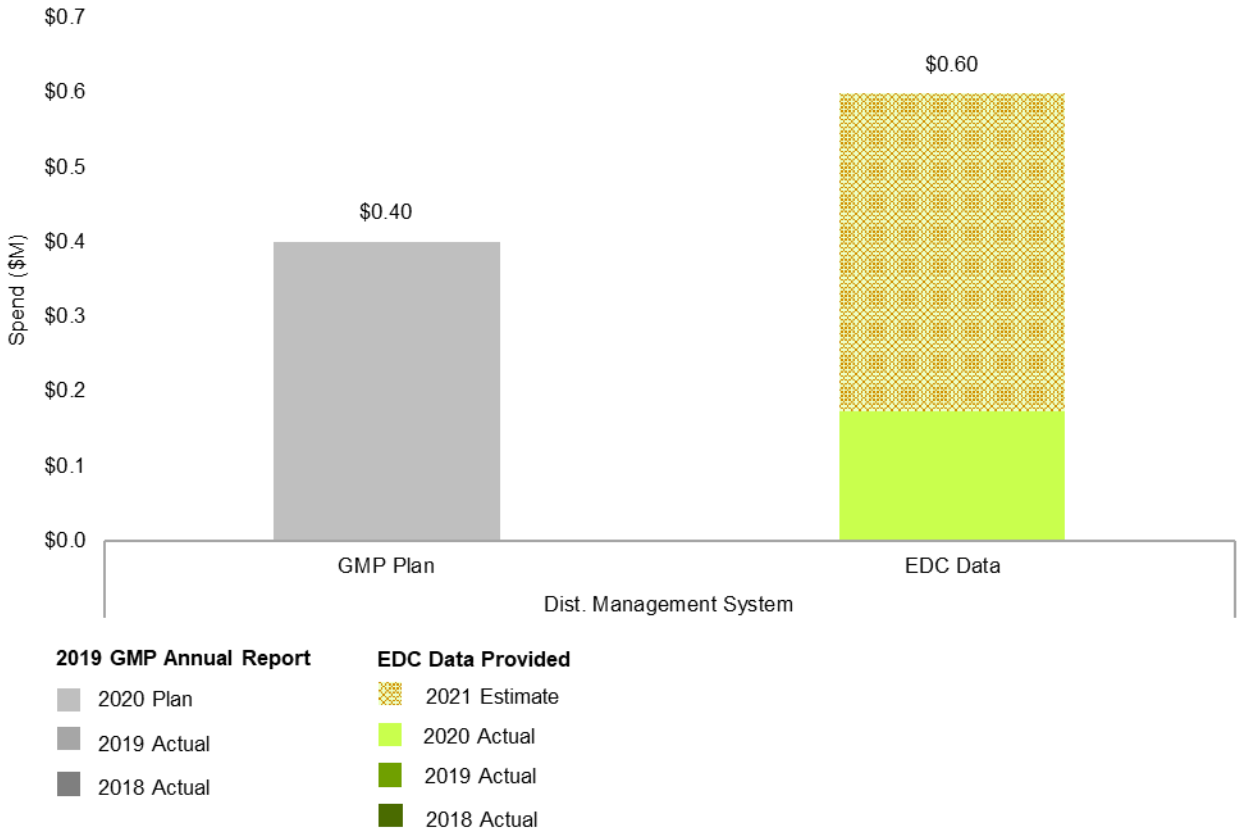


Source: Guidehouse analysis of DPU Order (May 10, 2018), 2019 GMP Annual Reports, GMP Extension and Budget filing (July 1, 2020), and EDC Data

3.2.4.3 ADMS Progress through PY2020

Figure 10 summarizes the planned and actual spend for Unitil's ADMS investment.

Figure 10. Unitil ADMS Spend Comparison (2018-2021, $M)



Source: Guidehouse analysis of 2019 GMP Annual Reports and EDC Data

Table 26 presents the total planned and actual spend for Unitil's ADMS investment during the evaluation period.

Table 26. Unitil ADMS Plan and Actual Spend (2018-2021, $M)

	Dist. Management System
2018-2021 Total	**$0.60**
PY2021 Estimate	$0.43
PY2020 Actual	$0.17
PY2019 Actual	$0.00
PY2018 Actual	$0.00

Source: Guidehouse analysis of 2019 GMP Annual Reports and EDC Data

3.2.4.4 Infrastructure Metrics Results and Key Findings

Table 27 presents the Infrastructure Metrics results through PY2020 for Unitil.

Table 27. Unitil ADMS: Infrastructure Metrics Summary

Infrastructure Metrics			Dist. Management System
GMP Plan Total, 2018-2020		Devices	N/A
		Spend, $M	$0.40
EDC Data Total, 2018-2021		Devices	N/A
		Spend, $M	$0.60
IM-4	Number of Devices or Other Technologies Deployed through PY2020	# Devices Deployed	N/A
		% Devices Deployed	N/A
IM-5	Cost for Deployment through PY2020	Total Spend, $M	$0.17
		% Spend	43%
IM-6	Deviation Between Actual and Planned Deployment for PY2020	% On Track (Devices)	N/A
		% On Track (Spend)	43%
IM-7	Projected Deployment for the Remainder of the GMP Term	# Devices Remaining	N/A
		Spend Remaining, $M	$0.43

IM = Infrastructure Metric

Source: Guidehouse analysis of 2019 GMP Annual Reports and 2020 EDC Data

Guidehouse's review of Unitil's ADMS progress confirmed that Unitil is ahead of its 2019 GMP Annual Report, given the updates to the evaluation period extension (i.e., inclusion of 2021 in the estimate). Key findings related to Unitil's progress include the following:

- Internal tracking of ADMS progress is comprehensive.
- Deployment is on track, with the schedule realigned to use ADMS as a platform for VVO, another Investment Area.
- Total ADMS spend is less than originally planned for the 2018-2020 evaluation period. Additional ADMS investment is planned in 2021 with the evaluation period extension.
- ADMS deployment is on an expedited schedule to enable VVO (using ADMS as the control system for VVO).
- Unitil has completed the upgrade to the GIS-ADMS integration engine.
- The first full ADMS test environment is active, and Unitil is in the process of building the production environment. Unitil identified and overcame challenges with network design, security, and meter data.

4. ADMS Performance Metrics

Guidehouse presents findings from the Performance Metric analysis for ADMS/ALF in Sections 4.2.1 and 4.2.4. Tables and figures highlight high level findings, with key findings presented thereafter.

4.1 Data Management

Guidehouse worked with the EDCs to collect data to complete the ADMS/ALF evaluation for the assessment of Infrastructure Metrics and Performance Metrics. The following sections highlight Guidehouse's data sources and data QA/QC processes to evaluate the Performance Metrics.

4.1.1 Data Sources

Guidehouse used a consistent methodology (across Investment Areas and EDCs) to evaluate the data and illustrate EDC progress toward the GMP metrics. The data sources used for the Performance Metrics are summarized as follows.

4.1.1.1 EDC PY2020 Device Deployment Data Template

Guidehouse collected ADMS/ALF-specific data at the feeder-level using standardized data collection templates for all EDCs. This data source is referred to as EDC Data in summary tables and figures throughout the report. Table 28 summarizes the file versions used for the evaluation.

Table 28. EDC ADMS/ALF-Specific Data Received for Analysis

Company	ADMS/ALF Supplemental Data Template
Eversource	Received 1/29/2020
National Grid	Received 1/26/2020
Unitil	Received 1/20/2020

Source: Guidehouse

4.1.1.2 DG Interconnection Data

This future prospective PM[33] is the comparison of reduction in average DG interconnection queue wait time between ALF-enabled vs. non-ALF-enabled feeders. The PM will evaluate reduction in average timing of DG interconnection requests for all EDCs across Massachusetts.

There is work in progress to capture, analyze, and process data for this future PM that is not required by the DPU, but evaluates progression on DER adoption. Eversource ALF was enabled in Q4 PY2020, DG Interconnection Queue Wait Time is a future PM for when there is sufficient data to evaluate.

[33] *This Performance Metric was added as an evaluation metric to help better understand the investment's ability to meet one of the three DPU grid modernization objectives: "Interconnect and integrate distributed energy resources (DER)." However, it is not one of the DPU Stamped Approved Metrics. Eversource ALF was enabled in Q4 PY2020, DG Interconnection Queue Wait Time is a future PM.

Guidehouse will use a public data set of DG interconnection queue information, and it is important to ensure that the relevant data points related to ADMS/ALF are being tracked properly by each EDC.[34] In the current public data set, there are gaps that will make establishing a baseline difficult once the EDCs do begin to see mature performance on ADMS/ALF.

4.1.2 Data QA/QC Process

To ensure accuracy, Guidehouse conducted high level QA/QC of all Performance Metric data received to confirm each of the required data inputs could be incorporated in the Performance Metrics analysis. This review involved following up with the EDCs for explanations regarding the following:

- Potential errors in how the forms were filled out (e.g., circuit information provided in the wrong field)
- Missing or incomplete information

4.2 Performance Metrics Analysis and Findings

4.2.1 Statewide Comparison

This section discusses statewide ADMS/ALF investment progress through PY2020 and projected PY2021 progress. Table 29 presents the progress of the three Performance Metrics across the state's three EDCs.

Table 29. ADMS/ALF Performance Metrics Progress

Performance Metrics		Eversource*		National Grid†		Unitil	
		Circuits	Substations	Circuits	Substations	Circuits	Substations
PM-1	Increase in Circuits and Substations with DMS Power Flow and Control Capabilities	-	-	-	-	411	1
PM-2	Control Functions Implemented by Circuit and Substation	-	-	-	-	411	1
PM-3	ALF – Percent of Milestone Completion	100%	100%	N/A	N/A	N/A	N/A
Other	DG Interconnection Queue Wait Time	N/A	N/A	N/A	N/A	N/A	N/A

PM = Performance Metric, N/A = Not Applicable (i.e., not sufficient data yet for evaluation)

[34] MassDGIC: Interconnection in Massachusetts, https://sites.google.com/site/massdgic/home/interconnection.

*Eversource ADMS implementation begins in PY2021. Eversource ALF was enabled in Q4 PY2020, DG Interconnection Queue Wait Time is a future PM for when there is sufficient data to evaluate.
† National Grid ADMS deployment is planned for 2021; work to-date has been preliminary data cleanup and is not shown here.
Source: EDC data

Eversource has implemented enhanced semiautomatic ALF analysis on all planned circuits. ADMS is planned for PY2021. Eversource ALF was enabled in Q4 PY2020, DG Interconnection Queue Wait Time is a future prospective PM[35] for when there is sufficient data to evaluate

National Grid ADMS deployment is planned for 2021; work to-date has been preliminary data cleanup and is not shown here.

Unitil has implemented VVO control function via ADMS on planned circuits at the Townsend substation.

4.2.2 Eversource

For Eversource, PM-1 (increase in circuits and substations with DMS power flow and control capabilities) is 0 for circuits and substations because its ADMS implementation is planned for PY2021. In addition, PM-2 (control functions implemented by circuit and substation) is 0 and 0.

Eversource has implemented enhanced semi-automatic ALF analysis on all planned circuits; this is reflected in PM-3 with 100% complete on all planned circuits and substations. The ALF implementation plan was completed on target for enabling basic semi-automatic and enhanced semi-automatic ALF in PY2020. Eversource placed the ALF project in-service once the enhanced semi-automatic level was considered enabled.

Eversource ALF was enabled in Q4 PY2020, DG Interconnection Queue Wait Time is a future PM for when there is sufficient data to evaluate.

4.2.3 National Grid

National Grid ADMS deployment of the monitor and inform phase is planned for 2021; work to-date has been preliminary data cleanup and is not shown in Table 29. PM-1 (increase in circuits and substations with DMS power flow and control capabilities) is 0 for circuits and substations for National Grid because its ADMS implementation has not yet started. In addition, PM-2 (control functions implemented by circuit and substation) is 0 and 0.

National Grid does not have an ALF investment, so PM-3 is N/A.

4.2.4 Unitil

Unitil has implemented VVO control function via ADMS on planned circuits at the Townsend substation, which aligns with its acceleration of ADMS to support the VVO Investment Area. PM-1 (increase in circuits and substations with DMS power flow and control capabilities) is 411

[35] *This Performance Metric was added as an evaluation metric to help better understand the investment's ability to meet one of the three DPU grid modernization objectives: "Interconnect and integrate distributed energy resources (DER)." However, it is not one of the DPU Stamped Approved Metrics. Eversource ALF was enabled in Q4 PY2020, DG Interconnection Queue Wait Time is a future PM.

and 1 for circuits and substations, reflecting the circuits associated with the Townsend substation. In addition, PM-2 (control functions implemented by circuit and substation) is 411 and 1 to reflect the VVO advanced application implemented within the ADMS.

Unitil does not have an ALF investment, so PM-3 is N/A.

For additional details on Unitil's VVO progress, see the Guidehouse PY2020 VVO Evaluation Report.

5. Conclusions and Recommendations

Throughout the PY2019 to PY2020 period, Guidehouse worked with the EDCs on the evaluation process. Guidehouse's conclusions and recommendations are listed as follows.

Conclusions:

- Moving circuits from cleaned to operational takes more steps than the EDCs thought. They have to clean the data multiple times before they can put the data in operation. Once the data is initially cleaned, it is ready for a final cleaning.
    - The process of implementation of ADMS depends heavily upon the input data. Multiple steps of cleaning, augmenting, and testing are required prior to enabling the ADMS to go into production with the circuit model.
    - For example, Unitil is using a multi-step process to clean, augment, and test the input GIS (and other system data) prior to creating the circuit model in ADMS and testing that load flow converges.
    - If there are data problems that prevent clear visibility, switching support, and inability for load flow to converge then system operations will have low confidence in the system, slowing or preventing adoption of the technology.
    - Taking a measured and deliberate approach to cleaning data is prudent to support long-term adoption and usage of ADMS.
- EDCs had flexibility in budgeting ADMS/ALF and supporting tasks and moved money from one task to another as needed. This approach is working but has introduced variance to the plan. The variance to plan is not material to the progress the EDC made in its ADMS/ALF deployment (i.e., the ADMS/ALF deployment was initially over-budgeted).
- Performance Metrics preliminarily indicate that the EDCs are working towards supporting the DPU's primary objectives of optimizing system performance, demand, and interconnection of DER. However, the EDCs still have work to do before seeing mature ADMS/ALF performance on circuits and substations.

Recommendations:

- Continue progressing circuits into go-live status (i.e., full operation) within ADMS/ALF to confirm complete understanding of the challenges, barriers, and costs associated with fully operationalizing ADMS/ALF. Guidehouse found that as each EDC gets closer to operationalization of the ADMS/ALF, more challenges and unknowns appear. Getting visibility into these early can help ensure that EDC plans remain on track.
- As the EDCs see more mature ADMS/ALF performance on circuits and substations, it will be important to have full clarity on data that supports enhanced system performance. For Eversource, this means ensuring clarity on where ALF optimizes the DG

interconnection queue process, and being able to show that within the publicly available data[36].

- The EDCs should work to explicitly track how this process is helping better achieve DER integration (e.g., lower costs or faster queue times).
    - For ALF Eversource, Guidehouse recommends to:
        - Expand the ALF development to include an external website where DER developers can log in and determine location and size of interconnections that are possible (similar to what is being done in Eversource Connecticut).
        - Track as a metric, how many individuals are accessing the website for feeder information.
        - Perform a survey both internal to the company (Eversource) and external DER developers on the effectiveness and recommended changes to the ALF.
    - For ADMS Eversource, Guidehouse recommends to:
        - Conduct extensive pilot testing of the ADMS software prior to any cut-over or go live.
        - Conduct a survey of other users (Utilities) that have cut over to an ADMS for lessons learned.

[36] MassDGIC: Interconnection in Massachusetts, https://sites.google.com/site/massdgic/home/interconnection.