Massachusetts Grid Modernization Program Year 2022 Evaluation Report: Communications

Massachusetts Electric Distribution Companies

Submitted by:

Guidehouse Inc.
77 South Bedford Street, Suite 400
Burlington, MA 01803
Telephone (781) 270-8300
Guidehouse.com

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Executive Summary

Introduction

As a part of the Grid Modernization Plan (GMP), the Massachusetts Electric Distribution Companies (EDCs) are investing in communications infrastructure to enable and support the grid modernization investments.

This evaluation focuses on the progress and effectiveness of each EDC's preauthorized Communications investments toward meeting the Department of Public Utilities (DPU) grid modernization objectives for Program Year (PY) 2022.

Evaluation Process

The DPU requires a formal evaluation process, including an evaluation plan and evaluation studies, for the EDCs' preauthorized grid modernization plan investments. Guidehouse is completing the evaluation to establish a uniform statewide approach and to facilitate coordination and comparability. The evaluation is to measure and assess progress toward achieving the DPU's grid modernization objectives. The evaluation uses the DPU-established Infrastructure Metrics and Performance Metrics along with a set of Case Studies to understand if the GMP investments are meeting the DPU's objectives.

The original Evaluation Plan developed by Guidehouse[1] was submitted to the DPU by the EDCs in a petition for approval on May 1, 2019. Modifications to this original Evaluation Plan were required to enable evaluation of PY 2022. These modifications included an 1) extension of the evaluation window from the four year term spanning 2018 – 2021[2] (hereon referred to as Term 1) to incorporate the new four year term spanning 2022 – 2025 (hereon referred to as Term 2), and 2) revisions required to reflect the new Term 2 investment activity. Modifications to the original Evaluation Plan were submitted to the EDCs for approval on March 1, 2023. The modified Evaluation Plan has been used to develop the analysis and evaluation provided below in this document.

Table 1 illustrates the key Infrastructure Metrics relevant for the Communications evaluation by EDC.

[1] Guidehouse had previously filed as "Navigant Consulting" and did so during the initial evaluation plan filing.

[2] On May 10, 2018, the Massachusetts DPU issued its Order regarding the individual GMPs filed by the three Massachusetts EDCs. 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 extending the 3-year grid modernization plan investment term to a 4-year term, which introduced a 2021 program year. In addition, on July 1, 2020, Eversource filed a request for an extension of the budget authorization associated with grid modernization investments. The 2018-2021 GMP term results provided for Eversource reflect these changes.

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Table 1. Communications Evaluation Metrics

Metric Type	Communications Evaluation Metrics	ES	NG	UTL
IM-4	Number of devices or other technologies deployed	✓	✓	✓
IM-5	Cost for deployment	✓	✓	✓
IM-6	Deviation between actual and planned deployment for the plan year	✓	✓	✓
IM-7	Projected deployment for the remainder of the GMP term	✓	✓	✓

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

Source: Stamp Approved Performance Metrics, July 25, 2019

Data Management

Guidehouse worked with the EDCs to collect data to complete the M&C evaluation for the assessment of Infrastructure Metrics, Performance Metrics and Case Studies. A consistent methodology was used across Investment Areas and EDCs for evaluating and illustrating EDC progress toward the GMP metrics.

Table 2 summarizes data sources used throughout the Communications evaluation for PY 2022. Section 3.1.1 details each of the data sources.

Table 2. Communications Data Sources

Data Source	Description
2021 Grid Modernization Plan Term Report[3,4,5]	Planned device deployment and cost information from each EDC's appendix to the *2021 GMP Term Report* (filed April 1, 2022). 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.
2022 Grid Modernization Plan Annual Report[6,7,8]	All PM-related data are from these 2022 GMP Annual Report Appendices. In addition, data collected as part of EDC Data Template (below) was compared to the data submitted by the EDCs to the DPU in the 2021 Grid Modernization Plan Term Reports and associated Appendix 1 filings. The evaluation team confirmed the consistency of the data from the various sources and reconciled any differences

[3] 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.
[4] 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. Note that Eversource Energy filed an updated Appendix 1 filing in December of 2021; however that update did not affect any of the data or results in the evaluation.
[5] 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.
[6] Massachusetts Electric Company and Nantucket Electric Company d/b/a National Grid, Grid Modernization Annual Report for Calendar Year 2022. Submitted to Massachusetts DPU on April 24, 2023, as part of DPU 23-30.
[7] NSTAR Electric Company d/b/a Eversource Energy, Grid Modernization Annual Report for Calendar Year 2022. Submitted to Massachusetts DPU on April 24, 2023, as part of DPU 23-30.
[8] Fitchburg Gas and Electric Light Company d/b/a Unitil, 2022 Grid Modernization Plan Annual Report. Submitted to Massachusetts DPU on April 24, 2023, as part of DPU 23-30.

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Data Source	Description
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. Device deployment information and estimated spend for 2022 were provided as well.
Eversource's 2021 DPU-Filed Plan[9]	Eversource's GMP extension request was approved by the DPU on February 4, 2021. It includes budgets for PY 2021 deployment at the Investment Area level. This data source is included in the EDC Plan for Eversource planned spend at the Investment Area level.
2022-2025 Grid Modernization Plan Track 1 Order[10]	The GMP Track 1 Order was filed by the DPU on October 7, 2022. It includes budgets for PY 2022-PY 2025 deployment at the Investment Area level. This data source is included in the EDC Plan for each EDC's planned spend at the Investment Area level.
EDC DOER Response Appendix[11]	Planned device deployment and cost information from each EDC's Appendix 1 filing was provided in response to DOER requests for information. 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.

Source: Guidehouse analysis

Findings and Recommendations

Table 3 summarizes the Term 1 Infrastructure Metrics results for each Eversource's Communications Investment Area through PY 2022.

Table 3. Term 1 Communications Infrastructure Metrics Summary

Infrastructure Metrics*			Eversource
GMP Plan Total, PY 2018-2022		Devices	20
		Spend, $M	$6.05
IM-4	Number of devices or other technologies deployed through PY 2018-2022*	# Devices Deployed***	21
		% Devices Deployed	105%
IM-5	Cost for Deployment PY 2018-2022*	Total Spend, $M	$4.06
		% Spend	67%
IM-6	Deviation Between Actual and Planned Deployment for PY 2022	% On Track (Devices)	114%
		% On Track (Spend)	20%
IM-7	Projected Deployment for the remainder of the GMP Term (i.e., Term 1)**	# Devices Remaining	0
		Spend Remaining, $M	$0.00

*The metric names have been slightly changed here to clarify the time span used in analysis.

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

[10] Massachusetts DPU 21-80/DPU 21-81/DPU 21-82 Order on Previously Deployed Technologies issued October 7, 2022.

[11] Plan data is sourced from EDC responses to the first set of information requests issued by the Department of Energy Resources (DOER). These responses were filed on October 4th, December 2nd, and October 5th, 2021, for Eversource, National Grid, and Unitil under DPU dockets 21-80, 21-81, and 21-82.

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**This metric has been interpreted here (i.e., within the context of the 2022 Program Year Evaluation) as the units and spending that the EDC plans to complete their most recent 4-year Term 1 plans. Additional Grid Modernization units and dollars incurred in 2022 are attributed to Term 2, as appropriate, and all units and dollars spent during 2023 through 2025 will be considered as part of Term 2 GMPs.

***Note that "Deployed" here refers to commissioned devices. For full definitions of deployment stages, see Docket 20-46 Response to Information Request DPU-AR-4-11, September 3, 2020.

Source: Guidehouse analysis of 2021 GMP Term Reports and 2022 EDC Data

Table 4 summarizes the Term 2 Infrastructure Metrics results for each EDC's Communications Investment Area through PY 2022.

Table 4. Term 2 Communications Infrastructure Metrics Summary

Infrastructure Metrics*			Eversource	National Grid**	Unitil
GMP Plan Total, 2022-2025		Devices	24	2,030	260
		Spend, $M	$23.54	$102.81	$0.78
EDC Data Total, 2022-2025		Devices	24	3,220	219
		Spend, $M	$23.97	$102.80	$0.39
IM-4	Number of devices or other technologies deployed thru. PY 2022	# Devices Deployed	0	95	37
		% Devices Deployed	0%	5%	14%
IM-5	Cost for Deployment thru. PY 2022	Total Spend, $M	$0.11	$8.55	$0.21
		% Spend	0%	8%	27%
IM-6	Deviation Between Actual and Planned Deployment for PY 2022	% On Track (Devices)	0%	27%	70%
		% On Track (Spend)	3%	61%	106%
IM-7	Projected Deployment for the Remainder of the GMP Term	# Devices Remaining	24	3125	182
		Spend Remaining, $M	$23.85	$94.25	$0.18

*Note that "Deployed" here refers to commissioned devices. For full definitions of deployment stages, see Docket 20-46 Response to Information Request DPU-AR-4-11, September 3, 2020.

** To more closely align spend projections with DPU pre-authorized budgets, National Grid operations and maintenance (O&M) spend is included in actual and planned spend presented here. O&M spend is provided in aggregate for each investment area and is therefore excluded from device-specific summaries of spend.

Source: Guidehouse analysis of 2021 DOER Responses and 2022 EDC Data

Figure 1 compares the Term 1 GMP Plans and EDC Data totals and year-over-year spending for each Eversource.

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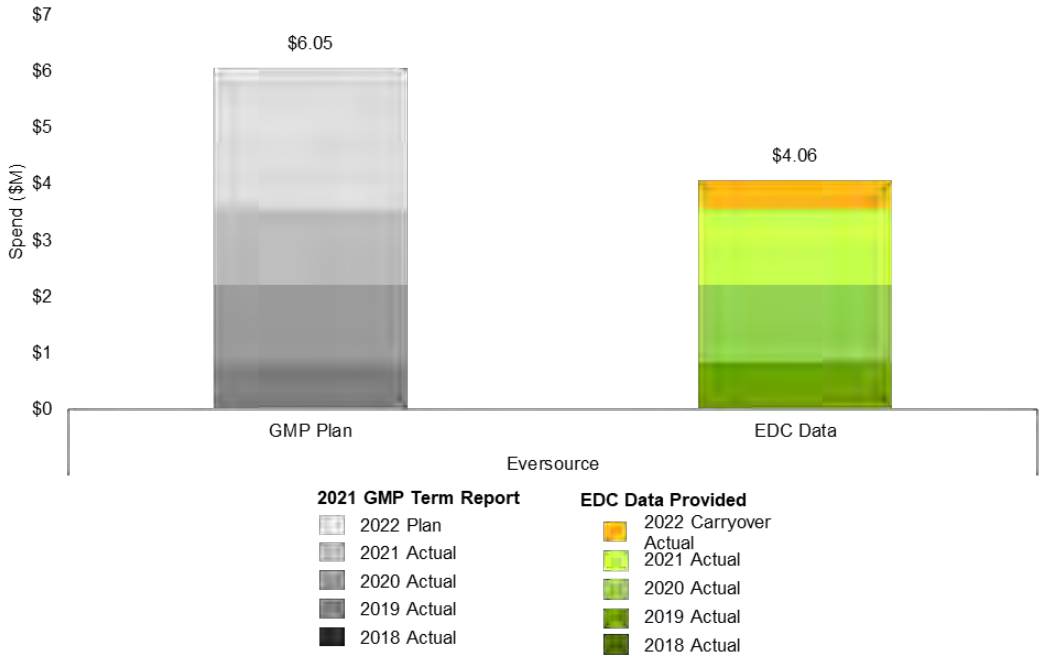
Figure 1. Communications Term 1 Spend Comparison (2018-2022, $M)

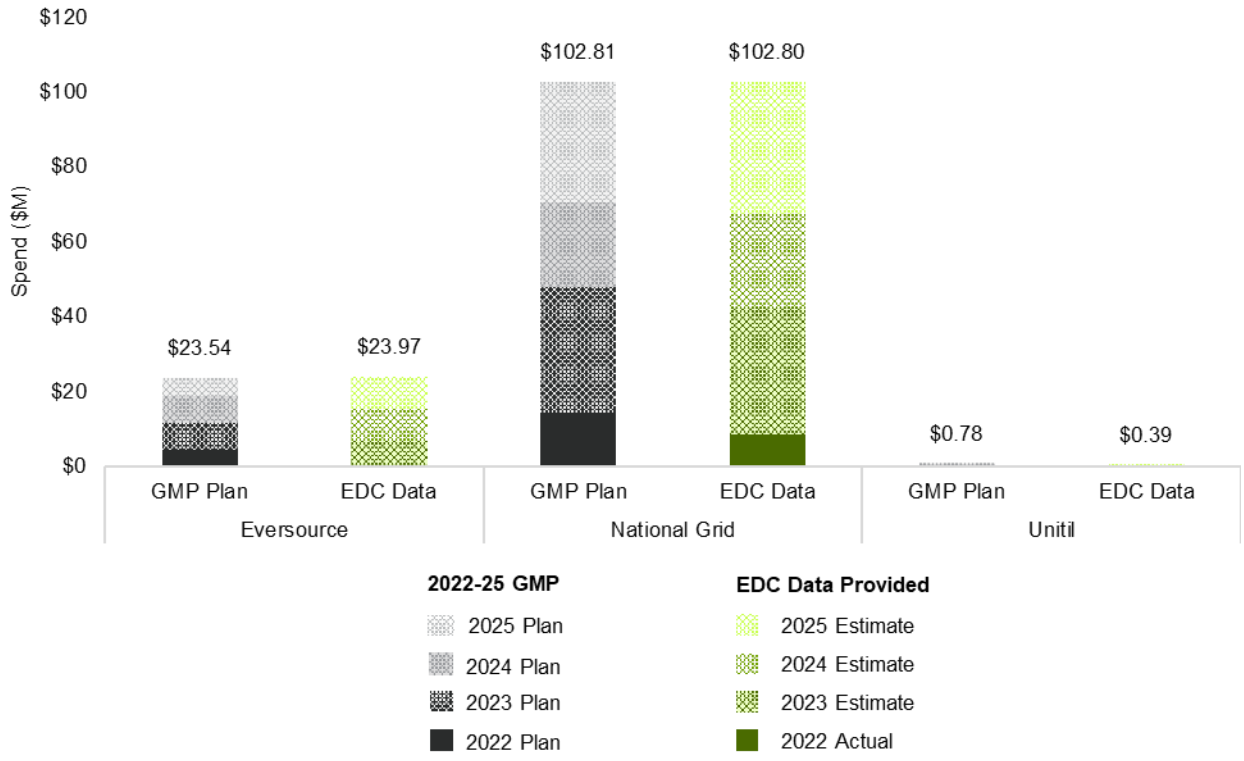


Note: Includes the Eversource planned spend on activity from 2021 that was transferred to 2022, set forth in Eversource's 2021 GMP Term Report, filed on April 1, 2022.

Source: Guidehouse analysis of 2021 GMP Term Report, "GMP Extension and Funding Report," and 2022 EDC Data

Figure 2 compares the Term 2 GMP Plans and EDC Data totals and year-over-year spending for each EDC.

Figure 2. Communications Term 2 Spend Comparison (2022-2025, $M)



Note: To more closely align spend projections with DPU pre-authorized budgets, National Grid operations and maintenance (O&M) spend is included in actual and planned spend presented here. O&M spend is provided in aggregate for each investment area and is therefore excluded from device-specific summaries of spend.

Source: Guidehouse analysis of DPU Order (October 7, 2022) and 2022 EDC Data

Table 5 summarizes key findings related Guidehouse's Communications deployment evaluation for each EDC.

Table 5. Summary of Infrastructure Metrics Findings for Communications Investment Area

EDC	Summary of Findings
Eversource	• PY 2022 node deployment for Eversource was 0% of their 2022 GMP Plan, with spend entirely for procurement and design packages and vendor identification to prepare for PY 2023 deployment. Overall spend was ~3% of plan spend. Delays in DPU approval impacted deployment schedule.
National Grid	• Total capital spend on the Communications investment area ($7.75M) was below plans for PY 2022 ($12.08M). Given lower spend than plan for PY 2022, National Grid plan spend was increased across PY 2023 – PY 2025 to match the DPU pre-authorized budget.

EDC	Summary of Findings
Unitil	• Unitil communications spend in PY 2022 met plan spend while deployment was below plan. Delays in VVO rollout and DPU approval delayed deployment. • Unitil plans to accelerate nodes deployment in PY 2023, but expects Term 2 costs and number of devices deployed to be lower than plan for 2022-2025.

Source: Guidehouse analysis of 2021 GMP Term Reports and 2022 EDC Data

Guidehouse submits the following recommendations for EDC consideration.

1) National Grid has decided to utilize both a private and public radio network. In prior year reports, it was recommended that coverage study be developed validating which network will provide the optimum expected performance. National Grid has advised that this recommendation has been or will be implemented, which is considered a best practice.
    a. **Recommendation for National Grid:** Field signal strength measurements will be taken, at field device locations, to validate that the private and or public network will provide acceptable communications performance. As part of the evaluation process, Guidehouse will review sample documentation of the coverage study.

2) Eversource is using a number of private radio frequencies for their communication networks. In prior year reports, it was recommended that Eversource perform coverage studies to validate the expected communications performance, as part of the investment, to determine expected improved performance after the investment is completed. Eversource has advised that this recommendation is in place, which is considered a best practice.

    Recommendations for Eversource:
    a. Continue to perform coverage studies and signal strength measurements to validate the performance and value of the investment. As part of the evaluation process, Guidehouse will review a sample of the coverage study documentation.

3) Unitil has decided to install field radios in conjunction with VVO rollout to improve efficiency of radio deployment. While Guidehouse agrees with this approach, the risk could be a delay in VVO investment deployment if unforeseen communications issues arise.
    a. **Recommendation for Unitil:** At the locations where VVO equipment will be installed, field signal strength measurements should be taken to validate that the public network will provide acceptable communications performance.

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1. Introduction to Massachusetts Grid Modernization

This section provides a brief background to the grid modernization evaluation process along with an overview of the Communications Investment Area and specific Communications evaluation objectives. These are provided for context when reviewing the subsequent sections that address the specific evaluation process and findings.

1.1 Massachusetts Grid Modernization Plan Background

The following subsections summarize the progression of Massachusetts Grid Modernization Plans (GMPs) filed by the three Massachusetts Electric Distribution Companies (EDCs): Eversource, National Grid, and Unitil.

1.1.1 Grid Modernization Term 1 (2018-2021)

On May 10, 2018, the Massachusetts DPU issued its Order[12] regarding the individual Grid Modernization Plans (GMPs) filed by the three Massachusetts EDCs.[13,14] 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[15] extending the 3-year grid modernization plan investment term to a 4-year term, which introduced a 2021 program year.

During the GMP term spanning 2018-2021 (hereon referred to as Term 1) 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)
- Volt/VAR Optimization (VVO)
- Advanced Distribution Management Systems/Advanced Load Flow (ADMS and ALF)
- Communications/IoT (Comms)
- Workforce Management (WFM)

A certain level of spending for each of these GMP Investment Areas was preauthorized by the DPU, with the expectation they would advance the achievement of DPU's grid modernization objectives:

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

[13] 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.

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

[15] 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).

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- 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)

For Term 1, the Massachusetts DPU's preauthorized budget for grid modernization varied 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 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.[16] The budget extension, approved by the DPU on February 4, 2021,[17] included $14 million for ADA, $16 million for ADMS/ALF, $5 million for Communications, $15 million for M&C, and $5 million for VVO.[18] These values are included in the Eversource total budget by Investment Area in Table 6.

Table 6. Term 1 (2018-2021) 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**
Comms	$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	--	--	$0.30	**$1.00**
2018-2021 Total	**$188.00**	**$82.20**	**$4.41**	**$272.65**

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

1.1.2 Grid Modernization Term 2 (2022-2025)

On July 2, 2020, the Massachusetts DPU issued an Order[19] that triggered further investigation into modernization of the electric grid. In the order, the DPU required that the EDCs file a grid modernization plan on or before July 1, 2021. In accordance with this order, the Massachusetts EDCs filed grid modernization plans for a 4-year period spanning 2022-2025 (hereby referred to as Term 2).[20] In these plans, the EDCs outlined continued investment in the areas that received

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

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

[18] The DPU allowed flexibility to these budgets to accommodate changing technologies and circumstances. For example, EDCs can shift funds across the different preauthorized investments if a reasonable explanation for these shifts is supplied.

[19] Massachusetts DPU 20-69: Investigation by the Department of Public Utilities on its own Motion into the Modernization of the Electric Grid – Phase Two (issued July 2, 2020).

[20] On July 1, 2021, Eversource, National Grid, and Unitil each filed a grid modernization plan with the DPU for the period spanning 2022-2025. The DPU docketed these plans as DPU 21-80, 21-81, and 21-82, respectively.

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investment during Term 1 (referred to as Track 1 Investment Areas), and investment in new Investment Areas (Track 2 Investment Areas). The Track 2 grid modernization investments were organized into the following additional Investment Areas to facilitate understanding, consistency across EDCs, and analysis.

- Interconnection Automation
- Probabilistic Power Flow Modeling
- Distributed Energy Resource Mitigation (DER Mitigation)
- Distributed Energy Resource Management System (DERMS)
- Demonstration Projects

1.1.3 Investment Areas

Table 7 and Table 8 summarize the DPU pre-authorized GMP investments.

Table 7. Overview of Term 2, Track 1 Investment Areas

Investment Areas	Description	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	Enhancing grid visibility and control capabilities, reliability increase
Advanced Distribution Automation (ADA)	National Grid-only investment for Term 2. ADA allows for isolation of outage events with automated restoration of unaffected circuit segments	Reduces the impact of outages
Volt/VAR Optimization (VVO)	Control of line and substation equipment to optimize voltage, reduce energy consumption, and increase hosting capacity	Optimization of distribution voltage to reduce energy consumption and demand
Advanced Distribution Management Systems	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	Enables 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	Enables the full benefits of grid modernization devices to be realized
Workforce Management (WFM)	Unitil-only investment for Term 2 to improve workforce and asset utilization related to outage management and storm response	Improves the ability to identify damage after storms

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

Table 8. Overview of Term 2, Track 2 Investment Areas

Investment Areas	Description	Objective
Interconnection Automation	Eversource plans to integrate, into a single software, both their existing Distributed Generation (DG) tools and customer interconnection portal.	Improve the DG interconnection process with reductions in time & resources for a growing number of applications
Probabilistic Power Flow Modeling	Eversource plans to use a simulation of locational load and generation based on variables such as customer behavior and energy market prices.	Leverage GMP term 1 ALF investments into an automated approach to system modelling.
DER Mitigation	Unitil plans to install ground-fault overvoltage protection as well as upgrade either voltage regulators or load tap changers for three substations with reverse power flow issues	Address reverse power flow issues caused by DER saturation at three specific substations.
DERMS	Software that forms the hub of DER management functions and integrates with other applications such as a Demand Response Management System ("DRMS") and ADMS, to create the DERMS Platform.	Cost-effectively optimize system performance and integrate DERS with more granularity
Demonstration Projects	Two demonstration projects proposed by National Grid to test new tools. Includes Active Resource Integration (ARI) and Local Export Power Control	Facilitates the interconnection of DG in certain areas of the EDC's distribution system that are approaching saturation
Project Management and Third-Party Evaluation	Investment into evaluation and project management. Evaluation includes third party evaluator budget, where the evaluator will conduct studies on appropriate topics related to the deployment of preauthorized investments. Project management includes portfolio management and reporting.	Assess and report on GMP deployment progress and performance of grid modernizing investments.

Source: Massachusetts DPU 21-80/DPU 21-81/DPU 21-82 Order on New Technologies and Advanced Metering Infrastructure Proposals issued November 30, 2022.

The Massachusetts DPU preauthorized budget for Track 1 investments and Track 2 investments on October 7, 2022[21] and November 30, 2022, [22] respectively. The preauthorized budget for grid modernization varies by Investment Area and EDC. National Grid has the largest preauthorized track one budget at $300.8 million, with Communications and VVO representing the largest share ($103 million and $76 million, respectively). Eversource's preauthorized Track 1 budget is $176.6 million, with M&C representing about 50% ($76.3 million). Unitil's preauthorized track one budget is $9.1 million with VVO making up more than 50% ($5.4 million).

[21] Massachusetts DPU 21-80/DPU 21-81/DPU 21-82 Order on Previously Deployed Technologies issued October 7, 2022.

[22] Massachusetts DPU 21-80/DPU 21-81/DPU 21-82 Order on New Technologies and Advanced Metering Infrastructure Proposals issued November 30, 2022.

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Table 9. Term 2 (2022-2025) Preauthorized Budget, $M

Investment Areas	Eversource	National Grid	Unitil	Total
ADA	--	$37.70	--	**$37.70**
ADMS*	$21.90	$61.00	$1.50	**$84.40**
Comms**	$38.00	$102.80	$0.82	**$141.62**
M&C	$76.30	$4.10	$1.10	**$81.50**
VVO	$40.40	$76.40	$5.40	**$122.20**
WFM	--	--	$0.25	**$0.25**
IT/OT	--	$18.80	--	**$18.80**
Track 1 Total	***$176.60***	***$300.80***	***$9.07***	***$486.47***
Interconnection Automation	$2.77	--	--	**$2.77**
Probabilistic Power Flow	$2.07	--	--	**$2.07**
DER Mitigation	--	--	$1.04	
DERMS	$16.00	$24.60	$0.16	**$41.80**
Demonstration Projects	--	$6.40	--	**$6.40**
Project Management and Third-Party Evaluation	$8.00	$4.40	$0.30	**$12.70**
Track 2 Total	***$29.00***	***$35.40***	***$1.50***	***$65.90***
2022-2025 Total	**$205.60*****	**$336.20**	**$10.57**	**$552.37**

* Given as $1.66M minus DERMS cost from DPU Order, Oct. 7, 2022, and calculated from DPU Order, Nov. 30, 2022.

** Includes Communications Modernization for Eversource, with added budget taken from DPU Order, Nov. 30, 2022.

*** Budget includes $16.3 million in funds remaining from the supplemental budget approved in D.P.U. 20-74 for DMS, substation automation, and VVO investments that Eversource sought to expend in calendar year 2022.

Source: DPU Order on Previously Deployed Technologies, October 7, 2022, and DPU Order on New Technologies, November 30, 2022 under docket 21-80, 21-81, and 21-82.

1.1.4 Evaluation Goals and Objectives

The DPU requires a formal evaluation process (including an evaluation plan and evaluation studies) for the EDCs' preauthorized GMP investments. Guidehouse is completing the evaluation to enable a uniform statewide approach and to facilitate coordination and comparability. The evaluation measures the progress made toward the achievement of DPU's grid modernization objectives. It uses the DPU-established Infrastructure Metrics and Performance Metrics, as well as Case Studies that illustrate the performance of specific technology deployments, to help determine if the investments are meeting the DPU's GMP objectives.

As previously noted, the Massachusetts DPU order on Track 2 technologies was released on November 30, 2022. The EDCs waited for DPU ruling on these technologies prior to commencing with significant investment, and thus were not able to complete deployment of

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Track 2 technologies within the remaining 2022 calendar year.[23] Guidehouse has, therefore, not included evaluation findings for Track 2 technologies in this PY 2022 evaluation report, but instead will report GMP Track 2 evaluation findings for PY 2023 through PY 2025 in future program year reports.

1.1.5 Metrics for Evaluation

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

1.1.5.1 Infrastructure Metrics

The Infrastructure Metrics assess the deployment of the GMP investments. Table 10 summarizes the Infrastructure Metrics.

Table 10. 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 Percent of Circuits with Installed Sensors**	Measures the total number of circuits with installed sensors which will provide information useful for proactive planning and intervention.	M&C	EDC
IM-4	**Number of Devices or Other Technologies Deployed**	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 relative to its GMP on a year-by-year basis.	All IAs	Evaluator

[23] Within PY 2022, there was limited spend for Track 2 technologies for both Unitil and Eversource. Unitil reported approximately $20k collectively across DER mitigation, workforce management, and Program Management and EM&V, while Eversource reported approximately $6k for DERMS.

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Metric		Description	Applicable IAs	Metric Responsibility*
IM-7	**Projected Deployment for the Remainder of the GMP Term**	Compares the revised projected deployment with the original target deployment as the EDC implements its GMP.	All IAs	Evaluator

PM = Performance Metric, IA = Investment Area, ES = Eversource, NG = National Grid, UTL = Unitil

* Column indicates which EDC is responsible for calculating each metric, for statewide metrics, all EDCs are responsible

Source: Guidehouse Review of DPU Order, May 10, 2018[24]

1.1.5.2 Performance Metrics

The Performance Metrics assess the performance of all the GMP investments. Table 11 summarizes the Performance Metrics used for the various Investment Areas. This report discusses Performance Metrics that pertain specifically to the M&C Investment Area.

Table 11. 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
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/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.	VVO	All
PM-5	**VVO Power Factor**	Quantifies the improvement that VVO/CVR is providing toward maintaining circuit power factors near unity.	VVO	All

[24] Massachusetts DPU 15-120/DPU 15-121/DPU 15-122 (Grid Modernization) Order issued May 10, 2018 (DPU Order), pg. 198-201.

Metric		Description	Applicable IAs	Metric Responsibility*
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 DMS Power Flow and Control Capabilities**	Examines the deployment and data cleanup associated with deployment of ADMS, 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 FLISR.	ADMS/ ALF	All
PM-10	**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
PM-11	**Grid Modernization investments' effect on outage durations**	Provides insight into how ADA and 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-12	**Grid Modernization investments' effect on outage frequency**	Provides insight into how ADA and 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-ES-1	**Advanced Load Flow – Percent Milestone Completion**	Examines the fully developed ALF capability across Eversource's circuit population.	ADMS/ ALF	ES
PM-ES-2	**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

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Metric		Description	Applicable IAs	Metric Responsibility*
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-NG-1	**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 = Performance Metric, IA = Investment Area, ES = Eversource, NG = National Grid, UTL = Unitil

* Column indicates which EDC is responsible for calculating each metric, for statewide metrics, all EDCs are responsible

Source: Stamp Approved Performance Metrics, July 25, 2019.[25]

1.1.5.3 Case Studies

The impacts of GMP devices on system reliability metrics can be difficult to discern due to the range of factors that affect these metrics. Storm conditions, vehicle accidents and other factors drive reliability from year to year. This is especially likely if the device has less than several full years of operation to affect the metric.

Guidehouse, in consultation with the EDCs, developed a case study approach to provide more insight into the actual operation of the GMP devices and to illustrate how these investments provide customer reliability and operational benefits. The case studies help to illustrate the benefits provided by GMP devices during outages and other events. This approach investigates outage events on specific circuits where the GMP equipment was used to address the outage. The approach also allows for comparison between what did occur due to the presence of the GMP device and what would have likely happened had the GMP investment not been made.

1.2 Communications Investment Area Overview

As a part of the grid modernization efforts, the EDCs are making investments to advance their Communications capabilities and enhance network visibility, with the goal of delivering optimized system performance, higher reliability, and greater DER integration. Table 12 summarizes the preauthorized budget for the Communications Investment Area for the first and second GMP terms.

[25] Massachusetts Department of Public Utilities, Grid Modernization Plan Performance Metrics. Submitted on July 25, 2019, as part of DPU 12-120,15-121, & 15-122

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Table 12. GMP Preauthorized Budget for Communications, $M

Period	Eversource	National Grid	Unitil	Total
Term 1 (2018 – 2021)	$23.00	$1.80	$0.84	**$25.60**
Term 2 (2022 – 2025)	$38.00	$102.80	$0.82	**$141.62**

Source: DPU Order, May 10, 2018, Eversource filing "GMP Extension and Funding Report," July 1, 2020, DPU Order, October 7, 2022, and DPU Order, November 30, 2022 under docket 21-80, 21-81, and 21-82.

The following subsection discusses EDC-specific approaches to Communications.

1.2.1 EDC Approach to Communications

The Communications Investment Area is an enabling technology that will support most (if not all) preauthorized investments, including ADA, VVO, ADMS, and M&C.

Investments in a robust and effective communication network are required for the other preauthorized investments to "(1) optimize system performance (by attaining optimal levels of grid visibility, command and control and self-healing)," "(2) optimize system demand," and "(3) interconnect and integrate distributed energy resources." [26]

All EDCs recognize that the successful deployment of communications systems will maximize GMP benefits. If communications network deployment is delayed, it can potentially limit the performance of other GMP devices.

Table 13 describes the areas or classifications of communications investments each of the EDCs are performing. While overall EDC communications goals are similar, each EDC begins with a different set of capabilities and needs, and so is charting a unique course to communications deployment.

[26] DPU Order at p. 106

Table 13. Communications Investment Plans by EDC

		Four-Year Deployment Plan		
Technology	**Description**	**Eversource**	**National Grid**	**Unitil**
Wide Area Network (WAN)	Fiber optic and supporting electronics, used as backhaul to bring data from substations and radio master sites to IT control systems	Existing: Eversource East has redundant WAN at major substations. Eversource West has limited WAN Planned: New deployments at key locations	Existing: Limited fiber optic coverage to substations; Obsolete DMX MUX hardware Planned: Replacement of obsolete Nokia DMX system Planned: Replacement of obsolete DS0 communications lines. Fiber standards development and deployment in progress	No existing WAN Planned: No WAN required with selected FAN approach

		Four-Year Deployment Plan		
Technology	**Description**	**Eversource**	**National Grid**	**Unitil**
Field Area Network (FAN)	Communications systems used to monitor and operate field end devices	Existing: Private network with public cellular filling coverage gaps Planned: Augment existing wireless communications field area network through deployment of new base radios and associated infrastructure across eastern and western Massachusetts	Existing: Using public cellular network Planned: Evaluating FAN options	Existing: Using public cellular network Planned: Continuation of field area network project started in first phase of grid modernization. This includes installing modems connected to AT&T FirstNet as network service provider
Application Software	Applications use for the planning, designing, and deploying communication systems	Planned: Communication System Modernization. Project migrates from serial (D200) to end-to-end IP-based network	Planned: Install Telecom Operations Management System (TOMS) Planned: Further investments in IT/OT and comms that connect back-office systems to devices in field	Planned: No investments planned

Source: Guidehouse analysis of 2021 GMP Term Reports and 2022 EDC data

1.3 Communications Evaluation Objectives

This evaluation focuses on the progress and effectiveness of the DPU preauthorized Communications investments for each EDC toward meeting the DPU's grid modernization objectives. Table 14 illustrates the key Infrastructure Metrics relevant for the Communications evaluation.

Table 14. Communications Evaluation Metrics

Metric Type	Communications Evaluation Metrics	ES	NG	UTL
IM	Number of devices or other technologies deployed	✓	✓	✓
IM	Cost for deployment	✓	✓	✓
IM	Deviation between actual and planned deployment for the plan year	✓	✓	✓
IM	Projected deployment for the remainder of the 4-year term*	✓	✓	✓

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

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Source: Guidehouse review of Infrastructure Metric filings

The EDCs provided the data supporting the Infrastructure Metrics to the evaluation team. Section 3 presents results from the analysis of Infrastructure Metrics data. The Infrastructure Metrics analysis measures whether the investments are taking place on the projected schedule and budget.

Table 15 summarizes the communications M&V research questions addressed in this report. The scope of the Communications evaluation includes tracking the Communications infrastructure deployment against the plan.

Table 15. Communications Evaluation Research Questions

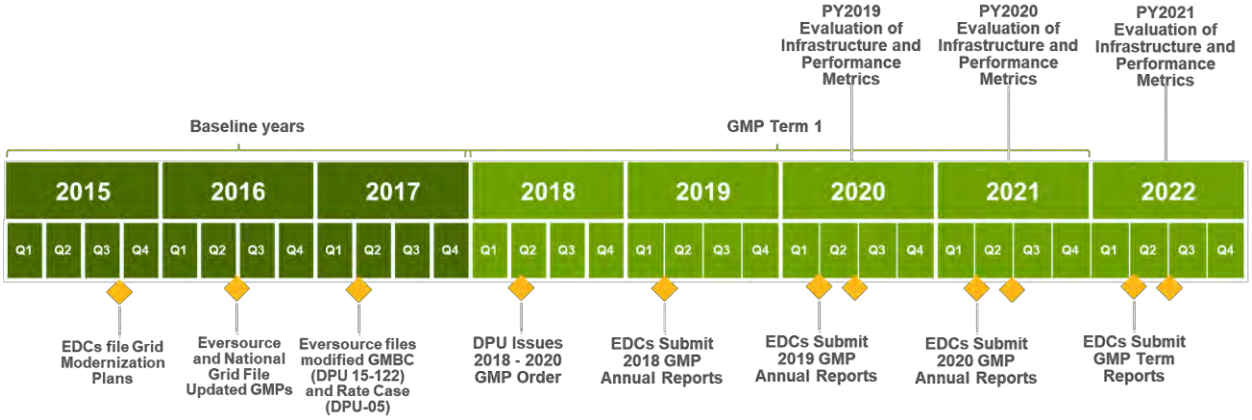
Research Questions
Are the EDCs progressing in deployment of their communications networks according to their GMPs?
What factors, if any, are affecting the deployment schedule of communications equipment?
What is the cost of deploying various types of communications equipment, including the FAN devices (radio base stations) and WAN (miles of fiber optics cables)?
Are the communication investments (WAN and FAN) effective at supporting the other DPU approved investments?

Source: Guidehouse Stage 3 Evaluation Plan submitted to EDCs on March 1, 2023

2. Communications Evaluation Process

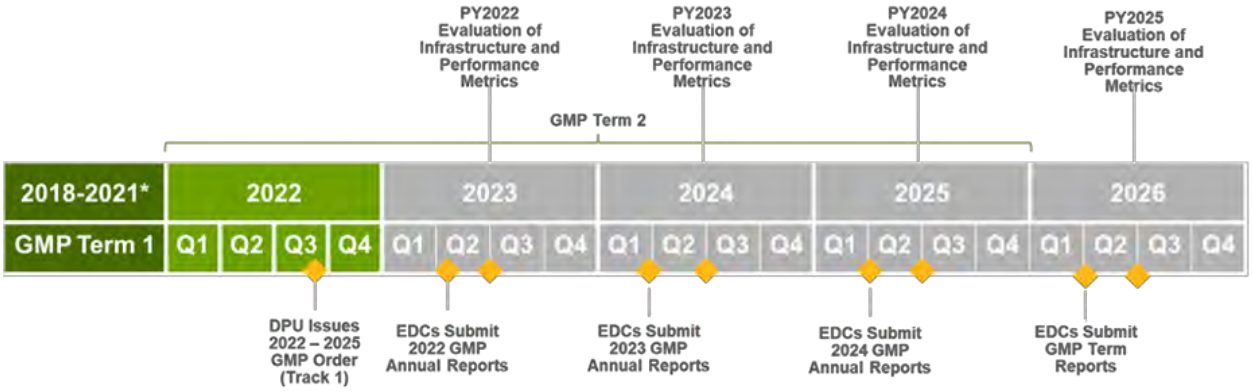
This section summarizes Guidehouse's methodologies for the evaluation of Infrastructure Metrics. Figure 3 highlights the Term 1 filing background and timeline of the GMP Order and the evaluation process, and Figure 4 indicates the expected timeline for Term 2.

Figure 3. Term 1 Infrastructure Metrics Timeline



Source: Guidehouse review of the DPU orders and GMP process

Figure 4. Term 2 Infrastructure Metrics Timeline



Note: Infrastructure Metrics Timeline for Term 2 does not incorporate Term 1 evaluations in PY 2022

Source: Guidehouse review of the DPU orders and GMP process

As a note, spend and deployment was conducted in PY 2022 to account for any spend and deployment from Term 1 (2018-2021 plan) as well as new spend to be included in Term 2 (2022 – 2025). Term 1 spend and deployment will be denoted separately within the analysis for Eversource, as Eversource provided data to support a comparison of Term 1 and Term 2 planned versus actual activity.

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2.1 Infrastructure Metrics Analysis

Guidehouse annually assesses the progress of each EDC toward communications deployment. Table 16 and Table 17 highlight the evaluated Infrastructure Metrics and their associated calculation parameters for both terms.

Table 16. Term 1 Infrastructure Metrics Overview – Eversource Only

Infrastructure Metrics			Calculation
IM-4	Number of devices or other technologies deployed thru. PY 2022	# Devices Deployed	$\sum_{PY=2018}^{2021}(Devices\ Commissioned)_{PY} + Devices\ Commissioned_{CY2022(T1)}$
		% Devices Deployed	$\frac{\sum_{PY=2018}^{2021}(Devices\ Commissioned)_{PY} + Devices\ Commissioned_{CY202}}{\sum_{PY=2018}^{2021}(Devices\ Commissioned)_{PY} + (Planned\ Devices)_{CY2022(T}}$
IM-5	Cost through PY 2022	Total Spend, $M	$\sum_{PY=2018}^{2021}(Actual\ Spend)_{PY} + Actual\ Spend_{CY2022(T1)}$
		% Spend	$\frac{\sum_{PY=2018}^{2021}(Actual\ Spend)_{PY} + Actual\ Spend_{CY2022(T1)}}{\sum_{PY=2018}^{2021}(Actual\ Spend)_{PY} + Planned\ Spend_{CY2022(T1)}}$
IM-6	Deviation Between Actual and Planned Deployment for PY 2022	% On Track (Devices)	$\frac{(Devices\ Commissioned)_{CY2022(T1)}}{(Planned\ Devices)_{CY2022(T1)}}$
		% On Track (Spend)	$\frac{(Actual\ Spend)_{CY2022(T1)}}{(Planned\ Spend)_{CY2022(T1)}}$
IM-7	Projected Deployment for the remainder of the GMP Term (i.e., Term 1)*	# Devices Remaining	N/A*
		Spend Remaining, $M	N/A*

Note**:** This table pertains to Infrastructure Metrics for Eversource only. Planned devices and spend are based on the 2021 GMP Term Report filing (filed on April 1, 2022 under DPU docket 21-80). All CY2022 spend and deployment data given above, to be calculated, includes only units/dollars dedicated to work intended for Term 1, and excludes any deployment and spend apportioned for Term 2.

* This metric has been interpreted here (i.e., within the context of the 2022 Program Year Evaluation) as the units and spending that the EDC plans to complete their most recent 4-year Term 1 plans. Additional Grid Modernization units and dollars incurred in 2022 are attributed to Term 2, as appropriate, and all units and dollars spent during 2023 through 2025 will be considered as part of Term 2 GMPs.

Source: Guidehouse

Table 17. Term 2 Infrastructure Metrics Overview – All EDCs

Infrastructure Metrics			Calculation
IM-4	Number of devices or other technologies deployed thru. PY 2022	# Devices Deployed	$(Devices\ Commissioned)_{PY2022}$
		% Devices Deployed	$\frac{(Devices\ Comissioned)_{PY2022}}{(Devices\ Comissioned)_{PY2022} + \sum_{PY=2023}^{2025}(Planned\ Devices)_{PY}}$

Infrastructure Metrics			Calculation
IM-5	Cost through PY 2022	Total Spend, $M	$(Actual\ Spend)_{PY2022}$
		% Spend	$\frac{(Actual\ Spend)_{PY2022}}{\sum_{PY=2022}^{2025}(Planned\ Spend)_{PY}}$
IM-6	Deviation Between Actual and Planned Deployment for PY 2022	% On Track (Devices)	$\frac{(Devices\ Commissioned)_{PY2022}}{(Planned\ Devices)_{PY2022}}$
		% On Track (Spend)	$\frac{(Actual\ Spend)_{PY2022}}{(Planned\ Spend)_{PY2022}}$
IM-7	Projected Deployment for the remainder of the GMP Term	# Devices Remaining	$\sum_{PY=2022}^{2025}(Planned\ Devices)_{PY} - (Devices\ Comissioned)_{PY2022}$
		Spend Remaining, $M	$\sum_{PY=2022}^{2025}(Planned\ Spend)_{PY} - (Actual\ Spend)_{PY2022}$

Note: CY2022 spend and deployment data given above includes only units/dollars within Term 2 plans, and excludes any deployment and spend apportioned for Term 1 (carryover).

Source: Guidehouse

Section 3.2 provides the results from the evaluation of the Infrastructure Metrics. To evaluate Infrastructure Metrics, Guidehouse:

- Reviewed the data provided by the EDCs to confirm their progress through PY 2022 (see Section 3.1.2, “Data QA/QC Process”)
- Interviewed representatives from each EDC to understand the status of the Communications investments, including:
    - Updates to their planned Communications investments
    - Reasons for deviation between actual and planned deployment and spend

3. Communications Infrastructure Metrics

3.1 Data Management

Guidehouse worked with the EDCs to collect data to complete the evaluation for the assessment of Communications Infrastructure Metrics. The sections that follow highlight Guidehouse's data sources and data QA/QC processes used in the evaluation of Infrastructure Metrics.

3.1.1 Data Sources

Guidehouse used a consistent methodology (across Investment Areas and EDCs) for evaluating the data and illustrating EDC progress indicated by the GMP metrics. The data sources are summarized below.

3.1.1.1 Term 1 Planned Deployment and Spend for PY 2022

To assess progress against planned carryover deployment and spend for Eversource, Guidehouse used the planned device deployment and cost information from each its *2021 GMP Term Report*[27,28,29], which were filed on April 1, 2022. These filings served as the sources for planning data in this report and are referred collectively as the *GMP Term 1 Plan* each EDC in summary tables and figures throughout this report.

Table 18 lists the sources for the planned and actual quantities reviewed, and it specifies the color/shade used to represent these quantities in graphics throughout the rest of the report.

Table 18. Term 1 Deployment Categories Used for the EDC Plan

Representative Color	Data	Description
	2022 Plan	Planned unit deployment and spend in 2022
	2021 Actual	Actual reported unit deployment and spend in 2021
	2020 Actual	Actual reported unit deployment and spend in 2020
	2019 Actual	Actual reported unit deployment and spend in 2019
	2018 Actual	Actual reported unit deployment and spend in 2018

Source: Plan and actual data is sourced from the EDCs' 2021 GMP Term Report Appendix 1 filed April 1, 2022.

[27] 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.
[28] 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. Note that Eversource Energy filed an updated Appendix 1 filing in December of 2021; however that update did not affect any of the data or results in the evaluation.
[29] 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.

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3.1.1.2 Term 2 Planned Deployment and Spend for PY 2022

Guidehouse used the planned device deployment and cost information from each EDCs' filed responses to the first set of information requests issued by the Department of Energy Resources (DOER).[30] These responses were filed on October 4th, October 5th, and December 2nd, 2021, for Eversource, Unitil, and National Grid respectively. These filings served as the sources for planning data in this report and are referred collectively as the *DOER Responses* for each EDC in summary tables and figures throughout this report.

Table 19 lists the different sources for the planned and actual quantities reviewed, and it specifies the color/shade used to represent these quantities in graphics throughout the rest of the report.

Table 19. Term 2 Deployment Categories Used for the EDC Plan

Representative Color	Data	Description
	2025 Plan	Projected 2025 unit deployment and spend
	2024 Plan	Projected 2024 unit deployment and spend
	2023 Plan	Projected 2023 unit deployment and spend
	2022 Plan	Projected 2022 unit deployment and spend

Source: Plan data is sourced from EDC responses to the first set of information requests issued by the Department of Energy Resources, filed October 4, October 5, and December 2, 2021 under DPU dockets 21-80, 21-82, and 21-81 for Eversource, Unitil, and National Grid, respectively.

3.1.1.3 PY 2022 Actual Deployment and Spend, Planned Deployment and Spend for the Remainder of Term 2

Guidehouse collected device deployment data using standardized data collection templates (e.g., the All Device Deployment workbook file) for all EDCs in January through March 2023. The data collected provides an update of planned and actual deployment, in dollars and device units, through the end of PY 2022. Data from these sources are referred to as EDC Data in summary tables and figures throughout the report.

The EDC device deployment data (collected in the All Device Deployment workbook) captured 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.

The evaluation team also collected the current implementation stage of the work order (commissioned, construction, or design), the commissioned date (if applicable), and all cumulative costs associated with the work order.

Table 20 summarizes the file versions used for the evaluation, and the following subsections provide additional detail surrounding requested inputs in each workbook. The collected data

[30] Plan data is sourced from EDC responses to the first set of information requests issued by the Department of Energy Resources (DOER). These responses were filed on October 4th, December 2nd, and October 5th, 2021, for Eversource, National Grid, and Unitil under DPU dockets 21-80, 21-81, and 21-82.

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was compared to the data submitted by the EDCs to the DPU in the 2021 Grid Modernization Plan Term Reports and associated Appendix 1 filings.[31,32,33] The evaluation team confirmed the consistency of the data from the various sources and reconciled any differences.

Table 20. All Device Deployment Data File Versions for Analysis

EDC	File Version
Eversource	Received 3/20/2023
National Grid	Received 3/29/2023
Unitil	Received 3/30/2023

Source: Guidehouse

Table 21 and Table 22 summarize 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.

[31] Massachusetts Electric Company and Nantucket Electric Company d/b/a National Grid, Grid Modernization Plan Annual Report 2022. Submitted to Massachusetts DPU on April 1, 2021 as part of DPU 22-41
[32] NSTAR Electric Company d/b/a Eversource Energy, Grid Modernization Plan Annual Report 2021. Submitted to Massachusetts DPU on April 1, 2022 as part of DPU 22-40
[33] Fitchburg Gas and Electric Light Company d/b/a Unitil, Grid Modernization Plan Annual Report 2021. Submitted to Massachusetts DPU on April 1, 2022 as part of DPU 22-42

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Table 21. Term 1 EDC Device Deployment and Spending Data Legend – Eversource Only

Representative Color	Data	Description
Device Deployment Data		
	2022 Design/Engineering	Detailed design and engineering is in progress, but the device is not yet in construction (from All Device Deployment workbook)
	2022 Construction	Field construction is in progress, but the device is not yet in-service (from All Device Deployment workbook)
	2022 In-Service	Device is installed and "used and useful" but not yet commissioned to enable all Grid Modernization functionalities (from All Device Deployment workbook)
	2022 Commissioned	Device is fully operational with all Grid Mod functionalities, and thus is considered "deployed" in PY 2022 (from All Device Deployment workbook)
	2021 Actual	Actual 2021 deployment (units) (provided in 2022 Appendix 1 filings)
	2020 Actual	Actual 2020 deployment (units) (provided in 2021 Appendix 1 filings)
	2019 Actual	Actual 2019 deployment (units) (provided in 2020 Appendix 1 filings)
	2018 Actual	Actual 2018 deployment (units) (provided in 2019 Appendix 1 filings)
Spend Data		
	2022 Actual	Actual 2022 spend (provided in All Device Deployment workbook)
	2021 Actual	Actual 2021 spend ($) (provided in 2022 Appendix 1 filings)
	2020 Actual	Actual 2020 spend ($) (provided in 2021 Appendix 1 filings)
	2019 Actual	Actual 2019 spend ($) (provided in 2020 Appendix 1 filings)
	2018 Actual	Actual 2018 spend ($) (provided in 2019 Appendix 1 filings)

Note: This legend for deployment and spend data summaries are provided for Eversource only, as National Grid and Unitil tracked all spending and all deployment for all of 2022, independent of Term status (i.e., whether the work was carried over from PY2021 of Term 1).

Source: Guidehouse analysis

Table 22. Term 2 EDC Device Deployment and Spending Data Legend

Representative Color	Data	Description
Device Deployment Data		
	2025 Plan	Planned 2025 Deployment
	2024 Plan	Planned 2024 Deployment
	2023 Plan	Planned 2023 Deployment
	2022 Commissioned	Device is fully operational with all Grid Mod functionalities, and thus is considered "deployed" in PY 2021
	2022 In-Service	Device is installed and "used and useful" but not yet commissioned to enable all Grid Modernization functionalities
	2022 Construction	Field construction is in progress but the device is not yet in-service
	2022 Design / Engineering	Detailed design and engineering is in progress but the device is not yet in construction
Spend Data		
	2025 Estimate	Planned 2025 spend
	2024 Estimate	Planned 2024 spend
	2023 Estimate	Planned 2023 spend
	2022 Actual	Actual 2022 spend

Source: Guidehouse analysis

3.1.2 Data QA/QC Process

Guidehouse reviewed all data provided for Infrastructure Metrics analysis upon receipt of requested data. The following sections detail the data QA/QC processes adopted for the two analysis areas.

3.1.2.1 Data QA/QC

To enable accuracy, Guidehouse conducted a high-level QA/QC of all device 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
- Large variation in the unit cost of commissioned devices
- Variance between the aggregated year-end total information and work order-level data
- Variance between the actual unit costs and planned unit costs

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3.2 Deployment Progress and Findings

Guidehouse presents findings from the Infrastructure Metrics analysis for the Communications Investment Area in the following subsections. Throughout this section, Guidehouse will reference Term 1 nodes and Term 2 nodes. Term 1 nodes are the nodes identified by each of the EDCs Grid Modernization Plans that achieved full communications functionality in 2018 through 2021. Term 2 nodes are nodes that are currently planned to achieve full communications functionality in Term 2 spanning 2022 through 2025.

3.2.1 Statewide Comparison

This section discusses the current scope of Communications investments within the EDCs in Massachusetts and it summarizes the deployment progress and findings across all three EDCs.

3.2.1.1 Eversource Communications Plan – Term 1 and Term 2

During Term 1, Eversource focused on building out its FAN master radio node sites to improve capacity, communication coverage and signal strength. To accomplish these improvements in communications, Eversource worked on eight master communications sites from which two sites were completed and commissioned in 2021. Of the eight master radio sites, four are located in Eversource's eastern region and four are located in their western region. See Section 3.2.2 for a more complete breakdown and status of the master radio installations. In addition to the installation of the master radio sites, Eversource installed three fiber optics cables between substation 23 to a master radio, substation 318 to a master radio and the Bear Hill Master Radio Tower Site.

In Term 2, Eversource will continue working to develop a comprehensive FAN telecommunications strategy that builds upon its existing network infrastructure and that will allow for further capacity to support the development of DMS and DERMS. Currently, Eversource's private communications network and its supporting infrastructure are unable to meet the full demands of planned new control room technologies (SCADA, DMS, OMS, DERMS) and a variety of technologies (e.g., legacy SCADA radios) that are in use to support FAN communications are approaching their end-of-life and require replacement. To address these issues, Eversource's 2022-2025 GMP FAN strategy will focus on the build out of a private radio network, which will include the design of a comprehensive network of new base radios in Eastern and Western Massachusetts. This buildout will include the commissioning of approximately 24 new base radios enabling approximately 50 related remote terminal units per base station. To date, Eversource has deployed nine new nodes in the system that have expanded the 450MHz and 900MHz private radio network. Eversource will also continue planning the transition to internet protocol (IP) on its FAN and eliminate the GE D200 data concentrators along the communications path. This will include a serial to IP migration plan that will replace the serial-connected field devices with IP-based distributed network protocol connections.

3.2.1.2 National Grid Communications Plan – Term 1 and Term 2

During Term 1, National Grid's 2021 communications investment focused on: 1) performing a FAN strategy review which included equipment bench testing and some field test sites of a private 700MHz radio equipment, 2) Installing equipment on a public cellular network to support the other grid modernization investments, 3) Completing the Telecom Operations Management

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System (TOMS) installation and placing it in service, 4) Testing and evaluating an IP-based replacement for Nokia DMX to enhance FAN backhaul capability, and 5) Lease Line replacement for Verizon copper lines that cannot support the increased bandwidth needs. Each is described below:

1) **FAN Strategy Evaluation:** Evaluation of a 700MHz private radio system. Bench testing, field evaluation and coverage studies were performed.

2) **Radio Nodes:** While National Grid determines its longer-term FAN strategy (item 1 in this list), it is presently enabling the ADA and M&C investments using a public cellular network.

3) **Telecommunication Operations Management System (TOMS):** An integrated application to plan, design, engineer, deploy, commission, and maintain the operational telecom network for end-to-end connectivity. This investment has been placed in service to improve the efficiency and accuracy of National Grid-US telecom network build-out and operations.

4) **Transition to packet-based MPLS solutions:** This investment will transition the existing WAN to Multi-Protocol Label Switching (MPLS), which is protocol-independent and highly scalable, to allow for any type of transport medium. MPLS will enable true network convergence by providing the capability of combining many older legacy platforms while establishing the foundation for future technology growth and connectivity of the communications WAN.

5) **Pursue options for bandwidth needs:** National Grid is evaluating options to cost effectively expand and deploy incremental infrastructure investments for additional bandwidth needs, such as fiber optics or high speed radio networks.

In Term 2, National Grid will continue expanding 700 MHz solutions across its Massachusetts service territory and has brought on an engineering contractor to explore options and help complete detailed engineering in 2022 with the intent of beginning execution in 2023. Planned nodes for the GMP 2022-2025 term include those that support VVO, M&C, and ADA as well as nodes that support Communications specific functionalities such as DS0, DMX Replacement, and FAN systems.

3.2.1.3 Unitil Communications Plan – Term 1 and Term 2

During Term 1, Unitil's third-party communication study, started in 2019 and completed in 2020, led to the selection of AT&T FirstNet as Unitil's communications path forward. In 2021, Unitil started the installation process to connect its communications backbone to the AT&T communications backbone. This required existing backhaul fiber optics to be connected and tested between AT&T and Unitil. To enable redundancy paths for the fiber optic communications, routers were installed at two separate locations. Bench testing was successfully completed for the integration of field radios and devices. The bench testing determined that the field radios would properly send information to AT&T FirstNet which would then be backhauled to Unitil. The rollout process was finalized and documented during the year. It was determined from a control, process and efficiency standpoint, that the field radios would follow the VVO investment roll out. When a VVO field device (sensor) required

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communications, the sensor would be integrated with the field radio, fully tested on the bench and then taken into the field for final acceptance testing.

In Term 2, Unitil will largely continue progressing with the same projects it pursued in GMP Term 1. All planned nodes will continue supporting VVO deployment and will follow the VVO schedule accordingly. When commissioned, these communications investments will enable or support the M&C, ADA, and VVO equipment. The following sub-sections will discuss statewide infrastructure metrics for Term 1 and Term 2 investments.

3.2.1.4 Term 1 Infrastructure Metrics Results

At the request of Eversource, Guidehouse provided analysis of Eversource's Term 1 PY 2022 spend and deployment. Table 23 summarizes the Infrastructure Metrics results for Eversource's Communications Investment Area through PY 2022. Sections 3.2.2 through 3.2.4 explain each EDC's progress and plans in greater detail.

Table 23. Term 1 Communications Infrastructure Metrics Summary

Infrastructure Metrics*			Eversource
GMP Plan Total, PY 2018-2022		Devices	20
		Spend, $M	$6.05
IM-4	Number of devices or other technologies deployed through PY 2018-2022*	# Devices Deployed	21
		% Devices Deployed	105%
IM-5	Cost for Deployment PY 2018-2022*	Total Spend, $M	$4.06
		% Spend	67%
IM-6	Deviation Between Actual and Planned Deployment for PY 2022	% On Track (Devices)	114%
		% On Track (Spend)	20%
IM-7	Projected Deployment for the remainder of the GMP Term (i.e., Term 1)**	# Devices Remaining	0
		Spend Remaining, $M	$0.00

*The metric names have been slightly changed here to clarify the time span used in analysis.

** This metric has been interpreted here (i.e., within the context of the 2022 Program Year Evaluation) as the units and spending that the EDC plans to complete their most recent 4-year Term 1 plans. Additional Grid Modernization units and dollars incurred in 2022 are attributed to Term 2, as appropriate, and all units and dollars spent during 2023 through 2025 will be considered as part of Term 2 GMPs.

Source: Guidehouse analysis of 2021 GMP Term Report and 2022 EDC Data

Actual device deployment in PY 2022 was above the number of master radio node projects planned while spend was significantly lower than planned for Eversource. This was primarily due to the remaining Term 1 Communications budget being allocated to node projects, resulting in a higher budget than what was ultimately spent. Additionally, lower than expected costs were accrued due to delays in field equipment cutovers to the new 450MHz master radio system.

The total actual units deployment for the 4-year Term was slightly above previous estimated plan. Eversource deploying one additional node than planned while spend was slightly greater than half the original estimated 4-year plan.

Figure 5 compares Eversource's GMP plan spend versus actual spend on Communications for Eversource. Eversource reported no spend towards GMP Term 1 operations and maintenance (O&M) in PY 2022. Further details on the differences between planned and actual spend are provided in the Eversource results subsections.

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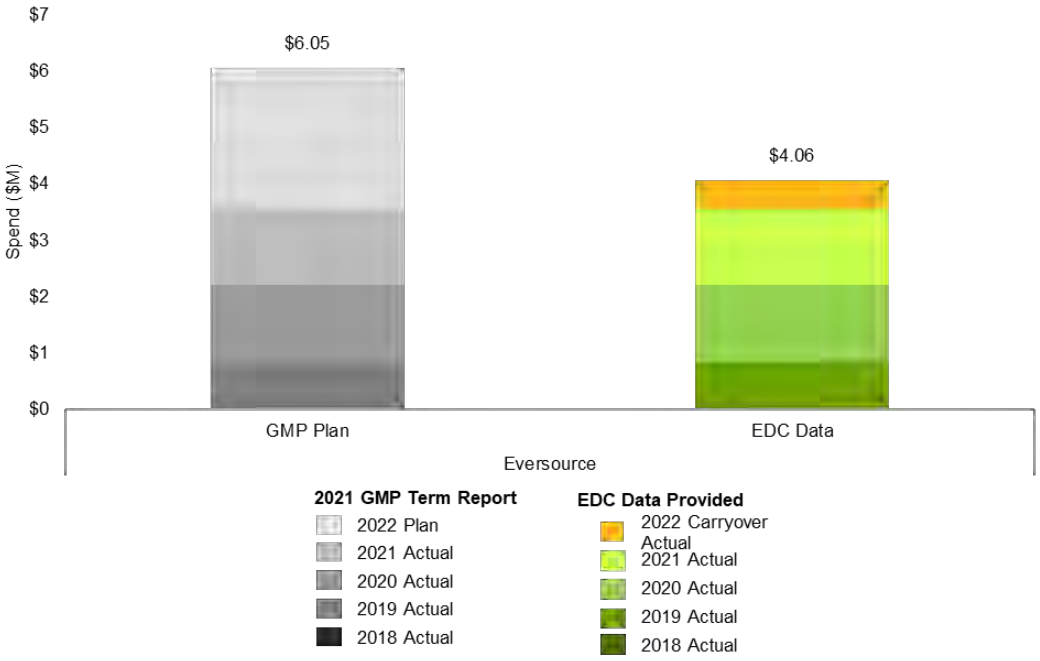
Figure 5. Term 1 Communications Spend Comparison (2018-2022, $M)



Note: Includes the Eversource planned spend for PY 2021, set forth in the GMP Extension and Funding Report, filed on July 1, 2020.

Source: Guidehouse analysis of 2021 GMP Term Report, GMP Extension and Funding Report, and 2022 EDC Data

3.2.1.5 Term 2 Infrastructure Metrics Results

Table 24 summarizes the Infrastructure Metrics results for each EDC's Communications Investment Area through PY 2022. Sections 3.2.2 through 3.2.4 explain each EDC's progress and plans in greater detail.

Table 24. Term 2 Communications Infrastructure Metrics Summary

Infrastructure Metrics*			Eversource	National Grid**	Unitil
GMP Plan Total, 2022-2025		Devices	24	2,030	260
		Spend, $M	$23.54	$102.81	$0.78
EDC Data Total, 2022-2025		Devices	24	3,220	219
		Spend, $M	$23.97	$102.80	$0.39
IM-4	Number of devices or other technologies deployed thru. PY 2022	# Devices Deployed	0	95	37
		% Devices Deployed	0%	5%	14%
IM-5	Cost for Deployment thru. PY 2022	Total Spend, $M	$0.11	$8.55	$0.21
		% Spend	0%	8%	27%
IM-6	Deviation Between Actual and Planned Deployment for PY 2022	% On Track (Devices)	0%	27%	70%
		% On Track (Spend)	3%	61%	106%
IM-7	Projected Deployment for the	# Devices Remaining	24	3,125	182

Infrastructure Metrics*		Eversource	National Grid**	Unitil
Remainder of the GMP Term	Spend Remaining, $M	$23.85	$94.25	$0.18

*The metric names have been slightly changed here to clarify the time span used in analysis.

** To more closely align spend projections with DPU pre-authorized budgets, National Grid operations and maintenance (O&M) spend is included in actual and planned spend presented here. O&M spend is provided in aggregate for each investment area and is therefore excluded from device-specific summaries of spend.

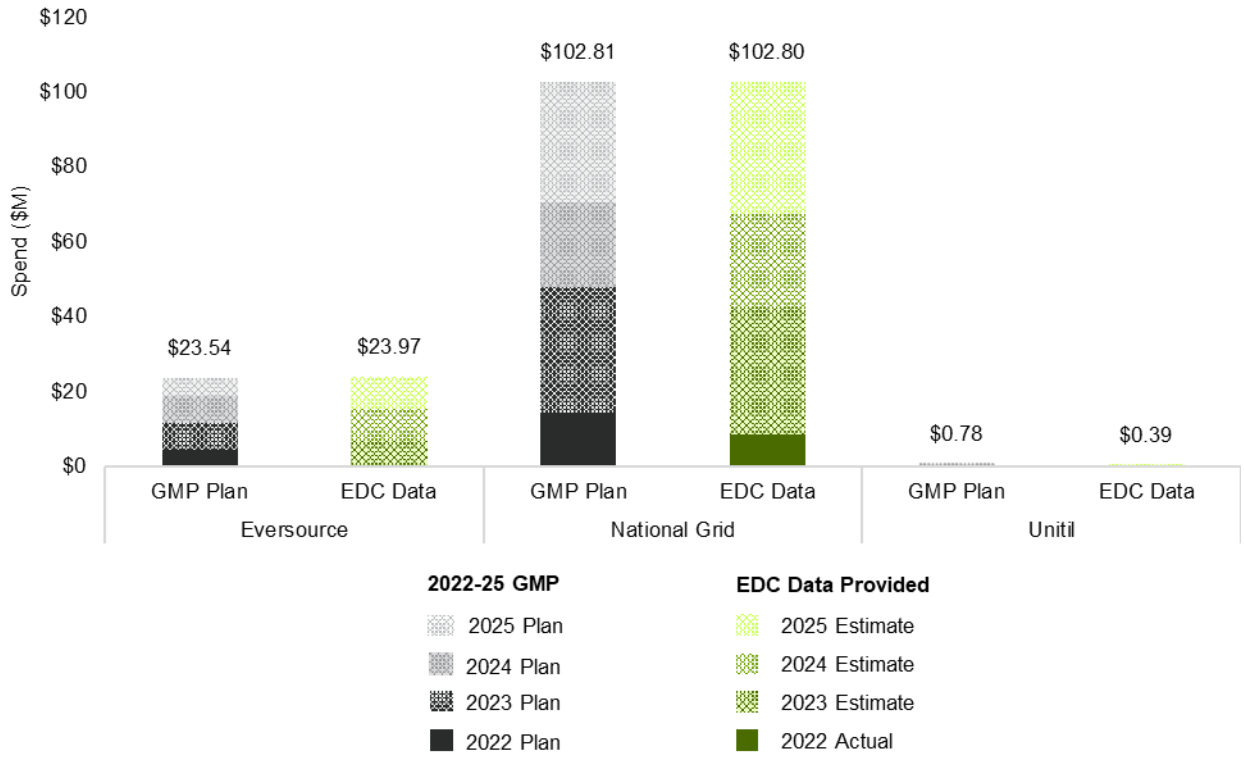
Source: Guidehouse analysis of 2021 DOER Responses and 2022 EDC Data

No actual device deployment and very little spend occurred for Eversource in PY 2022, largely due to a pause in deployment of some device types while awaiting approval from DPU to proceed with proposed plan. National Grid planned to deploy 347 node devices in PY 2022 but only deployed 97 devices due to delays in procurement; National Grid spend exceeded the plan by 51%, this was attributed to how the aggregation of reported spend across all Communications was tracked in its system. Unitil had delays in device deployment (see IM-6 in Table 34) due to delays in VVO progression.

The estimated units deployment for the 4-year Term is below the previous plan with far less than planned PY 2022 device deployment across Eversource and National Grid and slightly less deployment for Unitil. Eversource spent far less in PY 2022 than indicated in the previous plan, whereas National Grid reported higher spend on Term 2 activities in PY 2022 and Unitil met its planned spend target.

Figure 6 compares the GMP plans and EDC data totals and year-over-year spending for each EDC.

Figure 6. Term 2 Communications Comparison (2022-2025, $M)



Note: To more closely align spend projections with DPU pre-authorized budgets, National Grid operations and maintenance (O&M) spend is included in actual and planned spend presented here. O&M spend is provided in aggregate for each investment area and is therefore excluded from device-specific summaries of spend.

Source: Guidehouse analysis of DPU Order (October 7, 2022) and 2022 EDC Data

3.2.2 Eversource

This section discusses Eversource's Comms investment progress through PY 2022 for the following Terms:

- Term 1 Progress: a comparison of progress Eversource made in 2022 against its plans detailed in its *2021 GMP Term Report*. These results consider only the deployment and spending that were planned in 2021 to be carried over into 2022.
- Term 2 Progress: a comparison of progress Eversource made towards its 2022 plans outlined in its *2022-2025 GMP Plan.* These results do not consider deployment or spending that were planned in 2021 to be carried over into 2022.

3.2.2.1 Overview of GMP Deployment Plan

For Term 1, Eversource's GMP deployment plan, as articulated in its *2020 GMP Annual Report*, included a $5.1 million investment in a high-bandwidth communications network to enable near real-time data flows between the field devices and control systems. Eversource proposed enhanced bandwidth and data speeds for both fiber and radio networks across the service

territory. These upgraded communications capabilities will support the company's suite of grid modernization investments, in addition to existing infrastructure. This network investment is designed to enable and support ADA, M&C, and VVO functionalities.

Eversource's FAN coverage enhancement strategy is to install additional master radios (base stations) at new and existing locations. Our high-level evaluation, performed by reviewing a sample of communications coverage maps, determined that the greater number of master radio sites will improve the latency and overall performance of the communications network.

The radio nodes investment is focused on installing additional radio master nodes at existing radio tower sites, with different frequencies, or installing master radio at new base stations to expand coverage and reduce latency. Eversource is utilizing several licensed and unlicensed frequencies. These include a licensed private 900 MHz frequency, an unlicensed 900 spread spectrum frequency and a licensed 450 MHz frequency. ADA and M&C investment data is transmitted from the local device to the radio base station, then backhauled via the WAN fiber network to the GE distribution automation concentrators or the new front-end processors ("FEP") of the enterprise energy control system ("eECS"), and then displayed on SCADA screens for operator control.

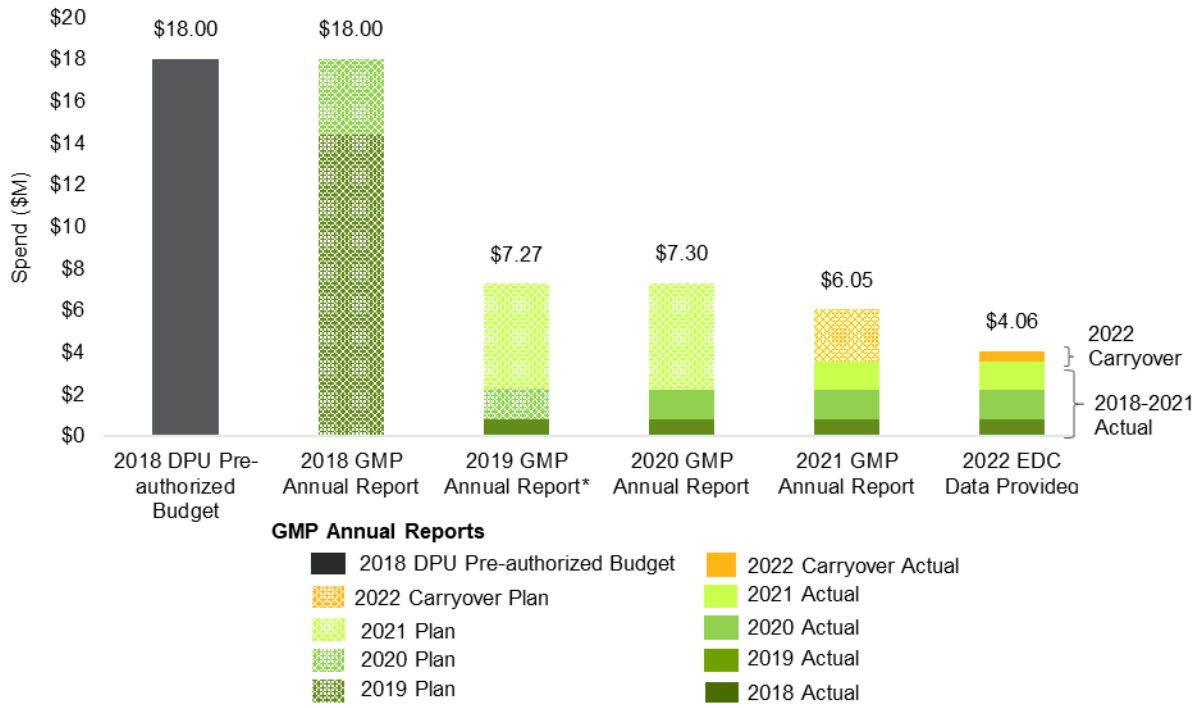
For Term 2, Eversource's GMP deployment plan, as articulated in its 2022-2025 GMP, is allocating $24 million over the 2022-2025 Term to Wireless Communications Improvements focused on enabling DMS, Substation Automation, PQ Monitoring, VVO, Dynamic DER Interface, and DERMS. Eversource's 2022-2025 GMP FAN strategy will focus on the build out of a private radio network, which will include the design of a comprehensive network of new base radios in Eastern and Western Massachusetts. This buildout will include the commissioning of approximately 24 new base radios enabling approximately 50 related remote terminal units per base station.

Eversource plans to spend an additional $14 million on Communication System Modernization over the 2022-2025 4-year Term. As a part of that effort, Eversource will plan the transition to internet protocol (IP) on its FANs and eliminate GE D200 data concentrators along the communications path. This will include a serial to IP migration plan that will replace the serial-connected field devices with IP-based distributed network protocol connections.

3.2.2.2 Term 1 Communications Deployment Plan Progression

Figure 7 shows the progression of Eversource's Communications deployment plans from DPU-preauthorization in 2018 through PY 2022.

Figure 7. Term 1 Eversource Communications Planned vs. Actual Spend, $M



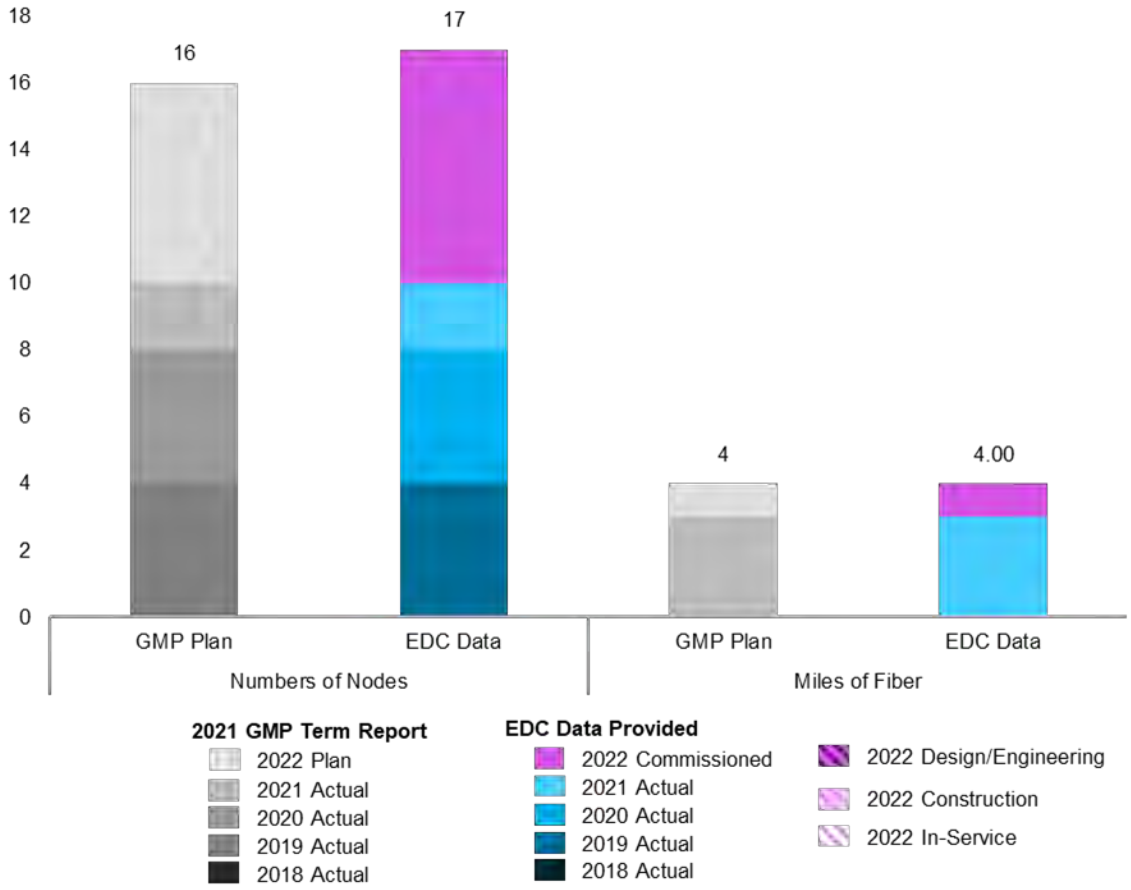
Source: Guidehouse analysis of DPU Order (May 10, 2018), 2018-2021 GMP Reports, Eversource GMP Extension and Funding Report filed on July 1, 2020, and *2022 EDC Data*

During PY 2022, Eversource spent about $2 million less than the PY 2022 planned spend. This was primarily due to over-estimation of the PY 2022 budget and lower-than-expected costs due to delays in field equipment cutovers to the new 450MHz master radio system. Overall, 4-year actual spending was significantly under the 4-year planned spending indicated in the 2021 GMP Annual Report.

3.2.2.3 Term 1 Communications Investment Progress through PY 2022

Overall, the number of nodes deployed slightly exceeded plans for PY 2022. Figure 8 shows the progress and details of node and fiber deployment for the 2018-2022 period.

Figure 8. Term 1 Eversource Communications Planned vs. Actual Deployment (2018-2022, Unit Count)



Source: Guidehouse analysis of 2021 GMP Term Report and 2022 EDC Data

The EDC Data presented in Figure 8 is also shown in tabular form in Table 25 to provide the specific deployment units in each category.

Table 25. Term 1 Eversource Communications Plan & Actual Device Deployment (2018-2022)

	Numbers of Nodes	Miles of Fiber
2018-2022 Total	**17**	**4**
Engineering/Design during PY 2022*	0	0
Construction during PY 2022*	0	0
In-Service during PY 2022*	0	0
Commissioned in PY 2022	7	1
Commissioned in PY 2021	2	3
Commissioned in PY 2020	4	0
Commissioned in PY 2019	4	0
Commissioned in PY 2018	0	0

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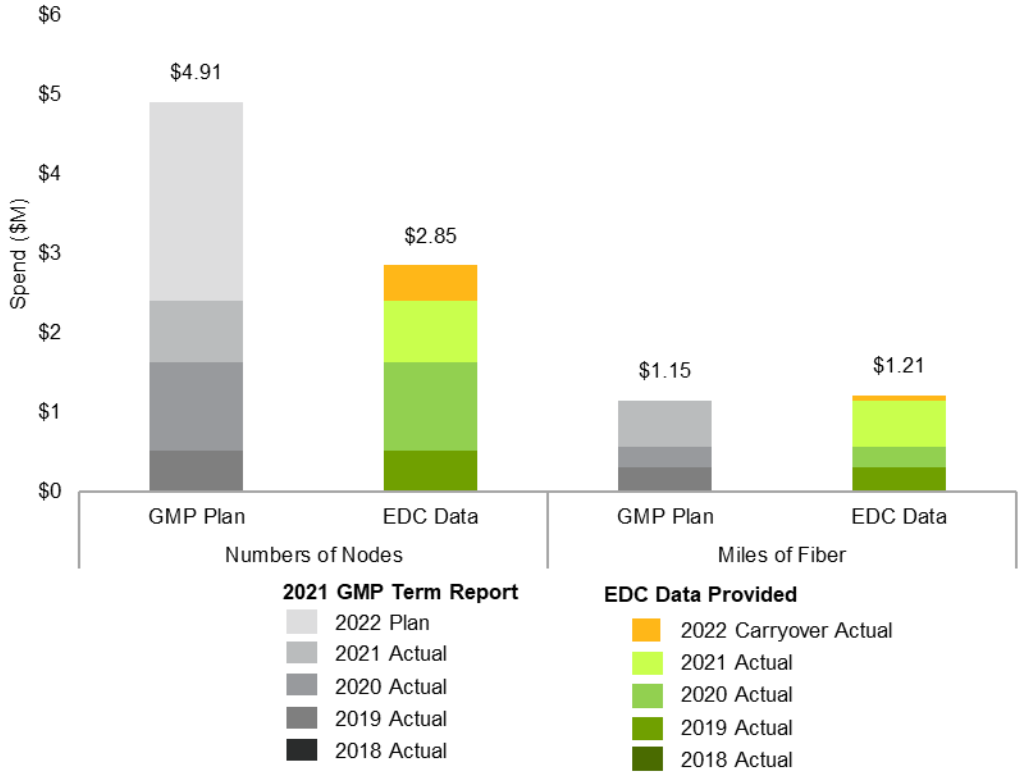
*Deployment of these devices began during PY 2022, but was not completed during the program year. All units and dollars spent to deploy remaining units during 2023 through 2025 will be considered as part of Term 2 GMPs.

Source: Guidehouse analysis of 2021 GMP Term Report and 2022 EDC Data

Eversource completed more master radio node projects in PY 2022 (a total of 7 projects) than what was originally planned (6 projects). The extra master radio project was Term 1 from PY 2020 that was delayed to PY 2022 due to ongoing efforts to commission the Eastern Massachusetts 450MHz backbone. Through the end of 2022, Eversource had deployed a total of 17 nodes, slightly more than the GMP plan. In addition to master radio node projects, Eversource ultimately deployed miles of fiber (4 miles) in line with their revised estimate for fiber (4 miles).

Figure 9 shows Eversource's corresponding planned versus actual spend over the 2018-2022 Term period, broken out into node spend and fiber spend.

Figure 9. Term 1 Eversource Communications Spend Plan vs. Actual (2018-2022, $M)



Source: Guidehouse analysis of 2021 GMP Term Report and 2022 EDC Data

The EDC Data presented in Figure 9 is also shown in Table 26 to provide the specific dollar spend in each category.

Table 26. Term 1 Eversource Communications Plan and Actual Spend (2018-2022, $M)

	Numbers of Nodes	Miles of Fiber
2018-2022 Total	**$2.85**	**$1.21**
PY 2022 Actual	$0.44	$0.06

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	Numbers of Nodes	Miles of Fiber
PY 2021 Actual	$0.78	$0.58
PY 2020 Actual	$1.11	$0.26
PY 2019 Actual	$0.52	$0.31
PY 2018 Actual	$0.00	$0.00

Source: Guidehouse analysis of 2021 GMP Term Report and 2022 EDC Data

Actual spending on nodes was $2 million below the initial plan, driven by overestimation and lower costs associated with delayed field equipment. Fiber spend in PY 2022 is slightly above planned spend, driven by higher than planned deployment of fiber for the master radio system. Spending was less than planned for nodes due to over-estimation of the PY 2022 budget as well as lower-than-expected costs caused by delays in field equipment cutovers to the new 450MHz system. Additionally, Eversource's planned master radio node location at Orleans station was cancelled due to the extensive amount of time it would have taken to complete the radio shelter and infrastructure upgrades, further decreasing spend.

3.2.2.4 Term 1 Infrastructure Metrics Results and Key Findings

Table 27 presents the Infrastructure Metrics results through PY 2022 for each device type related to Eversource's Comms Investment Area.

Table 27. Term 1 Eversource Communications Infrastructure Metrics Summary

Infrastructure Metrics*			Numbers of Nodes	Miles of Fiber
GMP Plan Total, 2018-2022		# Devices Planned	16	4
		Spend, $M	$4.91	$1.15
IM-4	Number of devices or other technologies deployed thru. PY 2022	# Devices Deployed	17	4
		% Devices Deployed	106%	100%
IM-5	Cost for Deployment thru. PY 2022	Total Spend, $M	$2.85	$1.21
		% Spend	58%	106%
IM-6	Deviation Between Actual and Planned Deployment for PY 2022	% On Track (Devices)	117%	100%
		% On Track (Spend)	18%	N/A
IM-7	Projected Deployment for the remainder of the GMP Term (i.e., Term 1)**	# Devices Remaining	0	0
		Spend Remaining, $M	$0.00	$0.00

*The metric names have been slightly changed here to clarify the time span used in analysis.

** This metric has been interpreted here (i.e., within the context of the 2022 Program Year Evaluation) as the units and spending that the EDC plans to complete their most recent 4-year Term 1 plans. Additional Grid Modernization units and dollars incurred in 2022 are attributed to Term 2, as appropriate, and all units and dollars spent during 2023 through 2025 will be considered as part of Term 2 GMPs.

Source: Guidehouse analysis of 2021 GMP Term Report and 2022 EDC Data

Eversource's node deployment through PY 2022 (Table 27, IM-4) was essentially on target at 6% higher than originally planned. Fiber deployment was 47% higher than planned due to the amount of fiber required to complete the project. Costs for nodes were about 41% under prior plan spending and fiber about 5% over prior plan spending.

3.2.2.5 Term 2 Communications Deployment Progress through PY 2022

Figure 10 shows the progression of Eversource's Communications deployment plans through PY 2025.

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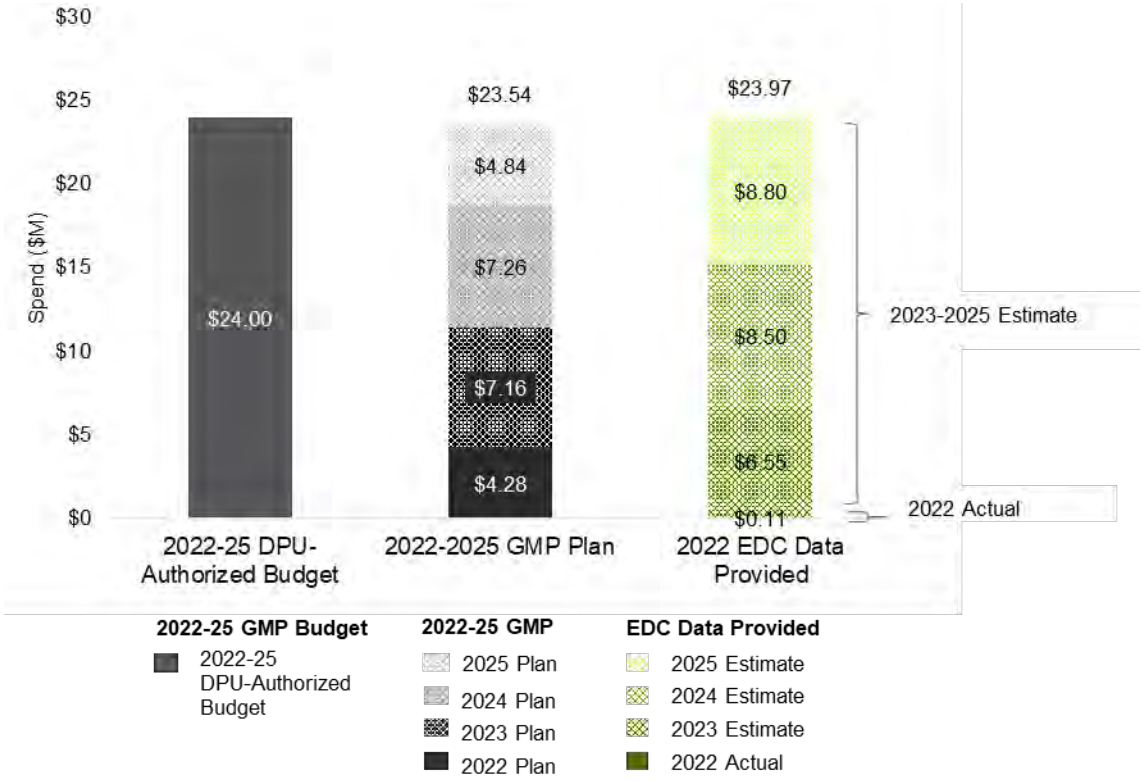
Figure 10. Term 2 Eversource Communications Planned and Actual Spend Progression, $M



Source: Guidehouse analysis of DPU Order (October 7, 2022), DOER Responses, and 2022 EDC Data

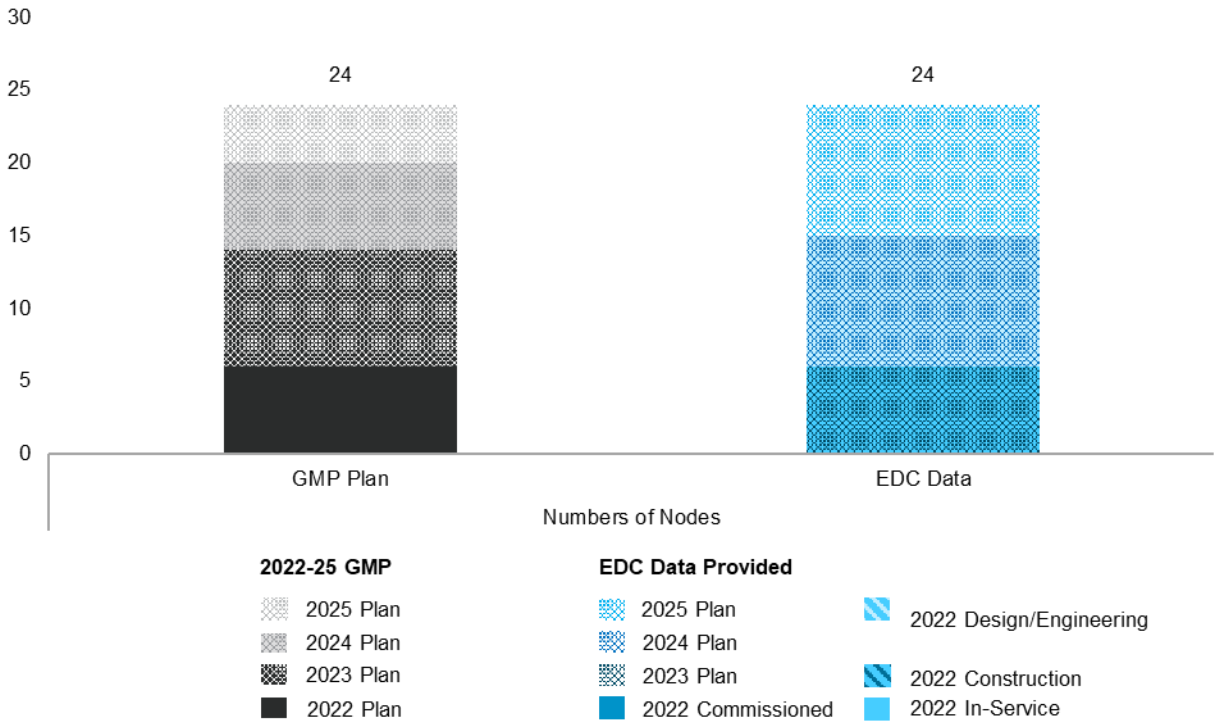
During PY 2022, Eversource spent about $4 million less than PY 2022 planned spend, with most of the remaining budget being carried over into 2023. Overall 4-year spending (i.e., 2022 actual plus 2023 through 2025 estimates) is about the same as the 4-year planned spending indicated in the 2021 GMP Term Report.

3.2.2.6 Term 2 Communications Investment Progress through PY 2022

No communications devices were deployed in PY 2022, which fell below plans for the year. Figure 11 shows planned versus actual device deployment progress for PY 2022, as well as planned investment for PY 2023 through PY 2025.

Deployment of node projects was paused while Eversource waited for program approval by the DPU. Eversource focused on engineering and design activities as well as procurement packages to ensure the beginning of deployment in 2023.

Figure 11. Term 2 Eversource Communications Device Deployment Comparison (2022-2025)



Source: Guidehouse analysis of DOER Responses and 2022 EDC Data

Eversource plans to increase the number of node project deployments between 2023 and 2025, with expectations to still meet GMP Plan despite no deployment occurring in PY 2022.

The EDC Data presented in Figure 11 is also shown in tabular form in Table 28 to provide the specific deployment units in each category.

Table 28. Term 2 Eversource Communications Plan & Actual Device Deployment (2022-2025)

	Numbers of Nodes
2022-2025 Planned Deployment	**24**
PY 2025 Planned	9
PY 2024 Planned	9
PY 2023 Planned	6
Commissioned in PY 2022	0
In-Service during PY 2022	0
Construction during PY 2022	0
Engineering/Design during PY 2022	0

Source: Guidehouse analysis of 2022 EDC Data

All spend in PY 2022 was focused on developing procurement and design packages and securing vendor material.

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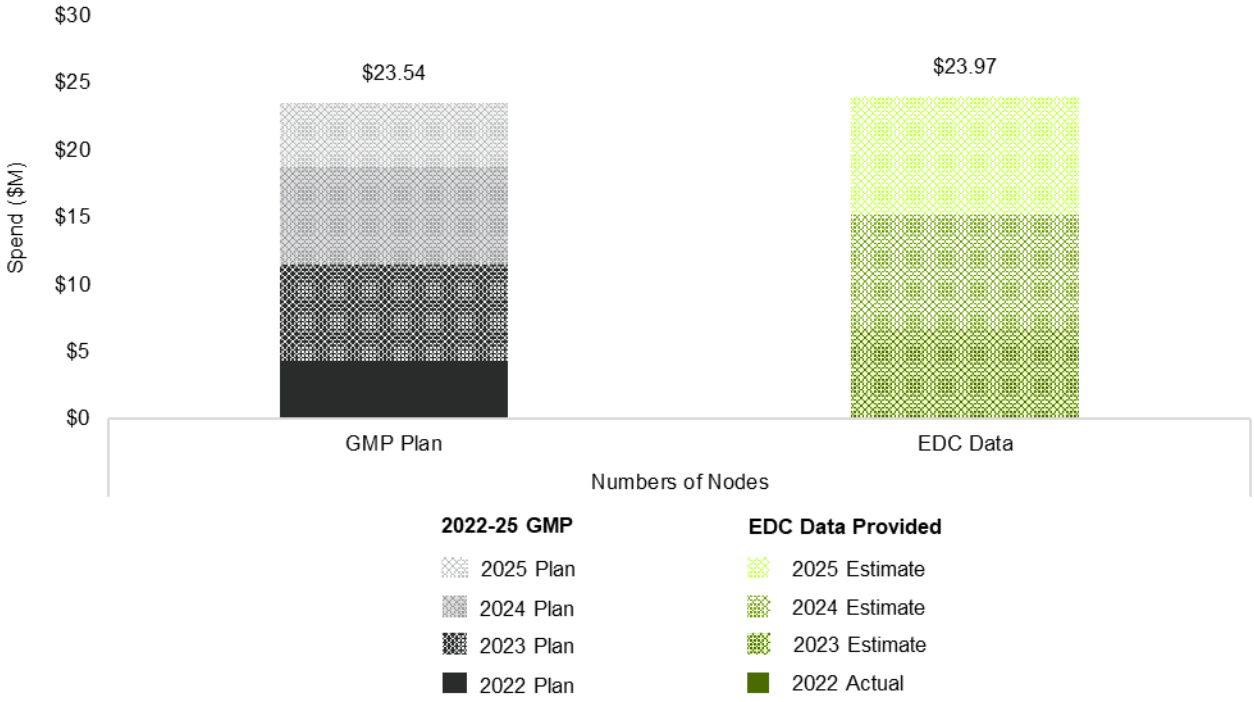
Figure 12 shows Eversource's corresponding planned versus actual spend for PY 2022, as well as planned investment for PY 2023 through PY 2025, broken out by device type.

Figure 12. Term 2 Eversource Communications Spend Plan vs. Actual (2022-2025, $M)



Source: Guidehouse analysis of DOER Responses and 2022 EDC Data

The EDC Data presented in Figure 12 is also shown in Table 29 to provide the specific dollar spend in each category.

Table 29. Term 2 Eversource Communications Plan and Actual Spend (2022-2025, $M)

	Nodes
2022-2025 Planned Spend	**$23.97**
PY 2025 Planned	$8.80
PY 2024 Planned	$8.50
PY 2023 Planned	$6.55
PY 2022 Actual	$0.11

Source: Guidehouse analysis of 2022 EDC Data

3.2.2.7 Term 2 Infrastructure Metrics Results and Key Findings

Table 30 presents the Infrastructure Metrics results through PY 2022 for each device type related to Eversource's Communications Investment Area.

Table 30. Term 2 Eversource Communications Infrastructure Metrics Summary

Infrastructure Metrics*		Nodes
GMP Plan Total, 2022-2025	# Devices Planned	24

Infrastructure Metrics*		Nodes	
		Spend, $M	$23.54
EDC Data Total, 2022-2025		# Devices Planned	24
		Spend, $M	$23.97
IM-4	Number of devices or other technologies deployed thru. PY 2022	# Devices Deployed	0
		% Devices Deployed	0%
IM-5	Cost for Deployment thru. PY 2022	Total Spend, $M	$0.11
		% Spend	0%
IM-6	Deviation Between Actual and Planned Deployment for PY 2022	% On Track (Devices)	0%
		% On Track (Spend)	3%
IM-7	Projected Deployment for the Remainder of the GMP Term	# Devices Remaining	24
		Spend Remaining, $M	$23.85

Source: Guidehouse analysis of DOER Responses and 2022 EDC Data
*The metric names have been slightly changed here to clarify the time span used in analysis.

Eversource's device deployment through PY 2022 was 0% of 2022 GMP Plan for node deployment. Actual spend in PY 2022 was entirely for procurement and design packages and vendor identification to prepare for PY 2023 deployment plans, with overall spend less than 97% of prior plan spending.

3.2.3 National Grid

This section discusses National Grid's planned and actual Communications investment progress through PY 2022.

3.2.3.1 Overview of GMP Deployment Plan

In Term 1, National Grid's legacy communications system consisted of a fiber optics network for a limited number of its substations, and a public cellular network to monitor and operate field devices. Recognizing that advanced GMP functions require a modern, reliable communications network, National Grid proposed to modernize its communications network as part of its GMP investments. National Grid's GMP communications proposal included backhaul (WAN) networks from substation using fiber optics or other communication means, transition to Multi-Protocol Label Switching (MPLS) which is protocol-independent and highly scalable multiplexing equipment, determining the requirements of a field-based (FAN) wireless communication network, and software to support the planning, development, and monitoring of its communication infrastructure.

In Term 2, National Grid will focus on investments to connect National Grid IT/OT infrastructure with field devices in the service territory. The existing communications network will be upgraded and expanded to support future grid modernization and enable greater reliability, control, monitoring, and security of the assets. National Grid's investments will consist of installing additional backhaul networks, substation fiber, a multi-tiered (private and public network) field based wireless communications. The existing communication networks include private fiber and microwave, along with commercial telecommunication carrier wireline and wireless services. In addition, an Integrated Network Operations Center (INOC) will be developed. The INOC is a central location from which network administrators manage, control, troubleshoot and monitor

one or more networks. The overall function is to maintain optimal network performance across a variety of platforms, mediums, networks, network segments and communications channels.

National Grid GMP stated goals and objectives for Term 2 are:

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

National Grid has chosen a Multi-Protocol Label Switching (MPLS), which is protocol-independent and highly scalable to replace its current DMX system, which is nearing end-of-life. For its FAN assets, National Grid is evaluating a private FAN to augment the existing cellular network. As a part of these modernizing efforts, National Grid's Term 2 Communications investments will focus on tele-protection (redundant path) upgrades, Analog DS0 Leased Circuit Replacements, Tier 3 Radio Sites, and DMX Node Replacement.

3.2.3.2 Term 2 Communications Deployment Plan Progression

Figure 13 shows the progression of National Grid's GMP Term 2 Communications deployment plans from DPU-pre-authorization covering PY 2022-2025. National Grid has spent $8.55 million through PY 2022 out of the DPU pre-authorized budget of $102M.

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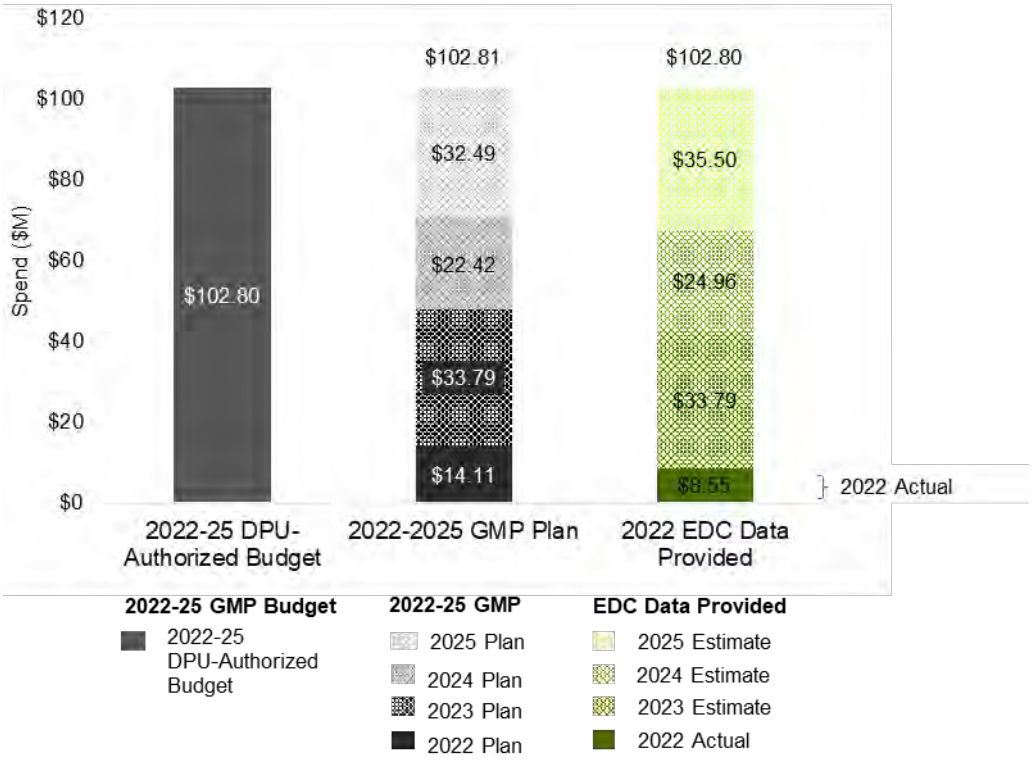
Figure 13. Term 2 National Grid Communications Planned and Actual Spend Progress ($M)



Note: To more closely align spend projections with DPU pre-authorized budgets, National Grid operations and maintenance (O&M) spend is included in actual and planned spend presented here. O&M spend is provided in aggregate for each investment area and is therefore excluded from device-specific summaries of spend.

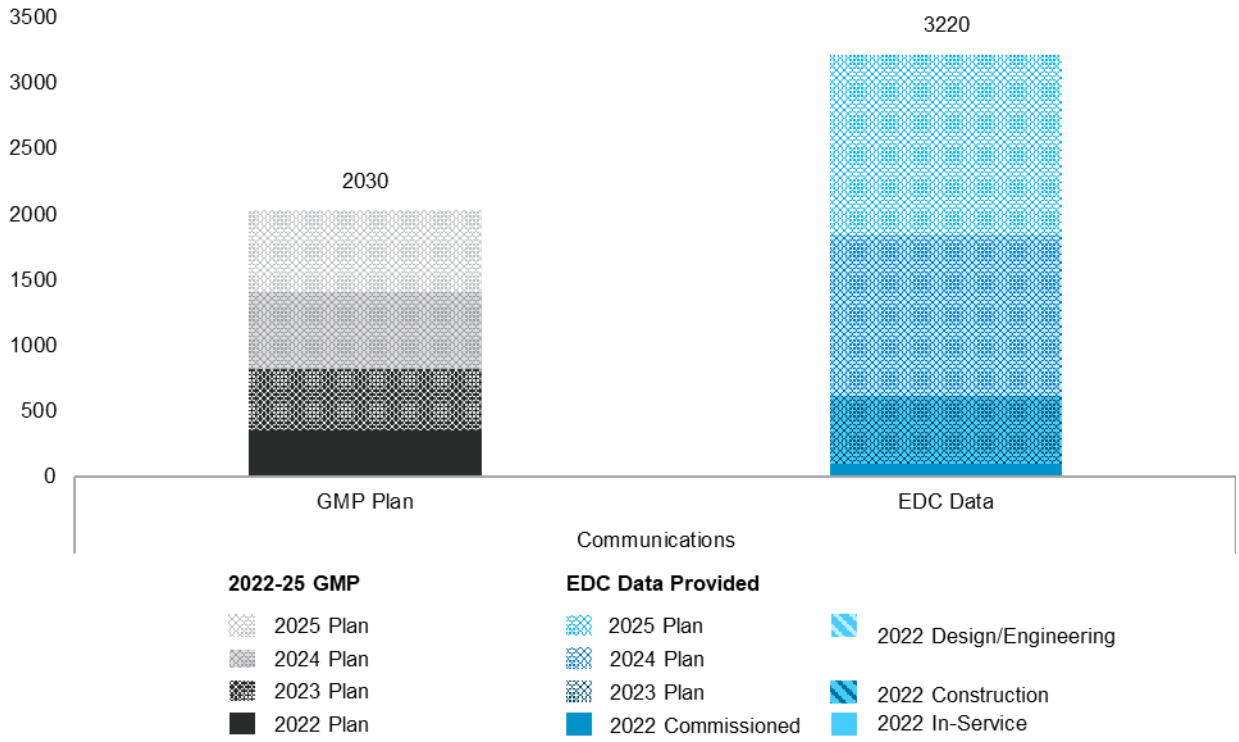
Source: Guidehouse analysis of DPU Order (October 7, 2022), DOER Responses and 2022 EDC Data

3.2.3.3 Term 2 Communications Investment Progress through PY 2022

National Grid's Term 2 Communications investment consists of five elements: communications nodes, fiber optics, FAN wireless tower sites, spectrum acquisition, and INOC. Delays in VVO, M&C, and ADA investments, which require Communications Nodes, coupled with procurement delays for long-lead items such as fiber-optic cable resulted in lower than planned deployment in PY 2022.

Figure 14 shows planned versus actual device deployment progress for PY 2022, as well as planned investment for PY 2023 through PY 2025.

Figure 14. Term 2 National Grid Communications Device Deployment Comparison (2022-2025)



Note: INOC is not tracked on a per-unit basis

Source: Guidehouse analysis of DOER Responses and 2022 EDC Data

Some devices that were planned for deployment in PY 2022 were still in the engineering/design phase at the end of the year. National Grid plans on allocating spend in the 2023 to 2025 period to commission devices originally planned for PY 2022 and complete deployments to help meet previously planned device deployment goals.

The EDC Data presented in Figure 14. Term 2 National Grid Communications Device Deployment Comparison (2022-2025) is also shown in Table 31 below.

Table 31. Term 2 National Grid Communications Plan and Actual Device Deployment (2022-2025)

	Communications
2022-2025 Planned Deployment	**3,220**
PY 2025 Planned	1,376
PY 2024 Planned	1,226
PY 2023 Planned	523
Commissioned in PY 2022	95
In-Service during PY 2022	69
Construction during PY 2022	162
Engineering/Design during PY 2022	128

Source: Guidehouse analysis of 2022 EDC Data

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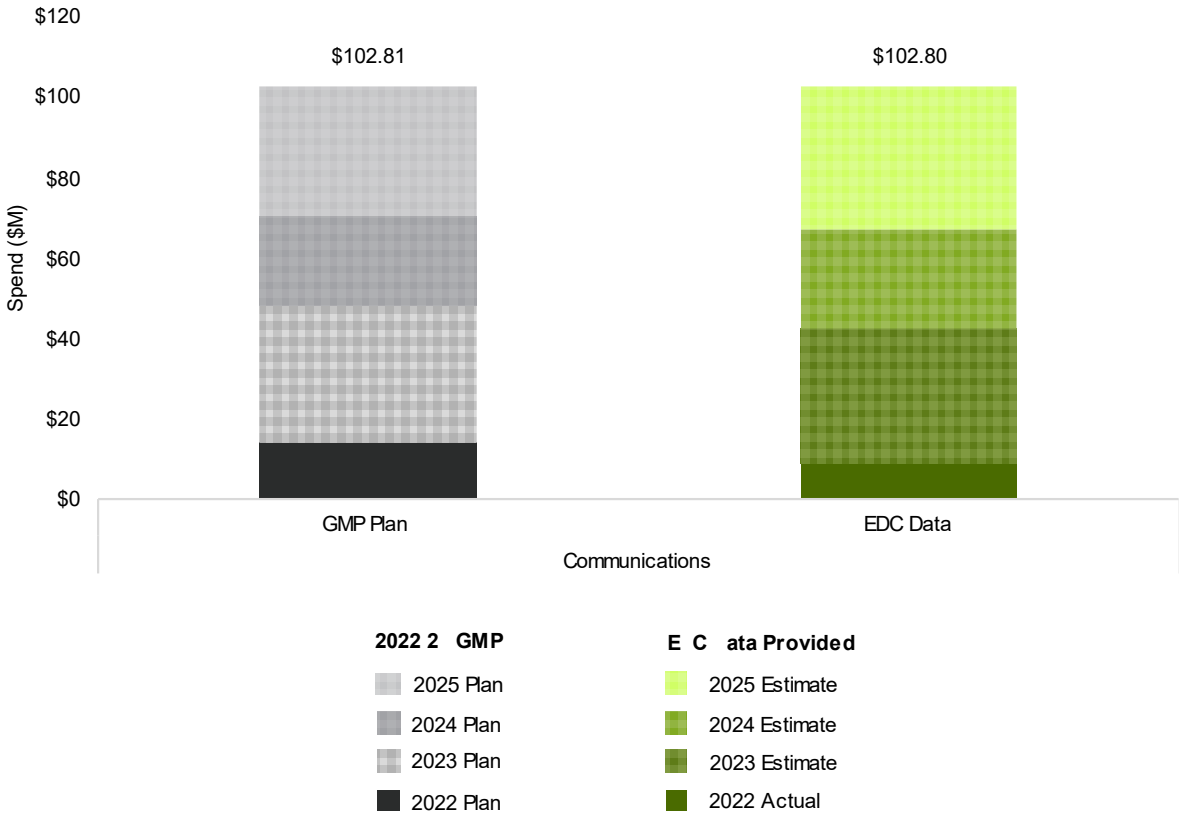
National Grid deployed 95 nodes in PY 2022, which is fewer than the previous plan of 347, due primarily to delays in the deployment of VVO, M&C, and ADA devices that require communications nodes. The remaining 279 nodes are either in their engineering/design or construction phases and are planned to be commissioned in 2023. National Grid plans on deploying 1,194 more nodes than its prior plan to account for increases in planned devices for VVO, ADA, and M&C deployment; the remaining 2,970 node projects are planned to be deployed between 2023 and 2025.

Figure 15 shows National Grid's planned versus actual spend for PY 2022, as well as planned investment for PY 2023 through PY 2025. Spend data provided for PY 2022 was aggregated across all Communications device categories. As such, Guidehouse has provided a summary of planned versus actual spend for the Communications investment area overall. Total spend on the Communications investment area ($7.75M) was below plans for PY 2022 ($12.08M).

Figure 15. Term 2 National Grid Communications Spend Plan vs. Actual (2022-2025, $M)



Note: To more closely align spend projections with DPU pre-authorized budgets, National Grid operations and maintenance (O&M) spend is included in actual and planned spend presented here.

Source: Guidehouse analysis of DOER Responses and 2022 EDC Data

The EDC Data presented in Figure 15 is also shown in Table 32.

Table 32. Term 2 National Grid Communications Plan and Actual Spend (2022-2025, $M)

	Communications
2022-2025 Planned Spend	**$102.80**

	Communications
PY 2025 Planned	$35.50
PY 2024 Planned	$24.96
PY 2023 Planned	$33.79
PY 2022 Actual	$8.55

Source: Guidehouse analysis of 2022 EDC Data

3.2.3.4 Term 2 Infrastructure Metrics Results and Key Findings

Table 33 presents the Infrastructure Metrics results through PY 2022 for National Grid's communications investment.

Table 33. Term 2 National Grid Communications Infrastructure Metrics Summary

Infrastructure Metrics*			Communications
GMP Plan Total, 2022-2025		# Devices Planned	2,030
		Spend, $M	$102.81
EDC Data Total, 2022-2025		# Devices Planned	3,220
		Spend, $M	$102.80
IM-4	Number of devices or other technologies deployed thru. PY 2022	# Devices Deployed	95
		% Devices Deployed	5%
IM-5	Cost for Deployment thru. PY 2022	Total Spend, $M	$8.55
		% Spend	8%
IM-6	Deviation Between Actual and Planned Deployment for PY 2022	% On Track (Devices)	27%
		% On Track (Spend)	61%
IM-7	Projected Deployment for the Remainder of the GMP Term	# Devices Remaining	3,125
		Spend Remaining, $M	$94.25

Source: Guidehouse analysis of DOER Responses and 2022 EDC Data
*The metric names have been slightly changed here to clarify the time span used in analysis.

Overall, National Grid's Communications progress is behind what was planned for PY 2022, with both spend and deployment below plans. The primary cause of deployment delays and shortfalls was delays in the deployment of other investment area devices that require communications nodes. These delays pushed deployment of 252 node projects as well as 3 miles of fiber into 2023. By the end of PY 2022, National Grid was in the engineering/design or construction phases for the remaining 252 nodes planned for PY 2022 and plans to carry this work into 2023. So far, 95 nodes have been deployed since the beginning of the 4-year term. Deployment of other device types is still expected to meet plan between 2023 and 2025. Given lower spend than plan for PY 2022, National Grid plan spend was increased across PY 2023 – PY 2025 to match the DPU pre-authorized budget.

3.2.4 Unitil

This section discusses Unitil's planned and actual Communications investment progress through PY 2022.

3.2.4.1 Overview of GMP Deployment Plan

For Term 1, Unitil's legacy communications network consisted of a combination of public cellular and land-line telecommunications services, and power-line carrier (PLC) technology for its AMI endpoints. This existing communications network was inadequate to support GMP functions including M&C and VVO. In its GMP, Unitil proposed to build a FAN for communications

between collectors and endpoint devices, and a WAN for the backhaul of communications from substations to the central office.

Unitil determined that a private network offered by AT&T, called FirstNet, would be its path forward for its FAN. With this approach the construction of a WAN was no longer required since the backhaul was provided within the AT&T network. During 2020, Unitil entered into contract with AT&T for the FAN, and with installation providers for the backhaul connections and routers between AT&T and Unitil. In 2021, Unitil set up the backhaul fiber optics connections to AT&T, the cellular provider. This work required the installation of routers and fiber optic connections to existing fiber optics cables at Exeter and Hampton locations in New Hampshire.

To assure proper operations, Unitil performed "bench testing" of the radio equipment integrated with devices that was to be installed in the field. A rollout process was validated and documented. In the 2nd quarter of 2021 Unitil deployed the FirstNet field radios. The communications rollout plan is in sequence and timing to support the VVO GMP investment. The field deployments to support the VVO project were on the Townsend circuits. This enabled 22 field devices to send data to the AT&T FirstNet communications and then to the ADMS.

For Term 2, Unitil will largely continue progressing with the same projects it pursued in GMP Term 1. All planned nodes will continue supporting VVO deployment and will follow the VVO schedule accordingly.

3.2.4.2 Term 2 Communications Deployment Plan Progression

Figure 16 shows the progression of Unitil's Communications Term 2 deployment plans from DPU pre-authorization for 2022 through PY 2025. Unitil has spent $0.2 million through PY 2022 out of the DPU pre-authorized budget of $0.82M.

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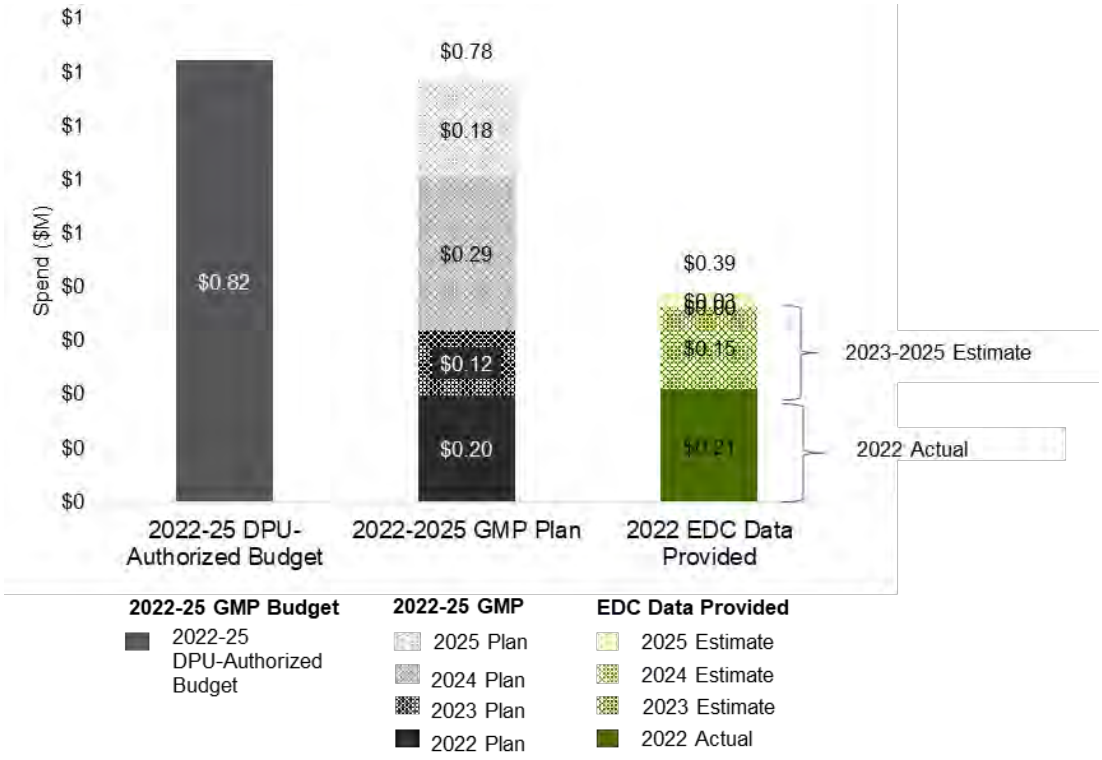
Figure 16. Term 2 Unitil Communications Planned and Actual Spend Progression, $M



Source: Guidehouse analysis of DPU Order (October 7, 2022), DOER Responses, and *2022 EDC Data*

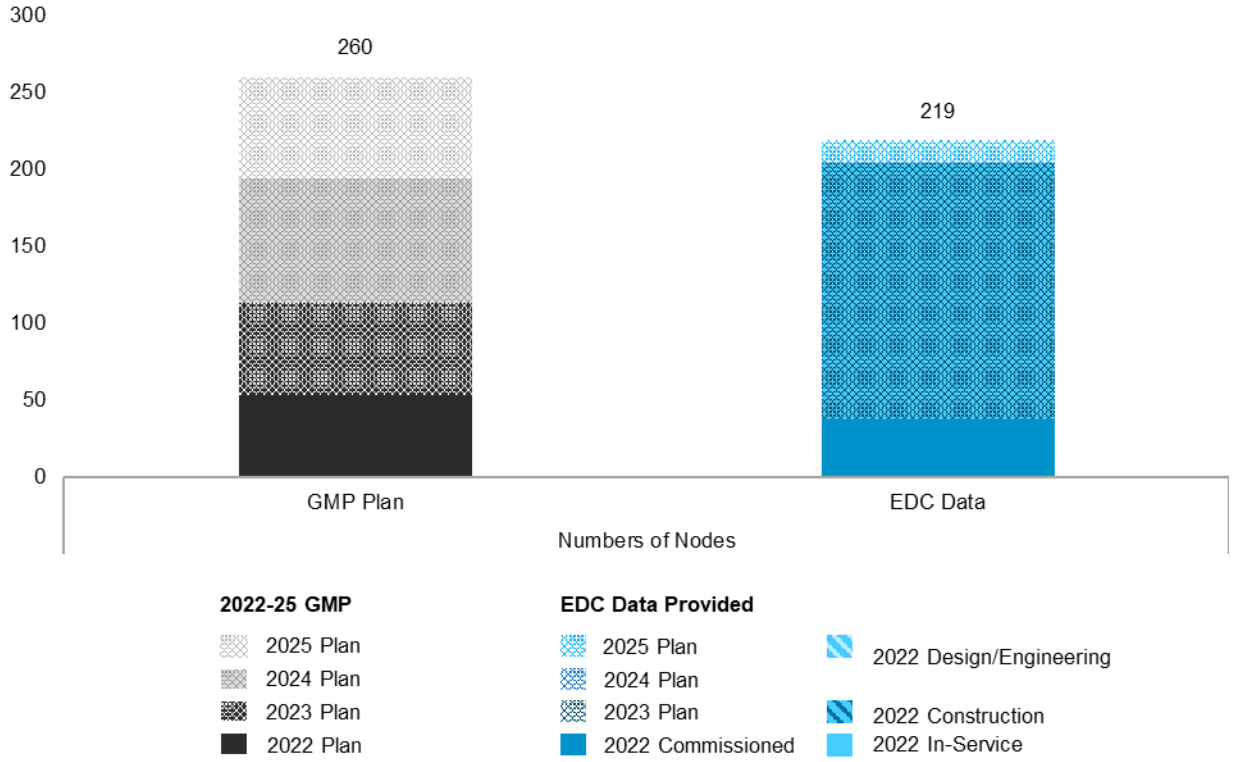
3.2.4.3 Term 2 Communications Investment Progress through PY 2022

Deployment and spend for 2022 Communications investments were approximately on-track with initial plans. Accomplishments in 2022 included improvement of internal processes which resulted in lower costs for node project deployment.

Figure 17 shows planned versus actual device deployment progress for PY 2022, as well as planned investment for PY 2023 through PY 2025.

In PY 2022, Unitil's progress toward node project deployment was slightly lower than planned, largely due to delays in VVO device deployment as well as Unitil pausing deployment until it received approval of plans from DPU. All node deployment supports VVO deployment, so Communications spend and deployment is tied to the VVO schedule.

Figure 17. Term 2 Unitil Communications Device Deployment Comparison (2022-2025)



Source: Guidehouse analysis of DOER Responses and *2022 EDC Data*

The EDC Data presented in Figure 17 is also shown in Table 34.

Table 34. Term 2 Unitil Communications Plan and Actual Device Deployment (2022-2025)

	Numbers of Nodes
2022-2025 Planned Deployment	**219**
PY 2025 Planned	14
PY 2024 Planned	1
PY 2023 Planned	167
Commissioned in PY 2022	37
In-Service during PY 2022	9
Construction during PY 2022	74
Engineering/Design during PY 2022	1

Source: Guidehouse analysis of 2022 EDC Data

Unitil spend and deployment for nodes projects in PY 2022 went largely according to plan. FAN system installation closely followed VVO progression, which faced delays due to software algorithm issues, but ultimately installed 37 nodes compared to the original 22 planned node projects for PY 2022. Figure 18 shows Unitil's planned versus actual spend over the 2022-2025 period. The EDC data presented in Figure 18 is also shown in Table 35.

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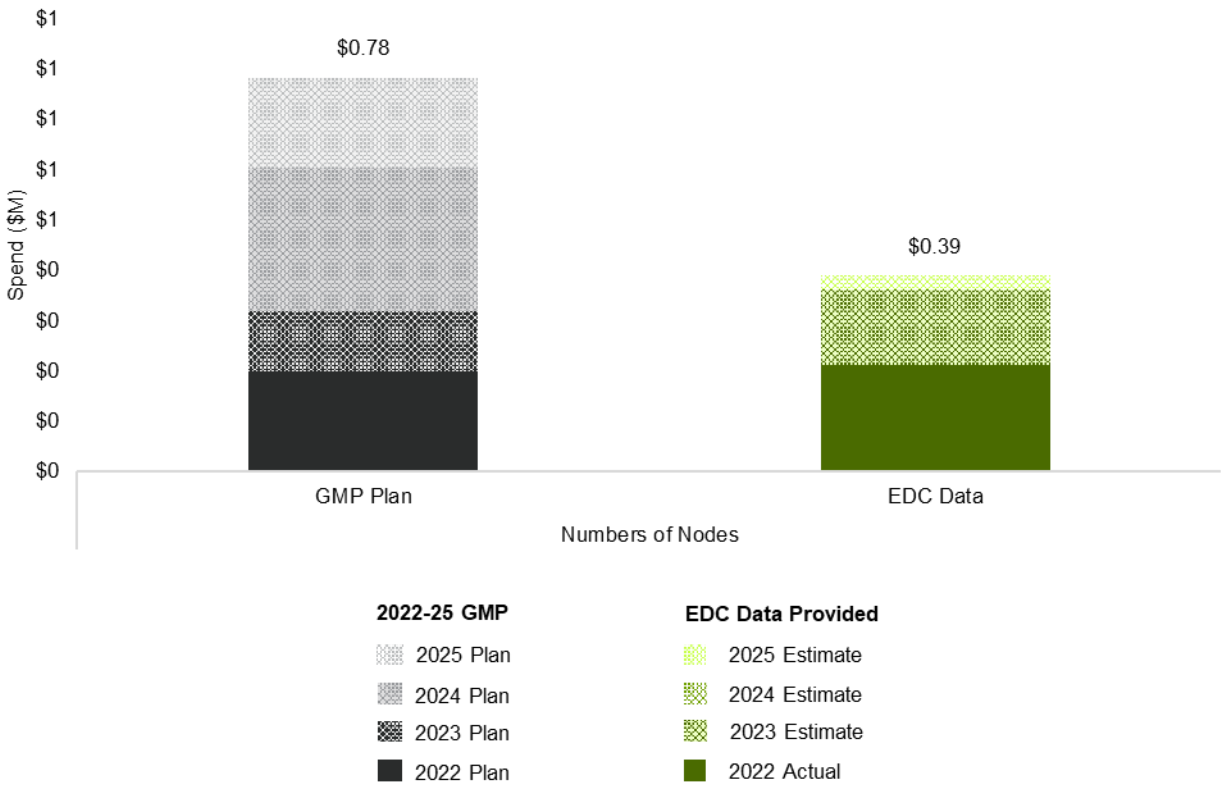
Figure 18. Term 2 Unitil Communications Spend Plan vs. Actual (2022-2025, $M)



Source: Guidehouse analysis of DOER Responses and 2022 EDC Data

Table 35. Term 2 Unitil Communications Plan and Actual Spend (2022-2025, $M)

	Numbers of Nodes
2022-2025 Planned Spend	**$0.78**
PY 2025 Planned	$0.18
PY 2024 Planned	$0.29
PY 2023 Planned	$0.12
PY 2022 Actual	$0.21

Source: Guidehouse analysis of DOER Responses and 2022 EDC Data

Unitil largely achieved planned deployment and spend targets in PY 2022, despite delays in VVO deployment and awaiting DPU program approval. While deployment was projected to be evenly distributed over the 2022-2025 term, Unitil has adjusted deployment plans to conduct most of its remaining deployment in PY 2023. Overall spend for the 4-year term is expected to be about $0.40M less than planned, driven partially by the lower than planned number of nodes required to support VVO as well as improvements in internal processes.

3.2.4.4 Term 2 Infrastructure Metrics Results and Key Findings

Table 36 presents the Infrastructure Metrics results through PY 2022 for the Unitil Communications Investment Area.

Table 36. Term 2 Unitil Communications Infrastructure Metrics Summary

Infrastructure Metrics*			Numbers of Nodes
GMP Plan Total, 2022-2025		# Devices Planned	260
		Spend, $M	$0.78
EDC Data Total, 2022-2025		# Devices Planned	219
		Spend, $M	$0.39
IM-4	Number of devices or other technologies deployed thru. PY 2022	# Devices Deployed	37
		% Devices Deployed	14%
IM-5	Cost for Deployment thru. PY 2022	Total Spend, $M	$0.21
		% Spend	27%
IM-6	Deviation Between Actual and Planned Deployment for PY 2022	% On Track (Devices)	70%
		% On Track (Spend)	106%
IM-7	Projected Deployment for the Remainder of the GMP Term	# Devices Remaining	182
		Spend Remaining, $M	$0.18

*The metric names have been slightly changed here to clarify the time span used in analysis.

Source: Guidehouse analysis of DOER Responses and 2022 EDC Data

Unitil's spend in PY 2022 went according to plan while deployment was below plan. Delays in VVO rollout and DPU approval were the primary drivers of delayed device deployment. Unitil plans to accelerate nodes deployment in PY 2023. Unitil expects overall 4-year Term costs and number of devices deployed to be lower than what was originally outlined in the GMP 2021 Plan. This is largely due to fewer devices needed to support the VVO investment.

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4. Conclusions and Recommendations

A robust and high-performance communications network will maximize the benefits of other GMP investments (M&C, VVO, and ADA). The DPU Order emphasized that communications be deployed in tandem with the GMP suite of investments to enable timely benefit realization. Table 37 summarizes Guidehouse's conclusions from evaluating the progress of the three EDCs toward GMP communications plans.

Table 37. EDC-Specific Communications Findings and Recommendations

EDC	Summary of Findings
Eversource	• PY 2022 node deployment for Eversource was 0% of their 2022 GMP Plan, with spend entirely for procurement and design packages and vendor identification to prepare for PY 2023 deployment. Overall spend was ~3% of plan spend. Delays in DPU approval impacted deployment schedule.
National Grid	• Total capital spend on the Communications investment area ($7.75M) was below plans for PY 2022 ($12.08M). Given lower spend than plan for PY 2022, National Grid plan spend was increased across PY 2023 – PY 2025 to match the DPU pre-authorized budget.
Unitil	• Unitil communications spend in PY 2022 met plan spend while deployment was below plan. Delays in VVO rollout and DPU approval delayed deployment. • Unitil plans to accelerate nodes deployment in PY 2023, but expects Term 2 costs and number of devices deployed to be lower than plan for 2022-2025.

Guidehouse submits the following recommendations for EDC consideration.

1) National Grid has decided to utilize both a private and public radio network. In prior year reports, it was recommended that coverage study be developed validating which network will provide the optimum expected performance. National Grid has advised that this recommendation has been or will be implemented, which is considered a best practice.
    a. **Recommendation for National Grid:** Field signal strength measurements will be taken, at field device locations, to validate that the private and or public network will provide acceptable communications performance. As part of the evaluation process, Guidehouse will review sample documentation of the coverage study.

2) Eversource is using a number of private radio frequencies for their communication networks. In prior year reports, it was recommended that Eversource perform coverage studies to validate the expected communications performance, as part of the investment, to determine expected improved performance after the investment is completed. Eversource has advised that this recommendation is in place, which is considered a best practice.

    Recommendations for Eversource:

    a. Continue to perform coverage studies and signal strength measurements to validate the performance and value of the investment. As part of the evaluation process, Guidehouse will review a sample of the coverage study documentation.

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3) Unitil has decided to install field radios in conjunction with VVO rollout to improve efficiency of radio deployment. While Guidehouse agrees with this approach, the risk could be a delay in VVO investment deployment if unforeseen communications issues arise.

    a. **Recommendation for Unitil:** At the locations where VVO equipment will be installed, field signal strength measurements should be taken to validate that the public network will provide acceptable communications performance.

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