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May 1, 2019

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

Re: Petition) of Massachusetts Electric Company and Nantucket Electric Company, d/b/a National Grid (D.P.U. 15-120), Fitchburg Gas and Electric Light Company d/b/a Unitil (D.P.U. 15-121), and NSTAR Electric Company d/b/a Eversource Energy (D.P.U. 15-122) for Approval by the Department of Public Utilities of Grid Modernization Plans

Dear Secretary Marini:

On May 10, 2018, the Department of Public Utilities (the "Department") issued a decision (the "Order") approving grid modernization plans ("GMPs") for Massachusetts Electric Company and Nantucket Electric Company, each d/b/a National Grid ("National Grid"), Fitchburg Gas and Electric Light Company d/b/a Unitil ("Unitil"), and NSTAR Electric Company d/b/a Eversource Energy ("Eversource") (together the "Companies"). The Department determined that a formal evaluation process, including an evaluation plan and studies, was necessary to help ensure that the benefits associated with the pre-authorized GMP investments are both maximized and achieved with greater certainty, with future GMP investments deployed effectively. D.P.U. 15-120/15-121/15-122, at 204. Accordingly, the Department directed the Companies to collaborate for the purpose of jointly developing an evaluation plan for the 2018-2020 grid modernization investment term for the Department's review. Id., at 205. As part of the evaluation process, the Department directed the Companies, in consultation with the Department of Energy Resources ("DOER"), to select an evaluation consultant(s) to conduct evaluation studies related to the deployment of the pre-authorized grid modernization investments approved for each Company. Id.

Consistent with the Department's directives, the Companies, in consultation with the DOER, developed a request for proposals ("RFP") in order to retain a consultant to assist in the development of the Evaluation Plan, as well as conduct the evaluation studies. The RFP was issued to the bidders list on August 8, 2018 and requested evaluation studies for the years 2018 through 2020 in six separate investment areas. Following that issuance, potential bidders, per the terms of the RFP, contacted Company representatives seeking clarifications or requesting additional information as to both the substantive and procedural requirements of the RFP. Given the depth and breadth of the substantive requests for information/clarification, the Companies, in consultation with the DOER, extended the RFP response deadline from September 7, 2018 to September 14, 2018. This extension enabled the potential bidders to incorporate the additional information/clarifications into their bids, resulting in more detailed and responsive bids. On

September 14, 2018, the Companies received bids from two consulting firms. On December 20, 2018, the Department issued a memorandum on the Companies' Evaluation Compliance Filing and set the deadline as May 1, 2019 to file a jointly-proposed evaluation plan for the 2018 through 2020 grid modernization investment term. December 20, 2018 Memorandum at 2. After a robust proposal review process with DOER, the Companies ultimately chose Navigant Consulting, Inc. ("Navigant") to develop the evaluation plans and conduct the evaluation studies.

Navigant developed a comprehensive, formal evaluation process, to measure and evaluate the progress of the Grid Modernization investments. The evaluation process is divided into three stages: planning, evaluation, and reporting. This enables Navigant to work with the Companies and understand the nature and the timing of the investments and data availability. Table 1 below provides a summary of these stages and the work to be undertaken in each stage:

Table 1. Evaluation Process

Stage	Activity	Timeframe	Details
Planning	Conceptual Framework (Stage 1)	Jan 2019 – Feb 2019	• Agree basic evaluation goals/objectives • Summary of approach and baselines • Basic data requirements
	Preliminary Evaluation Plans (Stage 2)	Feb 2019 – Mar 2019	• Refine evaluation goals/objectives • Agree on potential research design based on data availability • Summary of potential deliverables/schedule
	Detailed Evaluation Plans (Stage 3)	Mar 2019 – Apr 2019	• Finalize evaluation goals/objectives • Methodology finalized, baseline and/or sampling approach and data required • Milestone schedule
Evaluation	Evaluation In-Progress	May 2019 – Mar 2021	• Execution of Stage 3 Plans • Data collection and assimilation • Data analysis • Data analytics and modeling (as required)
Reporting	Reporting	2019 Evaluation Report (Q1 2020) 2020 Evaluation Report (Q1 2021)	• Evaluation Reports for each Investment Area will include findings and recommendations • These Reports will serve as inputs to the EDCs' 2019 Annual Report filed on April 1, 2020 and the 2018-2020 Term Report filed April 1, 2021

Navigant organized the Planning Stage into three separate stages. In Stage 1, Navigant met with the Companies to discuss evaluation requirements and developed brief evaluation overviews based on the discussion. In Stage 2, Navigant worked with the Companies to refine the investment areas discussed in Stage 1. The investment areas include Monitoring and Control, Communications, Advanced Distribution Automation, Volt Var Optimization, Workforce Management, and Advanced Distribution Management Systems and Advanced Load Flow. In Stage 3, Navigant finalized development of the six Evaluation Studies.

The Evaluation Stage will begin in May of 2019. During this period, Navigant will work regularly with the Companies to obtain and review relevant data and conduct analysis and assess progress of each investment area. The evaluation will leverage the established infrastructure metrics and the proposed performance metrics[1] to meet objectives specific to each. The infrastructure metrics are intended to measure the Companies' deployment progress under their respective GMPs, whereas the performance metrics are designed to measure improvements toward meeting the Department's grid modernization objectives. The evaluation will address both the infrastructure metrics and performance metrics for each investment area. Navigant will be responsible for developing the evaluation plans, ensuring consistency in definitions, and analyzing data, while the Companies will be responsible for providing the relevant data during this process.

Lastly, under the Reporting Stage, Navigant will provide the Evaluation Reports for each Evaluation Area that reflect each of the Companies' GMP investments, as applicable. The 2019 Evaluation Report will include analysis of the progress in 2018 and 2019, while the 2020 Evaluation Report will be cumulative from 2018 through 2020.

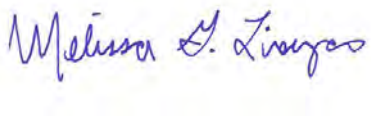
Consistent with the Department's December 20, 2018 Memorandum, the Companies are submitting the final Grid Modernization Evaluation Plan, which includes an Evaluation Study for each of the six identified investment areas. Each investment area Evaluation Study includes the methodology, the schedule, and the metric definitions to demonstrate for the process to be undertaken in the Evaluation and Reporting Stages. The Companies will continue to closely coordinating with Navigant to assist in developing a comprehensive evaluation of each Company's GMP.

[1] On April 9, 2019, the Companies submitted final revised proposed performance metrics consistent with the Department directives contained in its March 19, 2019 Memorandum. The Distribution Companies' April 9, 2019 proposed performance metrics are still pending before the Department. The Evaluation Stage will incorporate the Companies' performance under the finalized performance metrics.

Sincerely,

MASSACHUSETTS ELECTRIC COMPANY AND NANTUCKET ELECTRIC COMPANY EACH d/b/a/ NATIONAL GRID

By their attorney,



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Melissa Liazos, Esq.
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40 Sylvan Road
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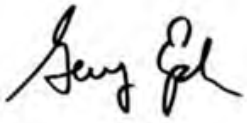
FITCHBURG GAS AND ELECTRIC LIGHT COMPANY d/b/a Unitil

By its attorney,



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6 Liberty Lane West
Hampton, NH 03862
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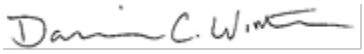
NSTAR ELECTRIC COMPANY d/b/a EVERSOURCE ENERGY

By its attorney,



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Enclosures

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

NAVIGANT

MA Grid Modernization Evaluation

Prepared for:

MA Electric Distribution Companies

Submitted by:
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April 29, 2019

NAVIGANT

MA Grid Modernization Evaluation

TABLE OF CONTENTS

EVALUATION APPROACH

1. Evaluation Introduction

The Massachusetts Electric Distribution Companies (EDCs) are investing in Grid Modernization technologies to be implemented from 2018 through 2020 and beyond. The Massachusetts Department of Public Utilities (DPU or Department) has *pre-authorized* the first 3 years for a number of these investments with the condition that it have a chance to "review the prudence of a company's implementation…"[1] The Department and the EDCs have classified these investments into six categories:

1. Monitoring and Control
2. Communications/IoT
3. Advanced Distribution Automation
4. Volt Var Optimization
5. Workforce Management
6. Advanced Distribution Management Systems & Advanced Load Flow

To better understand the benefits and track progress of these investments, and as part of its prudence review, "the Department has determined that it is appropriate to establish a formal evaluation process, including an evaluation plan and evaluation studies, for the Companies' preauthorized grid modernization plan investments."[2]

The overall goal of this evaluation is to measure and evaluate the progress of these grid modernization programs toward achieving the Department's Grid Modernization objectives: optimizing system performance, optimizing system demand, and facilitating the interconnection of distributed energy resources (DER). This study will provide the EDCs and relevant stakeholders insight into the performance, value and progress of each of the investments.

2. Process for Evaluation Plan Development

The evaluation plan development process is divided into Planning, Evaluation, and Reporting stages. The Planning Stage includes development of Stage 1, 2, and 3 plans. Dividing the planning stage into three phases allowed Navigant to work with the EDCs to understand the nature and timing of the investments and data availability. Development of the Stage 3 Plans have recently been completed in April 2019 (see Section 2.1 below). The Evaluation Stage then consists of execution of these Plans. Following the evaluation of each investment area, Navigant will prepare evaluation reports, which summarize the evaluations findings and can be incorporated into the EDCs' Annual and Term Reports. Table 1 provides a summary of these stages and what they encompass.

[1] Department of Public Utilities Order, May 10, 2018, p. 110.

[2] DPU, p. 204.

Table 1. Evaluation Process

Stage	Activity	Timeframe	Details
Planning	Conceptual Framework (Stage 1)	Jan 2019 – Feb 2019	• Agree basic evaluation goals/objectives • Summary of approach and baselines • Basic data requirements
	Preliminary Evaluation Plans (Stage 2)	Feb 2019 – Mar 2019	• Refine evaluation goals/objectives • Agree on potential research design based on data availability • Summary of potential deliverables/schedule
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Evaluation	Evaluation In-Progress	May 2019 – Mar 2021	• Execution of Stage 3 Plans • Data collection and assimilation • Data analysis • Data analytics and modeling (as required)
Reporting	Reporting	2019 Evaluation Report (Q1 2020) 2020 Evaluation Report (Q1 2021)	• Evaluation Reports for each Investment Area will include findings and recommendations • These Reports will serve as inputs to the EDCs' 2019 Annual Report filed on April 1, 2020 and the 2018-2020 Term Report filed April 1, 2021

2.1 Planning Stage

- **Conceptual Framework (Stage 1) – *Complete***

  Navigant and the EDCs attended a kickoff meeting discussing evaluation requirements for all investment areas. Navigant then developed brief evaluation overviews (Stage 1 Plan) based on the discussion. These plans included general descriptions of the investment areas, evaluation study goals and objectives, summary of approaches, general data requirements, and study timelines. After approval from the EDCs, Navigant commenced work on the Stage 2 Plans.

- **Preliminary Evaluation Plans (Stage 2) – *Complete***

  Navigant worked with the EDCs to refine the Stage 1 Plans for each investment area by incorporating feedback within the evaluation plans. These plans allowed Navigant and the EDCs to agree on definitions, confirm data availability and methodology proposed.

- **Detailed Evaluation Plans (Stage 3) – *Complete***

  Navigant finalized development of the Evaluation Plans in Apr 2019. These plans include detailed evaluation methodologies and task descriptions, identification of data assimilation and activities, deliverables, and schedule by task. See the attached Studies for the Detailed Evaluation Plans.

2.2 Evaluation Stage – In Progress

The final evaluation plans will be implemented and managed in this stage. As shown in Figure 1 in Section 3, Navigant will work regularly with the EDCs to obtain and review relevant data and conduct analysis of EDCs data and progress for each of the investment areas.

2.3 Reporting Stage

Navigant anticipates providing input to the EDCs' Annual Reports and Term Report via Evaluation Reports. Navigant will provide Evaluation Reports for each Evaluation Area that reflect investments of each EDC, as applicable. The 2019 Evaluation Report will include analysis of EDCs progress in 2018 and 2019, while the 2020 Evaluation Report will be cumulative from 2018 through 2020.

3. Evaluator's Role

As part of the Department's proposed evaluation process, the "Companies, in consultation with DOER, select[ed] an evaluation consultant … to conduct studies on appropriate topics related to the deployment of the preauthorized investments." [3] As the evaluator, Navigant is working with the EDCs towards establishing "a uniform statewide approach and standards to study the deployment of the preauthorized grid modernization investments to ensure that benefits are both maximized and achieved with greater certainty, and that future investments are more effective."[4]

The evaluation will leverage the established Infrastructure Metrics and proposed Performance Metrics[5] to meet these objectives:

- **Infrastructure Metrics (IM)**: The Infrastructure Metrics are intended to measure each EDC's deployment progress of their respective grid modernization plans. A total of seven Infrastructure Metrics will be leveraged in the evaluation.

- **Performance Metrics (PM)**: The Performance Metrics, on the other hand, are designed to measure improvements toward meeting the Department's Grid Modernization objectives.[6] Eleven Performance Metrics, with an additional metric to address Eversource's Advance Load Flow investment, will be leveraged in the evaluation process.

The evaluation processes and designation of roles between the EDCs and Navigant for evaluating Infrastructure and Performance Metrics are shown in Figure 1. The evaluation will address both Infrastructure and Performance Metrics for each investment area. In the Planning Stage, definitions of the metrics as well as data required to evaluate the metrics for each investment area will be discussed and confirmed with the EDCs. These discussions will help form appropriate evaluations for each investment area. The Evaluation Reports will then include a discussion of both of these metrics. The EDCs will incorporate these Evaluation Reports in the 2019 Annual Report filed on April 1, 2020 and the 2018-2020 Term Report filed April 1, 2021. In general, Navigant will be responsible for developing evaluation plans, ensuring consistency in definitions, and analyzing data. The EDCs will largely be responsible for

[3] DPU, p. 205.

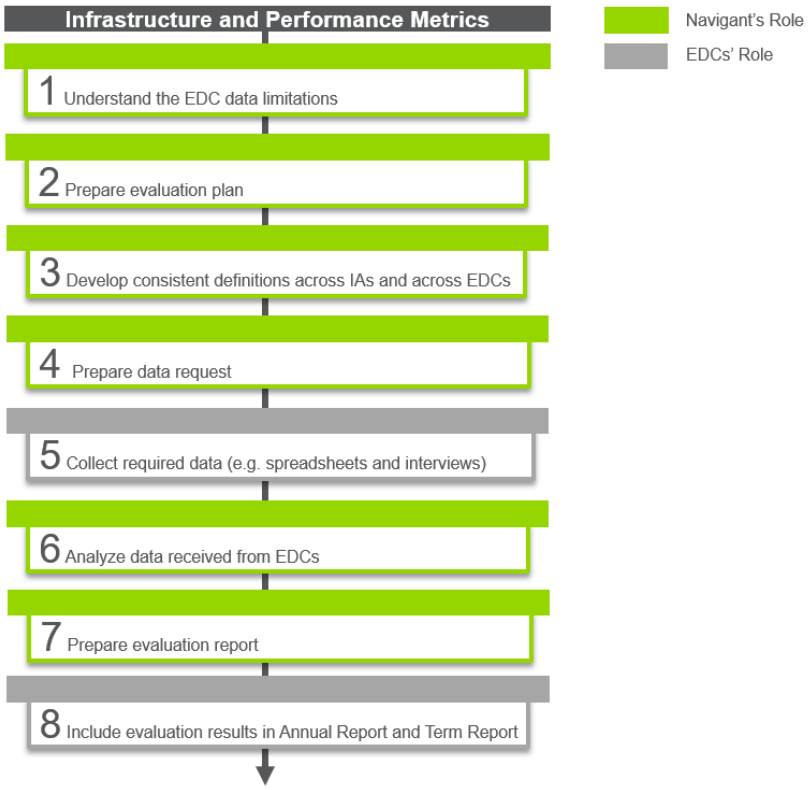
[4] DPU, p. 204.

[5] Note that the Performance Metrics' scope and definition has not been finalized by the DPU at the time of this writing.

[6] Department of Public Utilities Order, May 10, 2018, p. 201.

transmitting relevant data to Navigant. Plans for evaluating these metrics for each investment area are in development.

Figure 1. Evaluation of Infrastructure and Performance Metrics



4. Evaluation Schedule

Overall project schedule with EDC filing dates is shown in Table 2. Evaluation plans for each investment area have been completed. Navigant will prepare Evaluation Reports for each investment area and will include Infrastructure and Performance Metrics, as investments warrant. These reports will be used as input to the 2020 Annual Report and 2018-2020 Term Report.

Table 2. Project Schedule

Stages	2019				2020				2021			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
1 Planning		A										
2 Evaluation												
3 Reporting					B				C			

A. **Evaluation Plans: May 1, 2019** – plan for each Investment Area covering all 3 EDCs, as appropriate
B. **Input to 2020 Annual Report: April 1, 2020** – will include IMs and include PMs, as measurable at that time
C. **Input to 2018-2020 Term Report: April 1, 2021** – will cover IMs and PMs, as measurable at that time

4.1 Dependencies

It is important to note that Evaluation Plans may need to be updated based on several dependencies. For instance, evaluation activities will be dependent on the Department's final decision regarding Performance Metrics. In addition, evaluation of the investments is highly dependent on the timing and deployment schedule of investments. Some investments are planned for 2020, so there will be limited or no time to assess the performance of these investments by April 1, 2021.

5. Evaluation Topics

The six investment areas Navigant will evaluate are described in the sections below.

5.1 Monitoring and Control (M&C)

The M&C investment area includes investments in SCADA, microprocessor relay, and feeder monitors. The Infrastructure Metrics to be evaluated include system automation saturation, number/percentage of circuits with installed sensors, number of devices or other technologies deployed, cost for deployment, deviation between actual and planned deployment for the planned year, and projected deployment for the remainder of the three-year term. The Performance Metrics to be evaluated include grid modernization investments' effect on outage duration and outage frequency.

5.2 Communications/IoT (Comms)

The Comms investment area includes investments in Field Area Network (FAN) and Wide Area Network (WAN). The Infrastructure Metrics to be evaluated include number of devices or other technologies deployed, cost for deployment, deviation between actual and planned deployment for the planned year, and projected deployment for the remainder of the three-year term. No Performance Metrics were proposed for this investment.

5.3 Advanced Distribution Automation (ADA)

The ADA investment area includes overhead distribution with and without ties, oil switch replacement, vacuum fault interrupter (VFI) retrofit, and distribution automation. The Infrastructure Metrics to be evaluated include system automation saturation, number of devices or other technologies deployed, cost for deployment, deviation between actual and planned deployment for the planned year, and projected deployment for the remainder of the three-year term. Performance Metrics to be evaluated include numbers of customers that benefit from GMP funded Distribution Automation Devices, grid modernization investments' effect on outage duration and outage frequency.

5.4 Volt Var Optimization (VVO)

The VVO investment area includes investments in line and substation voltage control devices, line sensors, and VVO software (standalone or integrated with ADMS). The Infrastructure Metrics to be evaluated include number of devices or other technologies deployed, deviation between actual and planned deployment for the planned year, projected deployment for the remainder of the three-year term, and cost for deployment. Performance Metrics include VVO baseline, energy savings, distribution losses without AMF, power factor, peak load impact, and greenhouse gas emissions.

5.5 Workforce Management (WFM)

The WFM investment area includes investments in Mobile Damage Assessment for Unitil. Infrastructure Metrics to be evaluated include number of devices or other technologies deployed and cost for deployment. No performance metrics were proposed for this investment. As part of the WFM Evaluation Area, Grid Modernization Workforce Surveys will be conducted for National Grid and Unitil in Q2 2019 and in Q1 2021.

5.6 Advanced Distribution Management Systems and Advanced Load Flow (ADMS and ALF)

The ADMS investment area includes investments in RTU separation, GIS, DER analytics and visualization. Infrastructure Metrics to be evaluated include deviation between actual and planned deployment for the planned year and projected deployment for the remainder of the three-year term. Performance metrics to be evaluated include increase in substations with DMS power flow and control capabilities and control functions implemented by circuit. The ALF investment for Eversource includes investments in load flow integration and GIS data cleanup. Infrastructure Metrics to be evaluated include grid connected distribution generation facilities, deviation between actual and planned deployment for the planned year, and projected deployment for the remainder of the three-year term. Performance metrics include percent milestone completion.

NAVIGANT

Study #1 – Monitoring & Control Evaluation Plan

Stage 3 Plan

Prepared for:

Massachusetts Electric Distribution Companies

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Study #1 – Monitoring & Control Evaluation Plan

TABLE OF CONTENTS

1. INTRODUCTION

The Massachusetts Electric Distribution Companies (EDCs) will be making investments in monitoring and control (M&C) on their distribution networks to enable greater levels of automation and to improve reliability. These investments will total $48.16M over 2018 to 2020, including $41M for Eversource, $6.86M for National Grid, and $300k for Unitil.

1.1 Overall Study Goals

This plan will evaluate the progress and effectiveness of the DPU preauthorized M&C investments for each EDC towards meeting the DPU's grid modernization objectives. Evaluation will focus on the first objective: "(1) optimize system performance by attaining optimal levels of grid visibility, command and control…" Evaluation will also consider the other two objectives: "(2) optimize system demand" and "(3) interconnect and integrate distributed energy resources," given that M&C is a fundamental *enabling* technology for these objectives.

1.2 Research Questions

The research questions and evaluations will be performed on the M&C investments to determine the effectiveness of the M&C equipment to improve reliability, support the other investment areas, and accomplish the DPU grid modernization objectives.

Table 1. Research Questions

Research Questions	IM	PM
1) Are the EDCs progressing in deployment of their M&C investments according to their Grid Modernization Plans?	✓	
2) What factors, if any, are affecting the deployment schedule of M&C equipment?	✓	
3) What is the cost of deploying various types of M&C equipment, including SCADA retrofits and microprocessor relays?	✓	
4) What is the effect of M&C investments on key reliability metrics, such as SAIDI and SAIFI?		✓

1.3 Evaluation Metrics

Evaluation will leverage the infrastructure metrics and EDC *proposed* performance metrics shown in the table below. The infrastructure metrics are designed to measure the deployment progress against the EDC deployment goals. The performance metrics intend to measure accurately the improvements in reliability that can be attributed to M&C investments. Navigant will collect data from the EDCs to perform the evaluation. The type of data to be collected is described in Section 2 below. As part of the evaluation process, Navigant will develop data collection forms in consultation with the EDCs that will be aligned with the metrics calculations and reporting formats defined by the DPU. The forms will be collected semi-annually, and the data will be reported on a per feeder or per substation basis, as appropriate.

In addition, we will work with the EDCs to establish a common definition to assess the "level-of-complete" across their M&C investments, leading up to in-service dates for the various technologies and assets that are part of each EDC investment (see Section 4.1.3 for definitions).

Table 2. Evaluation Metrics

Metric Type	M&C Evaluation Metrics[1]	ES	NG	UTL
IM	System Automation Saturation	✓	✓	✓
IM	Number/Percentage of Circuits with Installed Sensors	✓	✓	✓
IM	Number of Devices Deployed and In-Service	✓	✓	✓
	Engineering Complete -- Number of Devices			
	Design Complete -- Number of Devices			
	Construction Complete -- Number of Devices			
IM	Cost for Deployment	✓	✓	✓
IM	Deviation Between Actual and Planned Deployment for the Plan Year	✓	✓	✓
IM	Projected Deployment for the Remainder of the Three-Year Term	✓	✓	✓
PM	Grid Modernization Investments' Effect on Outage Duration	✓	✓	✓
PM	Grid Modernization investments' Effect on Outage Frequency	✓	✓	✓

IM – infrastructure metric, PM – performance metric
Definitions of the "level-of-complete" stages can be found in Section 6.

[1] Note: to the degree that the *performance metrics* are modified or augmented during the stakeholder input process, the new metrics will be included in the evaluation plan.

2. METHODOLOGY

The evaluation will consist of the following major tasks:

- Task 1: Develop Stage 3 Plan includes preparing the evaluation plan (this document) and working with the EDCs to develop a uniform approach to defining the IMs and PMs and the associated baseline.
- Task 2: Collect and Review Data will include agreeing a format for sharing data and semi-annual discussions about the status of the M&C investments.
- Task 3: Complete Analysis includes analyzing the information and synthesizing the feedback from the EDCs from Task 2. We will share our observations in a presentation focused on the key findings.
- Task 4: Prepare Evaluation Reports includes a written Draft and Final Reports in Q1 2020 and Q2 2020.

The Evaluation Team's approach to each task is described in the sub-sections below.

2.1 Task 1. Develop Stage 3 Plan

Navigant will work with the EDCs to develop a detailed evaluation plan that addresses evaluation requirements for the M&C investment area. Key activities include:

- Understand planned schedule and investments for each EDC
- Discuss infrastructure and performance metrics
- Understand data availability
- Agree on overall evaluation scope, schedule, and budget
- Confirm allocation across EDCs

Deliverables:

- Final Stage 3 Evaluation Plan

2.2 Task 2. Collect and Review Data

Task 2 consists of collection of evaluation metrics from the EDCs, preliminary data validation, and communication of data collection status. Completion of Task 2 deliverables is contingent upon the on-time delivery of completed data request forms. Data validation will ensure the reported data complies with the metric definitions laid out in the Stage 3 Evaluation Plan, and that the data makes logical sense when compared to the baseline, prior report submissions, and the deployment plan. Anomalous data will be flagged and discussed with EDC personnel.

Navigant will provide the EDC a Data Request Form that will detail the information required to perform the analysis and evaluation. Navigant is requesting to receive data on a semi-annual basis. In the first half of the year, the completed data request will include any prior activity and investments. This semi-annual data will be used to evaluate the annual results. Navigant assumes the EDCs will provide complete and

accurate information. After the review and discussion, Navigant will share a brief memo sharing data and observations. A sample of some of the expected data will include:

1. Projected quantities and types of M&C devices to be installed by circuit and substation.
2. Estimated and approved cost for each M&C device to be installed.
3. The number of customers for whom the M&C equipment will improve reliability (customers that benefit)
4. For years 2015, 2016 and 2017, on a circuit level: AVERAGE ('CKAIDI 2015'+' CKAIDI Year 2016'+' CKAIDI Year 2017') = baseline 'CKAIDI. EDCs to calculate and provide value.
5. For years 2015, 2016, and 2017, on a circuit level: AVERAGE ('CKAIFI Year 2015'+' CKAIFI Year 2016'+' CKAIFI Year 2017') = baseline 'CKAIFI. EDCs to calculate and provide value.
6. CKAIDI for evaluation year n. EDCs to calculate and provide value.
7. CKAIFI for evaluation year n. EDCs to calculate and provide value.
8. Engineering Completed date for each M&C device
9. Design Completed date for each M&C device
10. Construction Completed date for each M&C device
11. In service date for each M&C device.
12. Actual final cost to install each M&C device
13. Reason for deviation in schedule and cost between actual and planned deployment for the plan year

We anticipate the EDCs completing and sharing the Data Request Form and files with Navigant. Navigant will have a call with each EDC to review the data provided. Navigant assumes the EDCs will provide complete and accurate information. After the review and discussion, Navigant will share a brief memo summarizing observations.

Deliverables:

- Data request form agreed with EDCs
- Semi-annual status memo of QA/QC of data and information gathered through Q2 2019 (~2-3 pages or ~10 slides)
- Semi-annual status memo of QA/QC of data and information gathered through Q4 2019 (~2-3 pages or ~10 slides)
- Semi-annual status memo of QA/QC of data and information gathered through Q2 2020 (~2-3 pages or ~10 slides)
- Semi-annual status memo of QA/QC of data and information gathered through Q4 2020 (~2-3 pages or ~10 slides)

2.3 Task 3. Complete Analysis

Task 3 consists of in-depth data analysis of the metrics reports and creation of draft results presentations. The basic analysis that Navigant will conduct is prescribed by the infrastructure and performance metrics. The analysis will also explore the research questions outlined in section 1.2. Navigant's analysis will

actively “follow the data” and explore, describe and visualize any trends, patterns or outcomes impacting the ability to achieve the M&C investment on budget and schedule.

Deliverables:

- Draft presentation of analysis based on 2019 data received (~10 slides per EDC)
- Draft presentation of analysis based on 2020 data received (~10 slides per EDC)

2.4 Task 4. Prepare Evaluation Reports

Navigant will prepare two evaluation reports. The first evaluation report will be completed in Q1 2020 for incorporation into the EDCs’ Annual Reports to be filed on April 1, 2020 (for evaluation year 2019). and the second evaluation report will be completed in Q1 2021 (for evaluation year 2020). for incorporation into the EDCs’ Term Reports to be filed on April 1, 2021.

Outline of Evaluation Report:

- Executive Summary
- Investment description
- Evaluation objectives
- Description of the evaluation approach
- Findings
- Recommendations
- Appendices with additional work product, for example,
    - Summary of data collected from the EDCs
    - Intermediate analysis outputs

Deliverables:

- Draft 2019 Evaluation Report
- Final 2019 Evaluation Report
- Draft 2020 Evaluation Report
- Final 2020 Evaluation Report

3. SCHEDULE

The overall timeline for the evaluation is shown in the Gantt Chart below:

Table 3. Three-Year Schedule

Key Tasks	2019				2020				2021			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
1 Develop Stage 3 Plan		A										
2 Collect & Review Data from EDCs		B	C		D		E		F			
3 Complete Analysis					G				H			
4 Prepare Annual Reports					I, J				K, L			

Milestones:

A. Final Stage 3 Evaluation Plan
B. Data request form agreed with EDCs
C. Semi-annual status memo of QA/QC of 2019 Q2
D. Semi-annual status memo of QA/QC of 2019 Q4
E. Semi-annual status memo of QA/QC of 2020 Q2
F. Semi-annual status memo of QA/QC of 2020 Q4
G. Draft presentation of the analysis of 2019 data
H. Draft presentation of the analysis of 2020 data
I Draft 2019 Evaluation Report
J. Final 2019 Evaluation Report
K. Draft 2020 Evaluation Report
L. Final 2020 Evaluation Report

4. METRIC DEFINITIONS

4.1 Infrastructure Metrics

To create a more accurate representation of deployment progress, and to provide evidence of intermediate progress, the infrastructure metrics regarding number of devices deployed will be reported according to the four steps defined below. There is a sequence of steps that occur prior to the equipment being placed in service, and the project can be considered complete. These steps can be defined generally as: 1) Engineering; 2) Design; 3) Construction; and 4) In-service. Progress can be measured not only as the quantity of units that are installed and in-service (Step 4 complete), but also the quantity of units that have completed design (Step 2) or construction (Step 3). Note that these metrics are not a requirement from the DPU but will allow Navigant to better tell the story of the deployment in the annual reports.

4.1.1 System Automation Saturation

System automation saturation measures customers served by fully automated or partially automated devices. The terms “fully automated” and “partially automated” refer to feeders and substations for which EDCs have attained optimal or partial levels of visibility, command and control, and self-healing capability through automation. The installations will not be limited to the main line infrastructure and will include no-load lines and distribution substation supply (“DSS”) lines. The metric is defined below.

System Automation Saturation =
Customers Served / (Fully Automated Device + 0.5*(Partially Automated Device))

Baseline saturation rate will be calculated based on what exists on the EDC systems as of the date the baseline was first calculated. As more automation is installed on EDC systems, both under the GMP and pursuant to other system investment outside of the GMP, the value of this metric will be reduced. The following matrix has been provided as guidance to determine which type of equipment would be considered partially automated, fully automated or included as a sensor.

Table 4. Grid Modernization Devices

Device Type	Sensor	Partial Automation	Full Automation
Recloser SCADA Enablement			X
Padmount Switchgear SCADA Enablement			X
Network Protector SCADA Enablement			X
4kV Circuit SCADA Enablement			X
Microprocessor Relays			X
Feeder Monitors with Communications			X
Substation SCADA Enablement			X

The overall Eversource baseline for this metric is 247, and Eversource has provided circuit-level baselines in Attachment 2 to "ES_Comp_Filing_8-15-18.pdf". Unitil circuit level baselines for each device type are defined in the document "Unitil_Compliance_Report_8-15-18.pdf". National Grid baselines will be incorporated into the first Grid Modernization Annual Report in 2019.

4.1.2 Number/Percentage of Circuits with Installed Sensors

This metric measures the total number of electric distribution circuits with installed sensors which will provide information useful for proactive planning and intervention. The installation of sensors is a key part of the measurement and control investment area and provides the means to enable grid modernization initiatives. Data for calculating this metric will consist of two parts, as defined below:

1. Number of circuits with installed sensors provided as a list of circuits indicating whether the circuit has one or more installed sensors.
2. Quantity of sensors by device type, by circuit

The baseline for this metric will be calculated based on what exists on the EDC systems as of the date the baseline was first calculated. See Table 4 above for devices that have been defined as "sensor" for determining whether a circuit has a sensor. To track intermediate progress, this metric will be reported according to the four deployment phases defined above.

Eversource has an overall baseline of 83% of circuits with installed sensors, and has provided circuit-level baselines in Attachment 2 to "ES_Comp_Filing_8-15-18.pdf". Unitil circuit level baselines for each device type are defined in the document "Unitil_Compliance_Report_8-15-18.pdf". National Grid will be incorporated into the first Grid Modernization Annual Report in 2019.

4.1.3 Number of Devices or Other Technologies Deployed

This metric measures how the EDCs are progressing with their GMPs from an equipment and/or device standpoint. The number of devices installed will be compared to the total number of devices planned by

circuit for each investment in each EDC. The following information will be tracked and reported upon per investment at the substation and circuit level where appropriate:

1. Number of devices or other technologies deployed
2. Total number of devices planned
3. Percent – Number of devices installed / total number of devices planned

This information will be provided on an annual basis. Data will be based upon the results at the end of the calendar year. This metric is strictly a grid modernization deployment metric: accordingly, the baseline for this metric necessarily starts at zero to ensure that prior investments are not captured in the baseline. The targets for this metric are the deployment plans defined above. To track intermediate progress, this metric will be reported according to the three "level-of-complete" deployment stages:

1) Engineering Completed: number of devices for which engineering work has been completed. This will track when the circuit and general location of the device has been determined
2) Design Completed: number of devices for which the design work has been completed. This will track when the detailed M&C design has been completed, which would include specific device location and cost estimate.
3) Construction Completed: number of devices for which construction has been completed. This will track when all field construction has been done.

4.1.4 Cost of Deployment

This metric measures the associated costs for the number of devices or technologies installed and is designed to measure how the EDCs are progressing in their grid modernization initiatives. The cost of devices installed will be compared to the total cost of devices planned by circuit for each investment. The following information will be tracked and reported upon per investment at the substation and circuit level where appropriate:

1. Cost of devices or other technologies deployed
2. Total cost of devices deployed
3. Percent – Cost of devices installed / total cost of devices deployed

This information will be provided on an annual basis. Results will be based upon the results at the end of the calendar year. The baseline comparison for this analysis is based upon a combination of the GMPs and any additional detailed design and planning where appropriate. The targets for this metric are the deployment plans defined above. To track intermediate progress, this metric will be reported according to the four deployment phases defined above.

4.1.5 Deviation Between Actual and Planned Deployment for the Plan Year

This metric is designed to measure how the EDCs are progressing on a year-by-year basis. The quantity and cost of devices or technology for each investment will need to be determined and/or updated from the initial GMPs on a year-by-year basis. The quantity and cost of devices or technology installed in a given GMP investment year will be compared on a year-by-year basis and any variations will be quantified and addressed. The following information will be tracked and reported upon per investment at the substation and circuit level where appropriate:

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

2. Cost of devices or technologies installed versus plan for a given year
3. Reason for discrepancies

This information will be provided on an annual basis. Results will be based upon the results at the end of the calendar year. The metric will be reported at the substation and circuit level where appropriate.

4.1.6 Projected Deployment for the Remainder of the Three-Year Term

This metric is designed to measure how the EDCs are progressing on a year-by-year basis. The metric will compare the revised projected deployment with the original targeted deployment as the EDCs progress in their implementation. The year-by-year investment plan is subject to change based upon the quantity of work completed, the availability of the technology, material lead times, contractor availability, etc. Each year's revised investment plan will be used as the basis of comparison for the following year's GMP work. The following information will be tracked and reported upon per investment at the substation and circuit level where appropriate:

1. Number of devices or technology to be installed the following year
2. Cost of devices or technologies installed the following year

This information will be provided on an annual basis. Results will be based upon the results at the end of the calendar year. The metric will be reported upon at the substation and circuit level where appropriate. The metric will be used as the baseline and target for the following year's work and will be reported on an annual basis.

4.2 Performance Metrics

For M&C investments, the primary impact is on the first DPU objective: "to optimize system performance by attaining optimal levels of grid visibility, command and control". M&C is primarily an enabling investment, however, the additional sensors and control points are expected to improve reliability as well. The performance metrics defined below intend to measure accurately the improvements in reliability that can be attributed to M&C investments.

4.2.1 Grid Modernization Investment Effect on Outage Duration

This metric will compare the experience of customers on circuits with M&C enabled through grid modernization investments as compared to the prior three-year average for the same circuit. This metric is intended to provide insight into how M&C can reduce the duration of outages. This metric will track and report on the following:

1. Circuit level SAIDI for circuits that have M&C enabled in the GMP plan year
2. Three-year average circuit level SAIDI covering years 2015, 2016, and 2017
3. Compare the current year SAIDI with the three-year historic average SAIDI of the circuit

This information will be provided on an annual basis. Results will be based upon the measurement at the end of the calendar year. The metric will use the circuit-level three-year (2015-2017) SAIDI average as the baseline. It will compare the SAIDI results of the plan year to the baseline.

4.2.2 Grid Modernization Investment Effect on Outage Frequency

This metric will compare the experience of customers on circuits with M&C enabled through grid modernization investments as compared to the prior three-year average for the same circuit. This metric is intended to provide insight into how M&C can reduce the frequency of outages. This metric will track and report on the following:

1. Circuit level SAIFI for circuits that have M&C enabled in the GMP plan year
2. Three-year average circuit level SAIFI covering the years 2015, 2016, and 2017
3. Compare the current year SAIFI with the three-year historic average SAIFI of that circuit

This information will be provided on an annual basis. Results will be based upon the results at the end of the calendar year. The metric will use the circuit three-year (2015-2017) SAIFI average as the baseline. Additionally, the baseline will be provided with and without Excludable Major Events along with a summary of the main causes of outages on each feeder. It will compare the SAIFI results of the plan year to the baseline.

4.2.3 Reliability-Related Company-Specific Performance Metrics

In addition, Eversource and Until have defined additional reliability metrics to be measured as described below. National Grid's reliability-related metric is under development.

Eversource Customer Outage Metric

This metric will measure Eversource's progress in sectionalizing circuits into protective zones designed to limit outages to customers located within the zone. The metric will track the average zone size in terms of number of customers interconnected in each protective zone for each circuit and sum of the circuits in Eastern and Western Massachusetts. The metric will use 2018 average zone size by circuit as baseline.

Unitil Reliability-Related Company-Specific Performance Metric

This metric will measure customer minutes saving per outage on each feeder. The metric will track and report upon an individual outage basis the following:

1. Time of first notification from AMI to OMS
2. Time of first customer call from IVR to OMS
3. Outage duration
4. Feeder and substation level CAIDI for the years 2015, 2016, and 2017

The number of minutes saved will be calculated using the following equation: (Time of first notification from AMI to OMS) – (Time of first customer call from IVR to OMS). Customer minutes saved is then determined by: number of minutes saved * number of customers affected. The metric will use static three-year average circuit level CAIDI in 2015, 2016, and 2017 for each feeder as baseline. Unitil targets saving an average of 5 minutes per outage.

NAVIGANT

Study #2 – Communications Evaluation Plan

Stage 3 Plan

Prepared for:

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NAVIGANT

Study #2 – Communications Evaluation Plan

TABLE OF CONTENTS

1. INTRODUCTION

The Massachusetts Electric Distribution Companies (EDCs) will be making investments in communications which will be a supporting investment to various grid modernization investments approved by the Department of Public Utilities (DPU). The investments in communications for the three EDCs will total $57.4M over the 2018 to 2020 time period.

1.1 Overall Study Goals

The Communications Investment is an enabling technology that will support most, if not all, the preauthorized investments, including Advanced Distribution Automation, Volt Var Optimization, Advanced Distribution Management Systems, and Monitoring and Control.

The Communications investments proposed by National Grid, Eversource, and Unitil will include a Wide Area Network (WAN) that is proposed to be either fiber optics or a wireless (radio) approach and a Field Area Network (FAN) that will be wireless (radio) approach.

This evaluation process will focus on the progress of deployment and toward the ability of the communication investments to enable the other preauthorized investments to achieve the DPU's grid modernization objectives. The Communications investments are enabling technologies that are necessary to the other investments to enable them to make progress on the DPU objectives. A robust and effective communication network is required for the other preauthorized investments to "(1) optimize system performance (by attaining optimal levels of grid visibility, command and control…," (2) "optimize system demand," and "(3) interconnect and integrate distributed energy resources"[1].

1.2 Research Questions

The below research and evaluations will be performed on the communication investments to determine the progress of deployment of the communication network and the readiness of the investments to support the other preauthorized investments.

Table 1. Evaluation Questions

Evaluation Questions
1) Are the EDCs progressing in deployment of their communications networks according to their Grid Modernization Plans?
2) What factors, if any, are affecting the deployment schedule of communications equipment?
3) 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)?
4) Are the communication investments (WAN and FAN) effective at supporting the other DPU approved investments?

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

1.3 Evaluation Metrics

To perform the evaluation, for year 2019, Eversource and National Grid, will leverage the Infrastructure Metrics (IMs) as shown in the table below. For Unitil, in year 2019, the evaluation will be based on the progress to complete the engineering study for a FAN. In year 2020, Unitil will follow the EDC proposed IM.

In addition to the IMs, Navigant is proposing to track progress toward achieving the metric "number of devices deployed." The EDCs will provide information on these additional metrics.

Table 2. Evaluation Metrics

Metric Type	Comms Evaluation Metrics[1]	ES	NG	UTL
IM	Number of devices deployed, tested and in-service	✓	✓	✓
	Engineering Completed -- Number of Devices	✓	✓	✓
	Design Completed -- Number of Devices	✓	✓	✓
	Construction Completed -- Number of Devices	✓	✓	✓
IM	Cost for deployment	✓	✓	✓
IM	Deviation between actual and planned deployment for the plan year	✓	✓	✓
IM	Projected deployment for the remainder of the three-year term	✓	✓	✓

IM – infrastructure metric

Section 4 provides a definition for each of the above metrics.

1.4 Summary of Evaluation Activities

Working with each EDC, Navigant will define baselines that will be used for the evaluation of the communication investments (WAN and FAN). These baselines will include deployment quantities, schedule, costs, etc., so that the progress along these baselines can be measured.

The following high-level tasks will be executed to perform the evaluation. Details of each task are defined in greater detail in Section 2.

- Task 1: Detailed Communication Evaluation Plan Development (this document) – Reviewed and approved by the EDCs.
- Task 2: Data Request Issued to EDCs – Navigant to request specific data on a semi-annual basis and reported on an annual basis.
- Task 3: Data analysis and evaluation for each metric – The calculation and analysis for each metric.
- Task 4: Development of Annual Reports – Draft presentation of results for EDC review, written Draft, Final-Draft, and Final report versions. These will support each annual reporting period (Annual Reports) and the Term Report.

[1] Note: to the degree that the *performance metrics* are modified or augmented during the stakeholder input process, the new metrics will be included in the evaluation plan.

2. METHODOLOGY

This section describes the Evaluation Team's approach to each task.

2.1 Task 1. Develop Stage 3 Plan

Navigant has worked with the EDCs to develop a detailed evaluation plan that addresses evaluation requirements for the Communications investment area. Key activities include:

- Understand planned schedule and investments for each EDC
- Discuss infrastructure and performance metrics
- Understand data availability
- Agree on overall evaluation scope, schedule, and budget
- Confirm allocation across EDCs

Deliverables:

- Final Stage 3 Evaluation Plan

2.2 Task 2. Collect and Review Data

Navigant will provide the EDC a Data Request Form that will detail the information required to perform the analysis and evaluation. Navigant is requesting to receive the data on a semi-annual basis. The first semi-annual data exchange will also include any prior activity and investments. This semi-annual data will be used to evaluate the annual results. A sample of some of the expected data will include:

14. By year, the projected quantities of communication nodes to be installed.
15. Estimated and approved budget cost for each communication node to be installed.
16. The distance point-to-point for each WAN (miles of fiber, distance of microwave links, etc.).
17. Work order design completed for each node.
18. Construction completed date for each node.
19. Testing procedure and date testing was completed for each WAN and/or FAN node.
20. Description of other DPU approved investments using the communications node placed into service.
21. Actual final cost to install each communications node.
22. Deviation in schedule and cost along with the reason for the deviation between actual and planned deployment for the plan year.
23. Projected deployment for the remainder of the three-year term.

We anticipate the EDCs completing and sharing the Data Request Form and files with Navigant. Navigant will have a call with each EDC to review the data provided. Navigant assumes the EDCs will provide complete and accurate information. After the review and discussion, Navigant will share a brief memo summarizing observations.

Deliverables:

- Data request form agreed with EDCs
- Semi-annual status memo of QA/QC of data and information gathered through Q2 2019 (~2-3 pages or ~10 slides)
- Semi-annual status memo of QA/QC of data and information gathered through Q4 2019 (~2-3 pages or ~10 slides)
- Semi-annual status memo of QA/QC of data and information gathered through Q2 2020 (~2-3 pages or ~10 slides)
- Semi-annual status memo of QA/QC of data and information gathered through Q4 2020 (~2-3 pages or ~10 slides)

2.3 Task 3. Complete Analysis and Presentation

Navigant will conduct the analysis for the evaluation to determine metric performance. Although the basic analysis that Navigant will run is designed to be relatively prescribed, the analysis will also explore the research questions outlined in section 1.2. In other words, Navigant's analysis will actively "follow the data" and explore, describe and visualize any trends, patterns, or outcomes impacting the ability to achieve the communications investment on budget and schedule.

We will analyze the available data and incorporate feedback from our prior discussions with the EDCs to answer the research questions identified in section 1.2. For example, we will assess whether the EDCs are progressing in deployment of their communications networks according to their Grid Modernization Plans, and what factors, if any, are affecting the deployment schedule of communications equipment. We will also explore whether the communication investments (WAN and FAN) are effectively supporting the other DPU-approved investments.

Deliverables:

- Draft presentation of the analysis of 2019 data (~10 slides per EDC)
- Draft presentation of the analysis of 2020 data (~10 slides per EDC)

2.4 Task 4. Prepare Evaluation Reports

Navigant will prepare two evaluation reports. The first evaluation report will be completed in Q1 2020 for incorporation into the EDCs' Annual Reports to be filed on April 1, 2020 (for evaluation year 2019). and the second evaluation report will be completed in Q1 2021 (for evaluation year 2020). for incorporation into the EDCs' Term Reports to be filed on April 1, 2021.

Outline of Evaluation Report:

- Executive Summary
- Investment description
- Evaluation objectives
- Description of the evaluation approach

- Findings
- Recommendations
- Appendices with additional work product, for example:
    - Summary of data collected from the EDCs
    - Intermediate analysis outputs

Deliverables:

- 2019 Draft Evaluation Report
- 2019 Final Evaluation Report
- 2020 Draft Evaluation Report
- 2020 Final Evaluation Report

3. SCHEDULE

Table 3 shows, at a high level, the overall three-year schedule.

Table 3. Three-Year Schedule

Key Tasks	2019				2020				2021			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
1 Develop Stage 3 Plan		A										
2 Collect & Review Data		B		C	D			E	F			
3 Complete Analysis					G				H			
4 Prepare Annual Reports					I, J				K, L			

Milestones:

A. Final Stage 3 Evaluation Plan
B. Data request form agreed with EDCs
C. Semi-annual status memo of QA/QC of 2019 Q2
D. Semi-annual status memo of QA/QC of 2019 Q4
E. Semi-annual status memo of QA/QC of 2020 Q2
F. Semi-annual status memo of QA/QC of 2020 Q4
G. Draft presentation of the analysis of 2019 data
H. Draft presentation of the analysis of 2020 data
I. Draft 2019 Evaluation Report
J. Final 2019 Evaluation Report
K. Draft 2020 Evaluation Report
L. Final 2020 Evaluation Report

4. METRIC DEFINITIONS

4.1 Infrastructure Metrics

4.1.1 Number of Communication Devices In-Service

These metrics measure how the EDCs are progressing with their communication investment from an equipment and/or device standpoint. As seen in Table 2, these metrics will track progress of the investment from the start of the process through in-service and useful.

4. Number of devices or other communication technologies deployed
5. Total number of devices planned
6. Percent – Number of devices installed / total number of devices planned

This information will be reported to the DPU and stakeholders on an annual basis. Data will be based upon the results at the end of the calendar year. This metric is strictly a grid modernization deployment metric. Accordingly, the baseline for this metric necessarily starts at zero to ensure that prior investments are not captured in the baseline. To track intermediate progress, this metric will be reported according to the three "level-of-complete" deployment stages:

4) Engineering Completed: number of devices for which engineering work has been completed. This will track when the circuit and general location of the device has been determined
5) Design Completed: number of devices for which the design work has been completed. This will track when the detailed Communications design has been completed, which would include specific device location and cost estimate.
6) Construction Completed: number of devices for which construction has been completed. This will track when all field construction has been done.

4.1.2 Cost to Deploy Communication Equipment

This metric measures the per unit costs for each device (communication nodes or distance of fiber) installed and is designed to measure how the EDCs are progressing in their communication grid modernization investment against cost estimates. The cost of devices installed will be compared to the per unit or per mile cost of equipment planned for each location:

4. Per unit cost of FAN or WAN devices deployed
5. Estimated (budgeted) cost of per unit device planned
6. Percent – Cost of device installed / cost of device planned

This information will be rolled up as an average and reported on an annual basis. Results will be based upon the results at the end of the calendar year.

4.1.3 Deviation Between Actual and Planned Deployment for the Plan Year

This metric is designed to measure how the EDCs are progressing on a year-by-year basis. The quantity and cost of devices or technology for each investment will need to be determined and/or updated from the initial GMPs on a year-by-year basis. The quantity and cost of devices or technology installed in a given GMP investment year will be compared on a year-by-year basis and any variations will be quantified and explained. The following communication investment information will be tracked and reported upon:

4. Number of communication devices, nodes or mile of fiber installed versus plan for a given year
5. Cost of communication devices, nodes of miles of fiber installed versus plan for a given year
6. Reason for discrepancies

This information will be reported on an annual basis. Results will be based upon the results at the end of the calendar year. The metric will be reported on a per location basis.

4.1.4 Projected Deployment for the Remainder of the Three-Year Term

This metric is designed to measure how the EDCs are progressing on a year-by-year basis. The metric will compare the revised projected deployment of communication investments with the original targeted deployment as the EDCs progress in their implementation. The year-by-year investment plan is subject to change based upon the quantity of work completed, the availability of the technology, material lead times, contractor availability, etc. Each year's revised investment plan will be used as the basis of comparison for the following year's GMP work. The following information will be reported upon on a per location basis:

3. Number of devices, nodes, or mile of fiber to be installed in the following year
4. Cost of devices or technologies installed in the following year

This information will be reported on an annual basis. Results will be based upon the results at the end of the calendar year. The metric will be reported upon on a per location basis. The metric will be used as the baseline and target for the following year's work and will be reported on an annual basis.

NAVIGANT

Study #3 – Advanced Distribution Automation Evaluation Plan

Stage 3 Plan

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Study #3 – Advanced Distribution Automation Evaluation Plan

TABLE OF CONTENTS

NAVIGANT

Study #3 – Advanced Distribution Automation Evaluation Plan

1. INTRODUCTION

Eversource Energy and National Grid will be making investments in Advanced Distribution Automation (ADA). These investments will enable a greater level of automation resulting in improved electric system reliability. The ADA investment for both Electric Distribution Companies (EDCs) is estimated to total $57.4M over the period of 2018 to 2020. The ADA investments for National Grid include $13.4M towards 92 overhead reclosers on 1616 overhead lines, and the Eversource investments include $44M toward reclosers on 196 overhead lines that have existing field ties, 38 overhead reclosers that require circuit ties, the replacement of 105 - 4 kV underground oil switches, and the retrofitting of 78 - 4kV underground vacuum fault interrupters.

1.1 Overall Study Goals

This plan will evaluate the progress and effectiveness of the DPU preauthorized ADA investments for Eversource and National Grid. The ADA projects are expected reduce customer outages and customer minutes of interruption. The evaluation will focus on the ADA investments' impact on "Reducing the Effects of Outages" as part of the DPUs grid modernization objective "(1) optimize system performance (by attaining optimal levels of grid visibility, command and control)."

1.2 Research Questions

The following research questions will help determine the effectiveness of the ADA investments in improving reliability, enabling automatic feeder reconfiguration and FLISR, and accomplishing DPU grid modernization objectives.

Table 1. Evaluation Questions

Evaluation Questions
1) Are the EDCs progressing in deployment of their ADA investments according to their Grid Modernization Plans?
2) What factors, if any, are affecting the deployment schedule of ADA equipment?
3) What is the cost of deploying various types of ADA equipment?
4) What is the effect of ADA investments on key reliability metrics, such as SAIDI and SAIFI?
5) Is the FLISR automation for the overhead and underground equipment operating as designed?

1.3 Evaluation Metrics

To perform the evaluation, for year 2019 and 2020, we will leverage the EDC Infrastructure Metrics (IM) as shown in Table 2.

In addition to the IMs, Navigant will track progress using three *level-of-complete* stages to inform the metric that tracks the "number of devices deployed," as shown in the table below. The EDCs will need to provide information on the level-of-complete activity.

Table 2. Evaluation Metrics

Metric Type	ADA Evaluation Metrics[1]	ES	NG	UTL
IM	System Automation Saturation	✓	✓	
IM	Number of Devices Deployed, Tested and In-Service	✓	✓	
	Engineering Completed -- Number of Devices	✓	✓	
	Design Completed -- Number of Devices	✓	✓	
	Construction Completed -- Number of Devices	✓	✓	
IM	Cost for Deployment	✓	✓	
IM	Deviation between actual and planned deployment for the plan year	✓	✓	
IM	Projected deployment for the remainder of the three-year term	✓	✓	
PM	Grid Modernization investments' effect on outage duration	✓	✓	
PM	Grid Modernization investments' effect on outage frequency	✓	✓	

IM – infrastructure metric, PM – performance metric (subject to DPU approval of final performance metrics)

Section 4 provides a definition for each of the above metrics.

1.4 Summary of Evaluation Activities

Methodology development leverages the approach proposed by the EDCs in their respective infrastructure metrics filings, joint performance metrics filing as well as those provided by DPU directives. For each EDC, Navigant will leverage the baseline definitions that have been agreed across the appropriate dimensions (e.g., deployment timeline and costs, reliability, etc.) so that the progress along these dimensions can be measured quantitatively. The data necessary to perform the evaluation and the expected timing and availability of the data required to meet the necessary analysis and filing timelines is identified at a high level below in this document. The performance metric definitions will be refined as required by the continuing stakeholder process being led by the DPU. The specific data required, and the focus and presentation of analysis results will be refined throughout the evaluation process to ensure that it can measure progress towards the DPU grid modernization objectives mentioned above.

The following high-level tasks will be executed to perform the evaluation.

- Task 1: Develop Stage 3 Plan (this document) – Reviewed and approved by the EDCs.
- Task 2: Collect and Review Data – Navigant to request specific data on a semi-annual basis.
- Task 3: Complete Analysis and Presentation - The review and analysis for each metric as well as other evaluation insights and/or recommendations will be developed and presented.

[1] Note: to the degree that the *performance metrics* are modified or augmented during the stakeholder input process, the new metrics will be included in the evaluation plan.

Task 4: Prepare Evaluation Reports – Draft report for EDC review and then a Final report incorporating EDC comments. These will support the EDC filings in 2020 and 2021 (for evaluation years 2019 and 2020 respectively). Task Detail and work product (deliverables) are defined in Section 2.

2. METHODOLOGY

This section describes the Evaluation Team's approach for each task.

2.1 Task 1. Develop Stage 3 Plan

Navigant will work with the EDCs to develop a detailed evaluation plan that addresses evaluation requirements for the ADA investment area. Key activities include:

- Understand planned schedule and investments for each EDC
- Discuss infrastructure and performance metrics
- Understand data availability
- Agree on overall evaluation scope, schedule, and budget
- Confirm allocation across EDCs

Deliverables:

- Final Stage 3 Evaluation Plan

2.2 Task 2. Collect and Review Data

Navigant will provide the EDC a Data Request Form that will detail the information required to perform the analysis and evaluation. Navigant is requesting to receive the data on a semi-annual basis. This data will be used to develop the results for the annual evaluation and term reports. A sample of some of the expected data will include:

24. The projected quantities, type of ADA equipment (reclosers, VFI, etc.) to be installed by circuit and substation. Need to know if it is planned to be fully automated or partial automated and why.
25. Estimated and approved budget for each ADA equipment to be installed.
26. The number of customers for whom the ADA equipment will improve reliability (customers that benefit).
27. For years 2015, 2016 and 2017, on a circuit level: AVERAGE ('CKAIDI 2015'+' CKAIDI Year 2016'+' CKAIDI Year 2017') = baseline 'CKAIDI. EDCs to calculate and provide value.
28. For years 2015, 2016, and 2017, on a circuit level: AVERAGE ('CKAIFI Year 2015'+' CKAIFI Year 2016'+' CKAIFI Year 2017') = baseline 'CKAIFI. EDCs to calculate and provide value.
29. CKAIDI for evaluation year n. EDCs to calculate and provide value.
30. CKAIFI for evaluation year n. EDCs to calculate and provide value.
31. Engineering completed for ADA equipment.
32. Design completed for ADA equipment.
33. Construction completed date for each ADA equipment.
34. In Service - testing procedure and date completed for each ADA equipment being placed into service.

35. Actual final Cost to install each ADA equipment.
36. Reason for deviation in schedule and cost between actual and planned deployment for the plan year.
37. Projected deployment for the remainder of the three-year term.
38. Should FLISR be in service during the evaluation period, report on the number of times FLISR automation operated correctly.
39. Should FLISR be in service during the evaluation period, report on the number of times the FLISR operated incorrectly and the cause.

We anticipate the EDCs completing and sharing the Data Request Form and files with Navigant. Navigant will have a call with each EDC to review the data provided. Navigant assumes the EDCs will provide complete and accurate information. After the review and discussion, Navigant will share a brief memo summarizing observations.

Deliverables:

- Data request form agreed with EDCs.
- Semi-annual status memo of QA/QC of data and information gathered through Q2 2019 (~2-3 pages or ~10 slides)
- Semi-annual status memo of QA/QC of data and information gathered through Q4 2019 (~2-3 pages or ~10 slides)
- Semi-annual status memo of QA/QC of data and information gathered through Q2 2020 (~2-3 pages or ~10 slides)
- Semi-annual status memo of QA/QC of data and information gathered through Q4 2020 (~2-3 pages or ~10 slides)

2.3 Task 3. Complete Analysis and Presentation

Task 3 consists of in-depth data analysis of the metrics reports and creation of draft results presentations. The basic analysis that Navigant will conduct is prescribed by the infrastructure and performance metrics, the analysis will also explore the research questions outlined in Section 1.2. In other words, Navigant's analysis will actively "follow the data" and explore, describe and visualize any trends, patterns or outcomes impacting the ability to achieve the ADA investment on budget and schedule.

We will analyze the available data and incorporate feedback from our prior discussions with the EDCs to answer the research questions identified in Section 1.2. For example, we will assess whether the EDCs are progressing in deployment of their ADA equipment according to their Grid Modernization Plans, and what factors, if any, are affecting the deployment schedule and cost. We will also assess the effectiveness of the ADA investments in improving overall reliability.

Deliverables:

- Draft presentation of the analysis of 2019 data (~10 slides per EDC).
- Draft presentation of the analysis of 2020 data (~10 slides per EDC).

2.4 Task 4. Prepare Evaluation Reports

Navigant will prepare two evaluation reports. The 2019 evaluation report will be completed in Q1 2020 for incorporation into the EDCs Annual Report to be filed on April 1, 2020, and the 2020 evaluation report will be completed in Q1 2021 for incorporation into the EDCs Term Report to be filed on April 1, 2021.

Outline of Evaluation Report:

- Executive Summary
- Investment description
- Evaluation objectives
- Description of the evaluation approach
- Findings
- Recommendations
- Appendices with additional work product, for example,
    - Summary of data collected from the EDCs
    - Intermediate analysis outputs

Navigant will share each evaluation report as “draft”. Then incorporate comments and feedback and prepare a final version.

Deliverables:

- 2019 Draft Evaluation Report
- 2019 Final Evaluation Report
- 2020 Draft Evaluation Report
- 2020 Final Evaluation Report

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Study #3 – Advanced Distribution Automation Evaluation Plan

3. SCHEDULE

Table 3 shows, at a high level, the overall three-year schedule.

Table 3. Three-Year Schedule

Key Tasks	2019				2020				2021			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
1 Develop Stage 3 Plan		A										
2 Collect & Review Data		B	C		D		E		F			
3 Complete Analysis					G				H			
4 Prepare Annual Reports					I, J				K, L			

Milestones:

A.: Final Stage 3 Evaluation Plan
B. Data request form agreed with EDCs
C. Semi-annual status memo of QA/QC of 2019 Q2
D. Semi-annual status memo of QA/QC of 2019 Q4
E. Semi-annual status memo of QA/QC of 2020 Q2
F. Semi-annual status memo of QA/QC of 2020 Q4
G. Draft presentation of the analysis of 2019 data
H. Draft presentation of the analysis of 2020 data
I. Draft 2019 Evaluation Report
J. Final 2019 Evaluation Report
K. Draft 2020 Evaluation Report
L. Final 2020 Evaluation Report

4. METRIC DEFINITIONS

The metrics that will be used in the evaluation of the ADA investments are further defined below. These definitions are consistent with those ordered by the DPU. The Performance Metrics have not been finalized at the time of writing, but the most recent definitions available are provided below.

4.1 Infrastructure Metrics

4.1.1 System Automation Saturation

"System Automation Saturation" is a measurement, calculated by using the number of customers that benefit from a fully automated or partially automated device. As defined by the EDC, the terms "fully automated" and "partially automated" will refer to benefits feeders received by attained optimal or partial, levels of visibility, command and control, and self-healing capability through the ADA investment. It is expected that all ADA equipment, upon being tested and placed into service will be fully automated. If not, it may be classified as partially automated. The following Table provides a list of equipment that is expected to be fully automated.

The metric calculation is defined and calculated as follows:

System Automation Saturation =
Customers Served / (Fully Automated Device + 0.5*(Partially Automated Device))

Baseline saturation value will be calculated based on what exists on the EDC systems as of the date the baseline was first calculated. As more automation is installed on EDC systems, both under the GMP and pursuant to other system investment outside of the GMP, the results of this metric will be expected to go down (lower number). Customers that can benefit from multiple devices will be counted as one for purposes of calculating the baseline.

Table 4. ADA Devices

Device Type	Full Automation
Overhead Reclosers/Switches	X
Overhead Reclosers/Switches with Feeder Tie	X
Oil Switch Replacement (New VFI)	X
Vacuum Fault Interrupter (VFI) Retrofit	X

4.1.2 Number of Devices or Other Technologies Deployed

The metric measures how the EDCs are progressing with their GMPs from an equipment and/or device installation standpoint. The number of ADA devices installed will be compared to the total number of

devices planned to be installed for each circuit. The following information will be tracked and reported upon for each ADA device at the circuit level and rolled up to the substation level:

1. Number of ADA devices deployed; by circuit
2. Total number of devices planned for the circuit
3. Percent – Number of devices deployed / total number of devices planned

This information will be provided on an annual basis. Data will be based upon the results at the end of the calendar year. This metric is strictly a grid modernization deployment metric: accordingly, the baseline for this metric starts at zero to ensure that prior investments are not captured in the baseline. To track intermediate progress, this metric will be reported according to the three "level-of-complete" deployment stages:

7) Engineering Completed: number of devices for which engineering work has been completed. This will track when the circuit and general location of the device has been determined
8) Design Completed: number of devices for which the design work has been completed. This will track when the detailed ADA design has been completed, which would include specific device location and cost estimate.
9) Construction Completed: number of devices for which construction has been completed. This will track when all field construction has been done.

4.1.3 Cost for Deployment

This metric measures the associated costs for the devices or technologies installed and is designed to measure how the EDCs are progressing, according to approved budgets. The actual cost of installing a device(s) on a circuit will be compared to the estimated cost for the installation of the device(s). The following information will be tracked and reported upon:

1. Actual cost to deploy ADA devices per circuit
2. Estimated cost for devices deployment per circuit
3. Percent – Cost of devices installed / estimated cost of devices deployed

This information will be provided on an annual basis. Results will be based upon the results at the end of the calendar year. The baseline comparison for this analysis will be based upon a combination of the GMPs and other additional detailed design and planning where appropriate.

4.1.4 Deviation between Actual and Planned Deployment for the Plan Year

This metric is designed to measure how the EDCs are progressing on a year-by-year basis. The quantity and cost of ADA devices or technology installed for the year will be compared to what was planned for each year and any variations will be reported. The following information will be tracked and reported upon at the circuit level and rolled up to the substation level:

1. Number of ADA devices or technology installed for the year versus what was planned for a given year

2. Total actual cost for devices or technologies installed in a given year compared to the total budgetary cost for a given year
3. Reason for discrepancies

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

4.1.5 Projected Deployment for the Remainder of the Three-Year Term

The metric will compare the revised projected deployment with the original targeted deployment as the EDCs progress in their implementation. The year-by-year investment plan may change based upon the quantity of work completed, the availability of the technology, material lead times, contractor availability, etc. Each year's revised investment plan will be used as the basis of comparison for the following year's GMP work. The following information will be tracked and reported upon for the ADA investment at the circuit level and rolled up to the substation level:

1. Number of devices or technology estimated to be installed the following year(s)
2. Budgetary cost to install devices or technologies in the following year(s)

This information will be provided on an annual basis. Results will be based upon the results at the end of the calendar year. The metric will be reported upon at the circuit level and rolled up to the substation level. The metric will be used as the baseline and target for the following year's work.

4.2 Performance Metrics

The primary benefit is to improve reliability measures by reducing the amount of time customers are without power and reducing number of customers affected by outages. The performance metrics defined below intend to measure accurately the improvements in reliability that can be attributed to ADA investments.

4.2.1 Grid Modernization Investment Effect on Outage Duration

This metric will compare the reliability of the circuits with the ADA investment as compared to the prior three-year average for the same circuit. This metric will provide insight into how ADA can reduce the duration of outages. As set by the MA DPU guidelines, the ADA restoration solutions must restore or avoid customer outage in under the one-minute threshold.

The metric will use a pre-investment baseline of a static three-year average circuit level SAIDI for years 2015, 2016, and 2017 for each circuit. The pre-investment baseline will be calculated by the EDCs with and without Excludable Major Events. The baseline will include a summary of the main causes of outages on each circuit. Based on the baseline, the metric will compare the SAIDI results of the plan year.

This metric will track and report on the following:

1. Circuit level SAIDI for circuits that have ADA installed in the plan year.
2. Three-year average (2015, 2016, 2017) circuit level SAIDI prior to grid modernization investments.

3. Compare the current year circuit SAIDI with the three-year historic average SAIDI of the circuit prior to grid modernization investments.

This information will be provided on an annual basis. Results will be based upon the results at the end of the calendar year. The target for this metric is to have the current year circuit level SAIDI to be less than the baseline.

4.2.2 Grid Modernization Investment Effect on Outage Frequency

This metric will compare the reliability of the circuits with the ADA investment as compared to the prior three-year average for the same circuit. This metric will provide insight into how ADA can reduce the frequency of outages. As set by the MA DPU guidelines, the ADA restoration solutions must restore or avoid customer outages in under the one-minute threshold.

The metric will use a pre-investment baseline of a static three-year average circuit level SAIFI for years 2015, 2016, and 2017 for each circuit. The pre-investment baseline will be calculated by the EDCs with and without Excludable Major Events. The baseline will include a summary of the main causes of outages on each circuit. Based on the baseline, the metric will compare the SAIFI results of the plan year.

This metric will track and report on the following:

1. Circuit level SAIFI for circuits that have ADA installed in the plan year
2. Three-year average (2015, 2016, 2017) circuit level SAIFI prior to grid modernization investments
3. Compare the current year circuit SAIFI with the three-year historic average SAIFI of the circuit prior to grid modernization investments

This information will be provided on an annual basis. Results will be based upon the results at the end of the calendar year. The target for this metric is to have the current year circuit level SAIFI to be less than the baseline.

Reliability-Related Company-Specific Performance Metrics

In addition, Eversource and Until have defined additional reliability metrics to be measured as described below. National Grid's reliability-related metric is under development.

Eversource Customer Outage Metric

This metric will measure Eversource's progress in sectionalizing circuits into protective zones designed to limit outages to customers located within the zone. The metric will track the average zone size in terms of number of customers interconnected in each protective zone for each circuit and sum of the circuits in Eastern and Western MA. The metric will use 2018 average zone size by circuit as the baseline.

Unitil Reliability-Related Company-Specific Performance Metric

This metric will measure customer minutes saving per outage on each feeder. The metric will track and report upon an individual outage basis the following:

5. Time of first notification from AMI to OMS

6. Time of first customer call from IVR to OMS
7. Outage duration
8. Feeder and substation level CAIDI for the years 2015, 2016, and 2017

The number of minutes saved will be calculated using the following equation: (Time of first notification from AMI to OMS) – (Time of first customer call from IVR to OMS). Customer minutes saved is then determined by: number of minutes saved * number of customers affected. The metric will use static three-year average circuit level CAIDI in 2015, 2016, and 2017 for each feeder as baseline. Unitil targets saving an average of 5 minutes per outage.

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Study #4 – Volt Var Optimization Evaluation Plan

Stage 3 Plan

Prepared for:

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Study #4 – Volt Var Optimization Evaluation Plan

TABLE OF CONTENTS

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Study #4 – Volt Var Optimization Evaluation Plan

1. INTRODUCTION

The Massachusetts Electric Distribution Companies (EDCs) will be making investments to enable volt var optimization (VVO) on selected feeders across their distribution networks. These investments will total $25.6m over 2018 to 2020; $13m by Eversource, $10.6m by National Grid and $2.0m by Unitil.

VVO is a solution that optimizes distribution voltage to achieve goals such as reducing energy consumption and demand without the need for customer interaction or participation. The core principle behind VVO is that for many end-use loads, power demand is reduced at voltages in the lower end of their allowable range.

The primary goal of VVO is to reduce circuit demand and energy consumption by flattening and lowering the voltage profile on the circuit while maintaining customer service voltage standards. In addition, VVO systems allow for more gradual and responsive control of reactive power control devices, such as capacitors, which can improve the overall system power factor and reduce system losses. VVO allows customers to realize lower consumption without experiencing a reduction in their level of service.

Quantifying VVO impacts requires interval measurements of circuit-level voltage and power demand while the voltage and reactive power controls are operated in both baseline (non-VVO) and VVO modes. If sufficient data is available, the impacts of pre-installation line-conditioning can also be measured. The metrics discussed below are all based on a measurement and verification ("M&V") process, which uses statistical analysis to quantify the impacts the VVO system has on the customers it serves.

Table 1. Cumulative Conditioned Feeders By EDC

	2018				2019				2020			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Eversource	0	0	0	0	0	0	0	5	27	27	27	27
National Grid	0	0	0	0	0	0	0	0	6	8	10	16
Unitil	0	0	0	0	0	0	0	3	3	4	5	6

Table 2. Cumulative VVO-Enabled Feeders by EDC

	2018				2019				2020			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Eversource	0	0	0	0	0	0	0	5	27	27	27	27
National Grid	0	0	0	0	0	0	0	0	6	8	10	16
Unitil	0	0	0	0	0	0	0	0	0	0	0	0

Eversource will be installing capacitor banks, regulators, LTC controls and line sensors over 2018 through 2019. These investments are planned to result in 27 conditioned feeders and VVO-enabled by the end of Q1 2020.

National Grid will make feeder conditioning investments during 2019 and through 2020 by adding voltage regulators, capacitor banks, LTC controls, and line voltage monitors. A total of six feeders will be

conditioned by the end of 2019 (shown as completed in Q1 2020) and another ten during 2020. The six feeders conditioned during 2019 will then be VVO-enabled and actively controlled during 2020.

Unitil will start making feeder conditioning investments in 2019. Starting in 2019, three feeders per year will be upgraded with automated voltage regulators. Unitil's GMP estimated each feeder will have three regulator locations for a total of nine regulators per feeder. In addition, three substation transformers per year will be fitted with automated load tap changers (LTC) starting in 2019. These investments address the same feeders. Unitil does not plan to enable active VVO control of these feeders before December 2020 because the VVO software will be integrated with ADMS.

1.1 Overall Study Goals

This plan will evaluate the progress and effectiveness of the DPU preauthorized VVO investments for each EDC towards meeting the DPU's grid modernization objectives.[1] The evaluation will primarily address the "optimize system demand objective". The evaluation will leverage the infrastructure metrics and EDC *proposed* performance metrics shown in the table below. As the details of the evaluation approach are developed, other metrics may be considered.

1.2 Research Questions

The scope of the VVO measurement and verification (M&V) will include tracking the VVO infrastructure deployment against plan, measuring the energy, peak demand, and greenhouse gas (GHG) impacts of making the feeder conditioning investments, and installing and operating VVO on the feeders that have feeder conditioning investments and/or have been VVO enabled (see Table 3).

Table 3. VVO M&V Objectives and Associated Questions

VVO M&V Objective	Associated Research Questions
Infrastructure Deployment	• What are the extent, type, and cost of VVO investments? • How well does each EDC's deployment track the planned deployment?
Energy & Peak Savings by Feeder (feeder conditioning*)	• How much energy savings has been realized from feeder conditioning on VVO-enabled feeders? • How much GHG emissions reduction has been enabled from feeder conditioning on VVO-enabled feeders?
Energy & Peak Savings by Feeder (VVO-operation)	• How much energy savings has been realized from VVO operating on VVO-enabled feeders? • What is the impact on peak load from VVO operating on VVO-enabled feeders? • How much GHG emissions reduction has been enabled from VVO operating on VVO-enabled feeders?
Voltage Complaints	• What is the impact of the VVO-related investments on the number of voltage complaints?

* Feeder conditioning comprises substation- or feeder-level improvements undertaken prior to, but in anticipation of, installing a VVO system. These may include, e.g., reconductoring, phase-balancing, or adding capacitors, regulators, and related equipment.

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

Table 4 and Table 5 show that each performance metric will be addressed by each stage of the research – feeder conditioning, and VVO-enabled operation.

Table 4. M&V Objectives by VVO stage

Performance Metrics	Feeder Conditioning	VVO Operation
PM-2 Energy Savings	✓	✓
PM-3 Peak Demand Savings	✓	✓
PM-4 Loss Reduction		✓
PM-5 Power Factor Improvement		✓
PM-6 GHG Emissions*	✓	✓
PM-7 Voltage Complaints	TBD	TBD

* Includes customer energy savings (PM-2) and feeder loss reduction (PM-4).

Table 5. M&V Objectives by EDC

	Eversource	National Grid	Unitil
Feeder Conditioning	✓*	✓	✓*
VVO-enabled	✓	✓	

* Eversource and Unitil have indicated hourly data may be available for some feeders during the pre-feeder conditioning period, but not all feeders

1.3 Evaluation Metrics

Table 6 shows the key metrics on which the evaluation will report. These include four infrastructure metrics and six performance metrics. The data supporting the infrastructure metrics will be collected and provided to the evaluation team by the EDCs. The evaluation team will collate them and discuss each EDC's progress relative to its planned deployments.

The performance metrics will be based on statistical analyses performed by the evaluation team using data provided by each EDC. These are detailed in the Appendix.

Table 6. VVO Evaluation Metrics

Metric Type	VVO 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 three-year term	✓	✓	✓
PM-1	VVO Baseline	✓	✓	✓
PM-2	VVO Energy Savings	✓	✓	✓
PM-3	VVO Peak Load Impact	✓	✓	✓
PM-4	VVO Distribution Losses w/o AMF (Baseline)	✓	✓	✓
PM-5	VVO Power Factor	✓	✓	✓
PM-6	VVO – GHG Emissions	✓	✓	✓
PM-7	Voltage Complaints	TBD	TBD	TBD

* IM = infrastructure metric, PM = performance metric

1.4 Summary of Performance Evaluation Activities

To assess the infrastructure metrics, Navigant will work with each EDC to identify the status of the pre-authorized grid modernization investments. In addition, Navigant will use predictive statistical modeling to assess each feeder's performance, where possible seeking to identify the impact of the pre-conditioning investments and the active VVO control.

The main tasks described within the Stage 3 Plan include:

- Task 1: Detailed Evaluation Plan development (this document) will confirm the specific data available from each EDC including from the pre-deployment period and experimental design (on and off testing) period and confirming the timing of when feeders will be enabled to support VVO.
- Task 2: Data Assimilation and Collection will establish the specific data required for the VVO evaluation and how the data will be transferred to Navigant on a regular basis.
- Task 3: Assessment of infrastructure metrics will compare and contrast the number of devices and cost for the deployment planned for each EDC and what was invested by year.
- Task 4: Data Analytics and Modeling for performance metrics will leverage statistical analyses to assess interval circuit-level demand and reactive power data together with temperature data to develop weather-adjusted load shapes for each VVO-enabled feeder. Recognizing that customer load mix varies seasonally and across feeders, separate estimates will be made on each test feeder for each season for the VVO-on and VVO-off states.
- Task 5: Reporting including an initial presentation with draft results, a written Draft, Final-Draft, and Final report versions. These will support the Annual Reports and Term Report.
- Task 6: Evaluation Management

2. METHODOLOGY

The evaluation will consist of the following major tasks:

- Task 1. Evaluation Plan
- Task 2. Data Assimilation and Collection
- Task 3: Assess Infrastructure Metrics
- Task 3. Data Analytics and Modeling (Performance Metrics)
- Task 4. Reporting

This section describes the Evaluation Team's approach to each task.

2.1 Task 1. Evaluation Plan

The detailed Evaluation Plan development (this document) will confirm the specific data available from each EDC including from the pre-deployment period and experimental design (on and off testing) period and confirming the timing of when feeders will be enabled to support VVO.

The key activities of this task include:

- Understand extent and schedule for the VVO investment for each EDC
- Align on the common terminology that will be used across the EDCs
- Confirm performance metrics definitions can be applied consistently across the EDCs
- Update/refine metric definitions, as necessary
- Identify data elements required for the evaluation and assess their availability across the EDCs
- Agree on the experimental design (e.g., on and off testing during the active VVO control period) and its duration
- Establish protocols for sharing data for the duration of the project
- Agree on the overall evaluation scope
- Agree on the frequency of data collection and analysis to be completed by Navigant
- Agree on the contents of subsequent reports
- Confirm allocation across EDCs

Deliverables:

- Final Stage 3 Evaluation Plan

2.2 Task 2. Data Assimilation and Collection

During this task Navigant will work with the EDCs to confirm the data required and available for completing the VVO evaluation. In addition, this section describes when the EDCs will share data with Navigant for further analysis, which is described in Task 3.

The data request will identify the specific data fields and when they will be needed from the EDCs. The final data request will incorporate the feedback of the EDCs and will include the schedule the team will work toward achieving.

We anticipate that data necessary to perform the evaluation will come from multiple sources: EDC data such as SCADA and/or sensor data and NOAA weather and/or climate data. Table 7 describes the data types and measurement frequencies required to implement the Evaluation, Measurement, and Verification (EM&V) protocol.

Table 7. Data Required for VVO Evaluation

Data Type	Data	Source
EDC System information	• One-line diagrams that include affected substations and feeders showing key system components and electrical relationships • Feeder characteristics (e.g., rated primary voltage, rated capacity, # capacitor banks, # voltage regulators, feeder length, # customer connections, load (%res, %com, %ind etc.), load factor (ratio of average load to peak load), ZIP code or town) • Distributed generation information (e.g., type, size, installation date, feeder) • Demand response events (time-stamped log of any system-wide DR (or similar) events, for example: ISO-NE DR, EDC direct load control programs, EDC behavioral DR programs) • Operational changes (time-stamped log of changes to substation and feeders away from normal operating state (temporary (e.g., maintenance) or permanent), and power outages)	EDC
Deployment information	• Description of voltage control devices • Voltage control devices installed by feeder • Cost of deployment by EDC	EDC
Time series data (hourly)	• Feeder head-end (voltage, current, apparent power, reactive power, power factor) • Distributed generation (gross generation)	EDC
VVO system information	• Time-stamped log of VVO state changes between on and off states and any other VVO modes	EDC
Weather data	• Hourly temperature data from selected weather stations	NOAA

As part of Task 2, we will provide you with a separate document listing the specific fields, keyed to field headers or labels from the sample data files and one-line diagrams you have already supplied. We will work with you to securely transfer the historical data (e.g., annual 2017) and the required test data

following each of the seasonal test periods (e.g., summer 2020, autumn 2020, winter 2020-2021). We assume relevant data will start to be shared quarterly with the Navigant team.

Upon receipt of each dataset, Navigant will perform QA/QC. The QA/QC includes checks to confirm each dataset can be incorporated within the regression analysis. Examples of the QA/QC include:

- Time series data is complete in time and extent of devices and does not include erroneous data (e.g., interpolated values, outliers)
- Weather data is complete and has reasonable values for the weather stations included in the analysis

Although we will perform this QA/QC, we assume that the data provided to Navigant by the EDCs will not require additional back and forth. Additional iteration will require a modification to scope and budget.

After data is received at the end of year, Navigant will provide a summary of the QA/QC metrics in a status update memo that will be provided to the EDCs that confirms receipt of the datasets and indicates quality.

Deliverables:

- Data request specific to each EDC
- Summary of the QA/QC by quarter (1 table per EDC) (assumes 7 quarters)

2.3 Task 3: Assess Infrastructure Metrics

Annually, assess the progress of the EDCs towards enabling VVO on their feeders

This task entails:

- Ensuring alignment of infrastructure metrics with the VVO investment
- Establishing the baseline as it relates to the VVO investment
- Obtaining and understanding planned VVO investments by EDC
- Interviewing a representative from each EDC to understand the status of the VVO investments
- Preparing a summary presentation that describes our understanding of the year's VVO investment relative to the baseline and plan (to be completed as inputs to the 2020 Evaluation Report and 2021 Evaluation Report)

We will work with the EDCs to establish a common description of asset types, for example:

- Line voltage control device – this can include capacitor banks or line regulators
- Substation voltage control device – LTCs
- Line sensors – Feeder head and end-of-line
- VVO software – standalone or integrated with ADMS

In addition, we will work with the EDCs to establish a common definition to assess the "level-of-complete" across their VVO and other Grid Modernization investments. See Section 4.1 for definitions.

These definitions will be utilized for the infrastructure metrics, described below, that will be discussed in the Annual Reports filed in 2020 (includes investments in 2018 and 2019) and 2021 (includes investments in 2018, 2019 and 2020).

Deliverables for Task 4:

- Draft summary presentation in advance of 2020 Evaluation Report
- Draft summary presentation in advance of 2021 Evaluation Report

2.4 Task 4. Data Analysis & Modeling for Performance Metrics

We will assess impact of feeder conditioning and of active VVO control of VVO-enabled feeders.

The key task includes completing an analysis of the QA/QC'd data collected during Task 2 to:

- Establish hourly profiles of pre-VVO-enabled feeders by season for each feeder for the following characteristics: voltage, apparent power, reactive power, power factor
- Establish hourly profiles VVO-on by season for each feeder for the following characteristics: voltage, apparent power, reactive power, power factor
- Establish hourly profiles VVO-off by season for each feeder for the following characteristics: voltage, apparent power, reactive power, power factor

These hourly profiles will then be compared to assess the impact of feeder conditioning and of VVO-enabled feeders.

- Feeder conditioning: compare VVO-off to pre-VVO
- VVO-enabled: compare VVO-on to VVO-off

The comparison would be completed by feeder and by season, as well as annually. Seasons will be defined as

- Winter: December, January, and February
- Spring: March, April, and May
- Summer, June, July, and August
- Fall: September, October, and November

We will perform our evaluation at the level of aggregation permitted by the data obtained from the EDCs' SCADA systems: at either the transformer or (preferably) the feeder level. We will develop power and voltage models trained to all of the data from each test period (i.e., the period during which the control state alternates on a day-on/day-off schedule), and then use these empirical models to simulate annualized profiles under VVO-on and VVO-off scenarios. The impacts will be measured as the summed difference between the two simulations.

The basic form of the models Navigant will use to estimate VVO impacts on real power, reactive power, or voltage on a given feeder or transformer[2] in a specific test period will be:

$$X_{i,t,p} = f(\textit{load-shape elements},\ \textit{weather features},\ \textit{feeder characteristics},\ \textit{VVO status}, \textit{FC status}, \textit{Events}, \Delta \textit{LRs})$$

where:

- i, t, and p index the feeder/transformer, time interval, and test period (i.e., summer, autumn, winter), respectively;
- $X_{i,t,p}$ is the interval load – in MW units in the case of real power, |MVAR| in the case of reactive power – or voltage on feeder/transformer i at time t in period p. Interval power should be measured at the substation, while voltage will be measured as the load-weighted average of interval voltage readings from the AMI meters of the connected customer service points on feeders (if any) where reliable AMI voltage data are available, or at the substation otherwise;
- *load-shape elements* refers to model components designed to capture the underlying time-varying patterns observed in the data, including hour of day, week of year, day of year, weekend, elapsed days since Jan 1, 2017, and holidays;
- *weather features* refers to the weather components included in the model, including heating and cooling degree-days, normalized heat build-up, and various lagged values of these features;
- *feeder characteristics* refers to static (or infrequently-changing) characteristics of each VVO-enabled feeder, such as average or typical load mix (by customer type), conductor miles, geographic location, load factor, most recent annual peak, rated load, rated primary voltage, number of capacitor banks and regulators;
- *VVO status* refers to whether the VVO controls are engaged or disengaged during time interval t;
- *Events* comprises a set of binary flags indicating whether time interval t falls during an event that temporarily affects feeder load, such as a DR event, outage, or temporary load-shifting;
- *FC status* refers to whether time interval t falls before, during, or after the feeder-conditioning phase; and
- ΔLRs comprises a set of binary flags indicating when a given load-regime change has occurred.

Deliverables from Task 4:

- Draft summary presentation of Performance Metrics for 2020 Annual Report[3]
- Draft summary presentation of Performance Metrics for 2021 Annual Report

2.5 Task 5. Reporting

By the time we start preparing the annual evaluation reports, the EDCs will be well-aware of our approach, findings, and recommendations through the presentations delivered in Task 3 and Task 4. During this task we will prepare a draft evaluation report (MS Word) and incorporate feedback in a final evaluation report (MS Word). The evaluation reports will include the following sections:

[2] If telemetry data are available by feeder we will perform a separate analysis for each feeder; otherwise, the analysis will be performed by transformer.

[3] The EDCs have requested complete an assessment of the VVO Performance Metrics in support of the 2020 and 2021 Annual Reports.

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Study #4 – Volt Var Optimization Evaluation Plan

- Executive Summary
- Investment description
- Evaluation objectives
- Description of the evaluation approach
- Findings
- Recommendations
- Appendices with additional work product, for example,
    - Summary of data collected from the EDCs
    - Intermediate analysis outputs

Deliverables:

- Draft 2019 Evaluation Report (Word)
- Final 2019 Evaluation Report (Word)
- Draft 2020 Evaluation Report (Word)
- Final 2020 Evaluation Report (Word)

3. SCHEDULE

Table 8 shows, at a high level, the overall three-year schedule.

Table 8. Three-Year Schedule

Key Tasks	2019				2020				2021			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
1. Develop Stage 3 Plan		A										
2. Collect & Review Data		B	C	D	E	F	G	H	I			
3. Assess IMs					J				K			
4. Analysis for PMs					L				M			
5. Reporting					N, O				P, Q			

Milestones:

A. Final Stage 3 Evaluation Plan
B. Data request form agreed with EDCs
C. Quarterly status memo of QA/QC of 2019 Q2
D. Quarterly status memo of QA/QC of 2019 Q3
E. Quarterly status memo of QA/QC of 2019 Q4
F. Quarterly status memo of QA/QC of 2020 Q1
G. Quarterly status memo of QA/QC of 2020 Q2
H. Quarterly status memo of QA/QC of 2020 Q3
I. Quarterly status memo of QA/QC of 2020 Q4
J. Draft presentation of the analysis of 2019 data (IMs)
K. Draft presentation of the analysis of 2020 data (IMs)
L. Draft presentation of the analysis of 2019 data (PMs)
M. Draft presentation of the analysis of 2020 data (PMs)
N. Draft 2019 Evaluation Report
O. Final 2019 Evaluation Report
P. Draft 2020 Evaluation Report
Q. Final 2020 Evaluation Report

4. EVALUATION METRICS

4.1 Infrastructure Metrics

IM-4. Number of Devices or other technologies deployed
The number of VVO-related devices installed by substation and/or circuit by calendar year will be compared to the total number of devices planned by substation and/or circuit over 2018 to 2020. The comparison will yield a percent – number of devices installed[4] / total number of devices planned.

Table 9. Number of Devices

EDC	Feeder	Preauthorized Device Type	2018 (Actual)	2019 (Actual)	2020 (Actual)	Planned Total (2018-20)	Percent as of Year
A	123	AAA	#	#	#	#	%
A	123	BBB	#	#	#	#	%
A	123	CCC	#	#	#	#	%
A	124	AAA	#	#	#	#	%
A	124	BBB	#	#	#	#	%
A	124	CCC	#	#	#	#	%

The “level-of-complete” deployment stages are defined as follows:

10) Engineering Completed: number of devices for which engineering work has been completed. This will track when the circuit and general location of the device has been determined

11) Design Completed: number of devices for which the design work has been completed. This will track when the detailed VVO design has been completed, which would include specific device location and cost estimate.

12) Construction Completed: number of devices for which construction has been completed. This will track when all field construction has been done.

IM-5. Cost for deployment
The cost of VVO-related devices installed by substation and/or circuit by calendar year will be compared to the total cost of devices planned by substation and/or circuit over 2018 to 2020. The comparison will yield a percent – cost for VVO-related devices / total planned cost for VVO.

[4] Beyond feeder conditioning and VVO enabled status, incorporating a “level of complete” for feeder conditioning may be appropriate. This may take the form of engineered, designed, constructed. Currently, this detail is not included in the scope of the Stage 3 Plan.

Table 10. Cost for Deployment

EDC	Feeder	Asset Type	2018 (Actual)	2019 (Actual)	2020 (Actual)	Planned Total (2018-20)	Percent as of Year
A	123	AAA	$	$	$	$	%
A	123	BBB	$	$	$	$	%
A	123	CCC	$	$	$	$	%
A	124	AAA	$	$	$	$	%
A	124	BBB	$	$	$	$	%
A	124	CCC	$	$	$	$	%

IM-6. Deviation between actual and planned deployment for the plan year
IM-7. Projected deployment for the remainder of the three-year term

The deviation between actual and planned deployment will focus on which feeders are VVO-enabled feeders by calendar year and season and compare to the plan.

Table 11. Deployment Status

EDC	Feeder	Anticipated Commission Date	Actual Commission Date	Status*
A	123	MM / DD / YYYY	MM / DD / YYYY	
A	124	MM / DD / YYYY	MM / DD / YYYY	
A	125	MM / DD / YYYY	MM / DD / YYYY	

* Status can be: planning, design, construction, feeder conditioning complete, or VVO enabled.

At the company level, provide the deviation between actual and planned cumulative VVO-enabled feeders by calendar year.

Table 12. Feeder Deployment

	2018	2019	2020	2018-20
Actual	#	#	#	#
Planned	#	#	#	#
Revised in 2020	#	#	#	#
Revised in 2021	#	#	#	#
% Actual of Revised	%	%	%	%

At the company level, provide the deviation between actual and planned cumulative VVO investment by calendar year.

Table 13. VVO Investment

	2018	2019	2020	2018-20
Actual	$	$	$	$
Planned	$	$	$	$
Revised in 2020	$	$	$	$
Revised in 2021	$	$	$	$
% Actual of Revised	%	%	%	%

4.2 Performance Metrics

PM-1. VVO Baseline

Two "baselines" concepts are relevant for evaluating VVO impacts: one based on data collected during the year prior to any VVO installation work is performed (feeder conditioning), and the other based on post-install data during the times the feeder is operated in VVO-off mode. The former is used only to measure the impacts of any feeder-conditioning steps undertaken in preparation for, or as part of, the VVO installation. These effects are measured by comparing the pre-install baseline to the VVO-off post-install baseline. The latter is used to measure the impacts of VVO when it is operating, which are captured by comparing the post-install VVO-off profile to the post-install VVO-on profile. The pre-VVO conditions will inform the impact of feeder conditioning and the VVO-off state will inform the impact of VVO-on state.

Navigant recommends obtaining one year of pre-VVO data and one year of test period data (nine months at a minimum to include summer, winter and either spring or fall) to capture the seasonal changes to customer loads

PM-2. VVO Energy Savings

Once VVO is enabled on the feeder, and after the completion of the on / off testing, Navigant would assess the energy impact of the VVO-on state. If pre-conditioning data is available, Navigant will also assess the impact of the feeder conditioning investment.

Data permitting, Navigant will report annual energy savings and energy savings for four additional periods, which are defined as

- Winter Peak Energy kWh: 7 AM – 11 PM, weekdays except holidays, October to May
- Winter Off-Peak Energy kWh savings: 11 PM – 7 AM weekdays, all day weekends and holidays, October to May
- Summer Peak Energy kWh savings: 7 AM – 11 PM, weekdays except holidays, June to September

- Summer Off-Peak Energy kWh savings: 11 PM – 7 AM weekdays, all day weekends and holidays, June to September

Navigant will recommend an approach when feeders are conditioned or enabled for a partial year.

PM-3. VVO Peak Load Impact

Navigant plans to assess the peak load impact by utilizing the ISO-NE definition of the summer on-peak period, which is 1:00 to 5:00 pm ET from June 1 to August 31 on non-holiday weekdays.[5]

PM-4. VVO Distribution Losses w/o AMF (Baseline)

Navigant assumes the EDCs will provide this estimate or provide an engineering estimate of the share of savings associated with customer savings and distribution losses.

PM-5. VVO Power Factor

Navigant will leverage the annualized hourly profile of power factor and take a simple average of the hours that correspond to power that is >75% of the feeder's peak annual demand.

The EDCs will then use the feeder averages to generate a system power factor performance, weighted by the peak demand of each respective circuit.

PM-6. VVO – GHG Emissions

Navigant will determine the GHG emissions reduction based on the GHG emissions factors provided by the EDCs on annual basis or for each energy period. The GHG emission reduction would include changes identified from the aggregate change in energy attributed to the VVO investment on each feeder.

PM-7. VVO – Voltage Complaints

As of the EDC's Performance Metric filing on April 3, 2019, this metric is under development.

[5] **Note**: The performance metric proposed in the August 15, 2018 filing for peak load impact seeks to assess the impact at the hour of the circuit peak and the hour of the system peak. However, it is not clear how the effect of the feeder conditioning nor the VVO enabled feeders will be determined. Thus, we are recommending that we evaluate the ISO-NE defined summer peak period, which contains more hours and will include many more days in the analysis.

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Study #5 – Workforce Management Evaluation Plan

Stage 3 Plan #5 – DRAFT

Prepared for:

Massachusetts Electric Distribution Companies

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Study #5 – Workforce Management Evaluation Plan

TABLE OF CONTENTS

1. INTRODUCTION

Through the pre-authorized investments, the MA EDCs will be making changes to internal systems and processes to improve the customer experience and increase efficiency. In addition, Unitil is specifically investing in software to improve the efficiency and effectiveness of its damage assessment process during major storms.

1.1 Overall Study Goals

The plan describes a Unitil-focused assessment of their Mobile Damage Assessment implementation and a Grid Modernization Workforce survey that will evaluate the progress and effectiveness of the DPU preauthorized investments towards improving workforce and asset management, which is subsumed within the DPU's three objectives for grid modernization, [1] for National Grid and Unitil.

Since the workforce management (WFM) investment is specific to Unitil, certain infrastructure metrics will only apply to Unitil. To assess the overall impact of the pre-authorized investments on National Grid's and Unitil's workforce, we will also identify research questions and metrics that that will be assessed via an online survey of employees.

1.2 Evaluation Metrics and Research Questions

Table 1 contains proposed metrics for evaluating the impact of the grid modernization investments on workforce management. Metrics associated with the progress of Unitil's rollout of the Mobile Damage Assessment are specific to Unitil. Metrics to assess the broader influence of National Grid and Unitil investments on their workforce are also proposed.

Table 1. 2019 - 2021 WFM Evaluation Metrics

Type	WFM Evaluation Metrics	ES	NG	UTL
IM	Number of devices or other technologies deployed[2]			✓
IM	Cost for deployment			✓
	Employee awareness & engagement in Grid Modernization		✓	✓

*IM – infrastructure metric

In addition to the metrics outlined above, the evaluation would look to inform the following qualitative research questions:

[1] DPU Order, May 10, 2018, p.105. Previously the DPU had listed "improve workforce and asset management" as a stand-alone objective for grid modernization, but in its May 10, 2018 Order it eliminated this as a stand-alone objective and subsumed it within the other three grid modernization objectives.

[2] Unitil's Mobile Damage Assessment will be a software rollout.

Table 2. 2019 - 2021 WFM Survey Evaluation Qualitative Research Questions

Grid Modernization Workforce Survey Research Questions	ES	NG	UTL
How engaged are employees with the company's grid modernization initiatives?		✓	✓
How have the company's investments changed the nature of interactions with customers?		✓	✓
How have the company's grid modernization investments increased employee efficiency and productivity?		✓	✓

1.3 Summary of Evaluation Activities

The following high-level tasks will be executed to perform the evaluation.

- Task 1: Detailed Evaluation Plan development (this document) will confirm the key attributes of the Unitil Mobile Damage Assessment, confirm the types of questions that would be included in the employee survey, and the survey fielding and analysis process.

- Task 2: Unitil WFM Metrics Tracking includes developing a data collection form. Data from Unitil will be collected and reviewed on an annual basis with data as of December 31, 2018 serving as the baseline for the Mobile Damage Assessment. Unitil Employee Case Studies will include the selection of 2-3 specific employees whose daily job functions have been positively impacted by the Mobile Damage Assessment over the 2019 to 2021 period. Case studies will profile selected employees' damage assessment during storms and how these have changed over time.

- Task 3: Grid Modernization Workforce Survey includes designing and fielding an online survey. We envision working with National Grid and Unitil to develop questions for an online survey that are common across the two EDCs with EDC-specific branding.[3] The survey will be fielded in 2019 to establish a baseline and again in 2021.

- Task 4: Reporting includes a written Draft and Final versions of the Unitil-specific memo covering the Mobile Damage Assessment investment and a memo explaining the Grid Modernization Workforce survey and findings. These memos will support the 2018-2020 Term Report.

These are described in more detail in the following section.

[3] The online employee survey could seek to identify what percent of employees by job category are aware of and familiar with the company's grid modernization investments, through questions such as: 1) Are you aware of the company's Grid Mod investments?; 2) Are you aware of the benefits of the company's Grid Modernization investments?; and 3) Have you completed a task that was changed because of the company's Grid Modernization Investments?.

2. METHODOLOGY

This section describes Navigant's approach to each task. The tasks are summarized in the table below and described in more detail in subsequent sections.

Table 3. 2019 - 2021 Evaluation Activities

Task	Activities	2019	2020	2021
Task 1. WFM Evaluation Planning	Stage 3 Plan development	✓		
Task 2. Unitil WFM Metrics Tracking	Define metrics		✓	
	Develop collection form		✓	
	Collect & summarize data			✓
	Identify 2-3 employees for case study			✓
	Prepare case study			✓
Task 3. Grid Modernization Workforce Survey	Develop survey	✓		
	Field & administer survey	✓		✓
	Analyze & share survey results	✓		✓
Task 4. Reporting	Unitil-specific memo			✓
	Grid Modernization Workforce survey memo			✓

2.1 Task 1. WFM Evaluation Planning

Navigant will work with the National Grid and Unitil to develop a detailed evaluation plan that addresses evaluation requirements for the workforce management investment area. Key activities include:

- Understand schedule and investment for Mobile Damage Assessment for Unitil
- Confirm infrastructure metrics for evaluating the Mobile Damage Assessment
- Agree on Grid Modernization Workforce survey design
- Agree on overall evaluation scope, schedule, and budget
- Confirm allocation across National Grid and Unitil

Deliverables:

- Stage 3 Evaluation Plan

Table 4. 2019 - 2021 Task 1 Activities

Task	Activities	2019	2020	2021
Task 1. WFM Evaluation Planning	Stage 3 Plan development	✓		

2.2 Task 2. Unitil WFM Metrics Tracking

Navigant will coordinate with Unitil to determine the metrics to track to evaluate progress in the Mobile Damage Assessment deployment. Potential metrics to track include:

- Number of devices or other technologies deployed[4]
- Cost for deployment

Once the metrics of interest have been confirmed, Navigant will develop a data collection form to capture the relevant attributes of the Mobile Damage Assessment investment. Unitil will identify the most appropriate staff member to complete the form and Navigant will distribute the form to this individual on an annual basis. Navigant will include in its Unitil specific evaluation memo a summary of the Mobile Damage Assessment investment over time and the situations when the investment was utilized.

In addition, Navigant will work with Unitil to identify storm response activities at Unitil that have benefited the most from the Mobile Damage Assessment and select 2-3 specific employees to participate in case study interviews within a month of a storm event. The case study will profile selected employees' damage assessment responsibilities during storms and how these have changed with the investment.

Table 5. 2019 - 2021 Task 2 Activities

Task	Activities	2019	2020	2021
Task 2. Unitil WFM Metrics Tracking	Define metrics		✓	
	Develop collection form		✓	
	Collect & summarize data			✓
	Identify 2-3 employees for case study			✓
	Prepare case study*			✓

* This task will only be completed after a storm event.

Deliverables:

- Agree data collection form and process
- Prepare summary of 2020 progress
- Prepare draft case study

2.3 Task 3. Grid Modernization Workforce Survey

Navigant will field a Grid Modernization Workforce survey in early 2019 and again in early 2021 to assess how the pre-authorized Grid Modernization investments changed the workforce at National Grid and Unitil. The surveys would focus on employee awareness of the Grid Modernization investments and engagement.

Navigant will develop a web-based workforce survey and coordinate administration of the survey to employees of National Grid who might be engaged with, support or benefit from Grid Modernization for

[4] Unitil's Mobile Damage Assessment will be a software rollout.

the Massachusetts Electric and Nantucket Electric operating companies, and to Unitil employees, in 2019 and 2021.[5] After administering the surveys, Navigant will analyze and summarize the results. Following the 2021 survey, the analysis will include a comparison of the differences in employee awareness and perceptions, workforce efficiency, and satisfaction related to their company's grid modernization investments over time. Task 3 activities are summarized in the table below.

Table 6. 2019 - 2021 Task 3 Activities

Task	Activities	2019	2020	2021
Task 3. Grid Modernization Workforce Survey	Develop survey	✓		
	Field & administer survey	✓		✓
	Analyze & share survey results	✓		✓

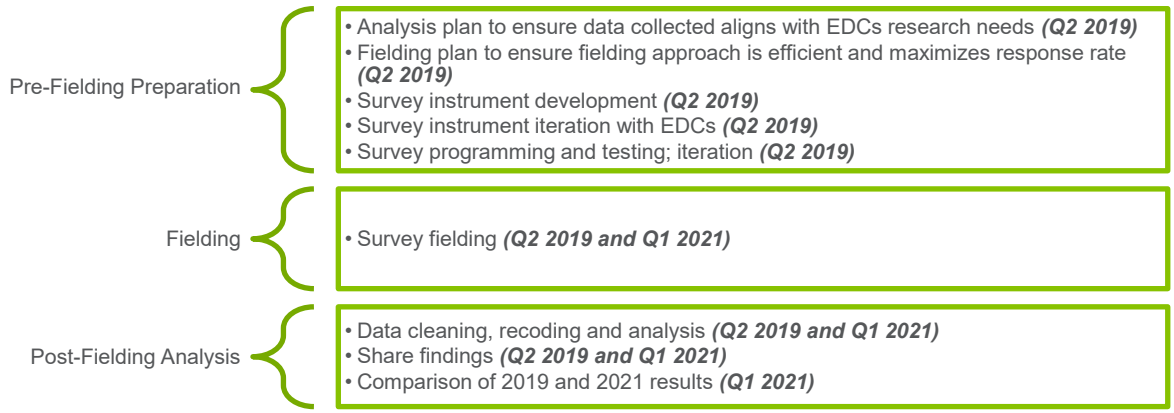
The table below outlines the characteristics of the survey effort.

Table 7. Grid Modernization Workforce Survey Characteristics

Survey Characteristics	Explanation
Frequency	Initial workforce survey in Q2 2019; second workforce survey in Q1 2021
Study Group(s)	Employees of National Grid and Unitil (or specific subgroups of employees, TBD)
Survey Mode	Online
Implementation Method(s)	Navigant sends survey links in invitation with EDC-specific branding or Navigant provides links to EDCs and EDCs send invites
Survey Quota/Sample Size	Send to all employees or employee subgroups of interest (TBD)

The workforce survey activities are detailed in the figure below.

Figure 1. Survey Approach and Schedule



[5] The survey will have the same questions for National Grid and Unitil for similar investment areas and will have the same formatting, but the introduction email and possibly some job filtering questions will be tailored for National Grid and Unitil.

Navigant will work with National Grid and Unitil to develop a survey instrument that captures key information needed to assess the impact of the companies' grid modernization investments on employee awareness and efficiency.

Navigant has outlined several illustrative questions in the table below.

Table 7. Illustrative Workforce Survey Questions

Topic	Example Questions
Employee Awareness and Perceptions	• Are you aware of the company's [planned] Grid Modernization investments? • Are you aware of the benefits of the company's Grid Modernization investments? • What benefits have you observed from the company's Grid Modernization investments, if any? • Provide an example of how the grid modernization investments have changed the way you interact with customers
Workforce Efficiency	• Have you completed a task that was changed because of the company's Grid Modernization Investments? • Provide an example of how the Grid Modernization investments have changed the way you do your job.

Deliverables:

- Survey instrument
- Programmed/Field survey
- Analysis of the 2019 survey (PowerPoint summary)
- Analysis of the 2021 survey (PowerPoint summary)

2.4 Task 4. Reporting

Navigant will prepare a Unitil-specific evaluation memo focused on the Mobile Damage Assessment and a Grid Modernization Workforce Survey evaluation memo that shares the results of the employee survey.

The Mobile Damage Assessment evaluation memo for Unitil will include:

- Discussion of the technology and when it would be used
- Explain timeline of investment & investment ($)
- Description of case study for one storm event

The Grid Modernization Workforce Survey evaluation memo will include:

- Identify evaluation objectives
- Discuss change management activities at National Grid and Unitil
- Explain overall approach & methodology (e.g., on-line surveys, surveys fielded in 2019 & 2021, number of responses for each cycle for National Grid and Unitil)
- Summarize results of the survey for National Grid and Unitil

Table 8. 2019 - 2021 Task 4 Activities

Task	Activities	2019	2020	2021
Task 4. Reporting	Prepare Mobile Damage Assessment memo			✓
	Prepare Grid Modernization Workforce Survey memo			✓

Deliverables:

- Draft Mobile Damage Assessment memo as input to the Unitil Term Report
- Final Mobile Damage Assessment memo as input to the Unitil Term Report
- Draft Grid Modernization Workforce Survey memo as input to National Grid's and Unitil's Term Report
- Final Grid Modernization Workforce Survey memo as input to National Grid's and Unitil's Term Report

3. SCHEDULE

The overall timeline for the evaluation is shown in the Gantt Chart below:

Table 9. Three-Year Schedule

Key Tasks	2019				2020				2021			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
1 WFM Evaluation Planning	A											
2 Unitil WFM Metrics Tracking					B				C,D			
3 Grid Mod Workforce Survey		E, F, G							H	I		
4 Reporting										J,K, L,M		

Milestones:

A. Evaluation Plan; agreed by March 29, 2019.
B. Agree data collection form and process
C. Summary of 2020 progress
D. Draft case study
E. Survey instrument
F. Programmed survey in 2019
G. Share findings from analysis of 2019 survey (PowerPoint)
H. Field survey in 2021
I. Share findings from analysis of 2019 survey (PowerPoint)
J,K. Mobile Damage Assessment evaluation memo (draft, then final) (Word)
L,M. Grid Modernization Workforce Survey memo (draft, then final) (Word)

A detailed schedule for Task 3 in Q2 2019 is shown below.

Table 10. Q3 2019 Schedule

Activities for Task 3	March					April				May				
	1	8	15	22	29	5	12	19	26	3	10	17	24	31
1 Analysis plan														
2 Fielding plan														
3 Invitation email development														
4 Survey instrument development							E							
5 Survey review														
6 Survey programming and testing									F					
7 Survey fielding														
8 Analysis of survey responses														
9 Share findings (PowerPoint summary)														G

Task 2 assumes the Mobile Damage Assessment will be deployed in 2020. Milestone B is dependent on this deployment schedule and whether a storm occurs during that time period.

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Study # 6 – Advanced Distribution Management System and Advanced Load Flow Evaluation Plan

Stage 3 Plan

Prepared for:

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Study #6 – Advanced Distribution Management System and Advanced Load Flow Evaluation Plan

TABLE OF CONTENTS

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Study #6 – Advanced Distribution Management System and Advanced Load Flow Evaluation Plan

1. INTRODUCTION

This plan will evaluate the progress and effectiveness of the DPU preauthorized *Advanced Distribution Management Systems (ADMS)* for the MA EDCs, and *Advanced Load Flow* (ALF) investments for Eversource only, towards meeting the DPU's grid modernization objectives.[1]

ADMS, which can include supervisory control and data acquisition (SCADA), outage management system (OMS), distribution management system (DMS), and advanced applications including operational power flow, volt-var optimization (VVO), and fault location isolation and service restoration (FLISR), is a software platform investment and is fundamental to a modernized grid. The capabilities of ADMS are key to delivering on all three of the DPU's Grid Modernization objectives, supported by the ability to control devices for system optimization, provide support for advanced distribution automation (ADA) and VVO, and serve as an enabling platform to support a high penetration of distributed energy resources (DERs).

The pre-authorized ADMS investments across the EDCs in the 2018 to 2020 timeframe are summarized in the following table.

Table 1. ADMS Investments

EDCs	Description
Eversource	Planning for ADMS
National Grid	Implementation of DMS and integration w/ SCADA
Unitil	Planning for ADMS

ALF investments are typically tightly coupled with ADMS investments, and Eversource is the only EDC with a separate investment plan for ALF.

1.1 Overall Study Goals

This evaluation plan will evaluate the progress and effectiveness of the DPU preauthorized ADMS and ALF investments for each EDC towards meeting the DPU's grid modernization objectives.[2] Evaluation will be developed to understand and measure these investments' contribution to meeting all three DPU objectives: "(1) optimize system performance (by attaining optimal levels of grid visibility, command and control…", "(2) optimize system demand", and "(3) interconnect and integrate distributed energy resources."

ADMS is a fundamental *enabling* technology that has the potential to significantly enhance the utility's ability to meet these objectives. ALF is a fundamental *enabling* technology for all three of the DPU's objectives by enabling improved modeling of the distribution system's current and future states. In addition, ALF is tightly coupled with the ADMS investment for Eversource in that the GIS and Other System data clean-up components of ALF enable the ability to perform engineering load flow in CYME, but also are necessary for the operational load flow, and other ADMS functions, in their future ADMS investment.

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

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

The key goals of the ADMS and ALF evaluation plan are the following:

- Ensure flexibility across EDCs relative to their specific investment implementation plans (scope and schedule) for the ADMS investment
- Assess either the native implementation or integration of key ADMS components
    - Supporting native ADMS DSCADA, integrated distribution SCADA component of energy management systems (EMS), or integrated distribution component of SCADA
    - Supporting native ADMS OMS, integrated OMS, or no integration of OMS in the 2018-2020 timeframe
- Assess data cleanup of GIS and Other Systems data[3] for ADMS and ALF
- Measure progress towards achieving engineering load flow capability supporting DER interconnection supported by the ALF investment

1.2 Research Questions

Navigant has established these research questions in the ADMS and ALF domain to establish a connection between each EDC's ADMS and ALF implementation and the DPU's criteria for value to customers.

The key research questions addressed in this plan are:

- How do the ADMS and ALF investments align with optimizing system performance, optimizing system demand, and enabling interconnection and integration of DER?
- What is each EDC's specific investment plan strategy for ADMS and ALF implementation (components and timeframes) during the pre-authorized investment period, 2018-2020?
- What does each EDC plan to leverage as a baseline ADMS and ALF application / component stack? (GIS, PI Historian, DSCADA, OMS, CYME, Other Systems, and/or other)
- What does each EDC plan to do related to ADMS functionality, including operational load flow, VVO, FLISR, and DERMS?
- What does each EDC plan to do related to ALF functionality, including static analysis, semi-automated analysis, and fully automatic analysis?
- What is the specific timing of ADMS implementation, integration with supporting systems, and data cleanup in GIS and Other Systems?
- What is the specific timing of ALF investment components including GIS data cleanup, Other System data cleanup, and CYME implementation?

1.3 Evaluation Metrics

The metrics for tracking ADMS and ALF are:

[3] ADMS investment that are filed including GIS and Other System data cleanup

- **Company Infrastructure Metrics**: The EDCs will implement project deviation tracking along with projecting ADMS and ALF (Eversource only) deployment over the entire 3-year period.
- **Performance Metrics**: The EDCs have proposed to score and then count the number of substations with fully implemented and successful ADMS power flow analysis and the number of circuits with the specified control functions implemented. For ALF, Eversource has proposed a metric designed to demonstrate progress towards the final completion of a fully automated modelling tool.

The infrastructure metrics and EDC *proposed* performance metrics for ADMS are shown below. As the details of the evaluation approach are developed, other metrics may be considered. As indicated above, National Grid will be making significant investments in ADMS before December 2020. Thus, only National Grid is indicated as having IMs and PMs. Eversource and Unitil will be planning for future investments.

Table 2. ADMS Evaluation Metrics

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

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

The ALF evaluation will leverage the infrastructure metrics and EDC *proposed* performance metrics shown in the table below. As the details of the evaluation approach are developed, other metrics may be considered, examples of which are included in the following table:

Table 3. ALF Evaluation Metrics

Type	ALF Evaluation Metrics	ES	NG	UTL
IM	Deviation between actual and planned deployment for the plan year	✓		
IM	Projected deployment for the remainder of the three-year term	✓		
PM	Advanced Load Flow – Percent Milestone Completion	✓		
	Data cleanup of GIS and Other Systems by circuit, substation, sub-region, and region	✓		
	Use of load flow tools for engineering (e.g., CYME, Synergi) by % of service territory	✓		
	% of region and sub-region using automated scripting on a monthly basis	✓		
	Use of near-real time system telemetry in load-flow analysis	✓		

NAVIGANT

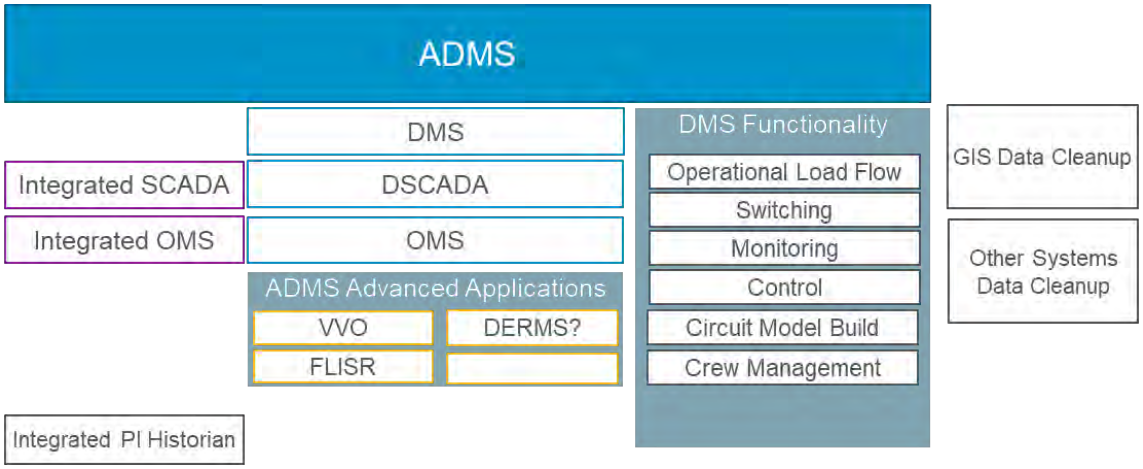
Study #6 – Advanced Distribution Management System and Advanced Load Flow Evaluation Plan

Type	ALF Evaluation Metrics	ES	NG	UTL
	% of DG interconnection requests that leverage Advanced Load Flow investment	✓		
	Comparison of reduction in average DG interconnection request between ALF-enabled vs. non-ALF enabled feeders	✓		

*IM – infrastructure metric, PM – performance metric

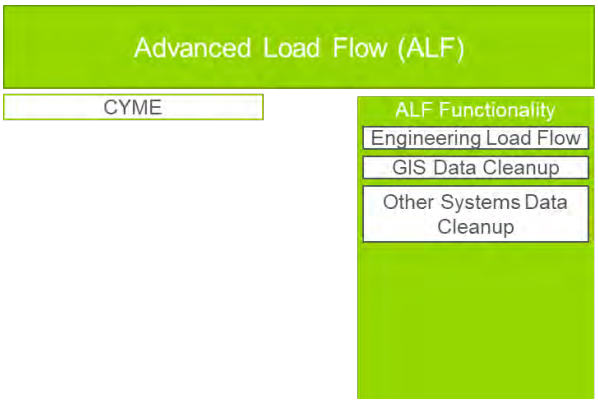
A picture of ADMS context is shown below in Figure 1. This diagram shows the normal native and integrated components of ADMS along with a functionality stack related to the DMS component of ADMS. The components and functionality shown below are foundational to the current industry status of ADMS and serve as the consistent picture for evaluation of ADMS at the EDC.

Figure 1. ADMS Evaluation Components & Functionality



A picture of ALF context is shown below in Figure 2. This diagram shows CYME and a functionality stack related to the data cleanup component of ALF. The components and functionality shown below are foundational to the current industry status of ALF and serve as the consistent picture for evaluation of ALF at Eversource.

Figure 2. ALF Evaluation Components and Functionality



1.4 Summary of Evaluation Activities

The ADMS evaluation will be based upon implementation of ADMS components and then progression of functional realization of the ADMS at each EDC. This ADMS evaluation framework is flexible and componentized to enable it to be applied to each EDC given the differences in ADMS strategy, ADMS implementation plan, and pre-existing ADMS components.[4]

The ALF investment supports the integration of DERs into the network from a regional, substation group, substation, and feeder level through CYME and in the future will provide necessary and required information to the ADMS investment. Tying the actual interconnection process duration to the ALF modeling of each region is complex and dependent upon many other variables, but ALF is a prerequisite for reducing the interconnection process duration and meeting the DPU's goal of enabling interconnection and integration of DERs. The cost and complexity of performing this evaluation to "connect the dots" between ALF and the integration of DERs into the electrical network will be reviewed.

[4] A different Stage 3 Plan discusses Eversource's ALF investment.

2. METHODOLOGY

Evaluation of the ADMS and ALF investments consists of four main tasks:

- Task 1. Develop Stage 3 Plan (this document)
- Task 2. Collect and Review Data
- Task 3. Complete Analysis and Presentation
- Task 4. Prepare Evaluation Reports

The first task is the stage 3 plan development consisting of defining overall study goals and metric identification. This task also includes a round of plan refinement and coordination with the EDCs prior to finalization. Data collection, task 2, will then occur on a semi-annual basis and include written data requests, each EDC providing the data, and Navigant conducting follow-up data review meetings. At the end of the year and following the data collection tasks, Navigant will analyze the data, task 3, producing a year-end draft presentation for each EDC to review in preparation for the reporting task. Following the yearly analysis review meetings with the EDCs, Navigant will provide an interim draft report, and incorporate feedback into a final evaluation report. The evaluation reports will be provided to the EDC for incorporation into filings or reports to the DPU.

This section describes the Evaluation Team's approach to each task.

2.1 Task 1. Develop Stage 3 Plan

Navigant will develop Stage 3 plans for the ADMS and ALF investments that will include a prescriptive approach to data collection, analysis, and reporting including integrated management of the overall evaluation. The stage 3 plan development includes defining overall study goals, metric identification, and is followed by plan refinement after review and coordination with the EDCs.

This task includes working with the EDCs to begin to develop a uniform approach to defining the IMs and PMs and the associated baselines. The stage 3 plan development also includes the following:

- Understand planned schedule and investments for each EDC
- Define overall study goals
- Discuss and confirm metrics
- Understand data availability
- Review and refine evaluation plan
- Confirm allocation across EDCs

Deliverables:

- Final Stage 3 Evaluation Plan (MS Word)

2.2 Task 2. Collect and Review Data

The data collection task includes defining details on the specific data to be collected, the timing of data collection, and designated owners at each EDC of the data (only Eversource for ALF data). Data collection coordination including scheduling and status reporting is included in the scope of this task. The objective of this task is to collect planning and cost information as well as data to track enabled power flow and control capabilities at regular intervals from each EDC based on the approved Evaluation Plan.

In general, because of the strategy of evaluation based upon implementation of ADMS components and then progression of functional realization of each EDCs' ADMS, the data will help identify progress each EDC has made in establishing the functionality of the ADMS starting with foundational prerequisites, basic ADMS software, integration of OMS and DSCADA components, data clean-up, enablement of functionality includes load flow on a circuit and substation basis, and advanced functionality including potentially including VVO, FLISR, and DERMS.

For Eversource's ALF investment, the data will help identify Eversource's progress toward establishing the functionality of the ALF starting with foundational pre-requisites, basic CYME software, integration of CYME to GIS and Other Systems, and data clean-up in both GIS and Other Systems.

The objective of this task is to collect baseline and periodic planning and cost information as well as data to track enabled power flow and control capabilities at regular intervals from each EDC based on the approved Evaluation Plan. This data collection task for ADMS and ALF includes:

- Defining specific data to be collected during the baseline assessment and then during the semi-annual reviews
    - Current state of prerequisite application components
    - Number of substations and circuits
    - Timing of integrations to GIS, Other Systems, and OMS / DSCADA if in the solution context
    - Status of engineering load flow analysis, automation, and advanced applications on each circuit
- Creation of data requests to each EDC for the baseline, semi-annual data collection, and year-end collection periods with specific owners at each EDC and clearly defined timeframes
- Preparing for data review meetings associated with the baseline, semi-annual data collection, and year-end collections to validate the data provided, ask additional questions, and get supporting or ancillary data if needed
- Summarizing findings from review meetings in brief memos

Deliverables:

- Memo (MS Word) defining specific types of data to be collected to support creation of evaluation baseline and data anticipated to be needed to support semi-annual reviews and year-end analysis and reporting.
- Semi-annual status memo of QA/QC of data and information gathered through Q2 2019 (~2-3 pages or ~10 slides)

- Semi-annual status memo of QA/QC of data and information gathered through Q4 2019 (~2-3 pages or ~10 slides)
- Semi-annual status memo of QA/QC of data and information gathered through Q2 2020 (~2-3 pages or ~10 slides)
- Semi-annual status memo of QA/QC of data and information gathered through Q4 2020 (~2-3 pages or ~10 slides)

2.3 Task 3. Complete Analysis and Presentation

The analysis task (Task 3. Complete Analysis and Presentation) will take data obtained in Task 2. Collect and Review Data, prepare a baseline, assess progress against the baseline in each functional area, and produce metrics and graphics for use in subsequent reporting on a yearly basis. This task will produce an interim output that will be presented in MS Power Point to the EDCs enabling a valuable feedback and correction cycle. Analysis coordination including scheduling and status reporting will be included as part of this task.

Task 3 will include analysis of the task 2 data and the following steps:

- Prepare a baseline,
- Determine progression against the baseline in functional areas, and
- Produce metrics and graphics for reporting.

Deliverables:

- Draft presentation that summarizes the analysis of progress during 2019 (MS Power Point)
- Draft presentation that summarizes the analysis of progress during 2020 (MS Power Point)

2.4 Task 4. Prepare Evaluation Reports

The reporting task (Task 4. Prepare Evaluation Reports) will take as input the output of the analysis task (Task 3. Complete Analysis and Presentation) combined with feedback from the EDCs and prepare the annual evaluation report (MS Word). Navigant will prepare two evaluation reports. The first evaluation report will be completed in Q1 2020 (for evaluation year 2019). for incorporation into the EDCs Annual Report to be filed on April 1, 2020, and the second evaluation report will be completed in Q1 2021 (for evaluation year 2020). for incorporation into the EDCs Term Report to be filed on April 1, 2021. The evaluation reports will address both infrastructure and performance metrics as they relate to ADMS and ALF. A draft report will be shared with the EDCs and their feedback will be incorporated in the final report.

Outline of Evaluation Report:

- Executive Summary
- Investment description
- Evaluation objectives
- Description of the evaluation approach

- Findings
- Recommendations
- Appendices with additional work product, for example:
    - Summary of data collected from the EDCs
    - Intermediate analysis outputs

Deliverables:

- Draft 2019 Evaluation Report in Q1 2020
- Final 2019 Evaluation Report in Q1 2020
- Draft 2020 Evaluation Report in Q1 2021
- Final 2020 Evaluation Report in Q1 2021

3. SCHEDULE

The overall timeline and schedule for the evaluation in shown in the Gantt chart below. Key milestone deliverables are marked with letters and are described below the chart.

Table 4. Three-Year Schedule

Key Tasks	2019				2020				2021			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
1 Develop Stage 3 Plan		A										
2 Collect & Review Data		B	C		D		E		F			
3 Complete Analysis					G				H			
4 Prepare Annual Reports					I, J				K, L			

Milestones:

A. Final Stage 3 Evaluation Plan
B. Data request form agreed with EDCs
C. Semi-annual status memo of QA/QC of 2019 Q2
D. Semi-annual status memo of QA/QC of 2019 Q4
E. Semi-annual status memo of QA/QC of 2020 Q2
F. Semi-annual status memo of QA/QC of 2020 Q4
G. Draft presentation of the analysis of 2019 data
H. Draft presentation of the analysis of 2020 data
I. Draft 2019 Evaluation Report
J. Final 2019 Evaluation Report
K. Draft 2020 Evaluation Report
L. Final 2020 Evaluation Report