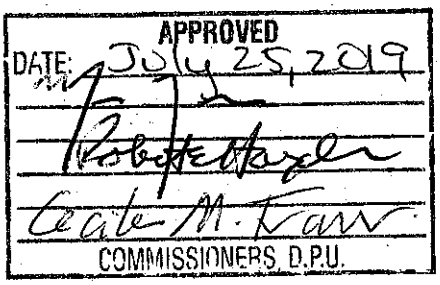

Grid Modernization Plan
Performance Metrics
Revised July 11, 2019

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

1 INTRODUCTION

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

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

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

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

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

Regarding the performance metrics proposed by the Companies in the GMPs, the Department determined that additional work was needed to develop metrics that appropriately track the quantitative benefits associated with pre-authorized grid-facing investments, and progress toward the Grid Modernization objectives. Id., at 95-106. The Department ordered the Companies to file revised proposed performance metrics designed to address the preauthorized grid-facing investments and noted that it would convene a stakeholder process to facilitate review of the revised performance metrics. Id., at 202.

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

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

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

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

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

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

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

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

2 STATEWIDE PERFORMANCE METRICS

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

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

2.1 VOLT VAR OPTIMIZATION AND CONSERVATION VOLTAGE REDUCTION BASELINE

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

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

2.1.1 Type of Metric

Statewide Performance Metric

2.1.2 Objective

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

2.1.3 Assumptions

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

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

2.1.4 Calculation Approach

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

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

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

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

2.1.5 Organization of Results

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

2.1.6 Baseline

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

2.2 VOLT VAR OPTIMIZATION (VVO) ENERGY SAVINGS

2.2.1 Type of Metric

Statewide Performance Metric

2.2.2 Objective

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

2.2.3 Assumptions

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

2.2.4 Calculation Approach

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

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

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

2.2.5 Organization of Results

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

2.2.6 Baseline

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

2.3 VVO PEAK LOAD IMPACT

2.3.1 Type of Metric

Statewide Performance Metric

2.3.2 Objective

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

2.3.3 Assumptions

For this metric, the Companies will utilize active circuit M&V peak demand reduction results from individual circuits. No M&V results older than 5 years will be used.

2.3.4 Calculation Approach

This metric will use the following data:

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

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

2.3.5 Organization of Results

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

2.3.6 Baseline

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

2.4 VVO – DISTRIBUTION LOSSES WITHOUT AMF (BASELINE)

2.4.1 Type of Metric

Statewide Performance Metric

2.4.2 Objective

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

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

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

2.4.3 Assumptions

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

- Unmetered load, such as street lights
- Electricity theft
- Circuit line losses

2.4.4 Calculation Approach

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

2.4.5 Organization of Results

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

2.4.6 Baseline

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

2.5 VVO POWER FACTOR

2.5.1 Type of Metric

Statewide Performance Metric

2.5.2 Objective

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

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

2.5.3 Assumptions

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

2.5.4 Calculation Approach

This metric will use the following data:

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

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

2.5.5 Organization of Result

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

2.5.6 Baseline

The baseline will be measured with VVO disabled and then again with VVO enabled to develop a baseline. The baseline for this metric will be reported in the first annual report after the measurement and verification is completed.

2.6 VVO ESTIMATED VVO/CVR ENERGY AND GHG IMPACT

2.6.1 Type of Metric

Statewide Performance Metric

2.6.2 Objective

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

2.6.3 Assumptions

For this metric, each Company will utilize active circuit M&V energy reduction results from individual circuits. No M&V results older than five years will be used. To calculate GHG reductions, each Company will use GHG emissions factors consistent with those used in the 2019-2021 Three-Year Energy Efficiency Plans for displaced GHG.

2.6.4 Calculation Approach

This metric will use the following data:

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

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

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

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

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

2.6.5 Organization of Results

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

2.6.6 Baseline

The baseline for this metric will be reported in the first annual report after the measurement and verification is completed.

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

2.7.1 Type

Statewide Performance Metric

2.7.2 Objective

This metric will demonstrate the progress in the Advanced Distribution Management System ("ADMS") investment by tracking the substations that have been equipped with power flow capabilities as well as the number of customers benefitting from the technology on each feeder. This metric will support the objective of optimizing system performance and more specifically improve asset utilization, improve reliability and integrate distributed energy resources. ADMS

gives system operators increased visibility on the real time output of generating facilities. This metric is designed to demonstrate that the model is an accurate representation of field conditions.

2.7.3 Assumptions

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

2.7.4 Calculation Approach

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

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

2.7.5 Organization of Results

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

2.7.6 Baseline

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

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

2.8.1 Type

Statewide Performance Metric

2.8.2 Objective

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

2.8.3 Assumptions

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

2.8.4 Calculation Approach

This metric will track and report on the following:

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

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

2.8.5 Organization of Results

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

2.8.6 Baseline

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

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

2.9.1 Type

Statewide Performance Metric

2.9.2 Objective

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

2.9.3 Assumptions

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

2.9.4 Calculation Approach

This metric will track and report on the following:

Circuit number
Number of customers impacted

2.9.5 Organization of Results

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

2.9.6 Baseline

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

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

2.10.1 Type

Statewide Performance Metric

2.10.2 Objective

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

2.10.3 Assumptions

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

2.10.4 Calculation Approach

This metric will track and report on the following:

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

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

2.10.5 Organization of Results

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

2.10.6 Baseline

The pre-investment baseline of a static three-year average circuit level SAIDI in 2015, 2016, and 2017 shall be provided for each feeder within the service territory. Additionally, the baseline shall be provided with and without Excludable Major Events[4] along with a summary of the main causes of outages on each feeder. The metric will use the circuit three-year SAIDI covering the years 2015-2017 average as the baseline. It will compare the SAIDI results of the plan year to the circuit's 2015-2017 three-year historic average.

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

2.11.1 Type

Statewide Performance Metric

2.11.2 Objective

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

2.11.3 Assumptions

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

2.11.4 Calculation Approach

This metric will track and report on the following:

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

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

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

2.11.5 Organization of Results

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

2.11.6 Baseline

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

2.12 VVO RELATED VOLTAGE COMPLAINTS PERFORMANCE METRIC AND BASELINE

2.12.1 Type of Metric

Statewide Performance Metric

2.12.2 Objective

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

2.12.3 Assumptions

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

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

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

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

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

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

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

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

2.12.4 Calculation Approach

This metric will track and report on the following:

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

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

2.12.5 Organization of Result

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

2.12.6 Baseline

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

APPENDIX A

Eversource-Specific Performance Metrics

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

App.A.1.0.1 Type

Eversource-specific Performance Metric

App.A.1.0.2 Objective

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

App.A.1.0.3 Assumptions

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

App.A.1.0.4 Calculation Approach

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

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

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

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

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

App.A.1.0.5 Organization of Results

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

App.A.1.0.6 Baseline

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

App.A.2.0 EVERSOURCE CUSTOMER OUTAGE METRIC

App.A.2.1 Objective

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

App.A.2.2 Assumptions

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

App.A.2.3 Calculation Approach

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

App.A.2.4 Organization of Results

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

App.A.2.5 Baseline

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

APPENDIX B

Unitil-Specific Performance Metric

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

App.B.1.0 Type of Metric

Company-Specific Performance Metric

App.B.1.0.1 Objective

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

App.B.1.0.2 Assumptions

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

App.B.1.0.3 Calculation Approach

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

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

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

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

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

App.B.1.0.4 Organization of Results

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

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

App.B.1.0.5 Baseline

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

App.B.1.0.6 Target

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

APPENDIX C

National Grid-Specific Performance Metric

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

App.C.1.0.1 Type of Metric

Company-Specific Performance Metric

App.C.1.0.2 Objective

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

App.C.1.0.3 Assumptions

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

App.C.1.0.4 Calculation Approach

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

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

App.C.1.0.5 Organization of Results

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

App.C.1.0.6 Baseline

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

APPENDIX D

Hosting Capacity Status Reporting

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

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

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

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

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

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

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