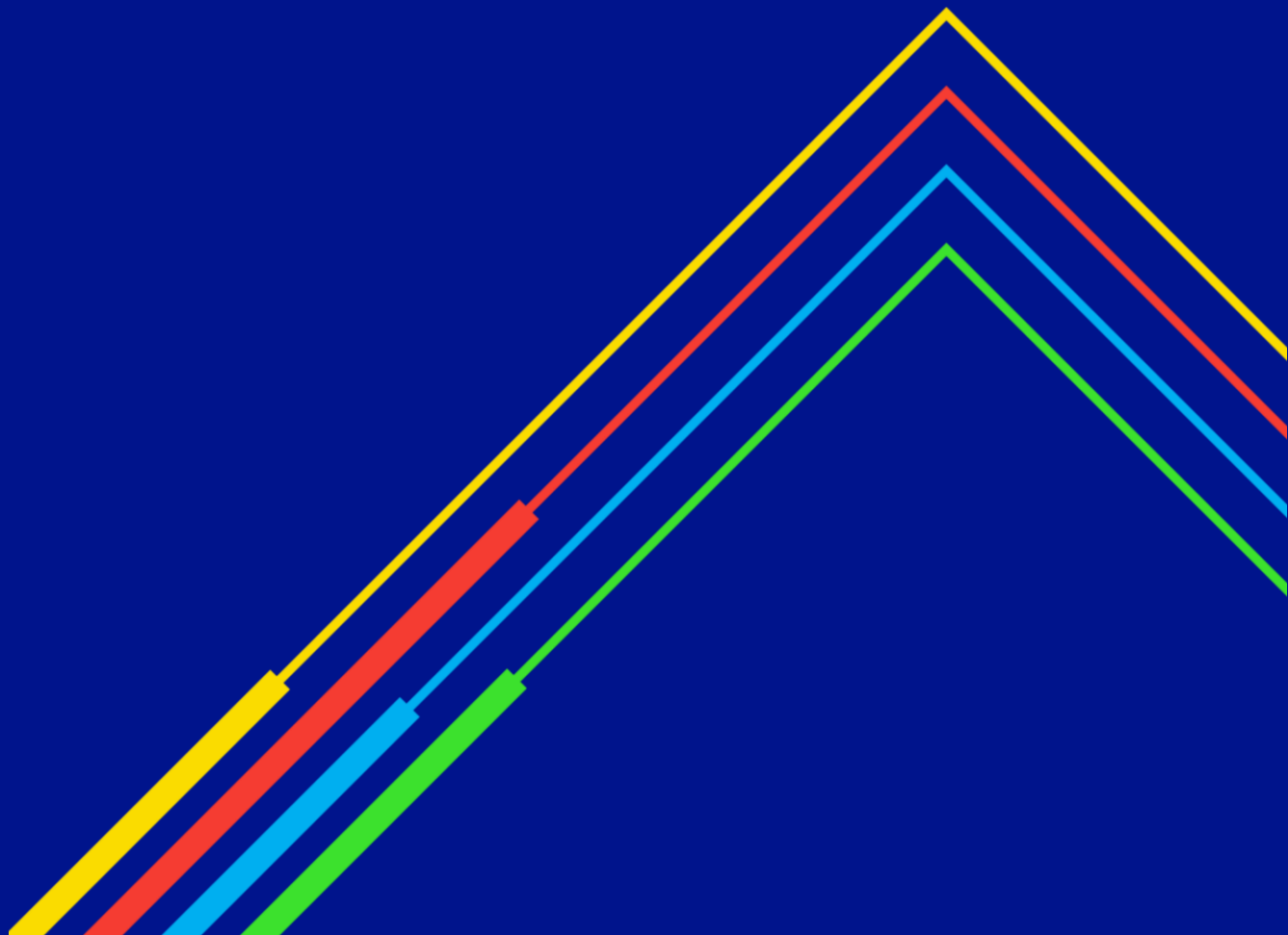
Central & Western MA Cluster Study Update

May 30, 2019
Marlborough



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Safety Message

General Cell Phone Statistics

- The National Safety Council reports that cell phone use while driving leads to 1.6 million crashes each year.
- Nearly 390,000 injuries occur each year from accidents caused by texting while driving.
- 1 out of every 4 car accidents in the United States is caused by texting and driving.
- Texting while driving is 6x more likely to cause an accident than driving drunk.
- Answering a text takes away your attention for about five seconds. Traveling at 55 mph, that's enough time to travel the length of a football field.
- Texting while driving causes a 400 percent increase in time spent with eyes off the road.
- Of all cell phone related tasks, texting is by far the most dangerous activity.

Tips to stop texting while driving:

- Put your phone out of reach or turn the volume to silent and turn vibrate off
- Use an app to block incoming texts or calls. Some apps can send an auto response back, letting the sender know that you are driving and will respond when you are parked.
- Pull over and stop the car if it's important.
- Parents lead by example

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Overview

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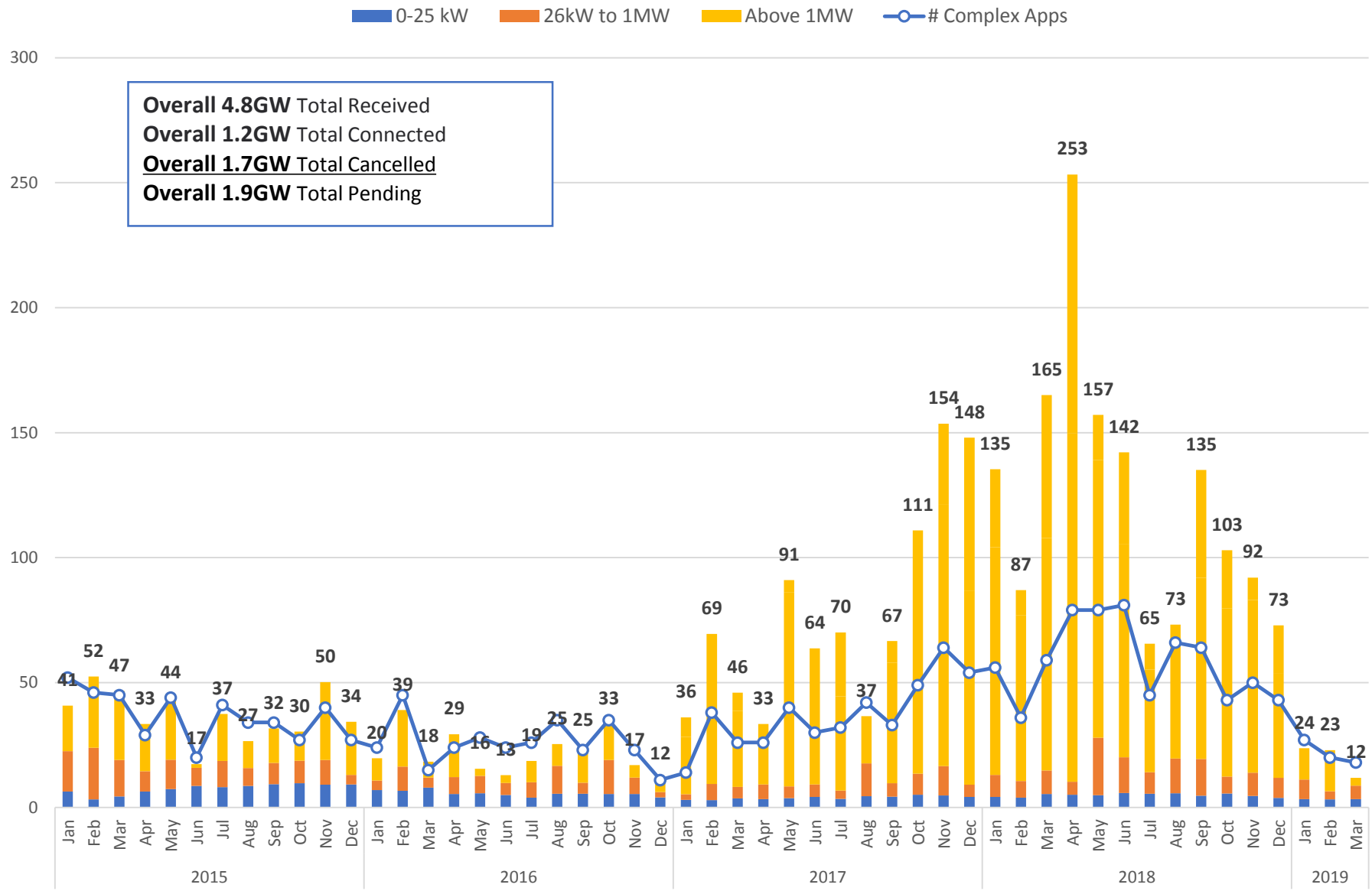
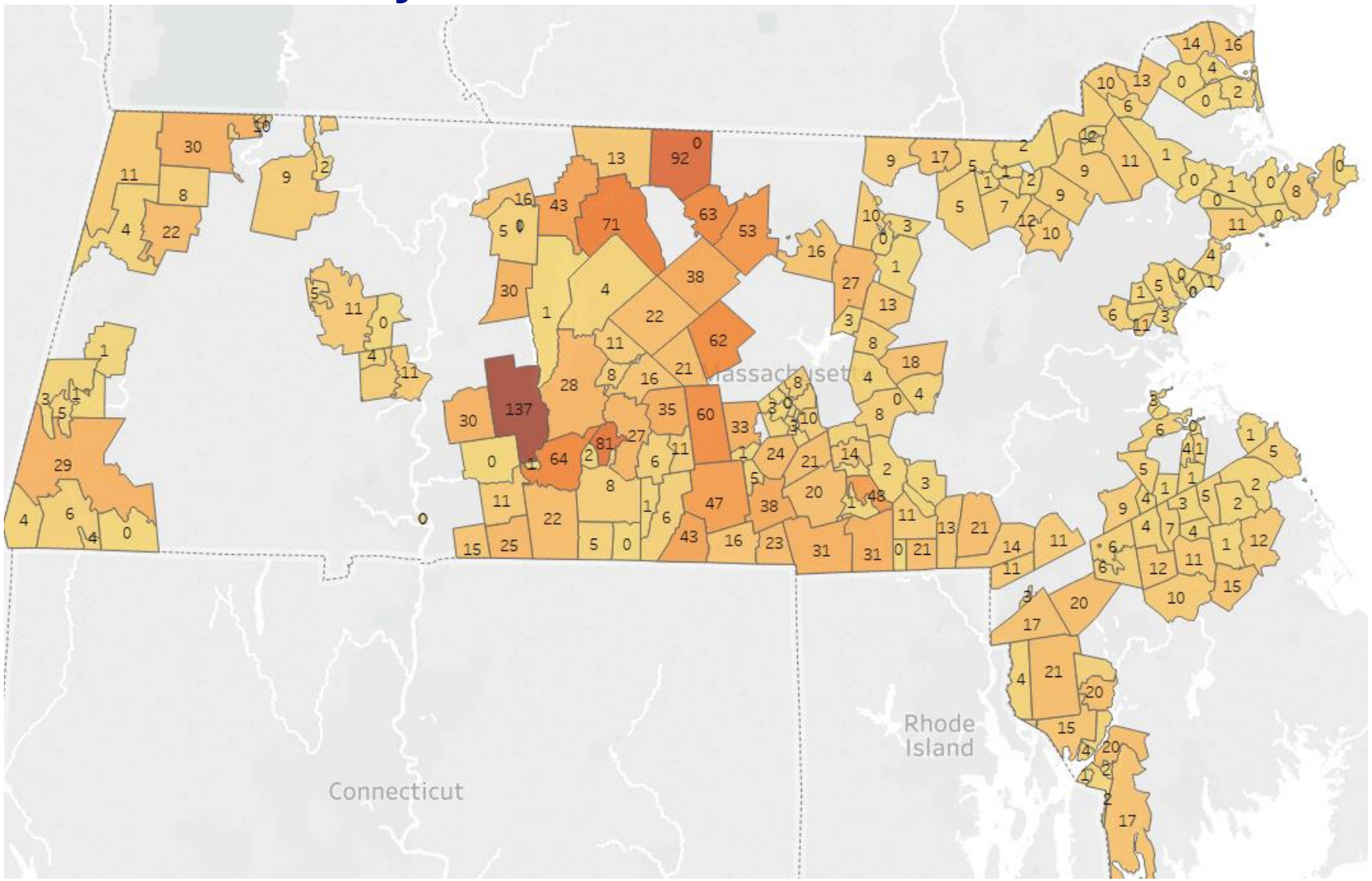
DG Applications Received in MA



Connected & Pending DG Penetration (MW) in MECo Service Territory



Key Stakeholders

- **Massachusetts Electric Company (MECO) –** Interconnecting Company & Coordinator, includes Customer Energy Integration (CEI) and Distribution Planning & Asset Management (DPAM) functions
- **New England Power Company (NEP) –** a MECo affiliate and also an Affected System Operator, includes the Transmission Planning and Asset Management (TPAM) function that is responsible to complete transmission analysis
- **Independent System Operator (ISO-NE) –** The Independent System Operator established in accordance with the NEPOOL Agreement and applicable FERC approvals, responsible for managing the bulk power generation and transmission systems in New England. The governing entity and also an Affected System Operator
- **Affected System Operator (ASO) -** Any neighboring Electric Power System not under control of MECo (i.e. municipal light company or other regulated utility)

03

ISO-NE I.3.9 Process

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04

Transmission Planning
New England Power Company

Barry Ahern

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Introduction

1. Cluster Study Scope
2. Goals
3. Process Overview
4. Study Components
5. Status of Progress

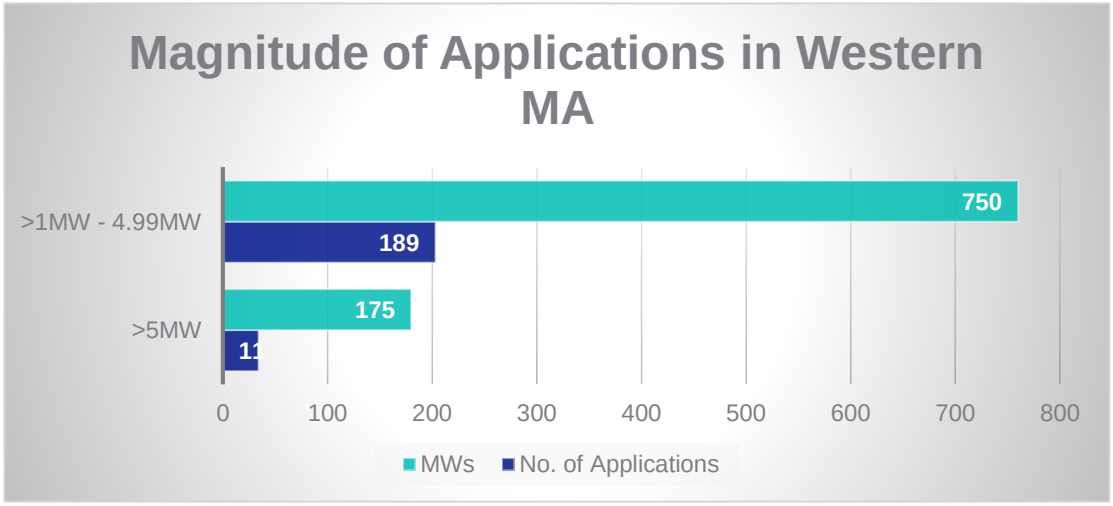
Cluster Study: Applications to ISO-NE Evaluation

- Proposed distributed generation (DG) resources (*i.e.,* those seeking to interconnect to Massachusetts Electric Company's (MECo) electric power system) above 1 MW must be reviewed by ISO-NE, and approved by the New England Power Pool Reliability Committee (NEPOOL RC) in accordance with ISO-NE's Tariff Section I.3.9 and planning procedures.* The main purpose of this review is to determine if there are any impacts to the regional transmission system pursuant to ISO Tariff Section I.3.9
- ISO-NE requires a generator notification form (GNF) for projects sized between 1MW and 5MW, and a proposed plan application (PPA) for projects sized 5MW** or greater, per ISO-NE planning procedure 5-1
- PPA submissions must be supported by a transmission impact study; GNF submissions do not automatically require a transmission study but ISO-NE has the discretion to request a study or analysis consistent with its planning procedures on an as-needed basis. More recently, ISO-NE started to exercise this discretion, requiring some level of transmission analysis for projects sized between 1MW and 5MW.
- Any ISO-NE required studies are performed by the applicable affected transmission system operator(s) (ASO). For DG interconnecting to MECo's electric power system, this is typically its transmission affiliate, New England Power Company (NEP).

*****See ISO-NE's tariff "Review of Market Participant's Proposed Plans" of the ISO New England Transmission, Markets and Services Tariff, Section I.3.9, and ISO-NE's planning procedures, including without limitation PP5-1 Entitled, "Procedure for Review of Governance Participant's Proposed Plans (Section I.3.9 Applications: Requirements, Procedures, and Forms)" and PP 5-3 Entitled, "Guidelines for Conducting and Evaluating Proposed Plan Application Analyses."

******References to project sizes through this presentation are individual and on the aggregate, as applicable, based on ISO-NE rules

Cluster Study: Application Profile



With Reference to PP5-1/PP5-3:

•>1MW to < 5MW: 189 generation resources; ISO-NE has requested transmission analysis. A single project analysis has ranged between 1-3 months.

•5MW and Over: 11 generation resources; study required. A single project study is typically completed as a PP5-3 Level 3 study ranging between between 3-12 months, depending upon complexity.

•Rather than perform individual *sequential* studies, a cluster study was determined to be the most effective and efficient method to progress these projects and arrive at the right conclusions.

Cluster Study Area and Scope

The “Cluster Study” is the study of the proposed DG interconnections in central and western MA being performed by NEP, with inputs from other ASOs, to determine the impacts on the transmission system in accordance with ISO-NE rules and planning procedures. This Cluster Study is separate from, and in addition to, the distribution studies performed by MECo and is required to support the submission of GNFs/PPAs (and obtain ISO-NE/NEPOOL RC approval).

The Cluster Study is being performed as a group transmission study and includes the following project breakdown:

- 1MW – 5MW
  - 189 generation resources*, totaling >750 MW
- 5 MW and above:
  - 11 generation resources, totaling >175 MW

In addition, there are projects behind Cluster Study and will be studied after the completion of ongoing Cluster Study

- 1 generation resource above 5MW and 47 generation resources between 1MW and 5MW totaling over 190MW

* *A generation resource could include more than one interconnection application*

Transmission: Goals

Speed: Facilitate developer interconnection as quickly as possible.

Reliability: Ensure that the interconnections do not compromise the reliability of the transmission system.

Coordination: Ensure the distribution upgrades are appropriately represented in the study assumptions.

Process: Abide by ISO-NE Planning Procedures.

Solutions: Develop the appropriate set of upgrades for the western/central MA area DG, as opposed to determining individual case-by-case upgrades, which more efficiently uses time, material and human resources, and avoids duplicative, out-of-date and/or unnecessary infrastructure (at the customer's cost).

- If projects do trigger adverse impacts, identify the appropriate upgrades that could resolve the issues identified.
    - Including Wire and Non-Wire solutions
    - Distribution revisions

Transmission: Process Overview

1. Study Scoping
    - Part 1 (Post ISA) – ~372MW (6-8 months)
    - Part 2 – >900MW (12-14 months)
    - Securing all of the data for the Cluster Study from DG customers
2. Initiation of Study
    - Steady State Analysis
    - Stability Analysis
    - Short Circuit Analysis
    - PSCAD Analysis
3. Proposed Plan Applications
4. Approval

Transmission: Study Components

Steady State Analysis

1. Determination of ISO-NE base cases:
   - Confirmations on all assumptions with completion of study
   - The FERC projects to include within the cases
2. Engage all ASOs in the scoping of the study
   - There are 10 ASOs participating in the Cluster Study
3. Modelling all projects into all of the cases
4. Stress all cases consistent with prevailing standards
5. Identify voltage and thermal issues
   - Propose solutions

Who are the Affected System Operators

1. NEP
2. ISO-NE
3. Eversource
4. Fitchburg Gas & Electric (UNITIL)
5. GMP (Green Mountain Power)
6. VELCO (Vermont Electric Power Company)
7. Templeton Municipal Light
8. Paxton Municipal Light
9. Ashburnham Municipal Light
10. MMWEC (MA Wholesale Electric Company)

Transmission: Study Components

Stability Analysis

5MW or Over:

- Data requirements communicated to developers
- Each stability model provided by developers must be checked and tested before running full stability study

>1MW to < 5MW:

A generic model can be utilized for each individual application

The stability study will identify any rotor angle or voltage stability problems caused by the projects

Transmission: Study Components

Short Circuit Analysis

- All projects must be aggregated and added to the short circuit program
- New distribution transformers and transmission topology changes must be represented (added) to the short circuit program
- Short circuit duties must not exceed equipment capability
- Identify any system upgrades required to address issues

Transmission: Study Components

PSCAD Study

A PSCAD Study is not a typical requirement for Non-FERC interconnection projects. However, given the high potential for adverse impact on the regional transmission system from the volume and location of the proposed generation, ISO-NE has requested a PSCAD review for all projects above 1MW.

This study will require data inputs from the developer to make the following assessments:

- Weak System Analysis
- Control Interaction Analysis
- Dynamic Performance Studies

NEP needs PSCAD Model from applicants above 1MW as soon as possible.

Status of Progress

High Level Cluster Study Estimated Timeline

- CY Q3 2019
  - Steady State & Short Circuit Analysis for Part 1 (Post ISA) - In progress
  - Preliminary results
  - Stability Analysis– Validating Models
  - PSCAD - Validating Models
- Status update – August 2019
- CY Q4 2019 – Part 1 of Study: Complete
- CY Q4 2019 – Outreach to Interconnecting Customers
- CY Q1 2020 – Part 2 of Study: Complete
- CY Q2 2020 – Outreach to Interconnecting Customers.

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Distribution Planning
Massachusetts Electric Company

Michael Porcaro

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Process Overview

- MECo coordinates with NEP on the submission of each GNF/PPA on behalf of its DG customers.
- MECo's distribution solution provides the injection point for the DG project's generation which is a critical input into any required transmission study.
- The ISO-NE approval process, particularly when a study or additional analysis is required, can affect MECo's interconnection processing timeframes.
  - DG cannot be safely and reliably interconnected unless MECo and ASOs, such as NEP and ISO-NE, when applicable, have evaluated the impacts of the proposed DG on their respective systems and any system modifications necessary to mitigate such impacts are in place.

DG Interconnection Processing Teams

CEI

- Coordinating with developers from application to interconnection

Distribution Planning

- Analyze and develop interconnection solutions at distribution level
- Coordinate across National Grid in development of most viable solution
- Coordinate with ASOs (such as NEP)

Substation Engineering

- Coordinate distribution level requirements at substations.

Protective Device Coordination

- Develop protection strategies to preserve safety and reliability given complex effects of high DG volume

Design, Resource Planning, Operations, etc.

- All downstream departments that implement the engineered solutions required for safe and reliable interconnections

Level of DG Saturation

Working with multiple developers on unprecedented volume of DG applications

- High volume of DG seeking to connect in concentrated geographic regions
- Prompting need for significant infrastructure upgrades to MECo's distribution system; exceeding capacity of distribution assets
- Significant upstream effect anticipated on NEP transmission system

Distribution planning need to evaluate individual and holistic impacts on the distribution system

- Exploring all feasible interconnection options that maintain the reliability, safety, and integrity of the system
- Least cost to serve solutions considering initial cost and recurring maintenance - avoid duplicative, out-of-date and/or unnecessary infrastructure (at the customer's cost)
- Consider MECo's operational needs and maintain operational flexibility for reliability; efficiently use time, material and human resources
- Balancing needs of DG developers, operational needs of MECo, and needs of National Grid's 1.3 million customers.

Level of DG Saturation (cont.)

Areas requiring MECo Distribution System upgrades

- Barre >80MW
- Belchertown >110MW
- Athol >95MW
- Gardner >150MW
- Leicester >65MW
- Brookfield >70MW
- Palmer >85MW

Total in excess of **650MW**

Upstream effect on additional substations that connect to the transmission lines serving above areas

- Considering these additional affected subs, **>900MW** seeking to interconnect

Perspective:

- Vermont Yankee, Nuclear Power Plant, Vernon VT: 620 MW (decommissioned 2014)
- Typical “Heavily Loaded” 15kV Feeder: ~10 MW
- “Worcester Area Load”: approx. ~165 MW (low period)

Distribution Area Preliminary Analysis

Distribution Planning identified 7 specific concentrated areas currently encompassing over 20 substations in MECo's service territory.

- 5 new substations
- 9 substations to be significantly expanded and/or rebuilt
- 2 substations to be retired
- Remaining substations to undergo upgrades in support of feeder level system modifications

Current expectations for Distribution Level solutions

- New substations and/or expansion of existing
- Rearrangement of distribution feeders
- Alternative distribution feeder voltage class

Gardner Area

Rebuild East Winchendon Substation at existing location:

- Replace (1) existing 115kV:13.8kV substation transformer with 55MVA unit
- Install (1) new 55 MVA 115 kV:13.8 kV substation transformer
- Install (1) new 75 MVA 115 kV:34.5 kV substation transformer

Retire existing Westminster Substation & replace with new at new location:

- Install (2) new 55 MVA 115 kV:13.8 kV substation transformers
- Install (1) new 75 MVA 115 kV:34.5 kV substation transformer

New transmission taps to new substation transformers

New distribution feeder installation and area feeder reconfiguration

Substation	Sum of Projects (MW)
CRYSTAL LAKE	50.5
E. WESTMINSTER	34.7
E. WINCHENDON	45.4
WESTMINSTER	RETIRING
WHITMANVILLE-Replacing Westminster	23.4
Grand Total	**154**

Values shown are approximate, for reference purposes of this presentation. Work scope describes the preliminary proposed distribution solution which will be reviewed by the ASO. This solution is subject to change in whole or part pending the results of the ASO studies. Does not reflect required system modifications for ASOs.

Leicester Area

Upgrade North Oxford Substation at existing location:

- Install (1) new 55 MVA 115 kV:13.8 kV substation transformer

Retire existing Leicester Substation and replace with new near Stafford St in Leicester:

- Install (2) new 55 MVA 115 kV:13.8 kV substation transformers

Install 3V0 at Pondville Substation

New transmission taps to new substation transformers

New distribution Feeder installation and area feeder reconfiguration

Substation	Sum of Projects (MW)
PONDVILLE	6.0
WEBSTER ST.	1.4
N. OXFORD	31.6
LEICESTER	RETIRING
STAFFORD ST-New	28.1
Grand Total	**67.1**

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Brookfield Area

Upgrade Meadow St Substation at existing location:

- Install (1) new 55 MVA 69kV:13.2kV substation transformer

Install new substation near Cronin Rd in Brookfield:

- Install (2) new 55 MVA 115 kV:13.2 kV substation transformers

New transmission taps to new substation transformers

New distribution Feeder installation and area feeder reconfiguration

Substation	Sum of Projects (MW)
LASHAWAY	7.3
MEADOW ST	46.9
BROOKFIELD-New	16.8
Grand Total	**71.1**

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Athol Area

Upgrade Royalston Substation at existing location:

- Replace existing 3.75MVA, 69kV:4kV transformer with 40MVA, 69kV:13.2kV

Install new substation in New Salem:

- Install (1) new 75 MVA 115kV:34.5kV substation transformer

Upgrade Wendell Depot Substation at existing location:

- Replace (1) existing 20MVA, 115kV:13.8kV substation transformer with 55MVA unit
- Install (1) new 55 MVA 115 kV:13.8 kV substation transformer

New transmission taps to new substation transformers

New distribution Feeder installation and area feeder reconfiguration

Substation	Sum of Projects (MW)
CHESTNUT HILL	30.6
ROYALSTON	13.4
WENDELL DEPOT	37.2
NEW SALEM-New	17.0
Grand Total	**98.2**

Values shown are approximate, for reference purposes of this presentation. Work scope describes the preliminary proposed distribution solution which will be reviewed by the ASO. This solution is subject to change in whole or part pending the results of the ASO studies. Does not reflect required system modifications for ASOs.

Palmer Area

Upgrade Palmer Substation at existing location:

- Replace (1) existing 20MVA, 115kV:13.2kV substation transformer with 55MVA unit
- Install (1) new 55 MVA 115kV:13.2kV substation transformer

Upgrade Little Rest Rd Substation at existing location:

- Install (1) new 55 MVA 115kV:13.2kV substation transformer
- Install (1) new 75 MVA 115kV:34.5kV substation transformer

New transmission taps to new substation transformers

New distribution Feeder installation and area feeder reconfiguration

Substation	Sum of Projects (MW)
LITTLE REST RD	52.5
SHEARER'S CORNER	3.2
PALMER	31.2
Grand Total	**86.9**

Values shown are approximate, for reference purposes of this presentation. Work scope describes the preliminary proposed distribution solution which will be reviewed by the ASO. This solution is subject to change in whole or part pending the results of the ASO studies. Does not reflect required system modifications for ASOs.

Belchertown Area

Upgrade Five Corners Substation at existing location:

- Install (1) new 55 MVA 115kV:13.2kV substation transformer

Upgrade Thorndike Substation at existing location:

- Install (1) new 75 MVA 115kV:34.5kV substation transformer

New transmission taps to new substation transformers

New distribution Feeder installation and area feeder reconfiguration

Substation	Sum of Projects (MW)
BELCHERTOWN	14.1
THORNDIKE	75.4
FIVE CORNERS	21.9
Grand Total	**111.5**

Values shown are approximate, for reference purposes of this presentation. Work scope describes the preliminary proposed distribution solution which will be reviewed by the ASO. This solution is subject to change in whole or part pending the results of the ASO studies. Does not reflect required system modifications for ASOs.

Barre Area

Upgrade Barre Substation at existing location:

- Replace (2) existing 12.5MVA and 9.375MVA, 115kV:13.8kV substation transformers with 55MVA units

Install new Substation in Barre (tentatively named Powder Mill):

- Install (1) new 75 MVA 115kV:34.5kV substation transformer

New Transmission taps to new substation transformers

New Distribution Feeder installation and area feeder reconfiguration

Substation	Sum of Projects (MW)
BARRE	13.2
WARE	29.5
POWDER MILL-New	38.2
Grand Total	**80.9**

Values shown are approximate, for reference purposes of this presentation. Work scope describes the preliminary proposed distribution solution which will be reviewed by the ASO. This solution is subject to change in whole or part pending the results of the ASO studies. Does not reflect required system modifications for ASOs.

MECo Distribution Study Status Summary

Present state:

- Significant coordination to ensure viable solution
  - Constructability
  - Operational requirements
  - Cost effective
  - Maintaining overall safety and reliability
- MECo's distribution interconnection solutions and system modification requirements were developed and provided as inputs to the Cluster Study

Next Steps:

- Continued collaboration with ASOs. Provide supporting information as needed for advancement of Cluster Study.
- Adjust distribution interconnection solutions as needed based on results of ASO study
- Communicate status updates and any additional requirements to customers, including any required system modifications to the ASO's electric power system(s) and the cost thereof

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Next Steps

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Long Term Plan

- MECo will provide updates as new information becomes available. Customers are encouraged to reach out to their CEI representatives if there are any questions regarding the status of the Cluster Study.
- MECo and NEP will continue to collaborate with each other and key stakeholders to jointly explore opportunities and assist in progression of DG.
  - There is continued collaboration with ISO-NE to minimize impacts of FERC projects on the queue for non-FERC (*e.g.* Company DG projects).
  - The Company and NEP will actively manage the Cluster Study project queue. If attrition is observed, the Company will work to advance subsequent projects on hold behind the Cluster Study.
- As the electric power systems become more saturated, National Grid anticipates more DG interconnection solutions will involve increased ISO-NE and ASO participation.
  - The Company is now working to have GNFs submitted earlier in the interconnection process so any additional transmission study required to support ISO-NE's approval of a GNF can be coordinated earlier in the process.
- Collaboration and thought leadership is needed from all stakeholders (National Grid, industry, and government agencies) to support the State's DG development goals and clean energy agenda, and continue to interconnect DG projects timely with cost-effective solutions.
- The Department of Public Utilities recently opened an inquiry (D.P.U. 19-55) into DG Interconnection to review the current standards and procedures for interconnection. The initial phase of the DPU's investigation will address the process related to ASO studies conducted during DG interconnection.

Questions

We are happy to take questions at this time. For any project specific questions, please contact your CEI representative.