ESMP Technical Deep Dive Discussion

December 7, 2023

I. Introduction & Session Objectives

5 Minutes

Background & Session Objectives

*The EDCs have completed two stakeholder workshops focused on understanding the ESMPs, demand forecasts, infrastructure needs, and stakeholder/community engagement plans. This **additional workshop** was requested by the GMAC to conduct a more **technical discussion** on specific aspects of the ESMPs with utility experts.*

Session Objectives:

- Discuss the current state of PV and storage **interconnection**, and discuss the EDCs' **infrastructure plans** necessary to enable increased integration of PV, storage, and beneficial electrification
- Provide an overview of the EDCs' **DERMS platform plans** (i.e., scope and pilot projects)
- Discuss EDCs' **NWA framework** and identify **specific locations/scenarios** where NWAs could be beneficial
- Encourage **open dialogue** and **collaboration** between utilities and DG stakeholders regarding specific technical challenges (e.g., interconnection standards, grid stability, and integration of renewable resources)

Detailed Agenda

Time	Topic	Facilitator
1:25 PM ET	**I. Session Objectives & Introductions** (5 Mins)	West Monroe Partners
1:30 PM ET	**II. ESMP Overview** a. Utility Overview (4 Mins) b. Clean Energy Targets & Objectives (2 Mins) c. Forecasting Methodology (3 Mins) d. EDC DG Forecast Assumptions (6 Mins) e. ESMP Summary (15 Mins) **Open Q&A** (30 Mins)	National Grid Unitil Eversource Eversource, Unitil, National Grid National Grid, Eversource, Unitil
2:30 PM ET	**Break** (5 Mins)	
2:35 PM ET	**III. Technical Discussion** (40 Mins) a. Current State of Interconnection b. Infrastructure Plans c. DERMS d. Non-Wire Alternatives **Open Q&A** (45 Mins)	National Grid, Eversource, Unitil
4:00 PM ET	**Adjourn**	

ESMP Technical Deep Dive Session Facilitator & Presenters

Session Facilitator

Sam Uyeno, Partner

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Utility Presenters

Gerhard Walker, Eversource
Manager, Advanced Forecasting and Modeling

Lavelle Freeman, Eversource
Director, Distribution System Planning

Sophia Zhang, Eversource
Forecasting Lead

Elton Prifti, National Grid
Director, Distribution Asset Mgmt. & Engineering

Emily Slack, National Grid
Manager, Distribution Planning & Asset Mgmt.

Rain Xie, National Grid
Manager, Electric Load Forecasting

Samer Arafa, National Grid
Principal Engineer, Innovative Grid Solutions

Josh Tom, National Grid
Director, Future of Electric for Customers

Kevin Sprague, Unitil
Vice President, Engineering

EVERSOURCE

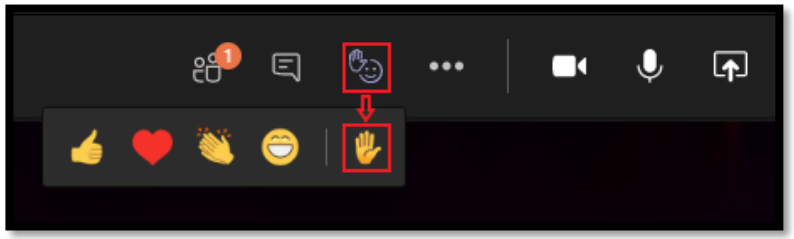
nationalgrid

Unitil

Session Ground Rules

This session is designed as a collaborative discussion to allow the respective EDCs to provide summary content followed by an open Q&A from the meeting participants. To maintain a productive and collaborative session, we ask that everyone adhere to the following:

1. We encourage active participation. After presentations, you're invited to contribute by using the **'raise hand'** feature in MS Teams. Our facilitator will then call on you to ensure an organized and fair speaking order.



2. When called upon to speak, please start by stating your **name**, **affiliation**, and **question**. This helps everyone in the meeting understand the diverse perspectives being represented.

3. We value your insights and ask you to be **succinct** in your questions and comments. This allows us to hear from as many voices as possible during our limited time together.

4. Let's please keep our discussion targeted on the **key themes** (e.g., load forecasting, DER penetration, DERMS implementation, NWA solutions). This focus will help us delve deeply into the subjects that matter most.

5. Please be considerate of **sensitive information**, refraining from sharing anything confidential. By joining this session, you acknowledge that it's being **recorded** and agree to this for the purpose of future reference and continuity of our work.

II. ESMP Overview

30 Minutes Presentation | 30 Minutes Q&A

II. ESMP Overview

a) Utility Overview

Elton Prifti, National Grid

Director, Distribution Asset Management & Engineering

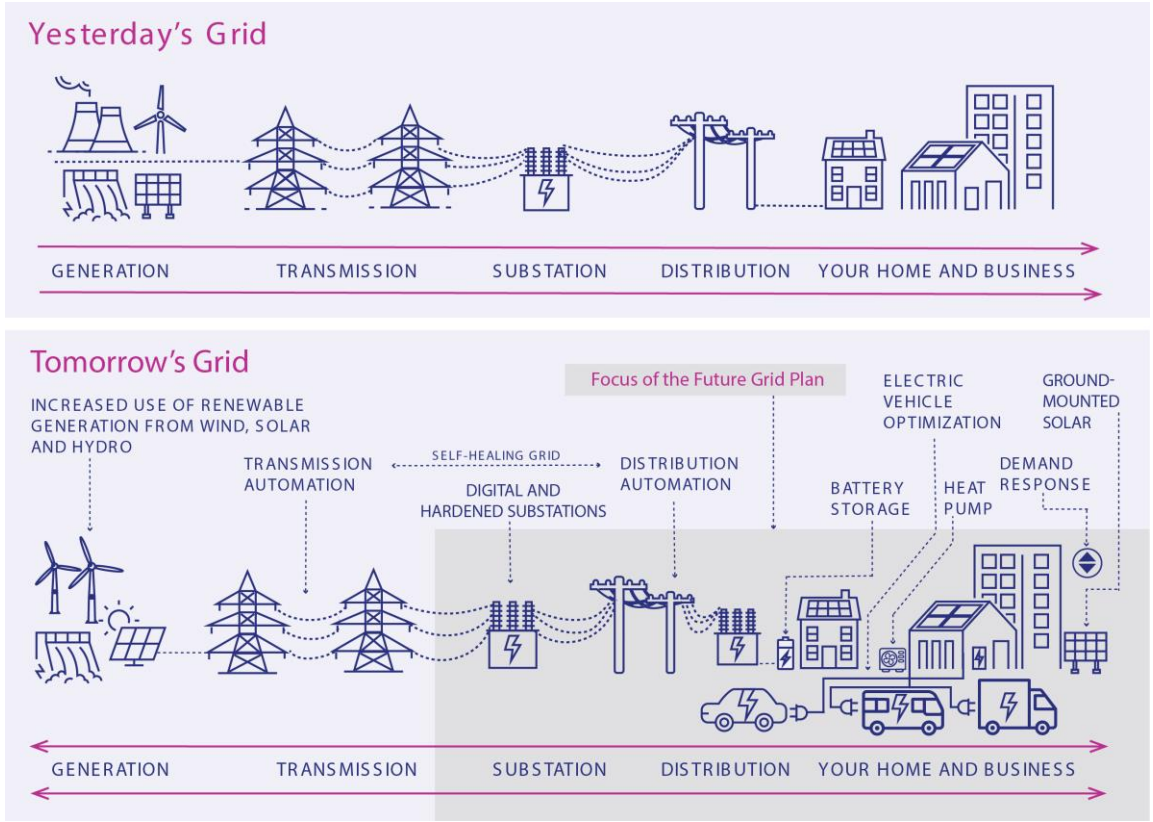
Grid Infrastructure – Current State

Transmission lines carry electricity long distances at high voltage levels (e.g., 69 kV, 115 kV, 345 kV)

Substation Transformers step voltage down to lower voltages safer for local distribution (e.g., 15 kV, 5 kV)

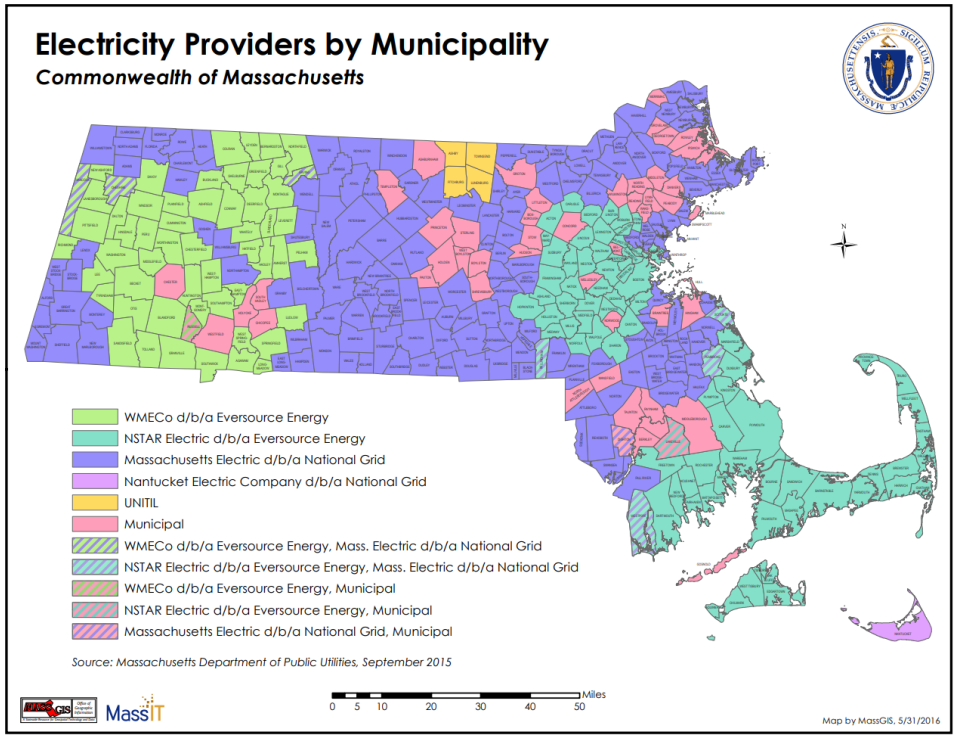
Distribution Lines or **Feeders** carry power overhead or underground to homes and businesses, where **Distribution Transformers** step voltage down further

Generation occurs both at a centralized level (feeding into transmission) and distribution level (DER)



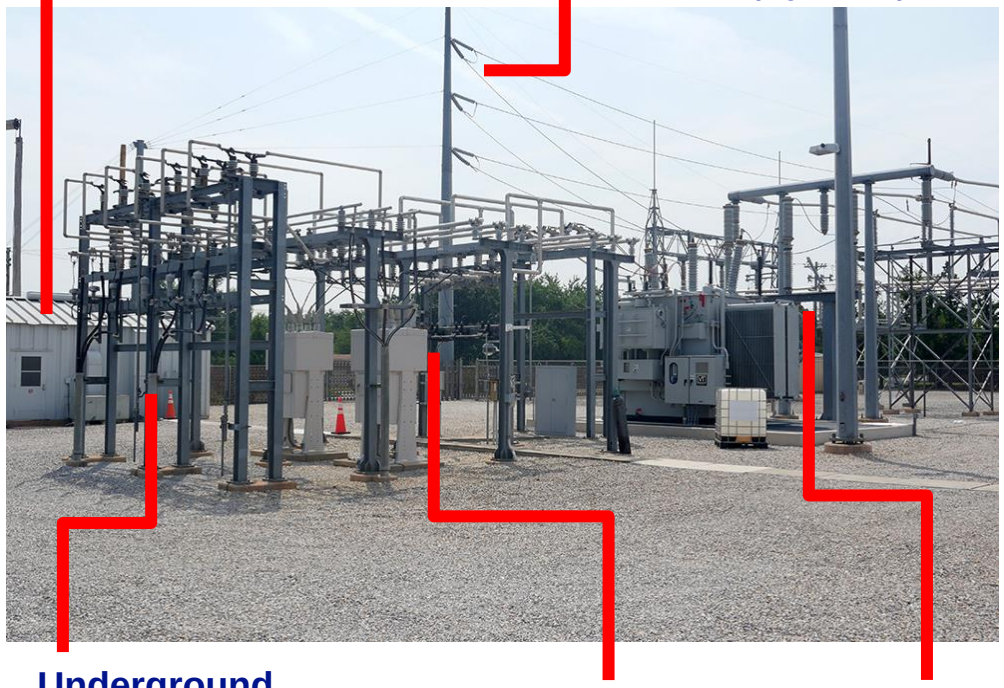
Grid Infrastructure by the Numbers

	Eversource	National Grid	Unitil	State-Wide
Planning Subregions	4	6	1	11
Substations	172	178	15	365
Miles Distribution	20,700	18,500	522	39,722
Miles Overhead	11,500	13,500	454	25,454
Miles Underground	9,200	5,000	68	14,268
Poles	500,000	720,000	19,100	1,239,100
Distribution Service Transformers	172,900	183,600	6,500	363,000
Electric Customers	1.5 million	1.3 million	30,500	2,830,500



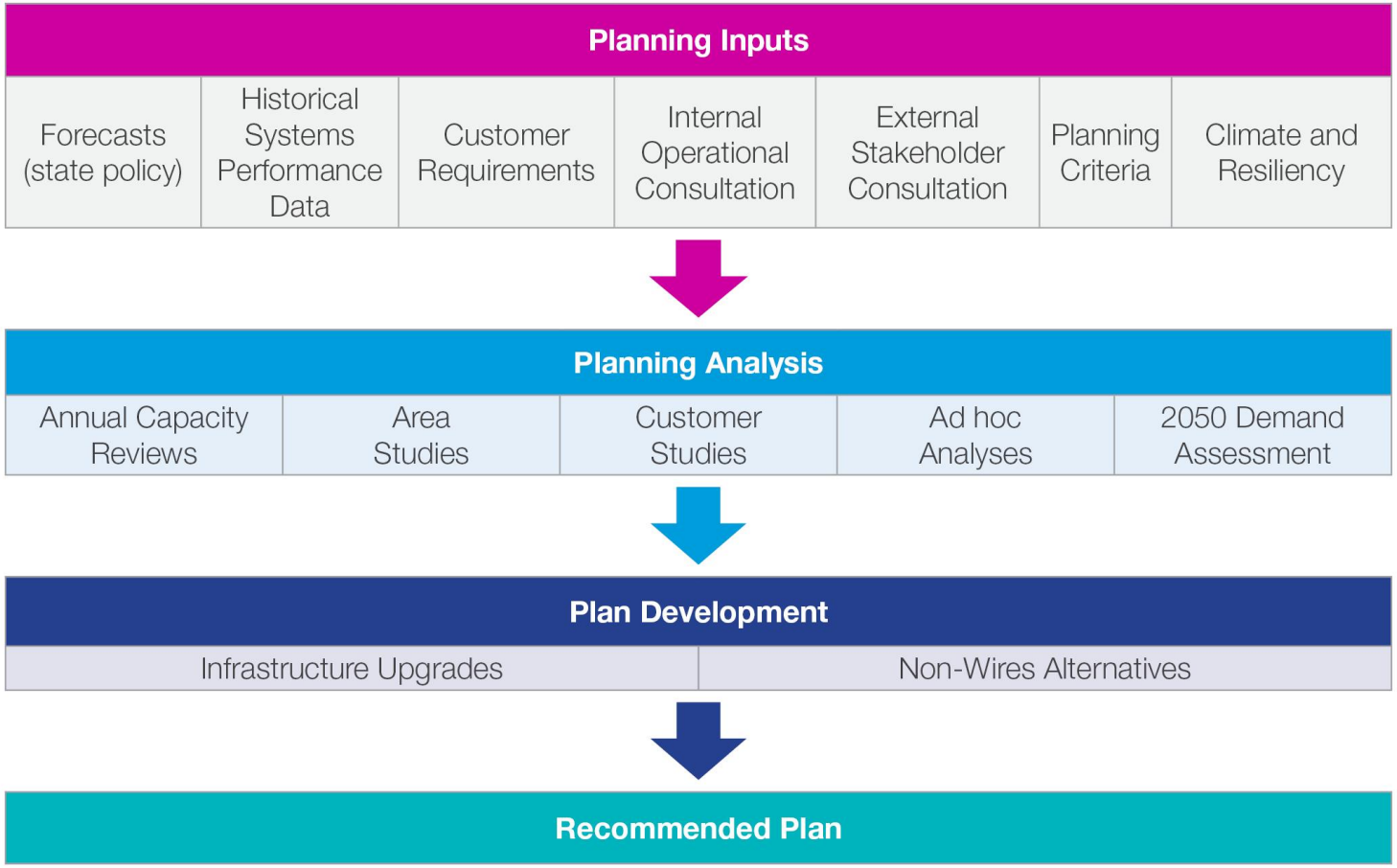
Substations - Key Component

- **Substations link the transmission system to the distribution system, and eventually the end users – our customers**
  - They convert power utilizing power transformers that do not move or rotate
- **Substations are a key component of the electric power system, essential in meeting customer demands and supporting 21st century economies**
  - They are critical in converting wind power, solar generation, and any form of clean energy resources from source to customers
- **Projects to expand or build new substations are high cost, long duration projects that can become a bottleneck to electrification and other customer requests, if we do not build in advance**



Grid Infrastructure – Planning Process

- **The EDCs have formal planning processes that are generally consistent across all three Companies**
  - Forecast identifies projected demand
  - Planning Criteria establishes thresholds for acceptable behavior (EDC-specific)
  - Recommendations (infrastructure and otherwise) are developed to address performance concerns
- **The ESMP process for each EDC was consistent with the goals identified in the legislation, and followed established planning processes; the outcomes are EDC-specific based on the unique characteristics of each Company's system.**



II. ESMP Overview

b) Clean Energy Targets & Objectives

Kevin Sprague, Unitil

Vice President, Engineering

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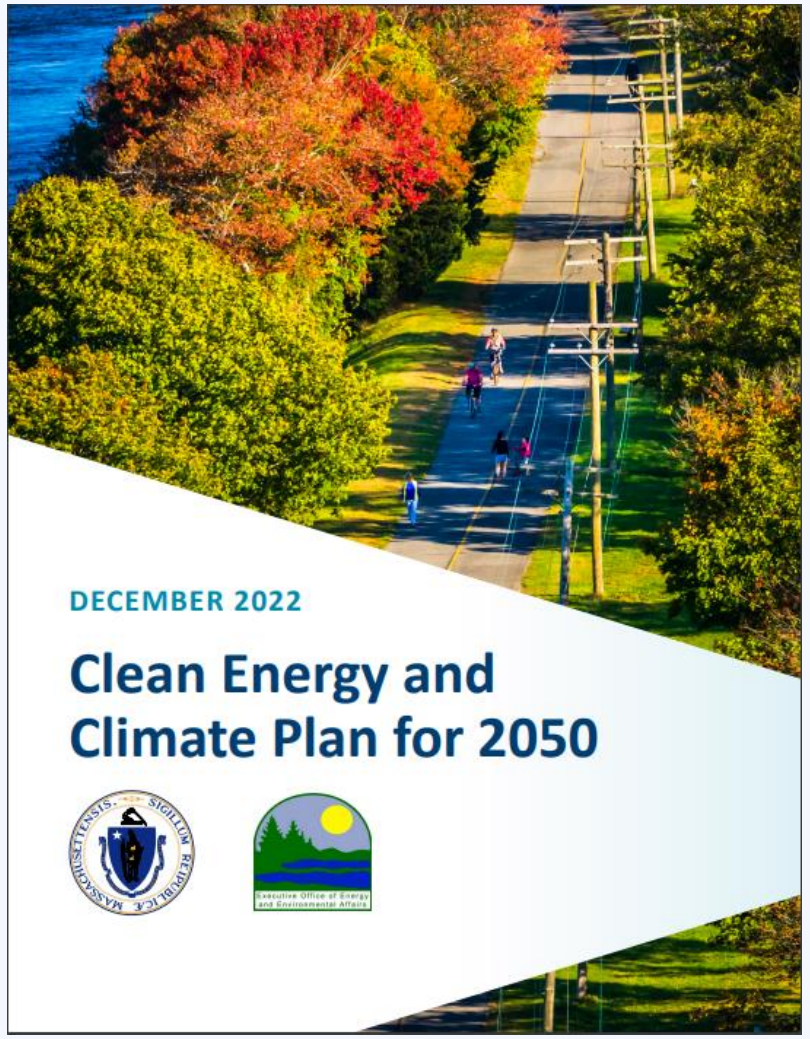
Support the Transition to a Cleaner Energy Future

Plans are designed to support the Commonwealth's climate goals

- Today's electric system not prepared for the level of electrification and interconnection of DERs identified in the CECP
- Support the Commonwealth's pathway to decarbonization with the following investments:
  - Core Investments
  - Hosting capacity (CIP)
  - AMI
  - Utility solar
  - Grid Modernization
  - EV programs
  - Customer investments
  - Platform investments
  - Network investments
  - Resiliency
- Goal - Ensure ESMPs distribute benefits in an equitable manner, with
  - attention to mitigate the impacts on historically disadvantaged communities to support a just transition.



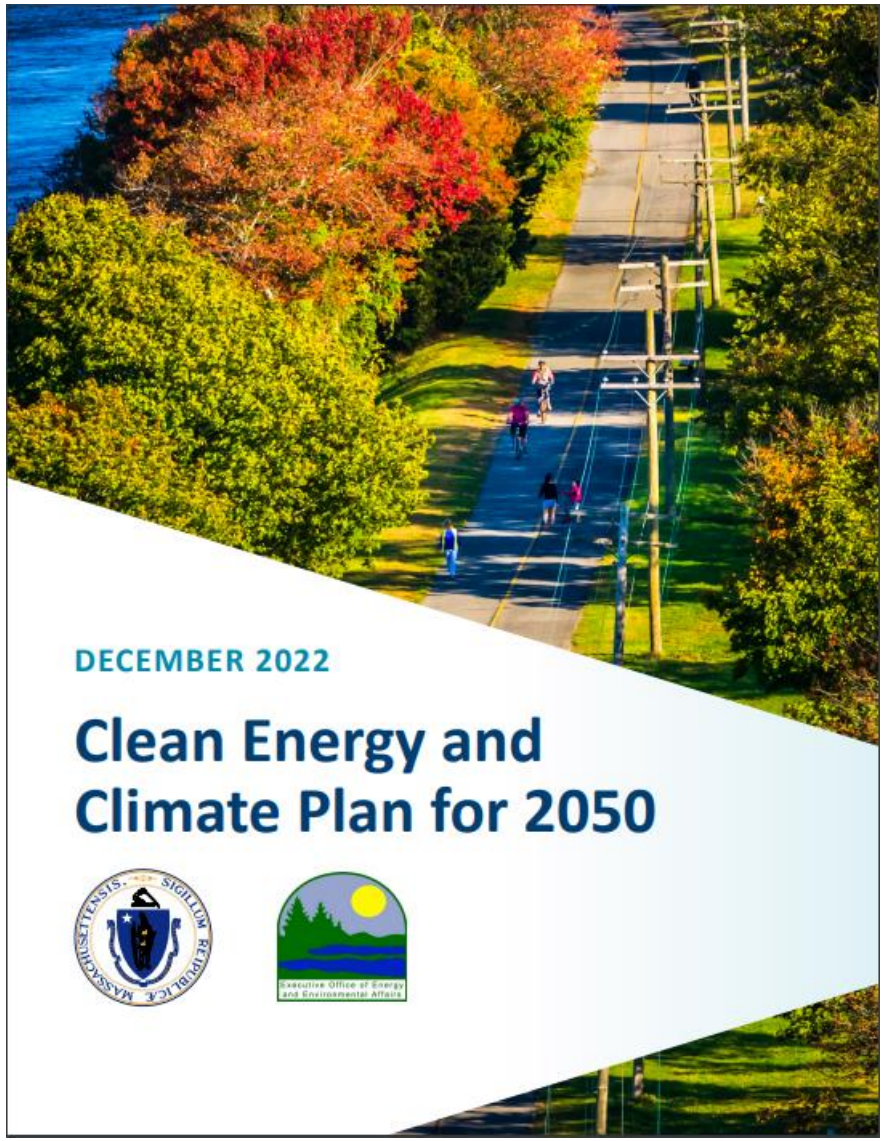
https://www.mass.gov/doc/2050-clean-energy-and-climate-plan/download

CECP 2050 Clean Energy Goas

The Commonwealth's goals for a clean energy future.

Sector	Description	State Benchmark
Transportation Sector		
	Light-Duty EV	5,000,000
	Medium/Heavy Duty EV	353,000
Building Sector (Note 2)		
	Residential air source heat pumps	2,000,000
	Residential Ground source heat pumps	195,000
	Residential EE Retrofits	1,300,000
	Commercial air source heat pumps	1,500,000,000
	Commercial ground source heat pumps	140,000,000
Power Sector (Note 2)		
	Offshore Wind	23.0
	Onshore Wind	1.0
	Solar	27.0
	Storage	5.8

Source: 2050 Clean Energy and Climate Plan, Table 3-3
https://www.mass.gov/doc/2050-clean-energy-and-climate-plan/download



II. ESMP Overview

c) Forecasting Methodology

Sophia Zhang, Eversource

Forecasting Lead

Why We Forecast

To understand future demand and service needs so that we can identify and provide orderly, economic investment, including expansion of equipment and facilities

- Ensure sufficient system capacity to meet future demand and service needs
- Satisfy voltage and power quality requirements within applicable limits
- Provide adequate reliability and resiliency to disruptive events
- Serve all customers safely wherever they are

… and do it all for the lowest reasonable cost

Utilities must forecast because infrastructure takes years to plan, site, and build

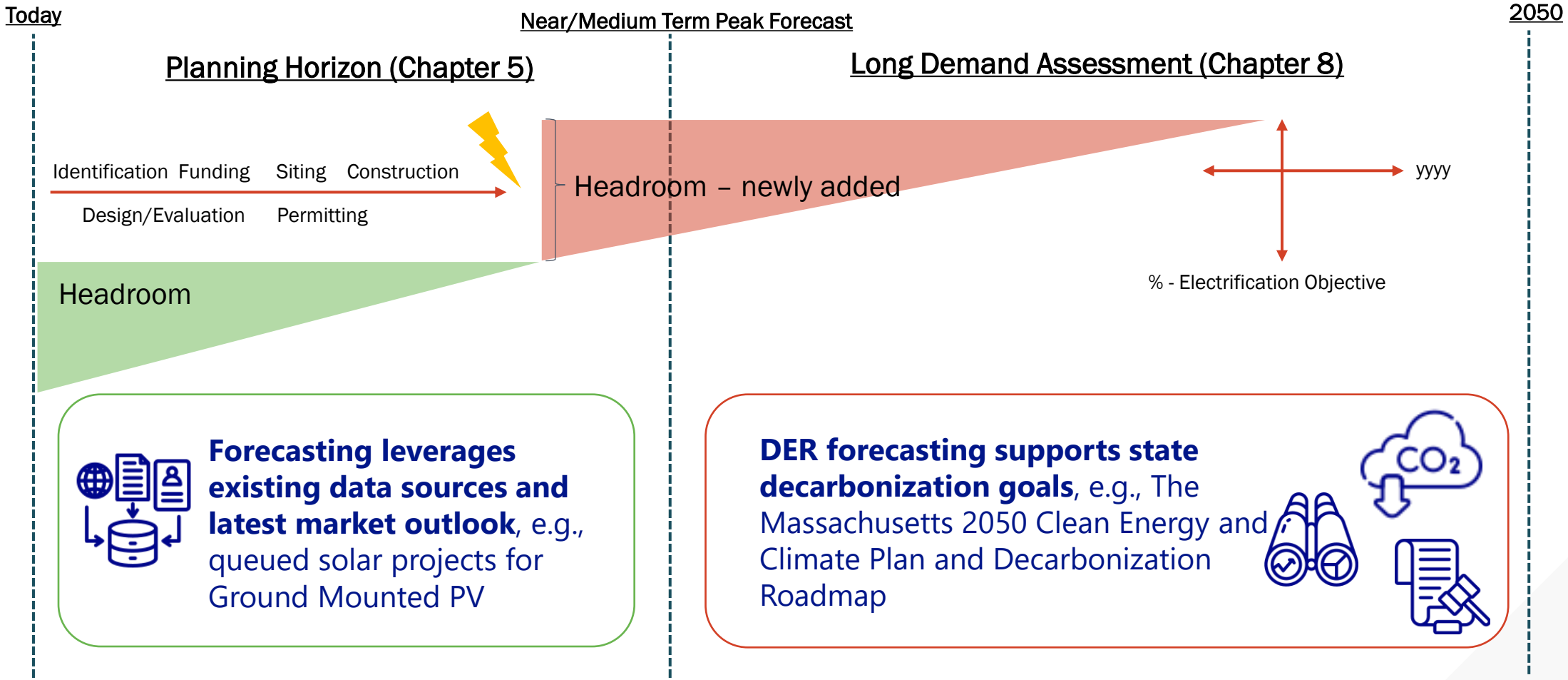
- Transmission → 10+ years
- Substations → 5-10 years
- Distribution → weeks for service upgrades, 2-3 years for circuit re-designs

The bigger the project, the longer it takes, the longer range the forecast

- Bigger Projects also have larger areas they service
- Forecasts over larger areas are significantly more accurate
- Geographically granular forecasts have significant uncertainties
- Forecasts are created by geographic region or bulk station

How We Forecast

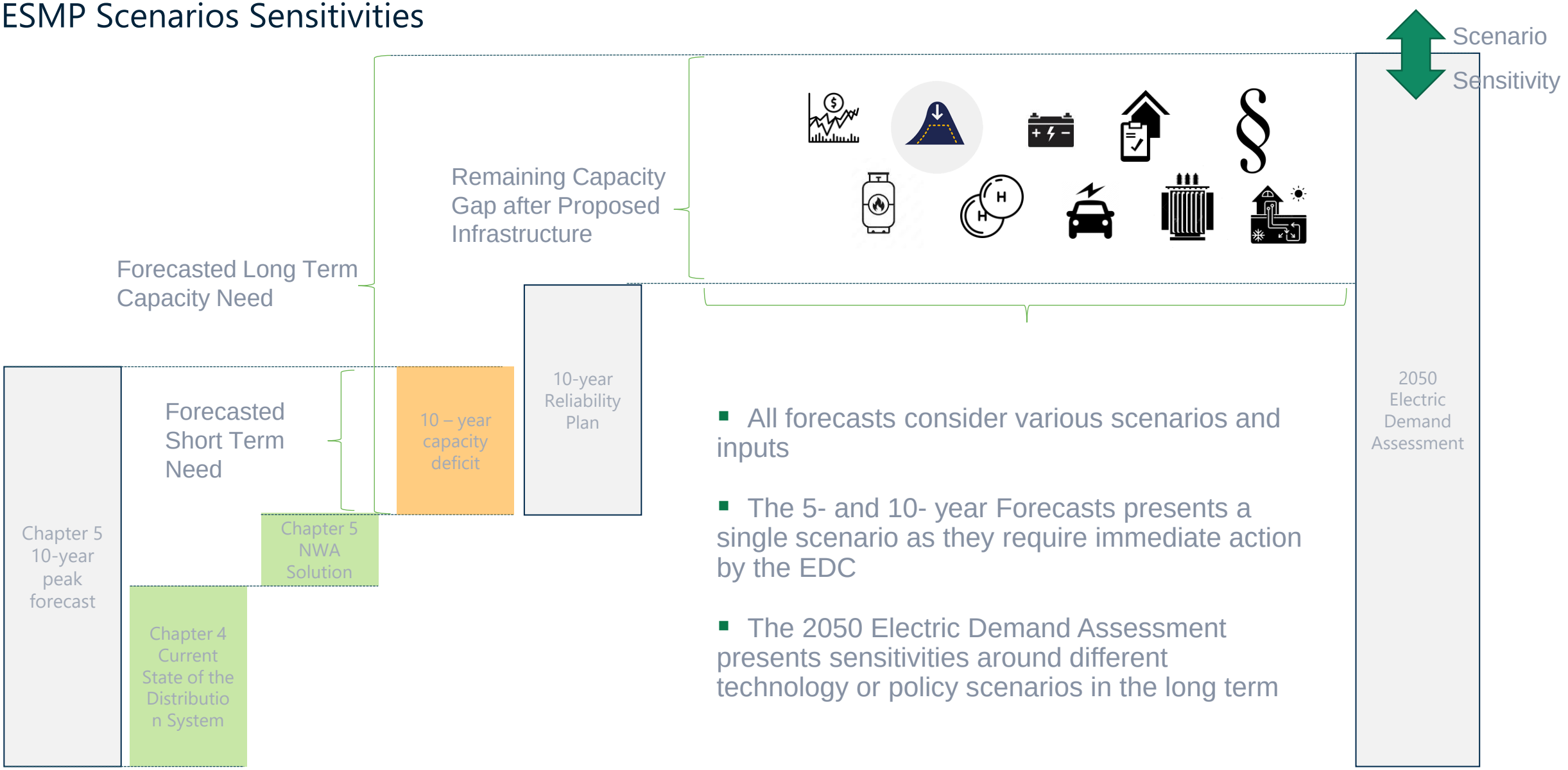
General Framework



Forecasting leverages existing data sources and latest market outlook, e.g., queued solar projects for Ground Mounted PV

DER forecasting supports state decarbonization goals, e.g., The Massachusetts 2050 Clean Energy and Climate Plan and Decarbonization Roadmap

ESMP Scenarios Sensitivities



- All forecasts consider various scenarios and inputs
- The 5- and 10- year Forecasts presents a single scenario as they require immediate action by the EDC
- The 2050 Electric Demand Assessment presents sensitivities around different technology or policy scenarios in the long term

How We Forecast

Reported Net Station Peak

Transfer Correction

Any other generation

Large Solar Generation at time of peak

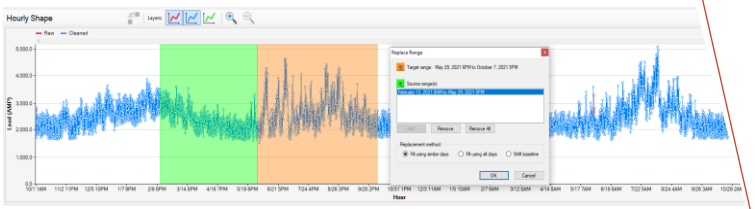
Small Solar Generation at time of peak

90/10 weather adjustment

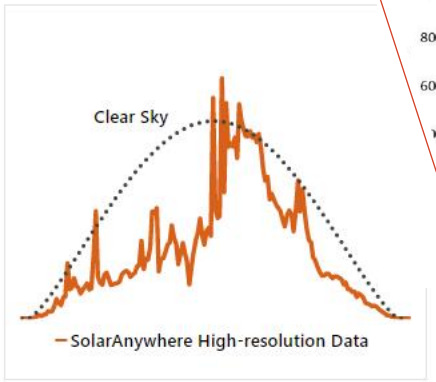
Final reported peak

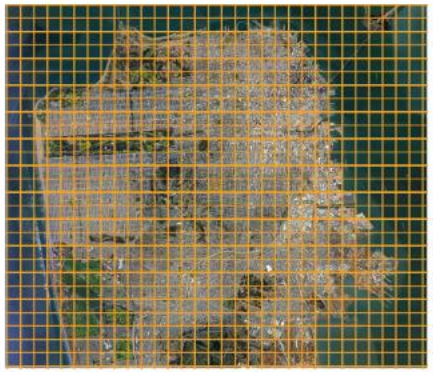
Reported Weather Normalized 90/10 Net Station Peak

Historic SCADA readings on all large generation installations



Historic, satellite-based weather data to calculate non-metered solar output





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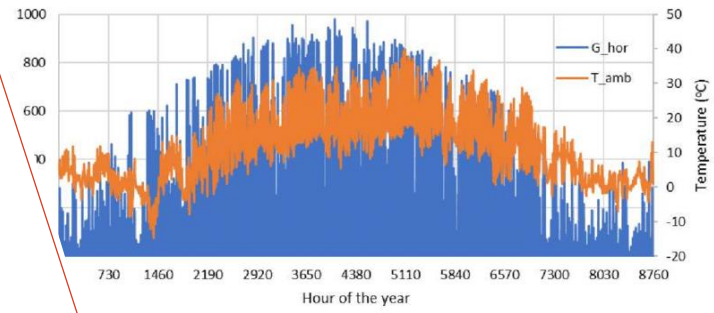

II. ESMP Overview

d) EDC DG Forecast Assumptions

Sophia Zhang, Eversource
Forecasting Lead

Kevin Sprague, Unitil
Vice President, Engineering

Rain Xie, National Grid
Manager, Electric Load Forecasting

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Massachusetts 2050 Decarbonization Goals & Objectives

	MA 2050 Roadmap "All Options" Pathway	MA CECP "High Elec." or "Phased" Pathway	EVERSOURCE Baseline Plan	
 Electric Vehicles	5.4 M	5.2 M	~92% LDV ~73% MDV/HDV	~2.7 M
 Res. Air Heat Pumps	2.8 M	2.0 M	~86% Residential ~71% Commercial heating	~1.1 M
 Solar	23 GW	27 GW	~70% Ground Mounted ~30% Rooftop	~8 GW
 Energy Storage	3 GW	5.8 GW	Proportion of state pathways relative to historic and in-queue projects	

EVERSOURCE

How We Forecast (Eversource)

Econometric Trend Load Model

Forecasted Weather Normalized 90/10 Gross Station Peak

Energy Efficiency Demand Res.

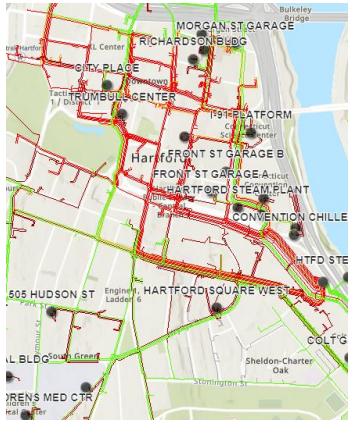
DER Forecast

Existing

Forecasted

Adoption propensity modeling using service territory wide parcel data base and geospatial forecasting

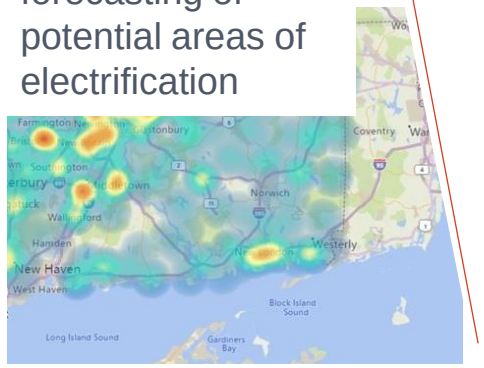
Permanent Load Transfers



Strategic system reconfiguration for load shifting

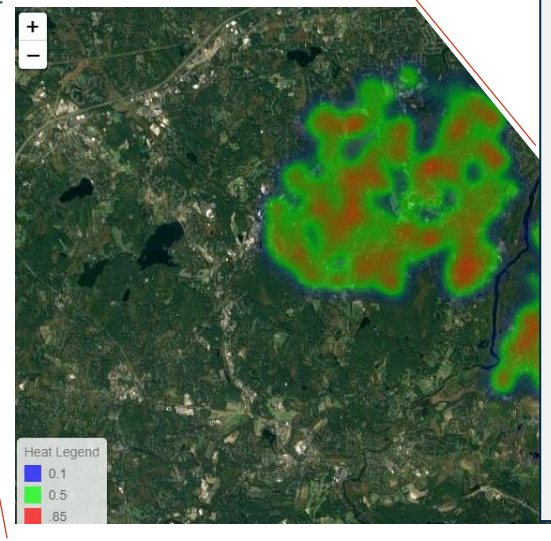
Step Loads

Tracking of every national and strategic account, bulk electrification efforts, and forecasting of potential areas of electrification

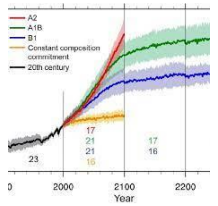


EV Growth

Adoption propensity model based on customer cluster classifications and GPS mobility tracking data



Climate



Climate impact with probability of future heatwaves

Forecasted Net Station Load with 90/10 Weather

Alignment with State Goals

Unitil's plan meets the 2050 Clean Energy Climate Plan goals.

	State Goal	Scaled Goal	Unitil Plan
 Electric Vehicles	~5.4 M	~50,000	~53,000 ✓
 Heat Pumps	~2.2 M	~20,000	~21,000 ✓
 Solar	23 GW	216 MW	~250 MW ✓
 Energy Storage	5.8 GW	54 MW	~60 MW ✓

Load Adders

What assumptions add to the Base Load Forecast?

Load Adders

Large Spot Loads

Assumptions:

- Known (or relatively certain) new spot loads are added to the forecast.
  - These loads are not grown into the future
  - i.e. future 3MW load on circuit 30W30
- Existing large spot loads are held constant throughout the forecast
  - i.e. 8MW load on circuit 50W53

Electric Vehicles

Assumptions:

- Separate 10 year EV forecast are completed and then added into the Base Load forecast
- ISO-NE EV Adoption Forecasts by state were used as the basis
  - High Rate – 100% of the ISO-NE Forecasts
  - Baseline Rate – 67% of the ISO-NE Forecasts
- Every owner will have charging
  - 33% - Level 1, 67% - Level 2 chargers
- DC fast charge facilities
  - High Rate – 2 DC fast charge facilities per year
  - Baseline – 1 facility every two years
- Anticipate EV adoption to be slower over next few years due to charging infrastructure
- Includes time of day charging assumptions

Electrification

Assumptions:

- Adoption assumption:
  - 2025 – 2029 – 1%
  - 2030 – 2034 – 2%
- Residential assumption
  - Appliance and heating/AC loads
  - Heat Pump SEER rating of 18 (13.68 btu/W)
- Commercial/Industrial assumption based upon CECP
  - peak gas loads for all commercial/industrial gas customers as the basis for is commercial/industrial electrification load forecasts
  - 87% small C&I customers to electrify
  - 52% large C&I customers to electrify
- Includes hourly usage assumptions

Electric vehicles and some electrification technologies have the ability to manage usage at peak load times.

Load Reducers

What assumptions reduce the Base Load Forecast?

Load Reducer

Energy Efficiency

Assumptions:

- Mass Save Energy Efficiency Plan
- Past energy efficiency savings included as part of base load measurement. Not able to separate the load reduction
- 2022-2024 Three-Year Energy Efficiency Plan - $22 million
- Passive and active energy savings is approximately 0.5 MW.

Distributed Energy Resources

Assumptions:

- Separate 10 year DER forecast are completed and then added into the Base Load forecast
- Solar PV
  - Based on the five year and three year historical slope of DER capacity growth
  - Projected incremental DER is used to develop hourly DER projections
  - Hourly peak DER output is calculated using the average hourly DER output of the large DG
- Energy Storage Systems
  - Sufficient Energy Storage Systems ("ESS") would be installed to level the load curve
  - Hourly dispatch (charge/discharge) were developed based on the forecasted peak day hourly interval data
  - Assumed a portion of ESS could be charging during peak or discharging during minimum load

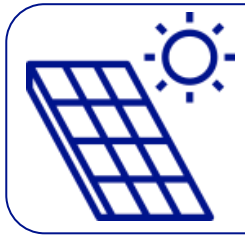
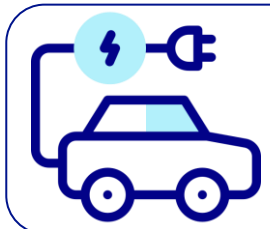
VVO

Assumptions:

- Anticipated reduction in current loads when VVO is implemented
  - Base Load Forecasts – 2% reduction
  - Residential Electrification – 1% reduction
  - Commercial/Industrial Electrification – 0.75%
  - EV – 2%
- Overall load reduction when VVO is fully deployed of approximately 1.75%

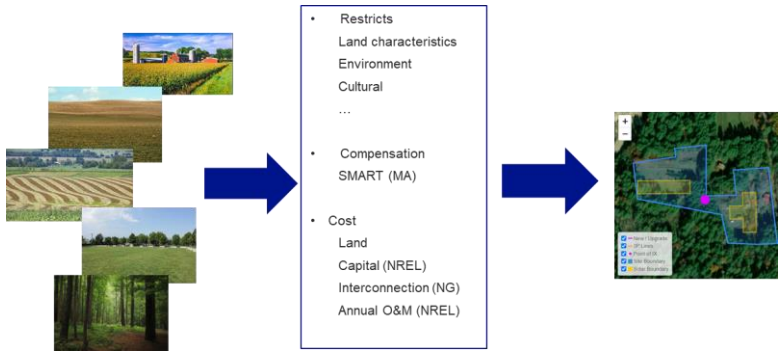
Electric vehicles and some electrification technologies have the ability to manage usage at peak load times.

Alignment with State Goals

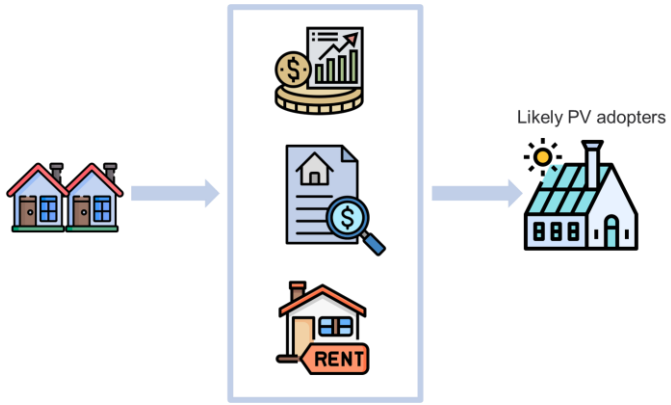
	Statewide Climate Target	Scaled Goal	NG Forecasting
	23 GW	~ 6,700 MW	~ 6,700 MW
	3 GW (All Option Scenario) 5.8 GW (Phased Scenario)	~ 350 MW ~ 650 MW	~ 500 MW
	~ 5.4 M	~ 2.7 M	~ 2.7 M
	~ 2 M	~ 1.13 M	~ 1.13 M

EDC DG Forecasts

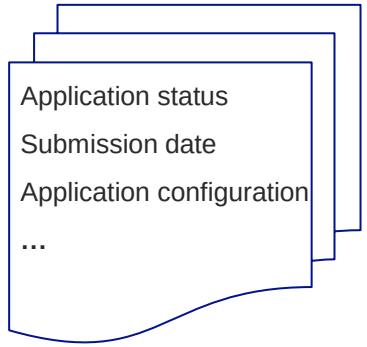
Ground-mounted PV

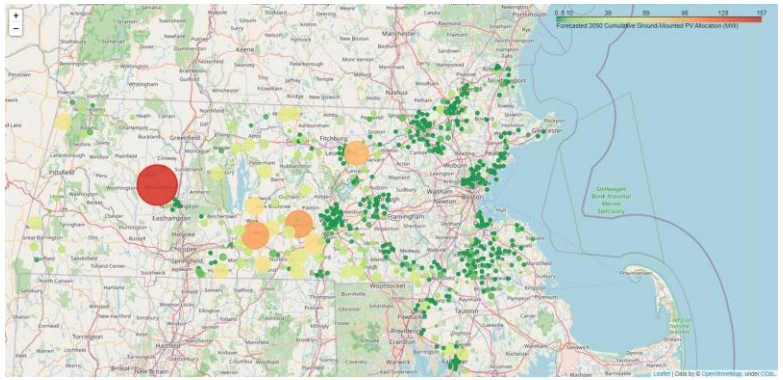


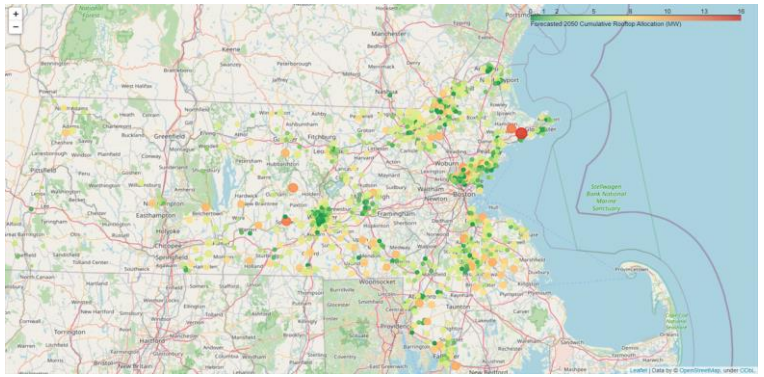
Rooftop PV

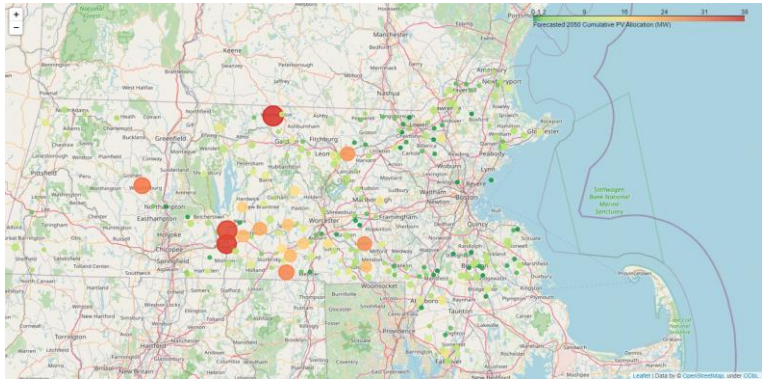


Energy Storage









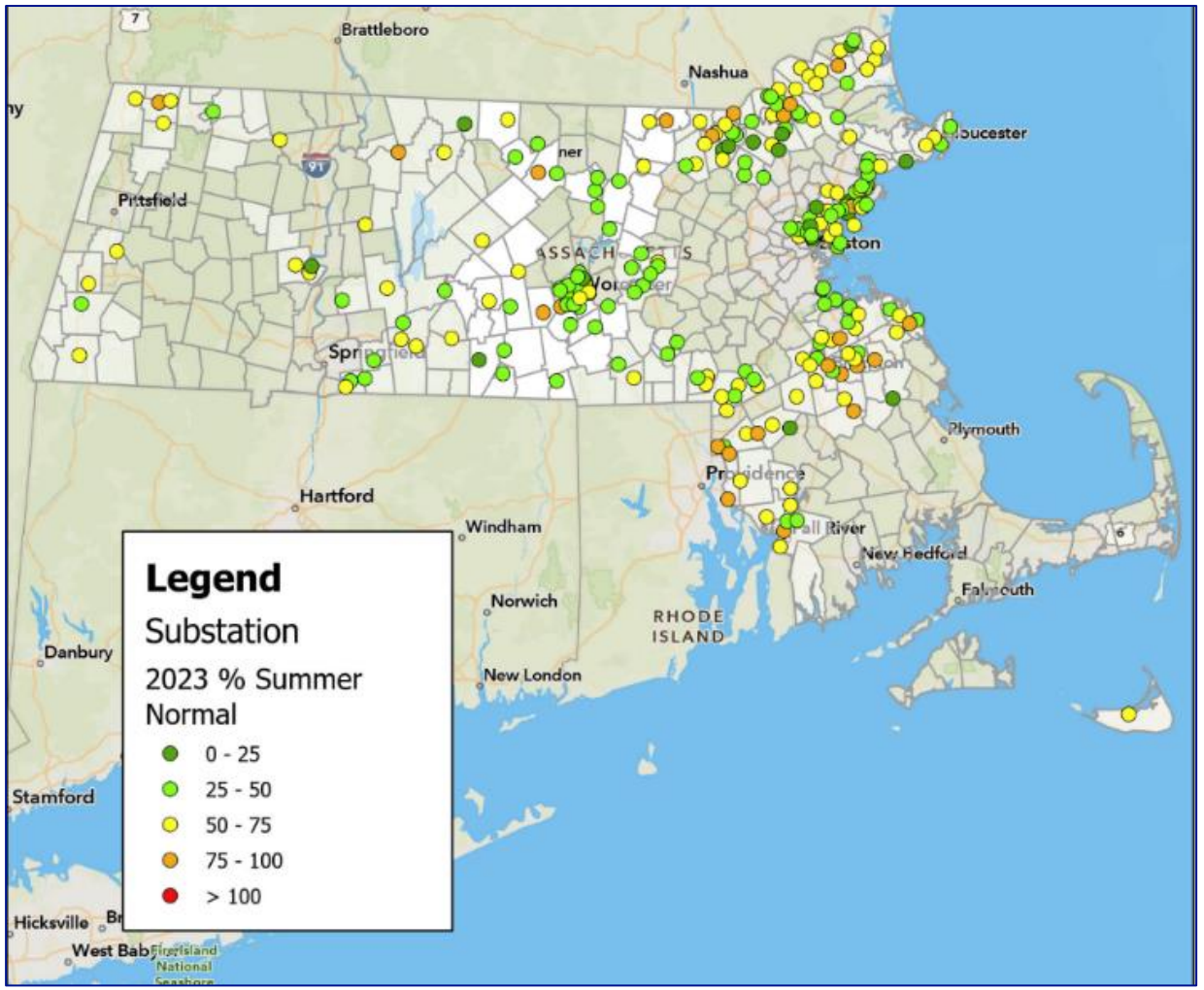
II. ESMP Overview

e) ESMP Summary: National Grid

Elton Prifti, National Grid

Director, Distribution Asset Management & Engineering

What our network looks like and what it enables today



Serving our 1.3M electric customers via our networks...

18K
Miles of electric distribution lines

178
Distribution substations

720K
Poles

...and by making customer connections.

200 MW
Total DER connected in 2022

~1,800
EV Chargers enabled to date

18K+
Households that installed heat pumps in 2022 through the Mass Save program, with 10k+ supported by National Grid

2GW
DER connected to our network

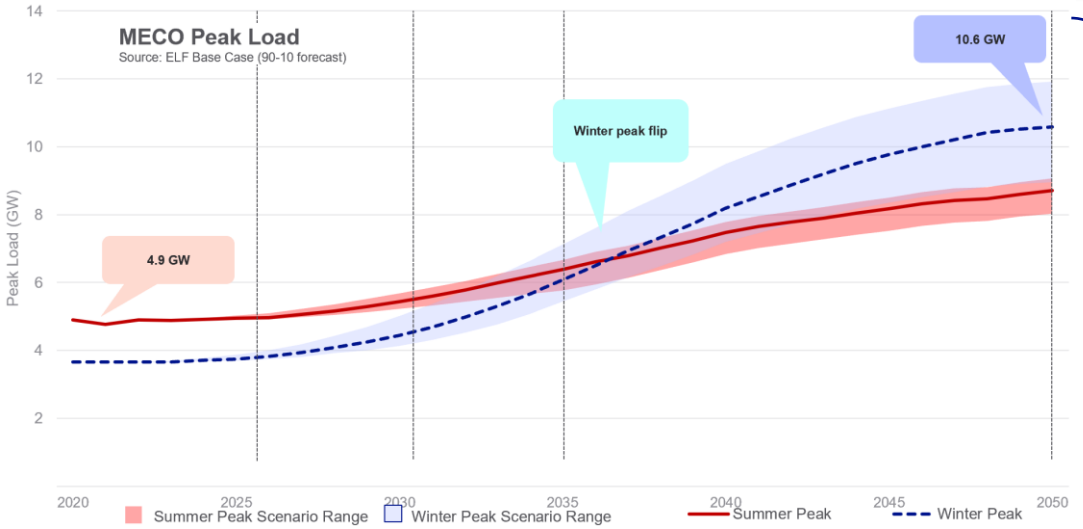
~32K
Additional EV Chargers to be enabled via Phase 3 EV programs

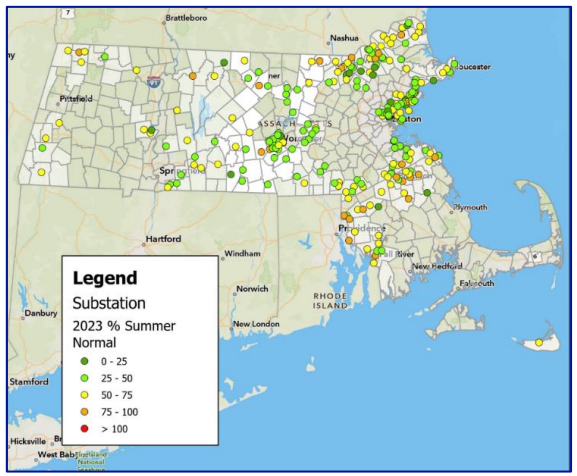
45K+
Planned additional households for heat pump installation through Mass Save by 2024, with 21k+ targeted for support by National Grid

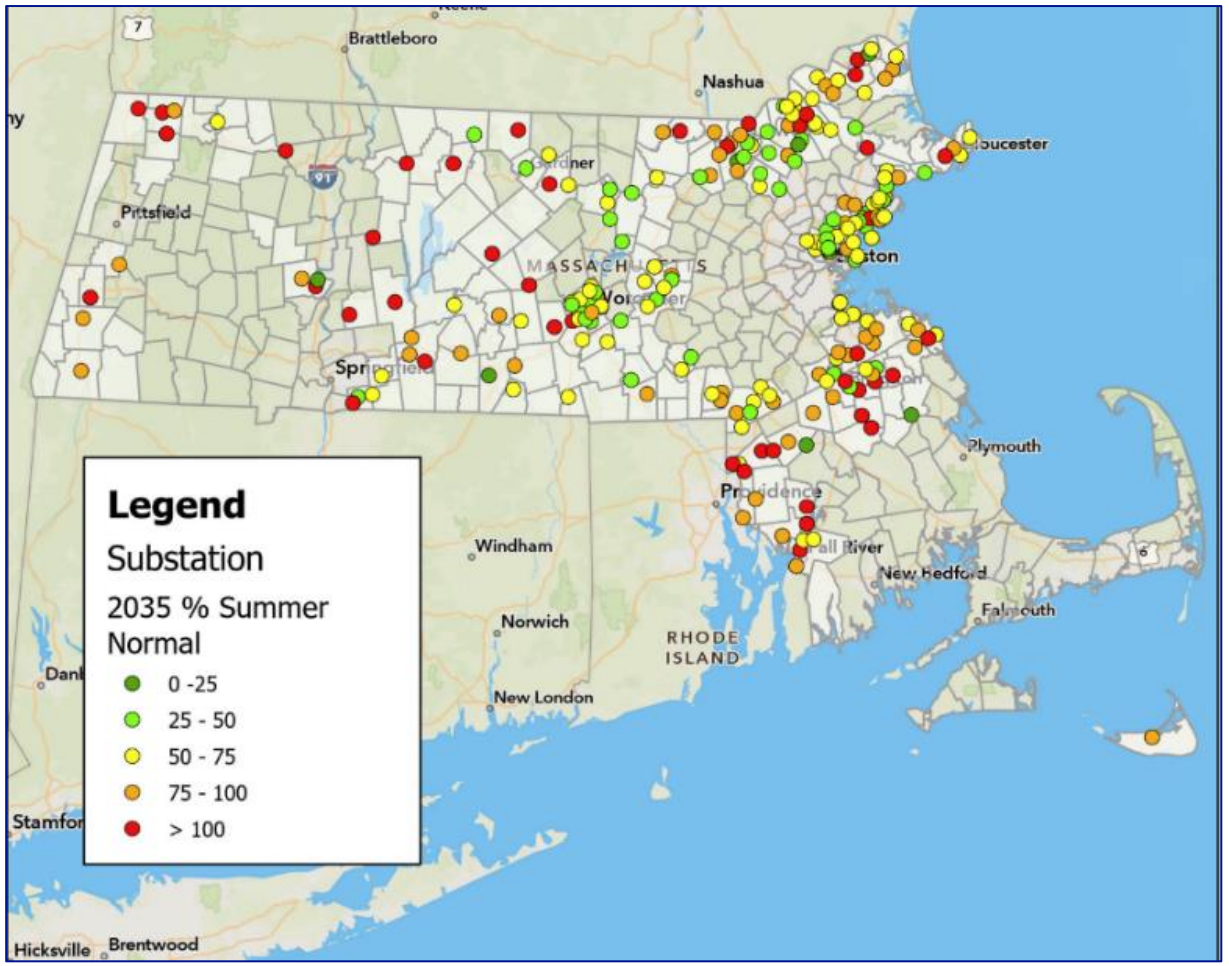
To deliver on the Commonwealth's climate goals, we will build an electric system that can support a doubling of electric demand

Our State's Goals by 2050

- **23 GW** of solar
- **26 GW** of offshore wind
- **6 GW** of energy storage
- **5M** electric vehicles
- **3M** decarbonized buildings





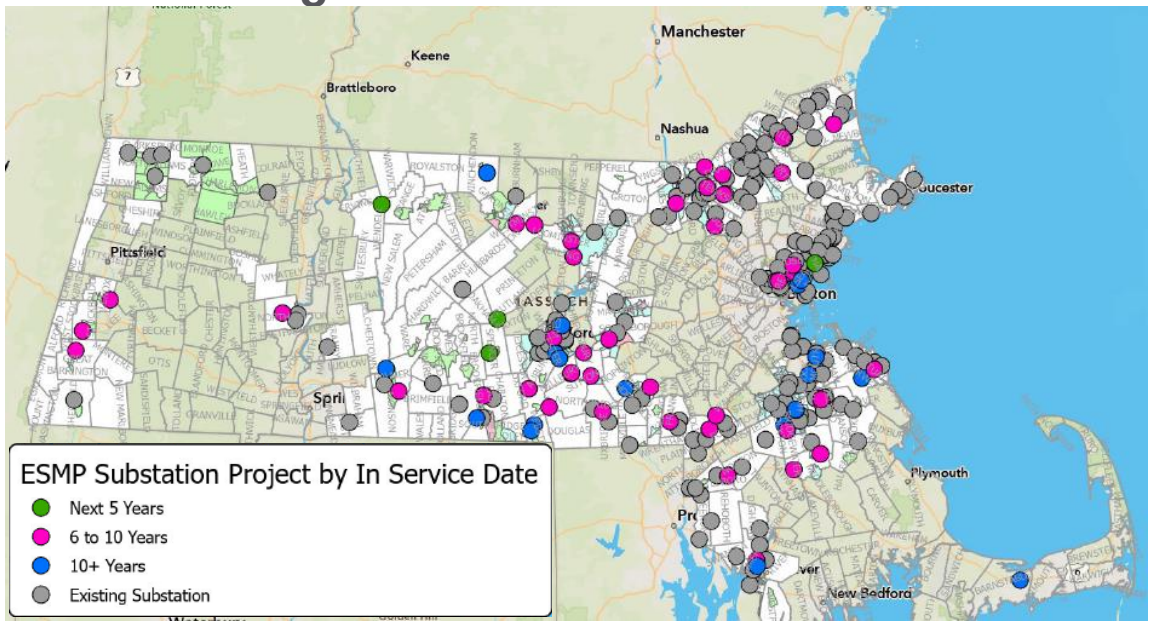


We must build out network infrastructure significantly to support this forecasted load growth

To address projected asset overloads resulting from forecasted load growth and to increase system capacity, the following investments were proposed*:

In the next 5 years…	2030-2034	2035 – 2050
0% Average System Load Growth	21% Load Growth (from 2022)	200% Load Growth (from 2022)
Upgrade 13 existing substations	Upgrade 17 existing substations	Upgrade 44+ existing substations
Add 32 feeders	Build 15 new substations	Build 26+ new substations
	Add 105 feeders	Complete 86 total projects

Existing & Future ESPM Substations

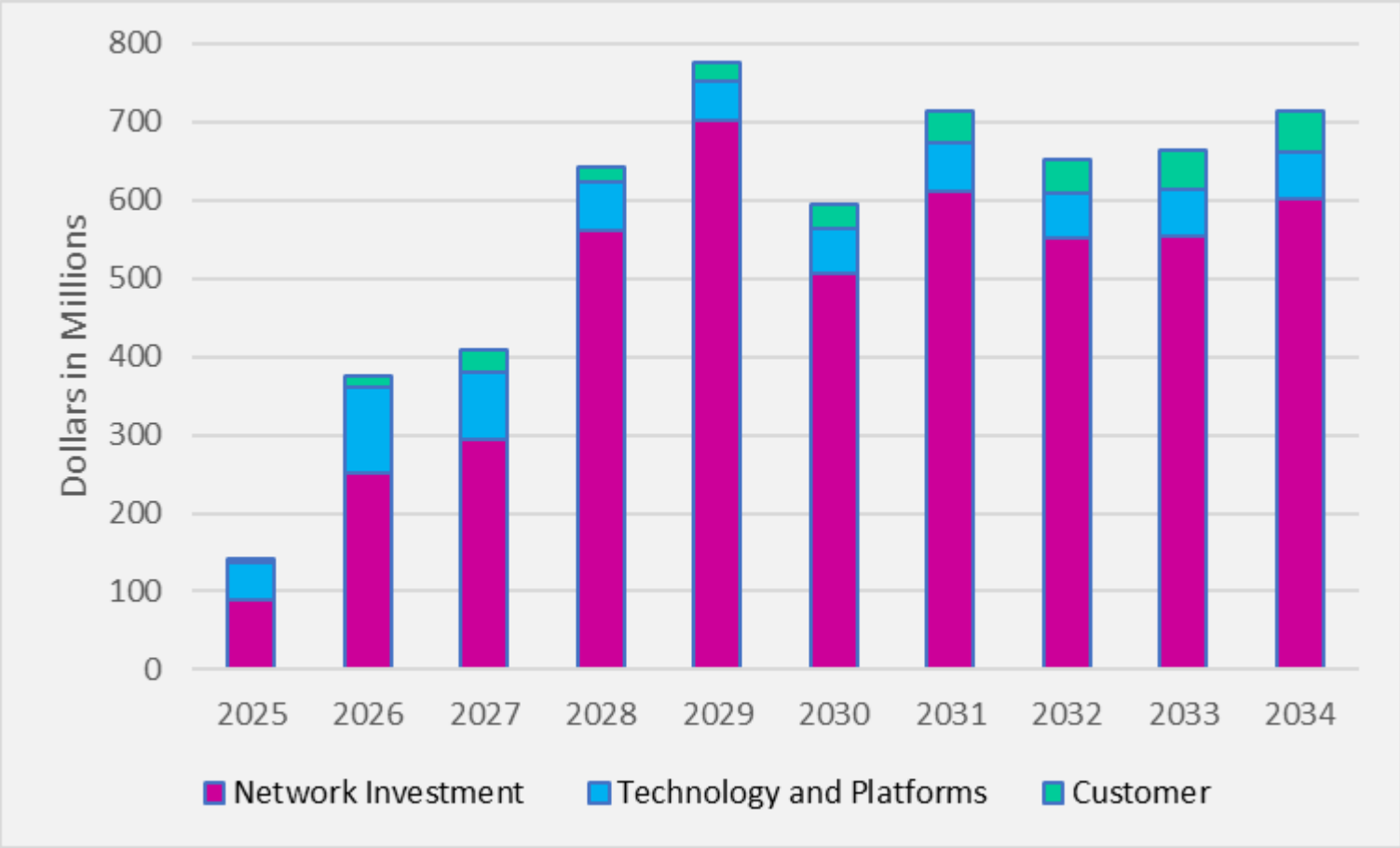


Non-Wires alternatives will be considered as "avoided infrastructure" and as a "bridge to wires"

The ESMP requires investment of $2.4bn over the next five years with Network Investments leading the way

We'll build key infrastructure…

Upgrade 13 substations, and execute work on 100+ miles of distribution lines by 2029



…enabling electrification

This work will enable 1 GW of beneficial electrification and DER hosting capacity, and lay the bricks for another 3 GW by 2034

II. ESMP Overview

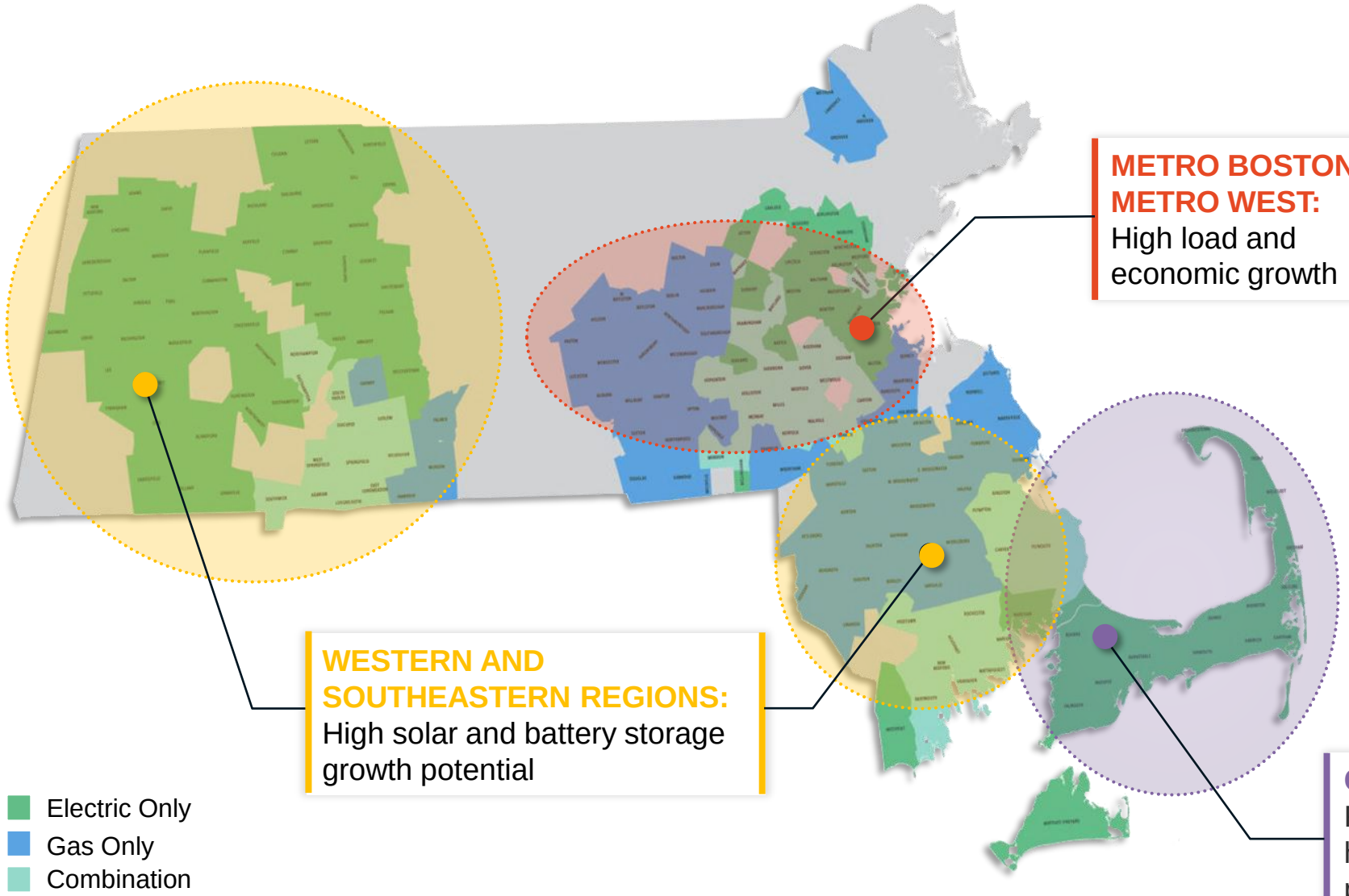
e) ESMP Summary: Eversource

Lavelle Freeman

Director, System Planning

westMONROE

Current State of the Distribution System



METRO BOSTON & METRO WEST:
High load and economic growth

WESTERN AND SOUTHEASTERN REGIONS:
High solar and battery storage growth potential

CAPE COD:
Resiliency impacts during storms, high DER penetration, and high potential for DER and OSW growth

- **172 substations (101 Bulk)**
  - 11,500 circuit miles of OH lines
  - 9,200 circuit miles of UG lines
  - 172,900 service transformers
- **1.5M Electric customers**
  - 50% in EJ communities
  - Peak demand: 6 GW
- **Hosting Capacity: 3.5 GW**
  - Online DER: 1.8 GW
  - Solar/ESS: 1.5 GW
  - In-Queue DER: 1.4 GW
  - Solar/ESS: 1.3 GW
- **Installed Capacity of 7.9 GW across 4 planning regions**

Current Grid Cannot Support Clean Energy Transition

ADDITIONAL INFRASTRUCTURE NEEDED

Bulk Distribution Substations as *clean energy hubs*, are critical elements of the clean energy transition, creating the necessary headroom to accommodate future system demand

Eversource's 10-Year Capital Plan:

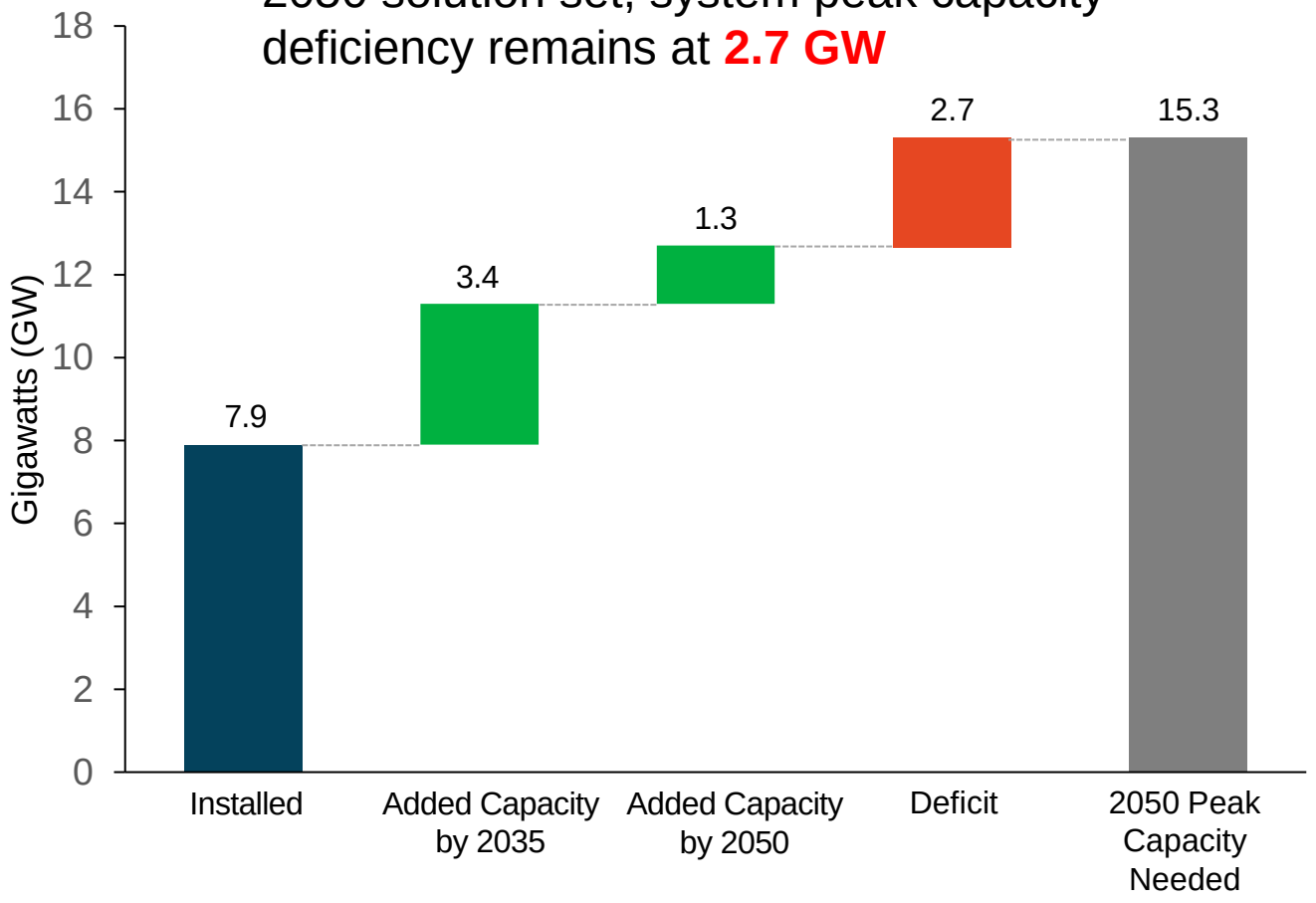
- Upgrades 12 existing substations
- Adds 14 substations

Beyond 2035:

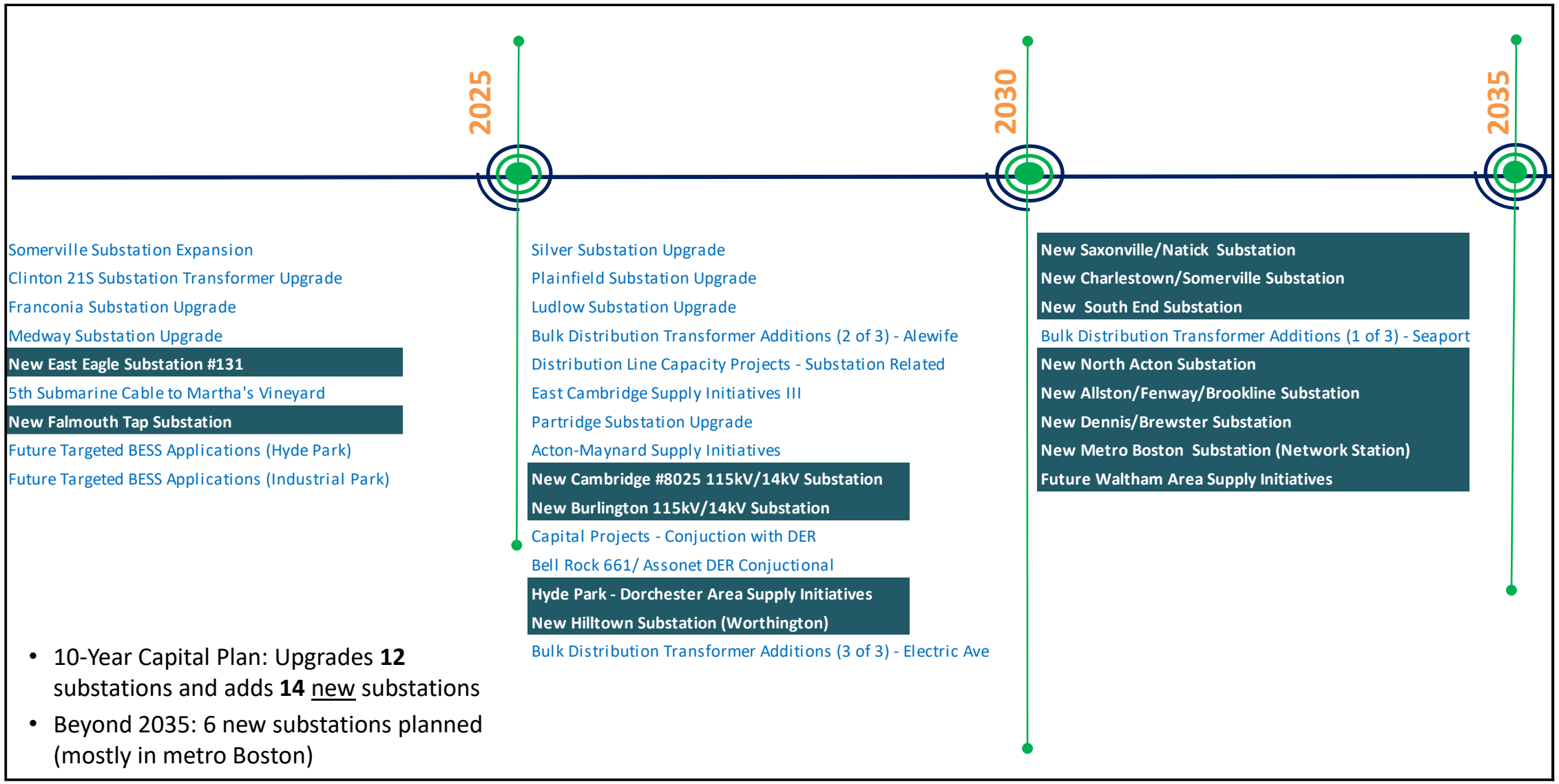
- 6 additional substations are currently planned, all in EMA

Additional infrastructure and policy changes will be needed to close 2050 gap

With existing 10-Year Capital Plan and 2050 solution set, system peak capacity deficiency remains at **2.7 GW**



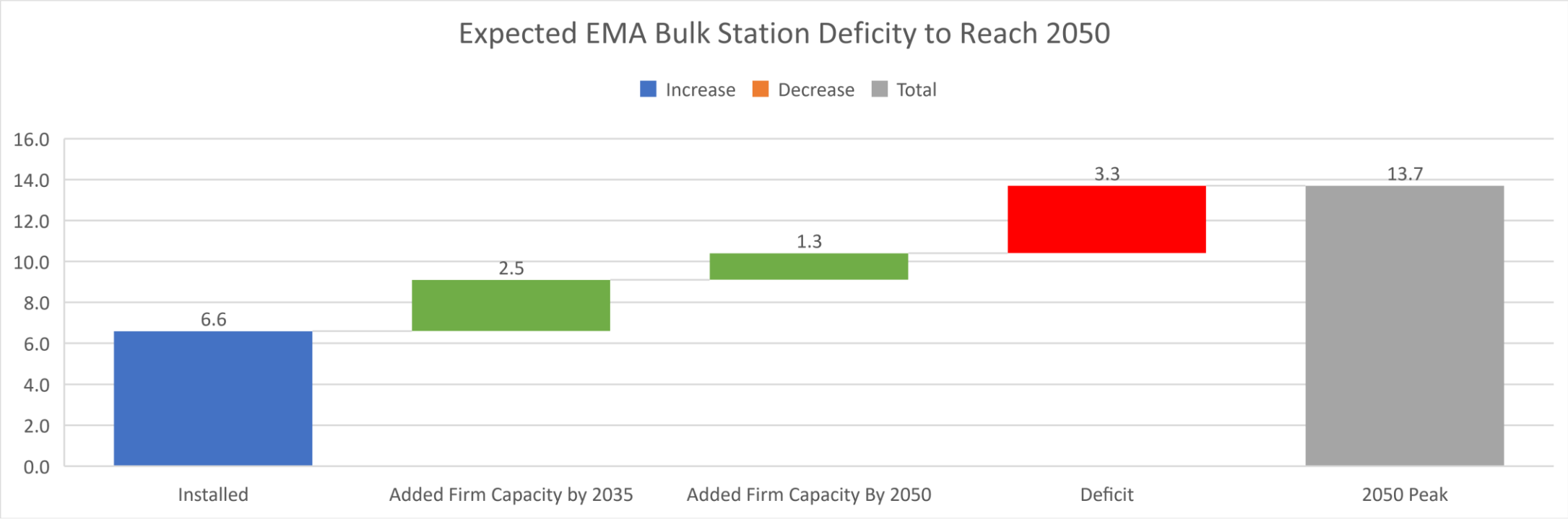
10 Year Infrastructure Plan – Major Capital Projects



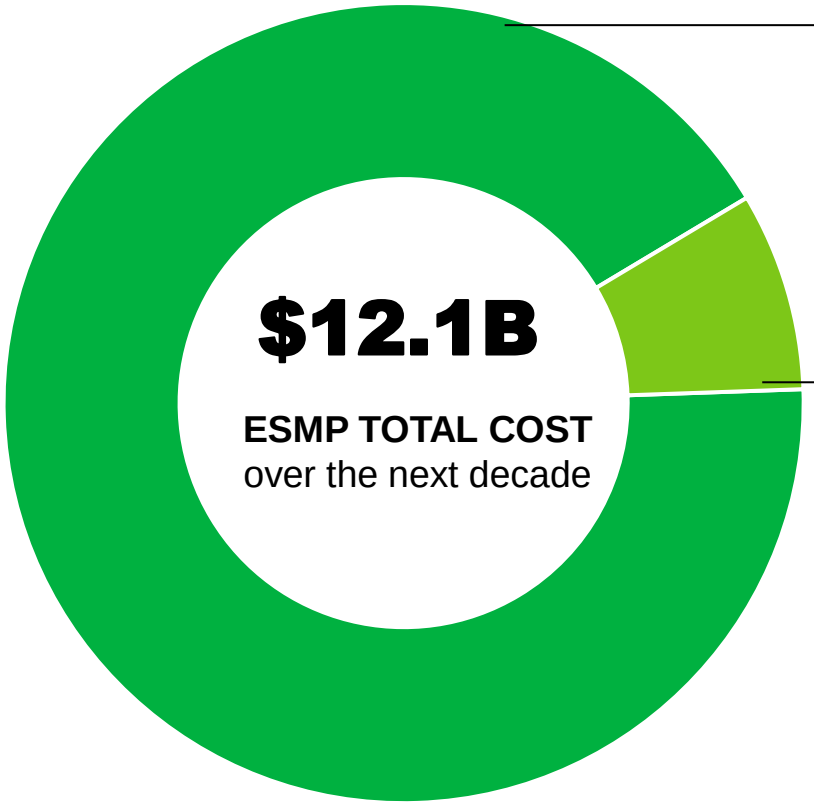
- 10-Year Capital Plan: Upgrades **12** substations and adds **14** new substations
- Beyond 2035: 6 new substations planned (mostly in metro Boston)

Projected Bulk Substation Capacity Deficiencies in EMA to Reach 2050 Goal
(Metro Boston, Metro West, Southeast)

- With existing 10-Year Capital Plan and planned substation additions and upgrades beyond 2035, Eastern Massachusetts system peak capacity deficiency remains at **3.3 GW** (1.7 GW in Metro West and 1.6 GW in Southeast)
- To close this gap with infrastructure, 11 additional new substations in the Metro West and 10-11 additional new substations in the Southeast regions would need to be constructed
- Additional solutions beyond large bulk substation additions are needed

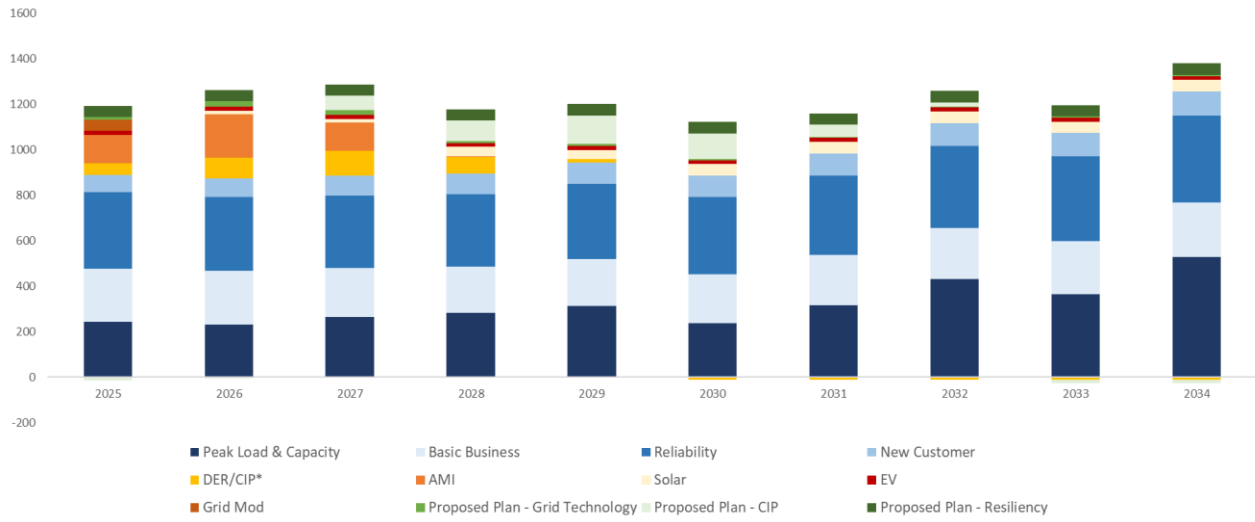


Proposed ESMP Investments Over 10 Years



~$11B **planned distribution system investments**
to provide safe and reliable service to customers and enable clean energy advancement

$960M **new capital expenses**
(proposed)



II. ESMP Overview

e) ESMP Summary: Unitil

Kevin Sprague, Unitil

Vice President, Engineering

westMONROE

ESMP Proposed Projects

What are the proposed projects and how will they benefit our customers?

Customer-Facing Projects

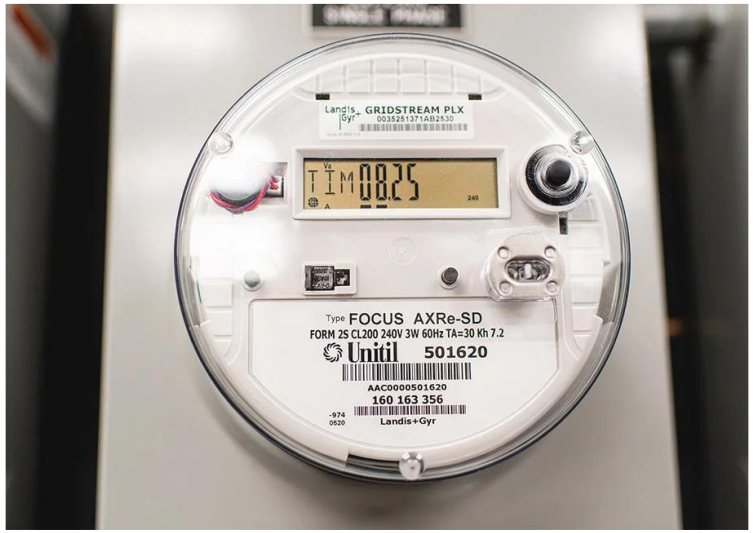
- Enable Grid Services
- FERC Order 2222 Implementation
- EV Charging and Make Ready

Projects and initiatives that include technologies that help support the adoption of distributed energy resources and customer access to third-party service providers and markets

Grid-Facing Projects

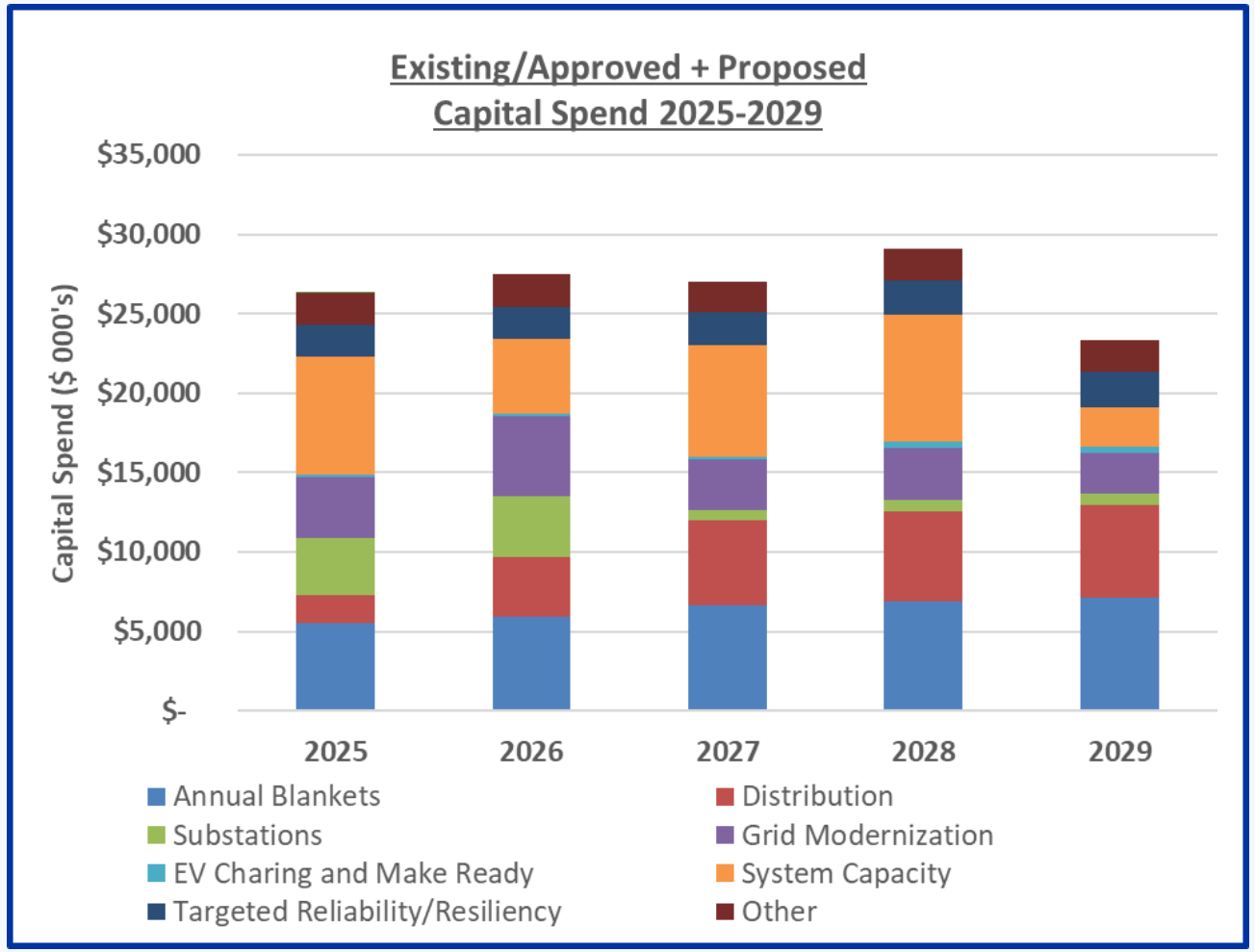
- Advanced Distribution Management System / Distributed Energy Resource Management System
- Volt-Var Optimization
- Supervisory Control and Data Automation
- Cyber Security
- Lunenburg Substation
- South Lunenburg Substation
- Targeted Reliability and Resiliency

Projects designed to increase capacity, improve efficiency, improve monitoring and control, increase DER hosting capacity, and improve the reliability and resiliency of the electric system.



2025-2029 Proposed Capital Spending Plan

Overall view of the 5-year view of existing/approved spending and proposed spending.



Proposed Capital Spending (2025 – 2029)

- Existing and Approved Spending ($86 million)
  - Annual Blankets
  - Distribution
  - Substation
  - Grid Modernization
  - EV Charging and Make Ready
  - Reliability/Resiliency
  - Other
- Proposed Spending ($46 million)
  - Enable DER Grid Services
  - ADMS/DERMS
  - VVO
  - Automation
  - FERC Order 2222
  - Cyber Security
  - Lunenburg Substation
  - South Lunenburg Substation
  - EV Charging and Make Ready
  - Targeted Reliability and Resiliency

The proposed spending plan ensures safe and reliable service to our customers while supporting the State's decarbonization goals.

Open Q&A
(30 Minutes)

Break
(5 Minutes)

III. Technical Discussion

National Grid (13 Mins)

Eversource (13 Mins)

Unitil (13 Mins)

Q&A (45 Mins)

National Grid (13 Min)

III. Technical Discussion

a) Current State of Interconnection
b) Infrastructure Plans

Emily Slack, National Grid
Manager, Distribution Planning & Asset Mgmt.

westMONROE

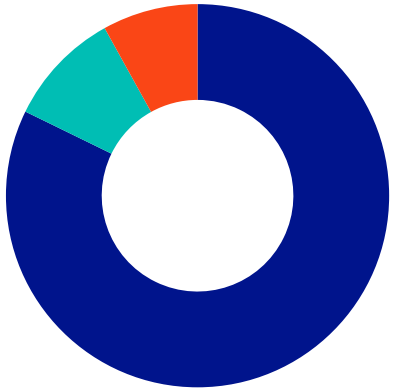
Current State of DG Interconnections

- **Over 2 GW of DG interconnected to date**
  - 1.8 GW PV | 215 MW Energy Storage
- **Over 2 GW of DG currently in queue**
  - 568 MW PV | 1.4 GW Energy Storage

Current interconnection policies and practices are limited by today's capabilities

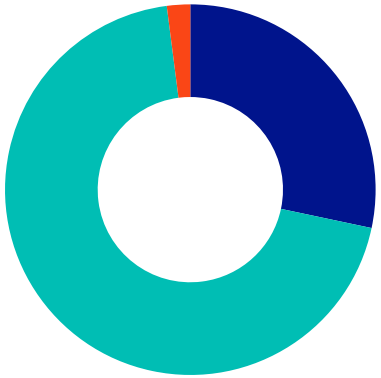
- 30 Group Study processes underway across all 6 subregions
  - 5 CIP proposals enabling 342 MW awaiting DPU order
- Queue-based interconnection studies using historical information and forecasts to mitigate system impacts to maintain safety & reliability
- Energy Storage offered choice of scheduled curtailment to avoid certain system modifications
- Interconnections governed by need to accommodate DG operation as memorialized in ISAs

2,216 MW Connected DG

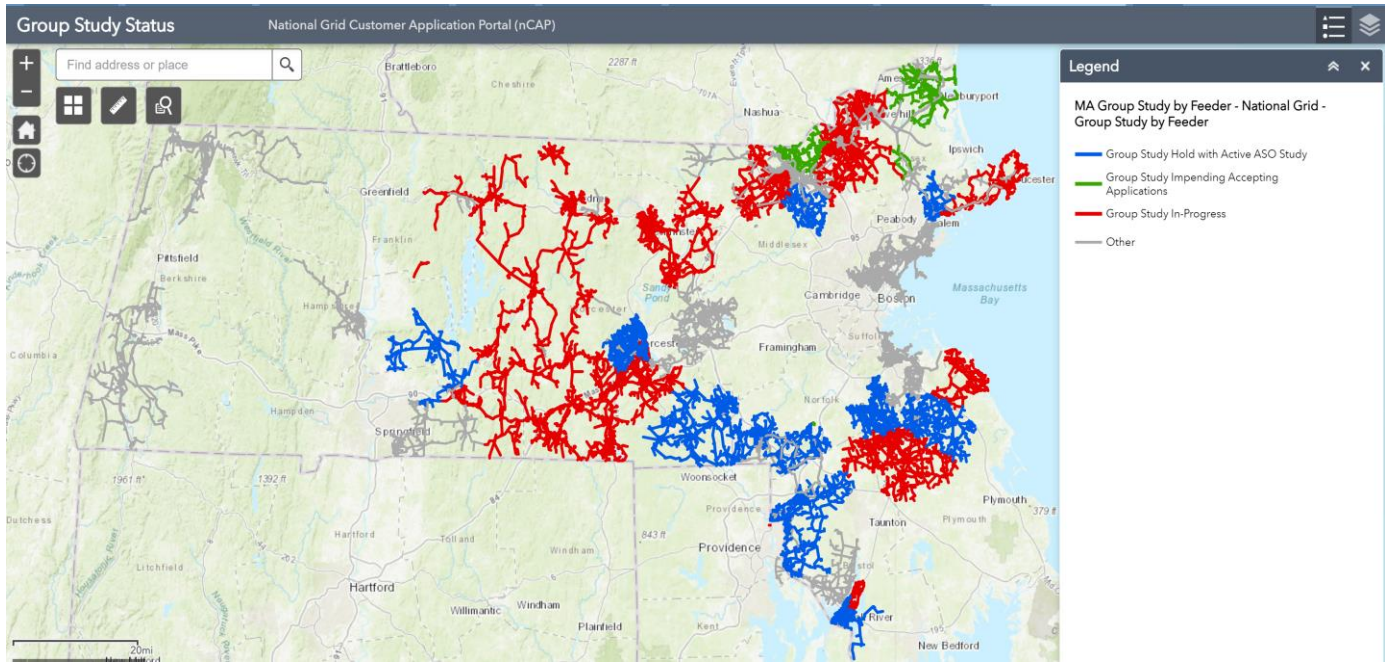


Connected PV Connected ESS Connected Other

2,004 MW Pending DG

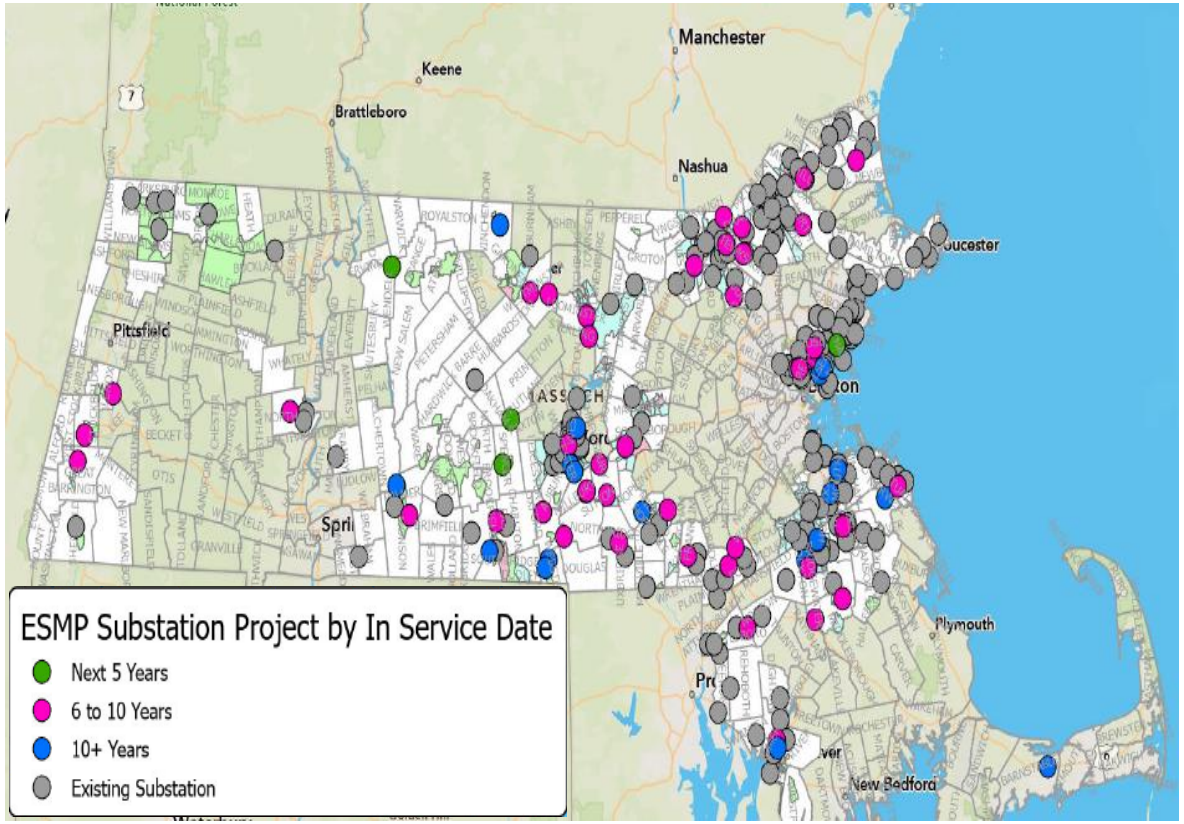


Pending PV Pending ESS Pending Other



ESMP Network Infrastructure to Support DG Interconnections

Existing & Future ESMP Substations



- **ESMP Network Infrastructure investments enable 1 GW of capacity for beneficial electrification and DG interconnections by 2029, and another 3 GW by 2034**
  - Load-serving capacity: EV, EH, ESS charging
  - Hosting capacity: PV, ESS discharge
- **While building out our network for the future, we need to continue to progress customers with active requests in our queue**
  - CIP cost allocation methodology proposed for group studies finalized following DPU approval of the extension of that methodology
  - Flexible interconnection capabilities in development

III. Technical Discussion

c) Distributed Energy Resource Management System - DERMS

Samer Arafa, National Grid
Principal Engineer, Innovative Grid Solutions

National Grid DERMS Definition

National Grid Distributed Energy Resource Management System (DERMS) approach:
1- Developing individual DER management capabilities in an agile environment to deliver customer value fast.
2- Integrating with enterprise capabilities to deliver incremental customer value.

How DERMS can help meet ESMP objectives?

1- Supporting Flexible Interconnections of DER

- Reduce DER Interconnection Cost and Time.
- Increase the ability of the system to host DER beyond its traditional hosting capacity methods.
- Help meet the Commonwealth's clean Energy goals.

2- Customer Grid Services Programs

- Allow customers to earn a return on the utilization of DER for Grid Services.
- Allow customers DER to support reliability.
- Allow customer DER to support system resilience.

Flexible Connections

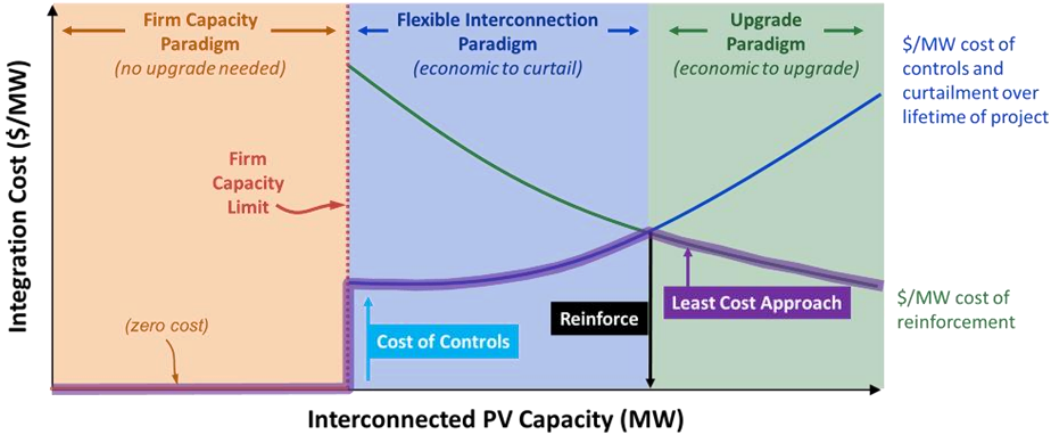
Flexible Interconnections offers DER operators and owners alternative options to integrate DER on the system.

Customer Value

- ✓ Reduces Interconnection **cost and time.**
- ✓ Allows the system to **host** more DER.
- ✓ Helps deliver Commonwealth's **clean energy goals.**

National Grid

How it Works



- Customers can select from **several connection options** including fixed limit, schedules and active management for **Solar, Energy Storage and Electric Vehicles**
- Enables interconnection engineers to assess **various connection options** during interconnection study
- Actively manages **DER** assets based on a **permanent or temporary** operating agreement between customer and utility
- Provides **adequate visibility and control** to control center operators
- Automated control technology **ensures safety and reliability of the system** under blue and black sky days

DERMS Investments Needed

DER Dispatch Engine: Makes the decision on when and which customer to be dispatched.

Grid Edge Control: Communicates squarely with customers on dispatch need.

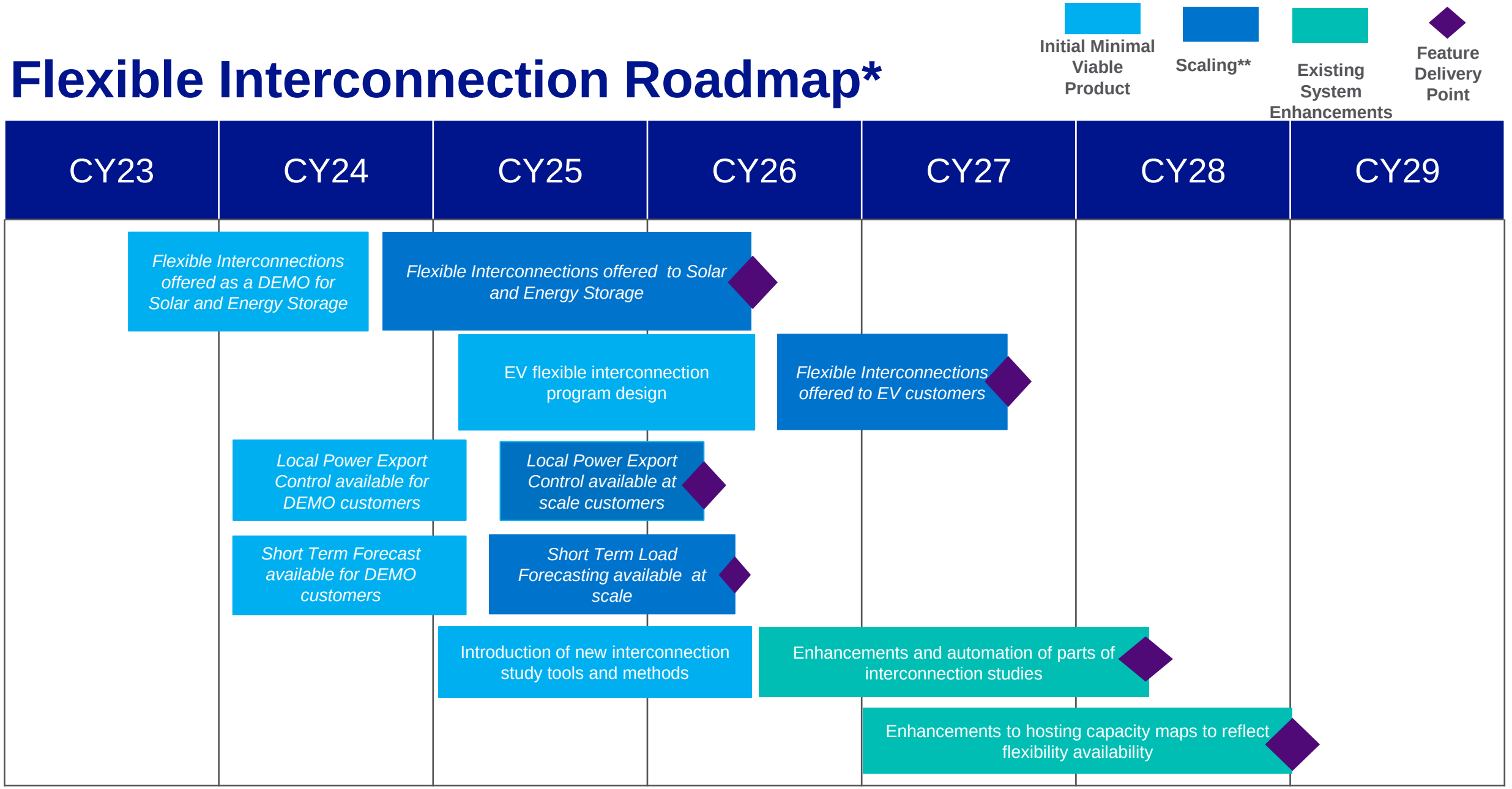
Short Term Forecasts: Provides Company on system needs and provides customers near team visibility into expected operations.

ADMS Integration integrates data from multiple sources to monitor and identify actions to take to manage distribution system conditions in near real-time.

Hosting Capacity Maps: Enhancements to hosting capacity maps to reflect enhancements due to flexibility.

Interconnection Study Enhancements: enables planning engineers to estimate and model impact of curtailment to support customer adoption of our product.

Flexible Interconnection Roadmap*



*Preliminary and subject to change.

**The scaling process does not imply that customer offerings will be available on all feeders nor that all DER sizes will be able to enroll in the program.

National Grid Flexible Interconnections Program

Website with full information:

- https://gridforce.my.site.com/s/article/ACTIVE-RESOURCE-INTEGRATION-ARI-FLEXIBLE-INTERCONNECTIONS-PILOT

Seeking interest from solar cases and storage cases

- **Energy Storage ARI Pilot Criteria & Eligibility Requirements**
- **Solar ARI Criteria & Eligibility Requirements**

To submit a request for pilot consideration a customer must:

1. Review pilot eligibility requirements to self-assess whether the application is a possible candidate
2. Prior to ***9/1/2024*** send an email to NationalGridARI@nationalgrid.com to submit a request for consideration. Example requests language and content listed on the website.
3. Once received, the application will be added to the possible candidate pool for consideration by National Grid. Requests received on or after ***9/1/2024*** will not be considered.
4. National Grid will provide responses to all requests in as timely a manner as possible, indicating denial or acceptance into the pilot.

Grid Services

An evolution of the Company's connected solution offering to dispatch customer DER to address local distribution system needs.

Customer Value

- ✓ **Enhanced Reliability**, as DER supports load relief.
- ✓ **Enhanced System Resiliency**, with DER supporting outage restoration efforts.
- ✓ Ability to **prioritize investments** to areas most needed.
- ✓ Procurement of **DER services** as a form of NWAs
- ✓ Ability for customers to **earn income** on grid services.
- ✓ Enables aggregators to participate in **FERC 2222**

National Grid

How it works

- Grid Services intends to create a process in where customer DER can be **relied** on to support the system. Allows system planners and operators to design processes to **integrate** customer DER in the planning and operating of the system.
- The Company has **identified multiple locations** where distribution system upgrades **will not be available** in time of the need.
- The Company will prioritize delivery of **"bridge to wires"** solutions to help reduce the likelihood and severity of expected overloads before needed network infrastructure projects can feasibly be constructed in areas. Hence customer DER will be utilized to **maintain reliability.**
- Customer DER can be **integrated** into network solutions such as Fault Location, Isolation and Service Restoration **(FLISR)** and be dispatched to reduce outage durations, hence help **improve resiliency.**

Additional DERMS Investments needed beyond flexible interconnections*

DER Registration and enrollment: registering and enrolling DER in the proper programs.

Market platform: platform that facilitates bidding between stakeholders (prosumers, aggregators, utilities, etc.)

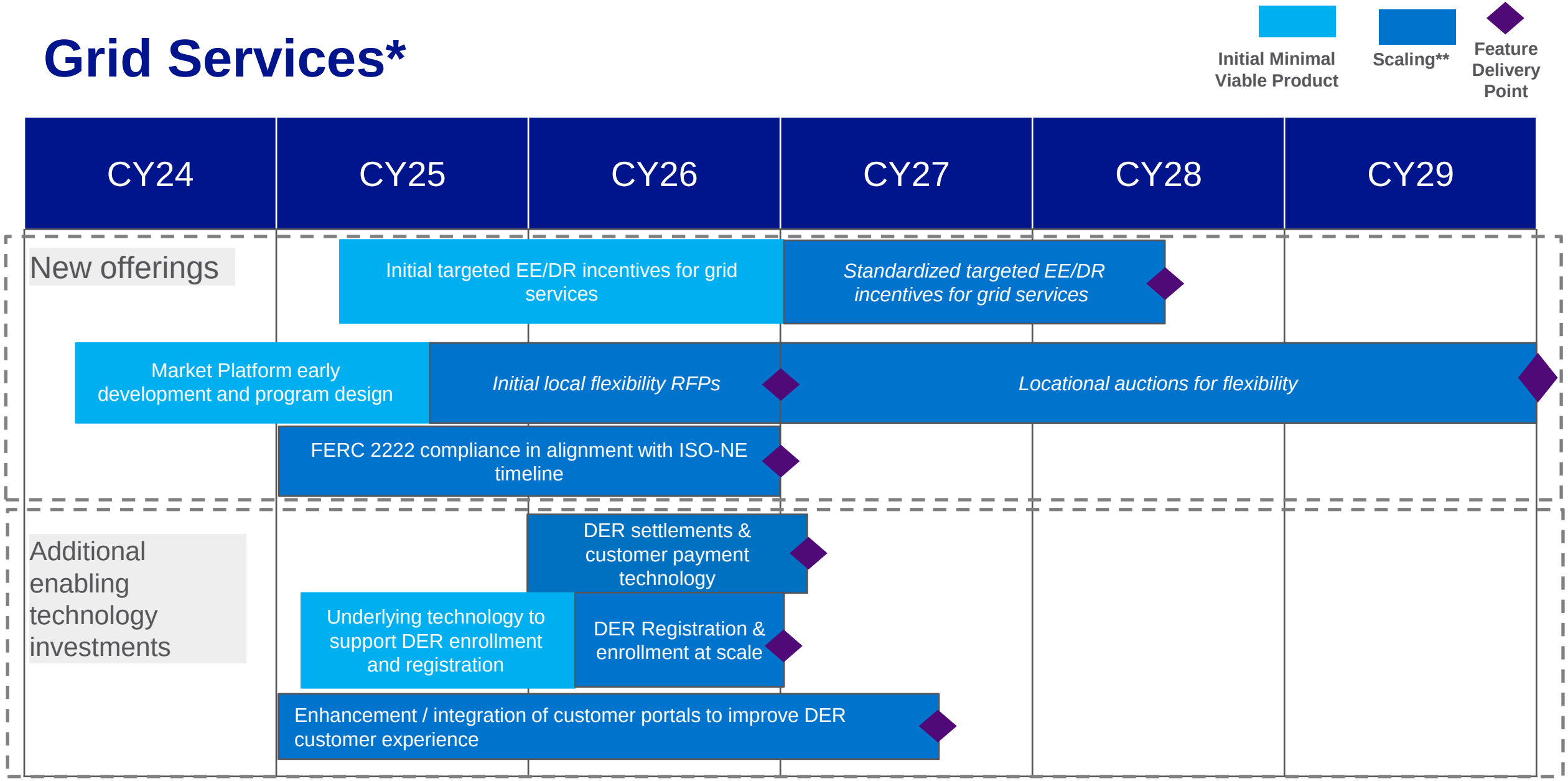
Grid Service Fund: Funding to support the Grid services.

Enhanced Customer Experience: Providing a seamless integrated experience along the whole DER customer journey.

Enhanced Billing & Settlements: Ability to settle with customers on grid services.

**Grid Edge Control, Short Term Forecasts, DER Dispatch Engine and ADMS Integration are technologies required to support both flexible interconnections and grid services.*

Grid Services*



*Preliminary and subject to change

**The scaling process does not imply that customer offerings will be available on all feeders nor that all DER sizes will be able to enroll in the program.

III. Technical Discussion

d) Non-Wires Alternatives

Josh Tom, National Grid
Director, Future of Electric for Customers

westMONROE

Defining NWAs* – Bridge to Wires vs Deferral NWAs

Bridge To Wires

The Company is faced with an imminent need for a capital project, but that capital project cannot feasibly be delivered in time to address the need. In this case, the “bridge to wires” solutions can be deployed quickly to reduce peak demand or increase peak supply to help **maintain reliability during that gap period when overloads on the network may be expected during peak hours**

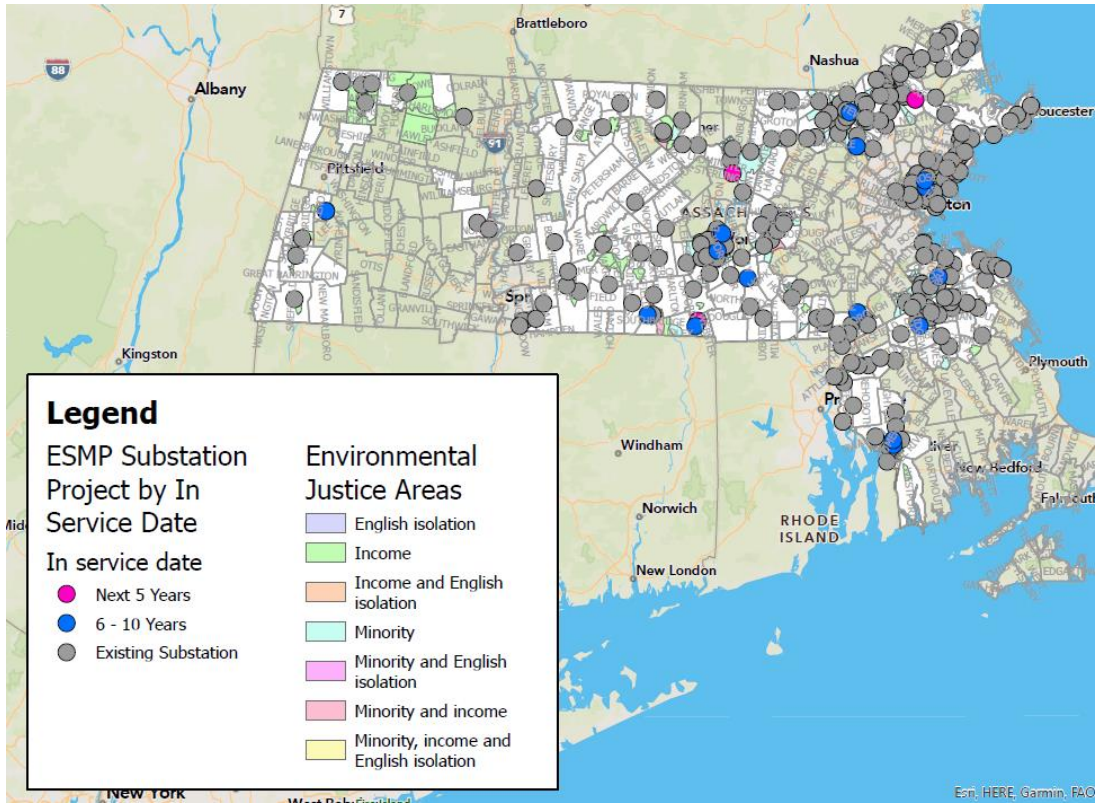
Deferral

Non-traditional solutions sufficiently reduce peak demand or increase peak supply in a given location to **defer the need for a planned wires investment until outside of the planning time horizon** or in some cases altogether. These NWAs are more applicable during a period of relatively stable demand or slow demand growth as seen during the prior 15 years.

**Our NWA focus is on third-party-owned solutions*

Key Bridge to Wires Locations

18 locations with at least 5 years of gap period between need-by date and expected project completion date



Project	Substation Location - Town	Projected In-Service Date	1st year of overload
Pratts Junction Rebuild	Sterling	2029	2023
New Substation Near Grafton	Grafton	2034	2026
East Webster Feeder Expansion	Webster	2029	2023
New Substation near Southbridge	Southbridge	2034	2023
New Substation near Webster	Webster	2034	2023
New Substation near Greendale	Worcester	2034	2025
Grafton Street Rebuild	Worcester	2034	2025
South Billerica 18 Rebuild	Billerica	2034	2025
Perry Street 3 Expansion	Lowell	2034	2025
Woodchuck Hill Rebuild	North Andover	2029	2023
New Substation near Malden	Malden	2031	2023
New Substation near Saugus	Saugus	2034	2028
New Substation near Grand Army Highway	Fall River	2034	2026
New Substation in North Foxboro	Foxboro	2034	2023
New Substation at Riverside	Swansea	2031	2023
New Substation near Brockton and West Bridgewater	Brockton	2034	2028
New Substation near South Weymouth	Weymouth	2034	2025
Lenox Depot Rebuild	Lenox	2034	2026

PRELIMINARY

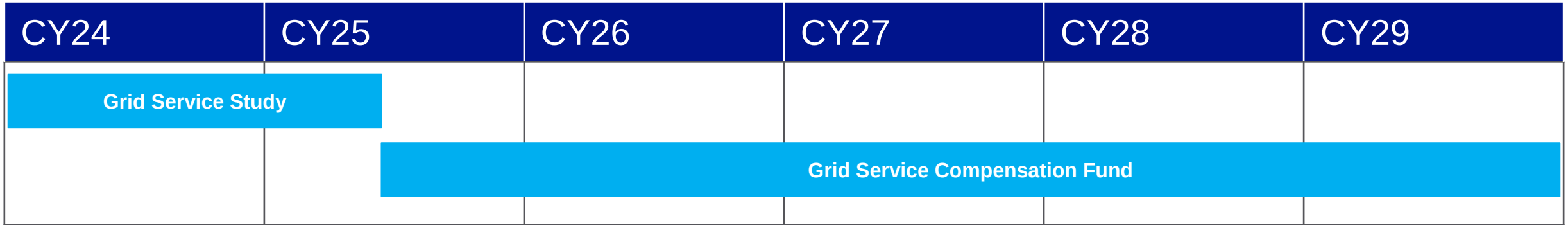
Using Grid Services to address Bridge to Wires needs

Grid Service Study

1	*Establish specific levels of compensation for DERs providing locational grid services, such as load flexibility*
2	*Recommend process mechanisms to implement grid services compensation framework*
3	*Study to be conducted in partnership w/ joint utilities & MassCEC*

Grid Service Compensation Fund

1	*Proposed $40M fund to compensate 3rd party dispatchable DER and flexible loads for addressing Bridge to Wires needs*
2	*Will fund enhanced locational DR program incentives and local flex market procurements*
3	*Technology-agnostic; inclusive of solar, storage, EV charging, smart thermostats, EE*
4	*Participants: developers, aggregators / flex service providers, direct customers*



Eversource (13 Min)

III. Technical Discussion

a) Current State of Interconnection
b) Infrastructure Plans

Lavelle Freeman, Eversource

Director System Planning

westMONROE

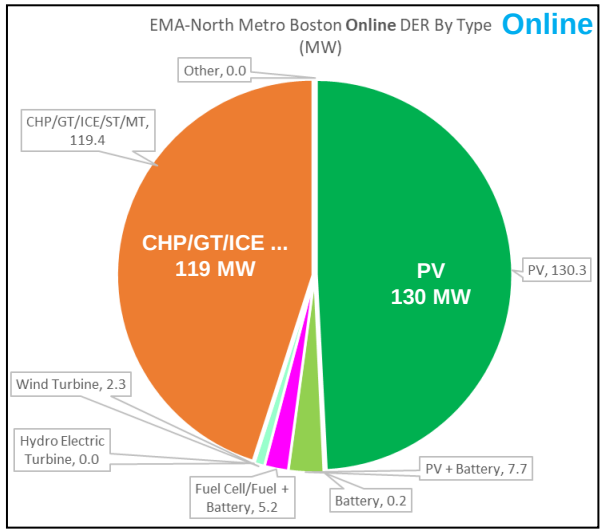
State of DER Interconnection

BY REGION

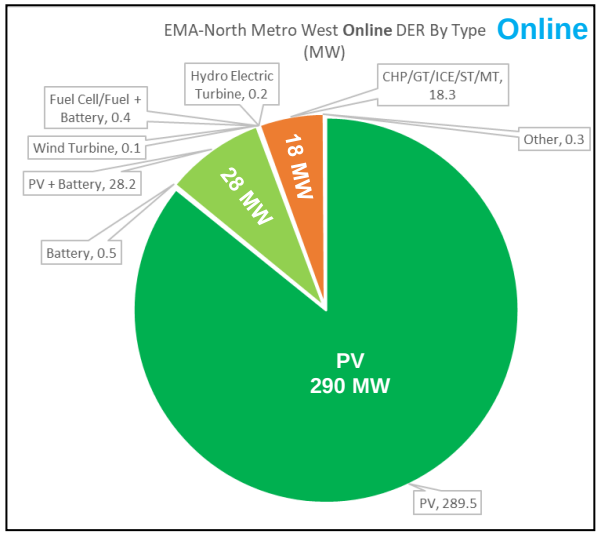
1.4 GW ONLINE

1.3 GW IN-QUEUE

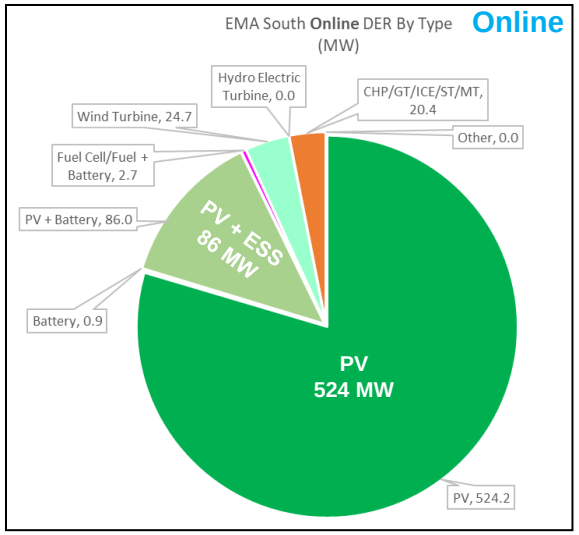
EVERSOURCE



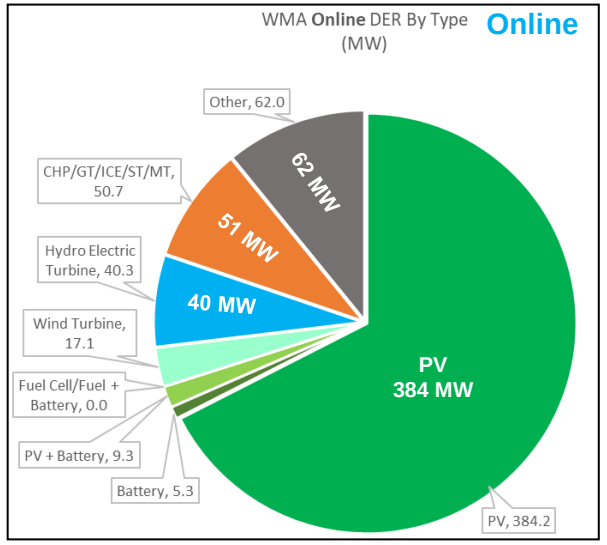
Metro Boston



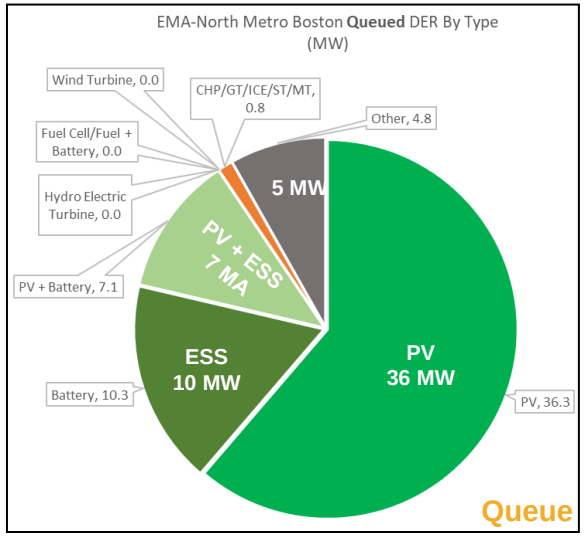
Metro West

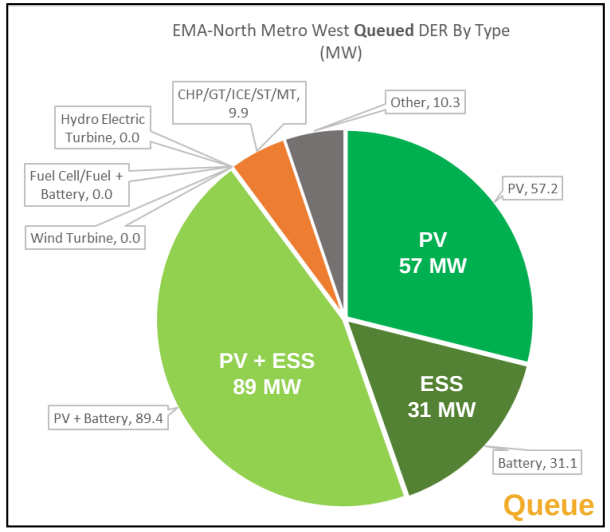


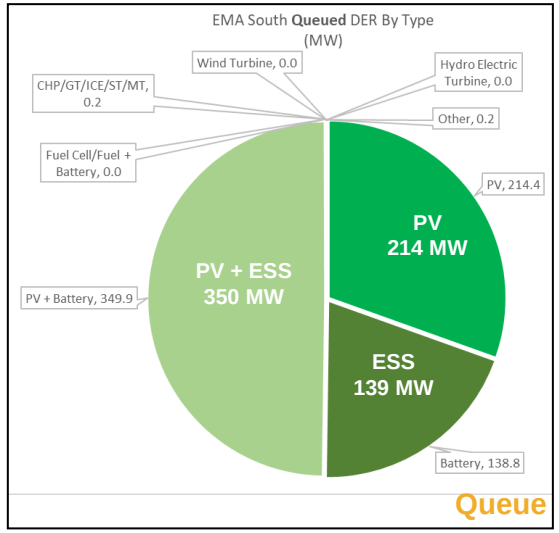
SEMA

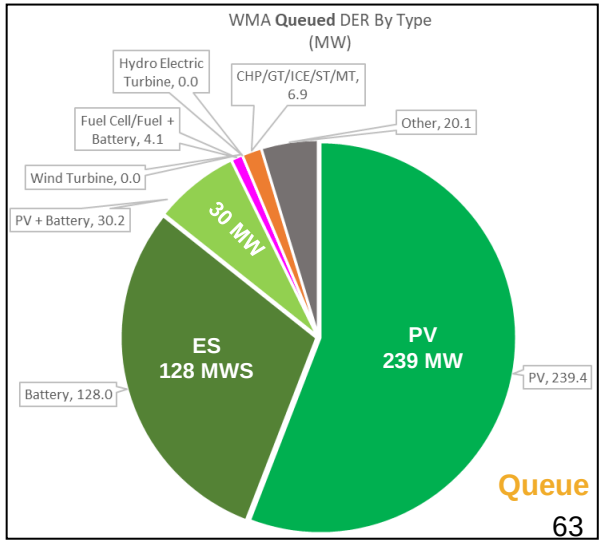


West







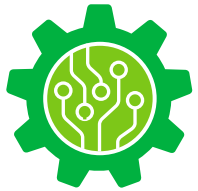


Clean Energy Objectives

Based on Robust Data Analysis and Community Input

UPGRADE AND EXPAND
to handle demand growth and enable large amounts of new clean energy

STRENGTHEN AND HARDEN
to withstand more frequent and more intense storms



MODERNIZE
with smart technologies that empower customers to have more control over their energy use and costs

SYSTEM PLANNING PROCESS

10-year planning process incorporates customer needs, **clean energy & equity policy objectives**

Incorporate MA's anticipated demand growth assumptions for EV/DER adoption and electric heating

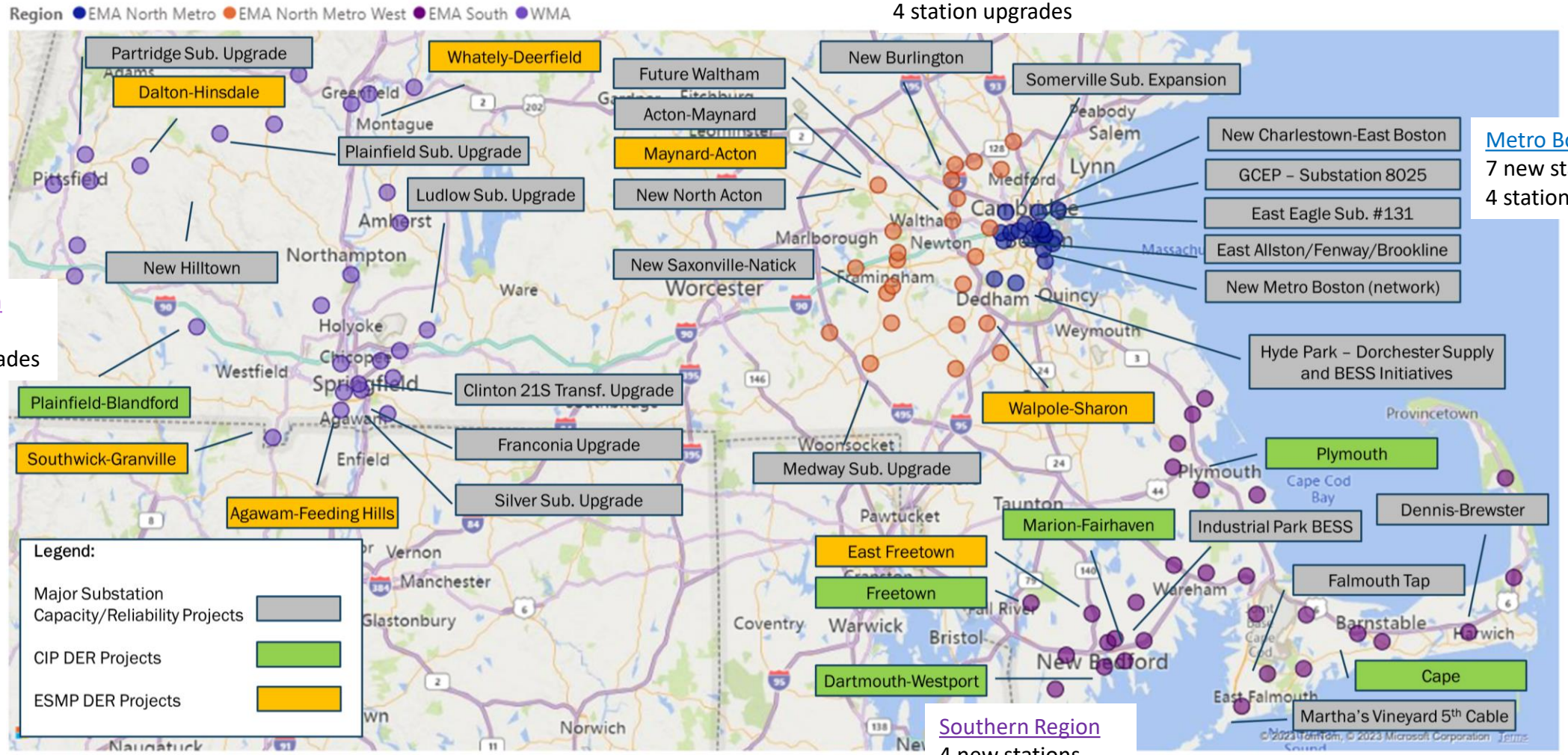
Analyze demand growth by region, community, station service area and distribution circuit

Identify grid needs and upgrades, focusing first on lowest-cost options and NWA solutions

Leverage stakeholder engagement process to seek communities' perspectives before projects proceed to siting

Major Capital Projects and CIPs in the 10-Year Plan

Metro West Region
4 new stations
4 station upgrades



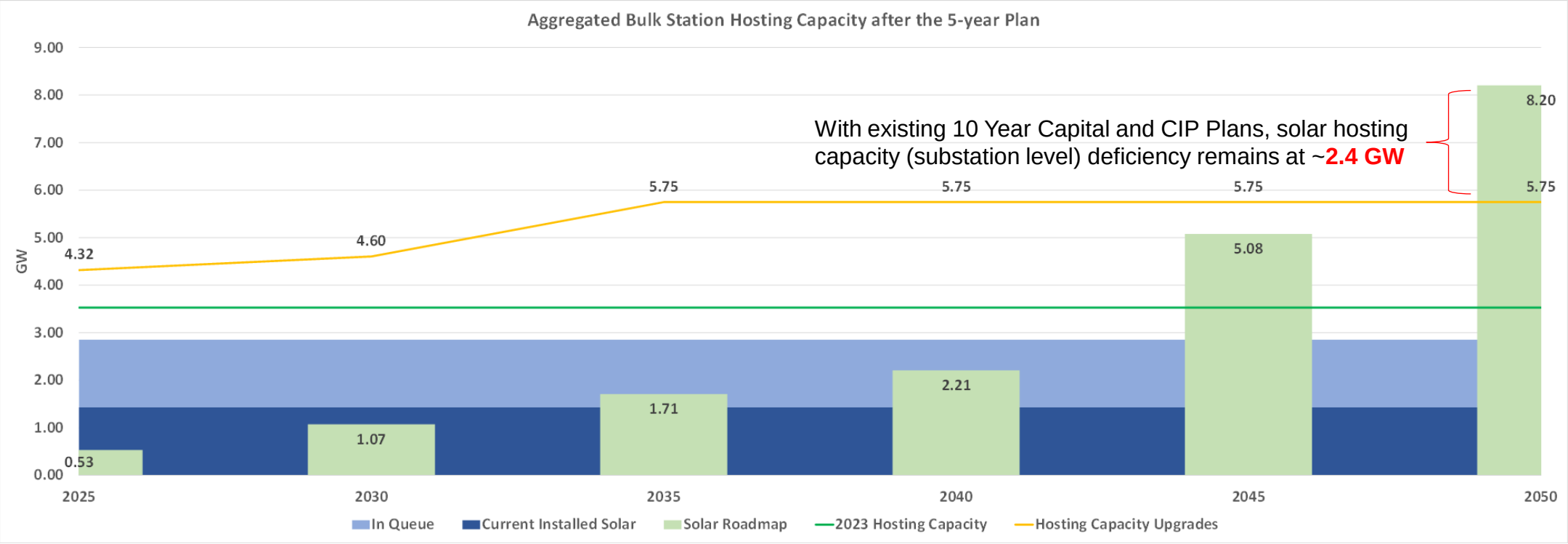
Western Region
2 new stations
11 station upgrades

Metro Boston Region
7 new stations
4 station upgrades

Southern Region
4 new stations
7 station upgrades

- 17 new substations (14 Load, 3 CIPs)
- 26 substation upgrades (12 Load and 14 CIPs)

5-10 Year and 2050 Plan: DER Hosting Capacity Needs and Solutions



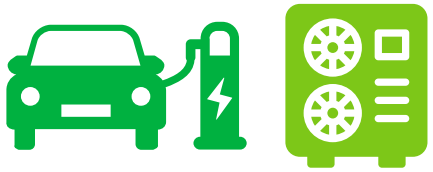
- As of 2023, total DER hosting capacity is **~3.5GW** with installed solar generation of **~1.5GW**
- Over the next 10-years, solar generation is forecasted to increase to **~2.9GW**
- 10-Year CIP solutions upgrades 14 substations and adds 3 new substations
- In addition to the 10-Year Capital Plan solutions, CIP solutions add incremental **~3 GW** of hosting capacity
- Significant number of additional CIPs and smart solutions needed to meet 2050 goals

Eversource's Plan

ENHANCES THE GRID & ENABLES CLEAN ENERGY

IDENTIFIES NEEDED INVESTMENTS OVER THE NEXT 10 YEARS
to support clean energy resources and drive improvements in grid reliability and resiliency

Increases grid capacity by 180% over the next decade (3.4 GW)



Allows for the **adoption of 2.5 million electric vehicles and 1 million heat pumps**

Enables **2.2 GW of solar, exceeding the state's 2040 goals** and reaching 72% of its 2050 goals

III. Technical Discussion

c) Distributed Energy Resource Management System - DERMS

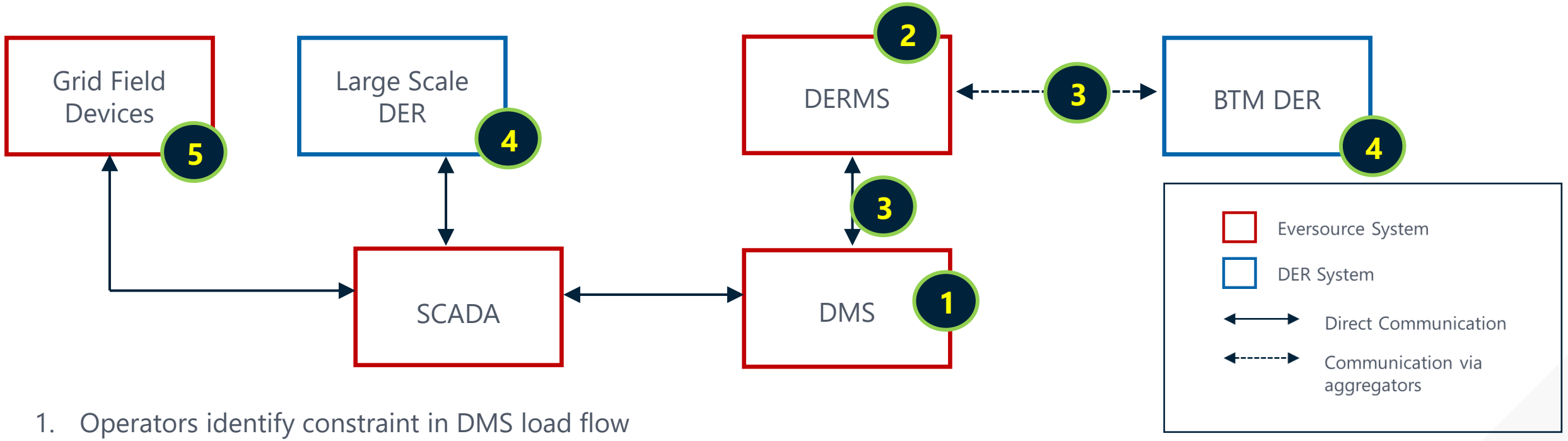
Jennifer Schilling, Eversource

Vice President Grid Modernization

westMONROE

Distributed Energy Resource Management System (DERMS)

Software, telemetry, tools and processes to enable Eversource control room operators to dispatch contracted DER in response to real time system conditions

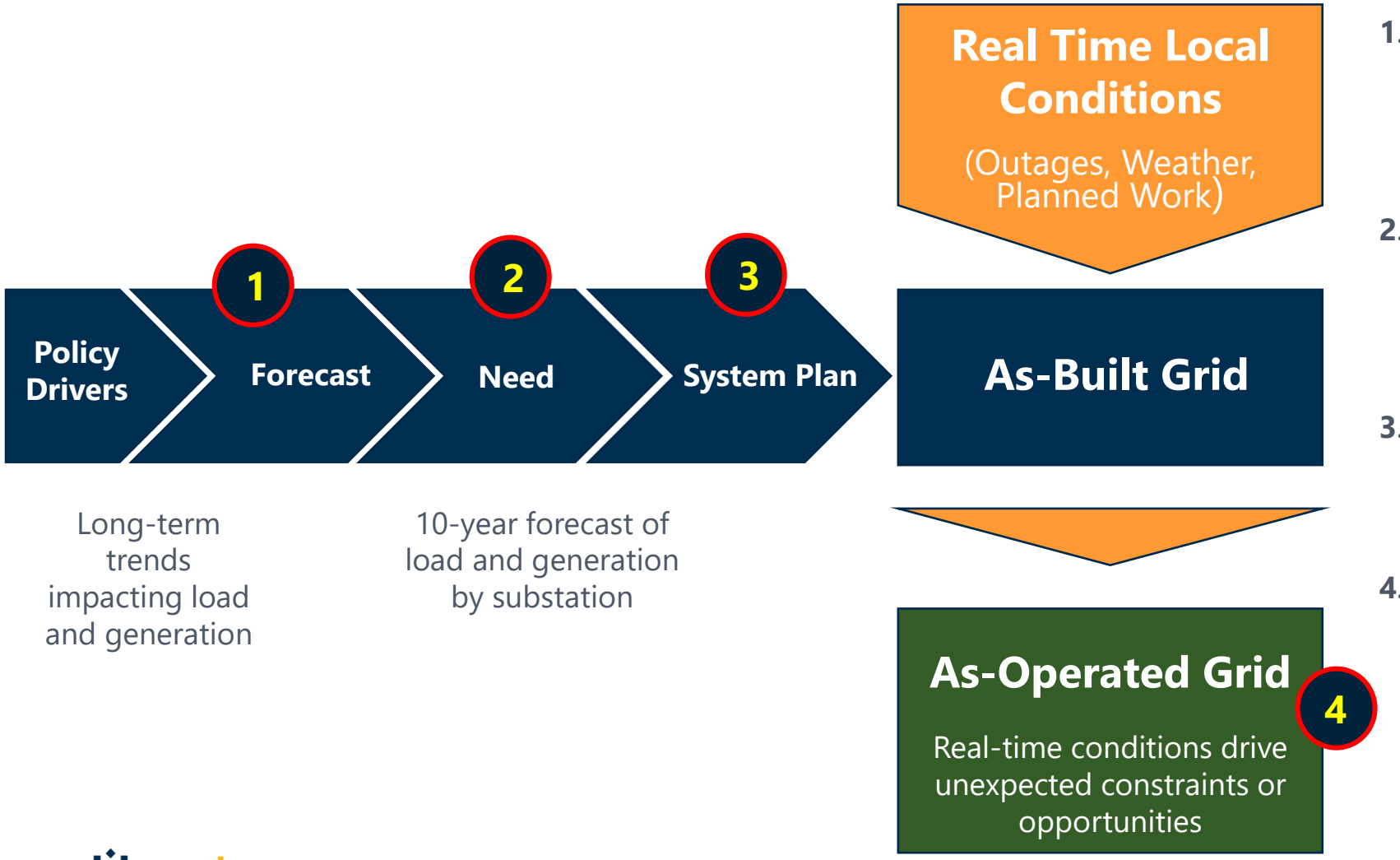


1. Operators identify constraint in DMS load flow
2. DERMS calculates a dispatch plan using available large-scale and BTM resources
3. DERMS signals DMS and aggregators to dispatch
4. DER responds
5. Grid field devices register changes to the grid and operators see impact in DMS load flow

Virtual Power Plant (VPP)

1. **Real Time Grid Constraint.** Local load at risk due to overload, or over/under voltage or ISO requires local DER dispatch to address transmission constraints
2. **Coordinated Dispatch.** Eversource dispatcher calls upon VPP in the affected local area
3. **VPP Responds.** Discharge Battery, call Demand Response or reduce charging demand, change Inverter settings to provide voltage, current or frequency support
4. **Constraint Alleviated.** VPP action addresses issue

The Value of Grid Flexibility



1. **Independent Resource Additions.** Energy efficiency, distributed generation, EV/battery discharge schedules happening independently of specific grid need (*included in forecast*)
2. **Bridge to Wires.** 3rd party Resources dispatched through DERMS and paid for by the Grid Services Compensation Fund to meet temporary grid need in advance of placing final solution in service
3. **Non-Traditional Approach.** Grid need (as defined by forecast) is addressed by Eversource-owned DER through the NWA Framework
4. **Grid Services Solution.** Third-party DER dispatched to respond to constraints in the as-operated grid dispatched through DERMS and paid for by the Grid Services Compensation Fund

Grid Services Compensation Fund

Provides funding to compensate DER for grid services without approval of a new tariff and incremental to Connected Solutions program

- State-wide study will be coordinated by MA CEC to establish compensation levels and high-level implementation framework
- Expected program start in 2025, following study completion
- Eversource will establish requirements for participation
  - Communications and control (direct for large-scale and via aggregator for BTM)
  - Contracted provisions for performance (e.g., over-ride ability)
- Compensation and dispatch frequency will vary based on local system need

III. Technical Discussion

d) Non-Wires Alternatives

Jennifer Schilling, Eversource
Vice President Grid Modernization

Gerhard Walker, Eversource
Manager Advanced Forecasting and Modeling

westMONROE

Alternatives to Traditional Investments – Impact on Company Forecast

Econometric Trend Load Model

Forecasted Weather Normalized 90/10 Gross Station Peak

Energy Efficiency Demand Res.

Programmatic NWAs, DERs, and DR and Charge Management

Charge Managed

EV Growth

DER Forecast

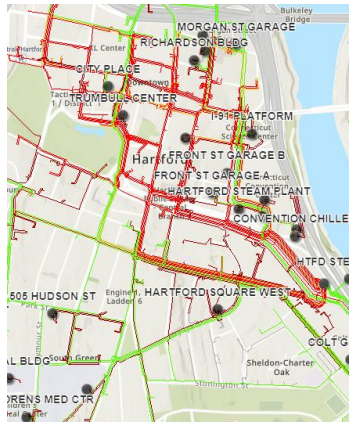
Existing

Forecasted

Permanent Load Transfers

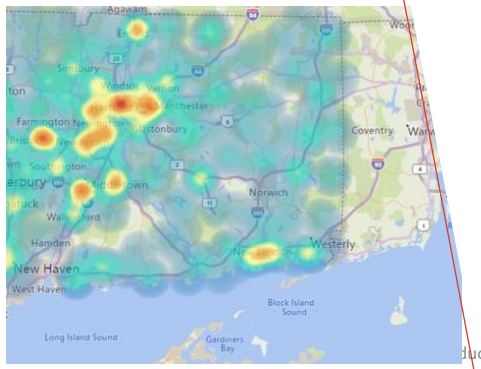
Step Loads

Adoption propensity modeling using service territory wide parcel data base and geospatial forecasting

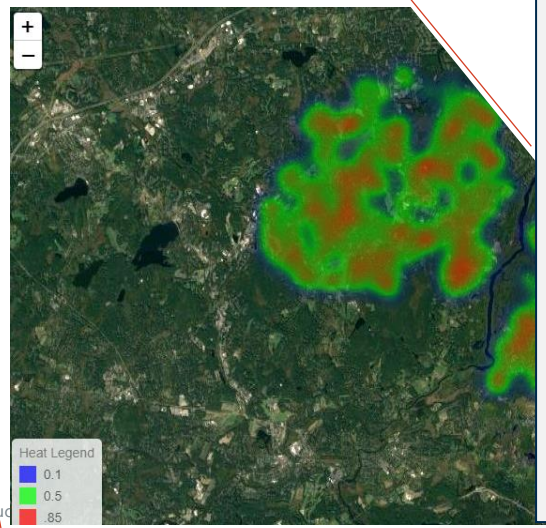


Strategic system reconfiguration for load shifting

Tracking of every national and strategic account, bulk electrification efforts, and forecasting of potential areas of electrification

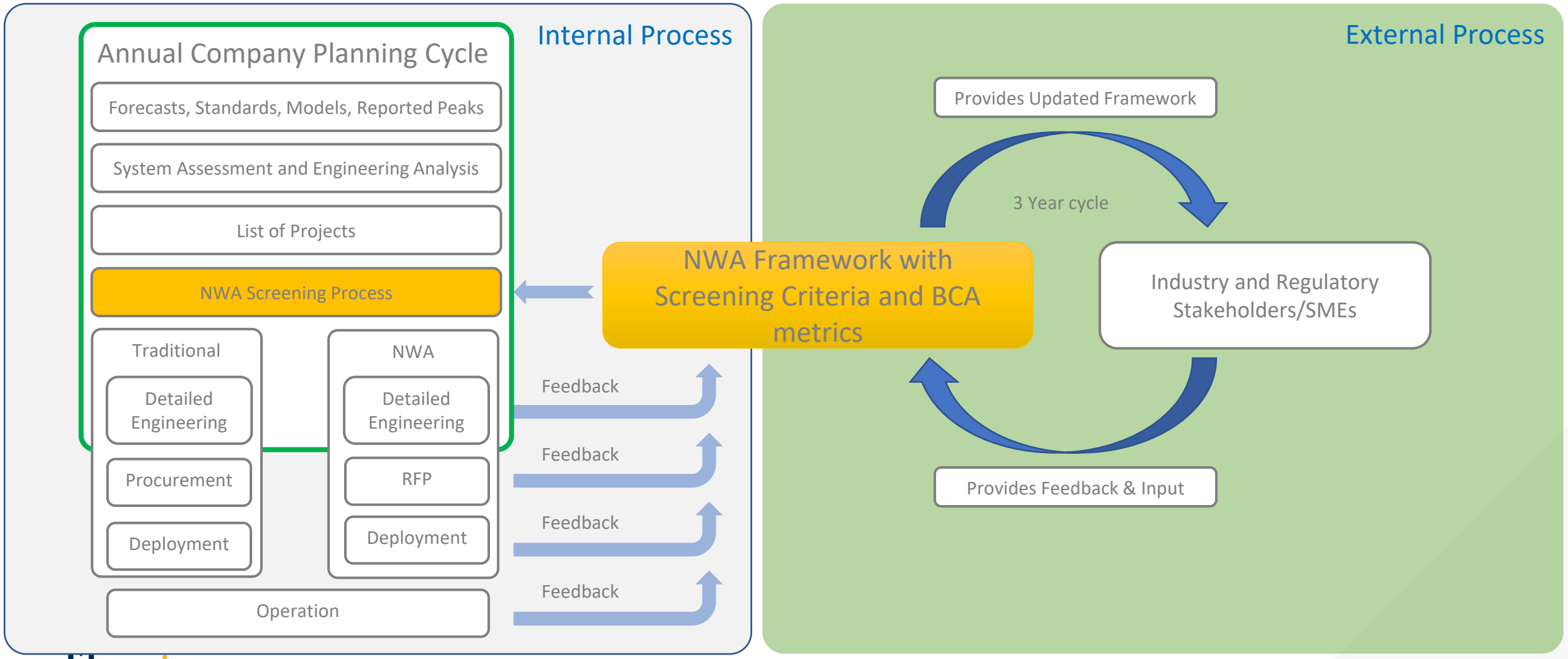


Adoption propensity model based on customer cluster classifications and GPS mobility tracking data

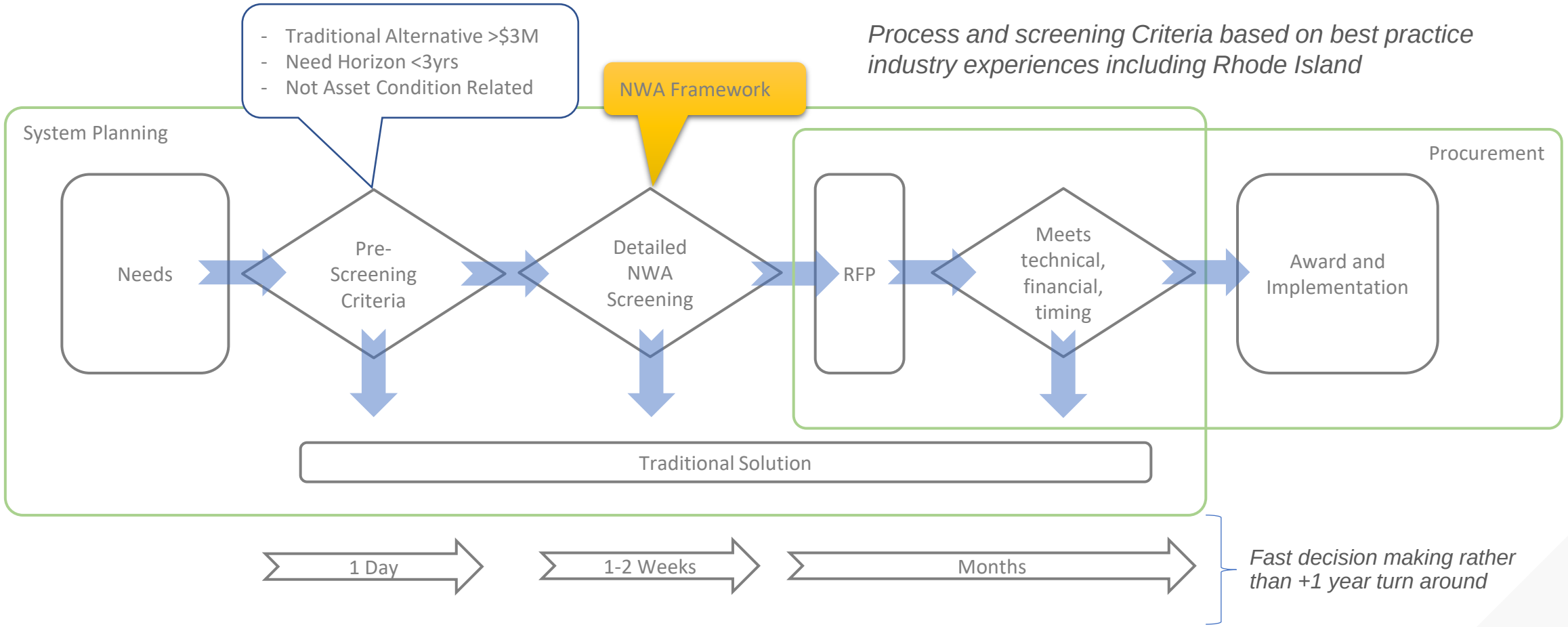


Forecasted Net Station Load with 90/10 Weather

Current Process in System Planning

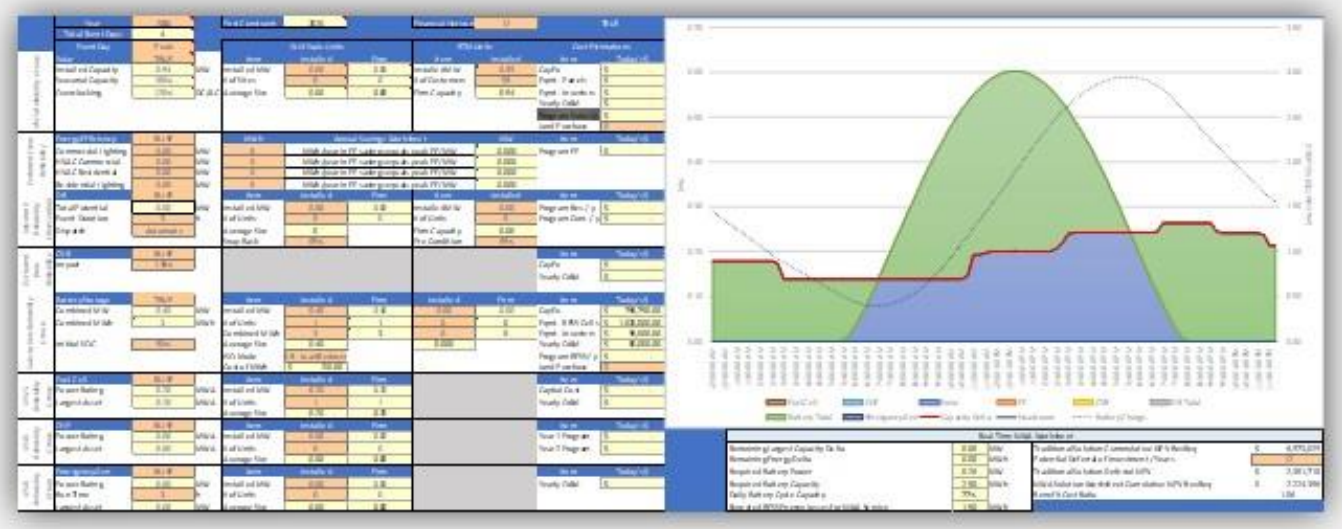


Existing Screening Process



Existing Framework Design – More than Value Stacking

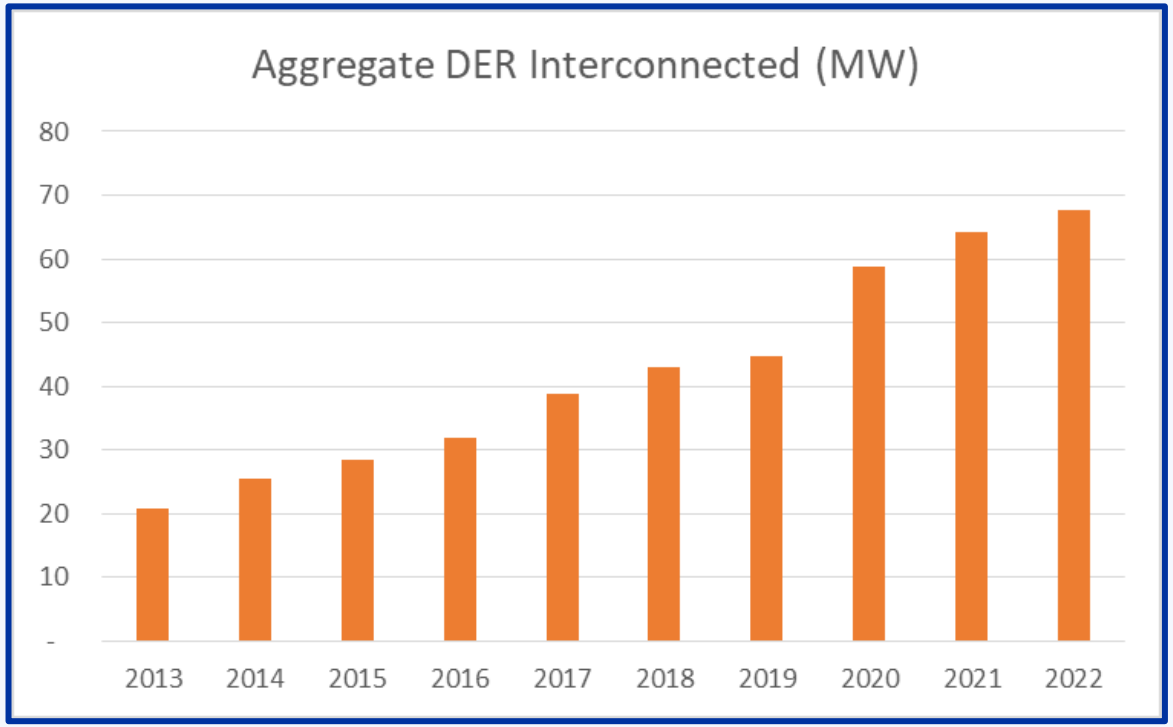
- Reliability Model
  - *How do we account for intermitted availability e.g. response of DR programs*
- Dispatch Model
  - *How do we model dispatch such as large battery assets on constraint systems*
- Cost Model
  - *How do we compare solution cost including standardized assumptions*
- Revenue Model
  - *What type of revenue options to we account for, including ISO market participation*
- Benefits Model
  - *What are the direct impacts on rates to customers, including value of deferred infrastructure*



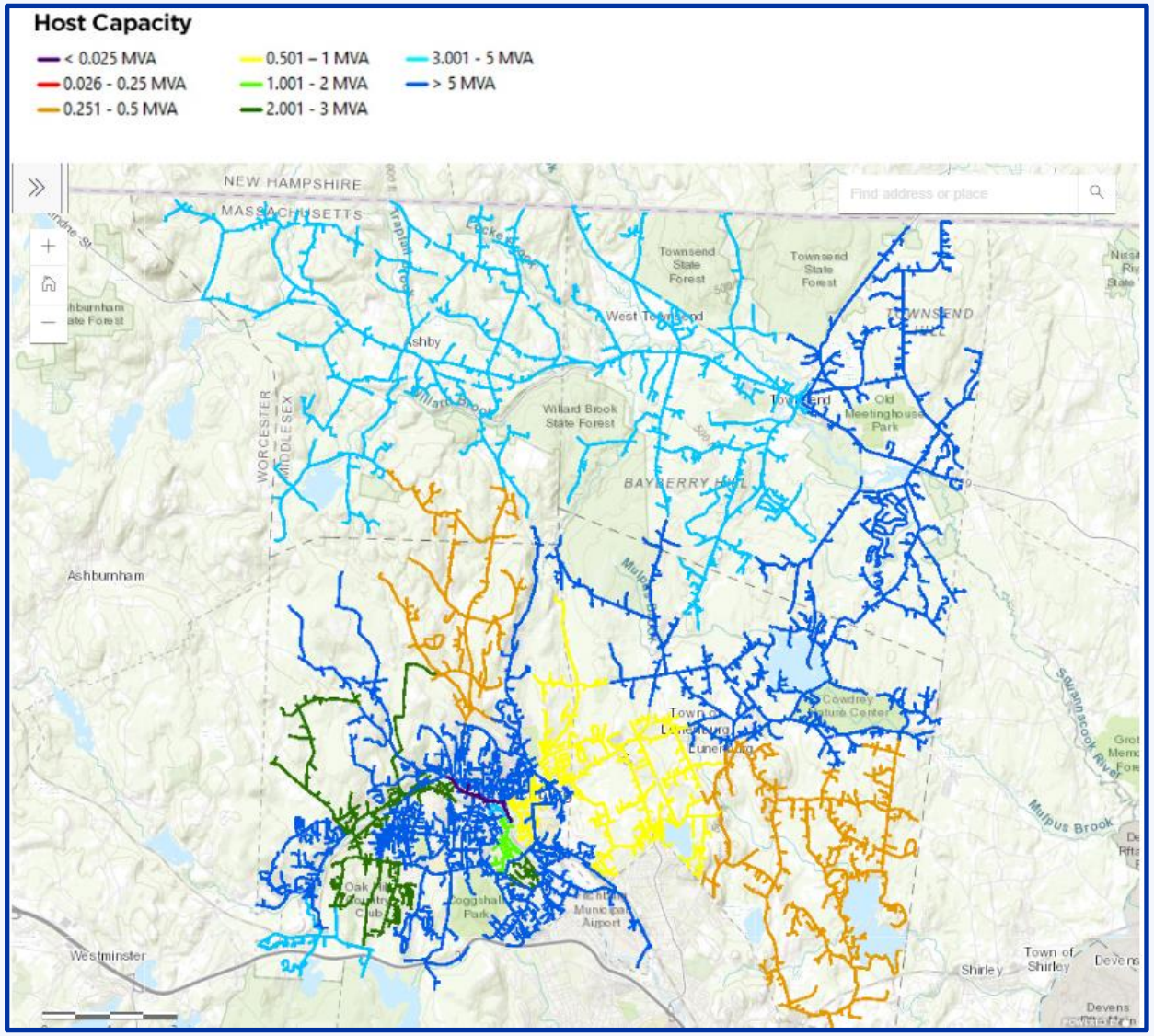
Unitil (13 Min)

Current State of Interconnection

High penetration of DERs across the system



Type of DER	No. of Facilities	Nameplate Capacity (MW)
Solar	2,723	43.7
Solar + Storage	36	1.2
Gas	7	0.4
Storage	3	2.0
Wood	1	18.0



Capacity Expansion 2025-2030

Projects identified to address capacity constraints (ESMP Section 6)

Lunenburg Substation Expansion - 2026

Constraints

2025 - Lunenburg Regulator Loading

2026 – Lunenburg Transformer Loading

Driver:

New 3 MW Customer on 30W30

Solution:

Install 30MVA 69/13.8kV Transformer

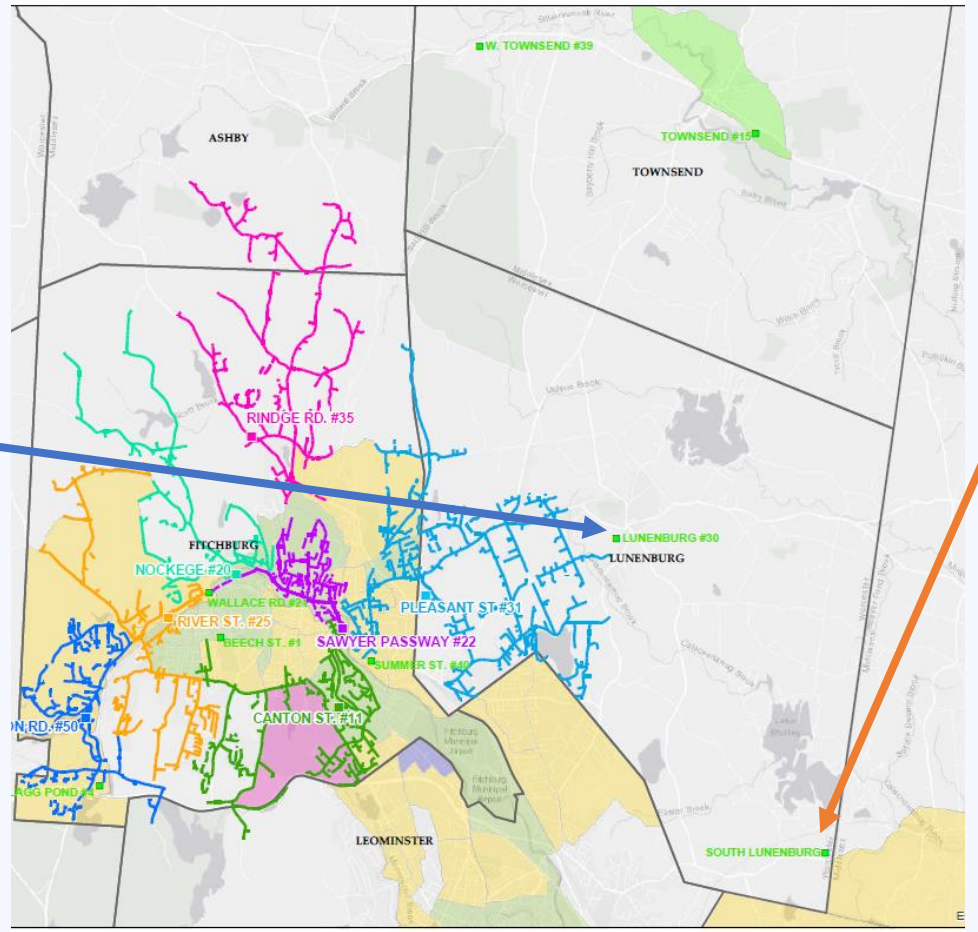
Split 30W30 into 2 circuits

Split 30W31 into 2 circuits

Costs ($9.1M):

2025 - $4.4M

2026 – $4.7M



New South Lunenburg Substation - 2030

Constraints

2030 – 08/09 Loading N-1 Condition

2034 – Flagg Pond loading

Driver:

Normal load growth on north end of system

Solution:

New system supply in South Lunenburg

115kV Ring Bus

115 x 69kV to 13.8kV

Offloads Flagg Pond, 01, 02, 08, 09 lines

Costs ($20.5M):

2025 - $3.0M

2027 – $7.0M

2028 - $8M

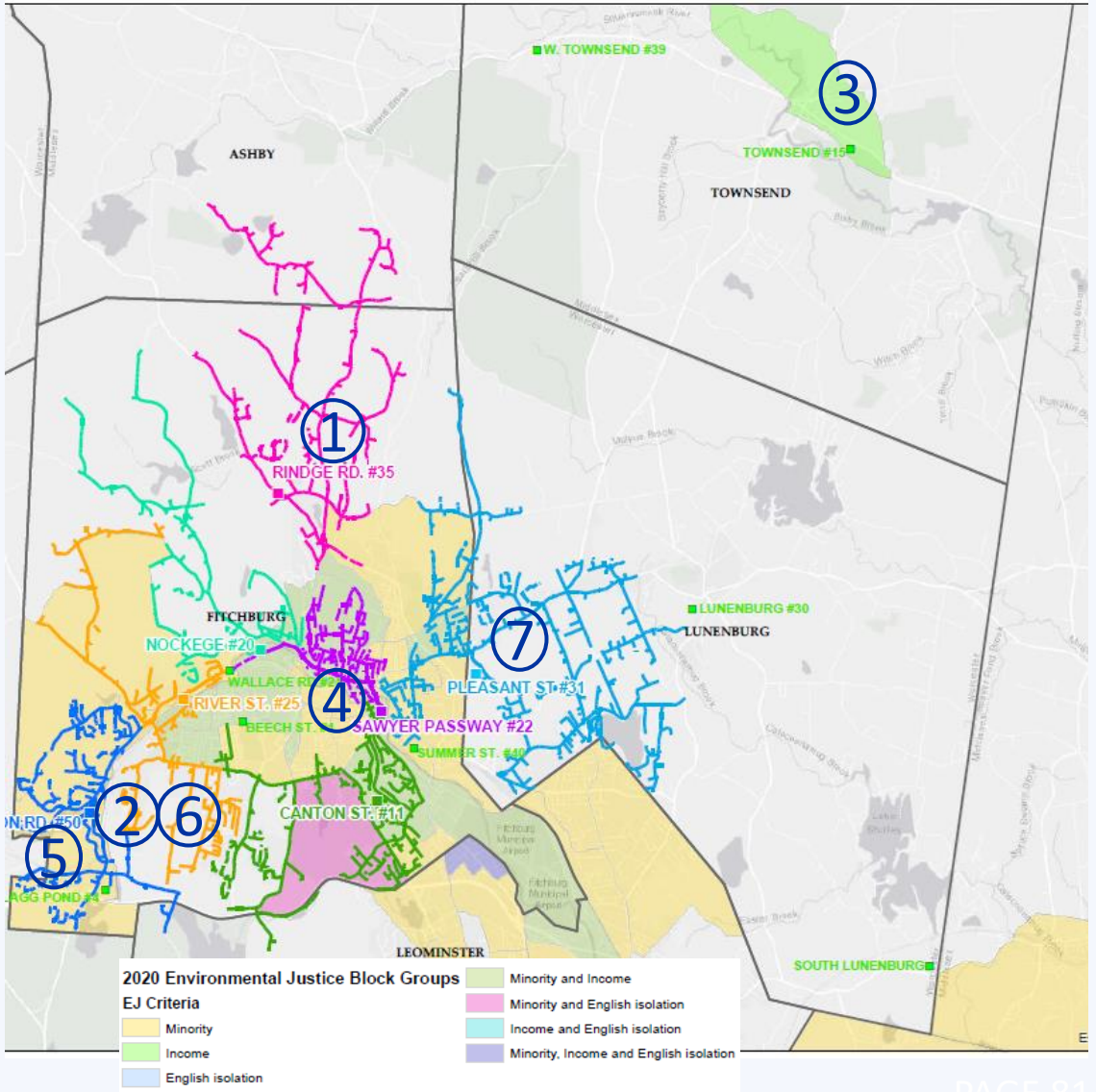
2029 - $2.5M

Capacity Expansion 2031-2039

Projects identified to address capacity constraints (ESMP Section 9)

1. Establish 2nd Circuit at Rindge Road – 2035
2. Replace Princeton Road 50T2 Transformer – 2035
3. Townsend Substation Capacity Additions – 2036
4. Install New Circuit and Split Circuit 22W1 – 2036
5. Flagg Pond Capacity Additions – 2037
6. Replace Princeton Road 50T3 Transformer – 2037
7. Pleasant Street Substation Capacity Additions - 2038

The projects shown here are based upon the most recent load forecast and demand assessment. These projects will be re-evaluated each year when the load forecast and demand assessment is updated with the most up to date load, DER and NWA information.

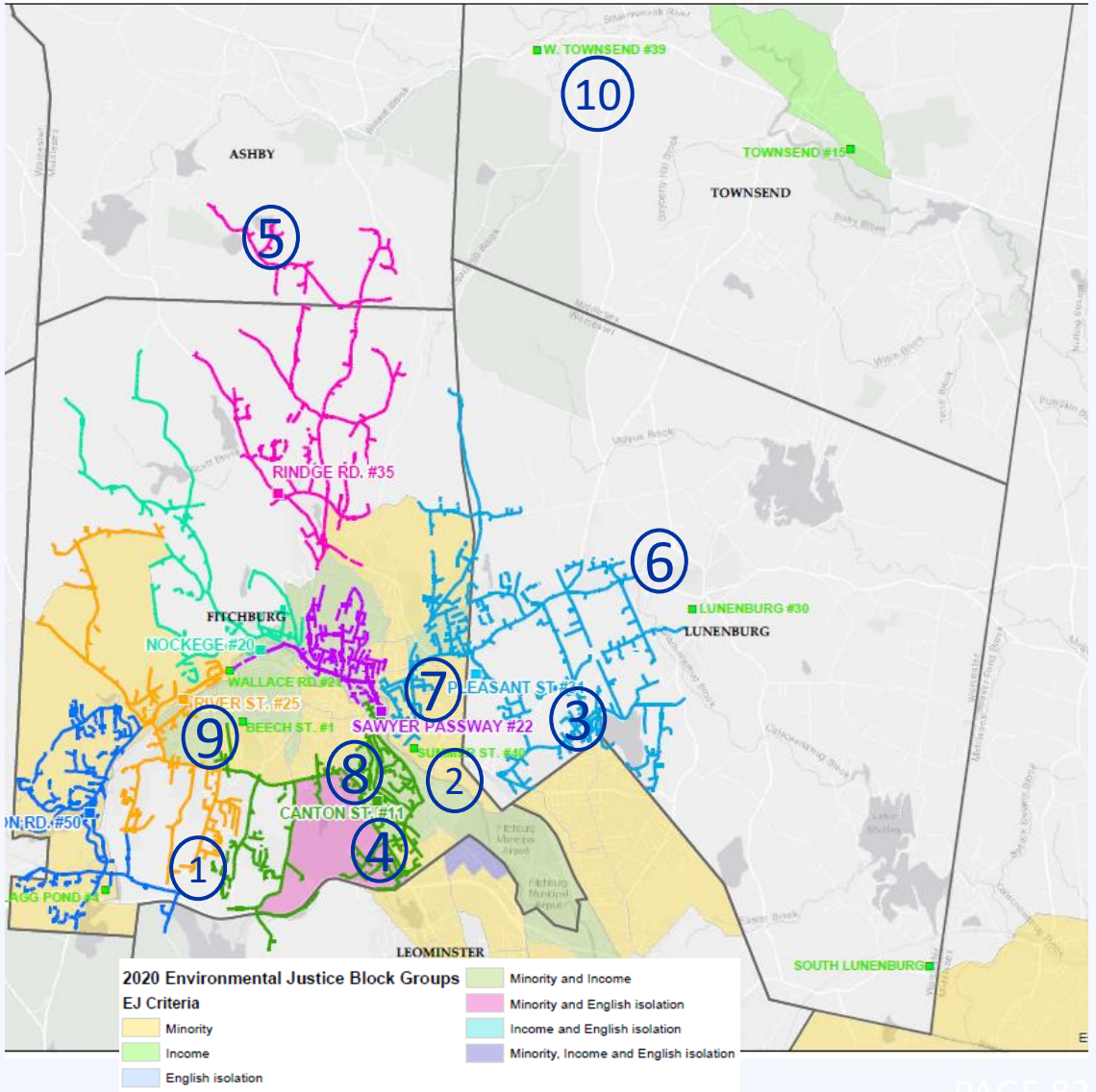


Capacity Expansion 2040-2050

Projects identified to address capacity constraints (ESMP Section 9)

1. 01 and 02 Line Capacity Additions – 2040
2. Summer Street Substation Capacity Additions – 2040
3. Construct New Lunenburg/Summer St Supply – 2042
4. Beech Street Tap Substation – 2042
5. New Rindge Road and Ashby Area Substations – 2044
6. Replace Lunenburg 30T1 Transformer – 2044
7. Construct 2nd 69kV Line between Summer St. and Sawyer Passway – 2045
8. Canton Street Substation Capacity Additions – 2047
9. Replace River Street 25T1 Transformer – 2048
10. Replace West Townsend 39T1 Transformer - 2050

The projects shown here are based upon the most recent load forecast and demand assessment. These projects will be re-evaluated each year when the load forecast and demand assessment is updated with the most up to date load, DER and NWA information.



ADMS and DERMS

Advanced monitoring and control to optimize the electric system

Advanced Distribution Management System / Distributed Energy Resource Management

- Computer system and communications to monitoring and control of electric system
- Platform for other functionality such as volt-var optimization and automation

Customer Benefits

- Improved outage response
- Improved outage restoration
- Improved monitoring and control allows for an increased amount of clean energy resources
- Facilitates demand response
- Benefits EJ and non-EJ Communities

- Existing Platform – Hitachi ADMS
  - OMS, SCADA, VVO, FLISR, switch order management
  - Common network model
- DERMS – 2025 - 2029
  - Addition of DERMS into the ADMS platform
  - Pilot with company owned facilities before adding others
  - Extend deployment to allow for monitoring and control of with DERs
- DERMS also supports
  - FERC Order 2222
  - Enable DER to provide grid services

ADMS and DERMS

ADMS is a computer software model that manages real-time information from the field to make decisions on how best to optimize the electric system. DERMS is portion of ADMS used to actively monitor and control distributed energy resources. ADMS is also the foundation for outage management, VVO, SCADA, FLISR and switch order management.

NWA Framework

Including Non Wires Alternatives

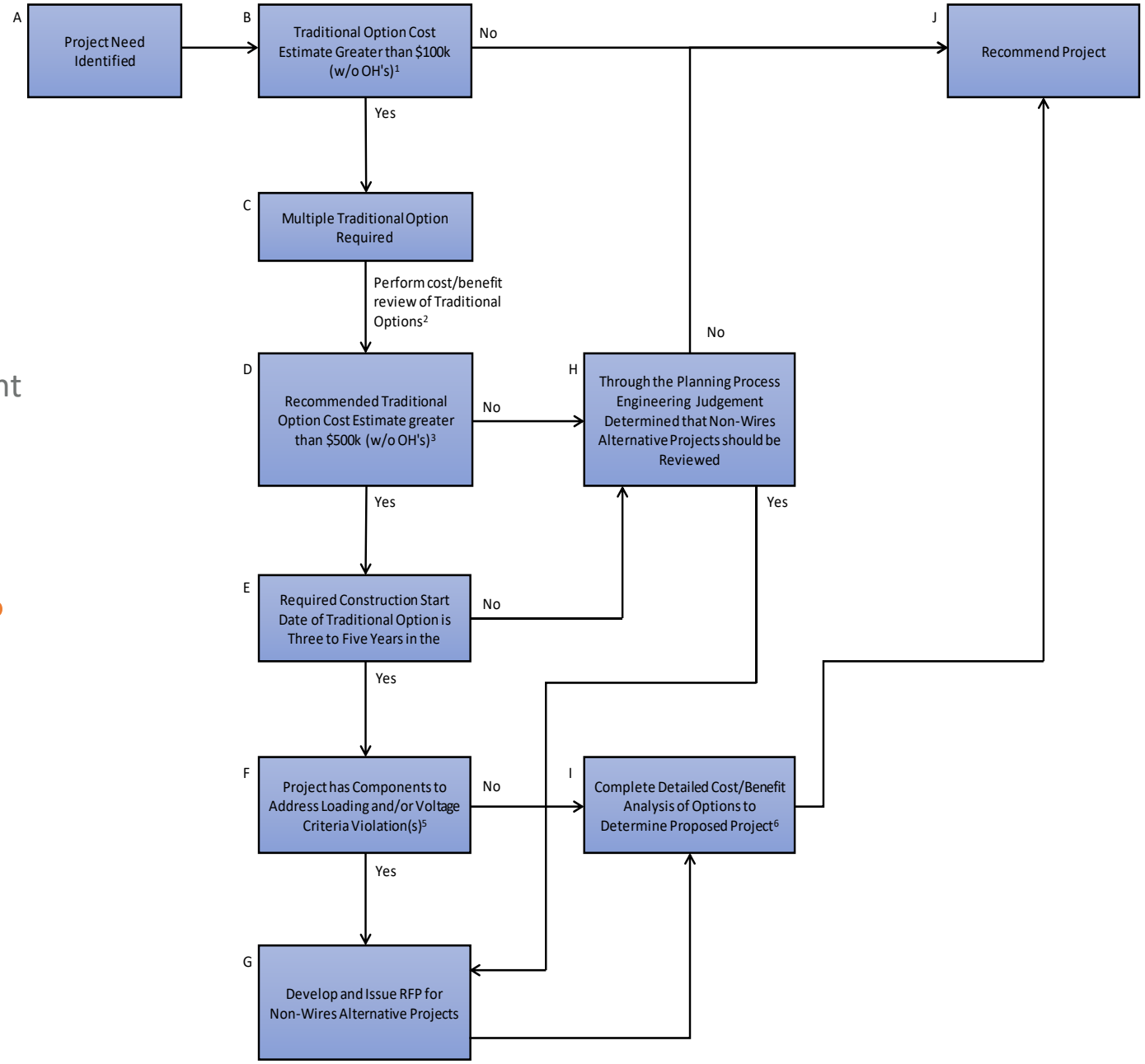
Non-Wires Alternative Evaluation Framework

- Project is needed to address loading and/or voltage violations
- Traditional solution option is greater than $500,000
- Required construction date is 3 – 5 years in future
  - At least 3 years to receive, evaluate, and implement NWA proposals
- Reliability, availability and capacity characteristics included in the evaluation
- RFI and RFPs used to identify potential NWAs

What would be considered for non-wires alternatives?

- DER or DG
- Energy storage and/or solar plus storage
- Demand response
- Energy efficiency
- Managed charging
- Combined heat and power (CHP)
- Microgrid
- Future technologies not yet known

Project Evaluation Workflow



Enable DER as a Grid Service

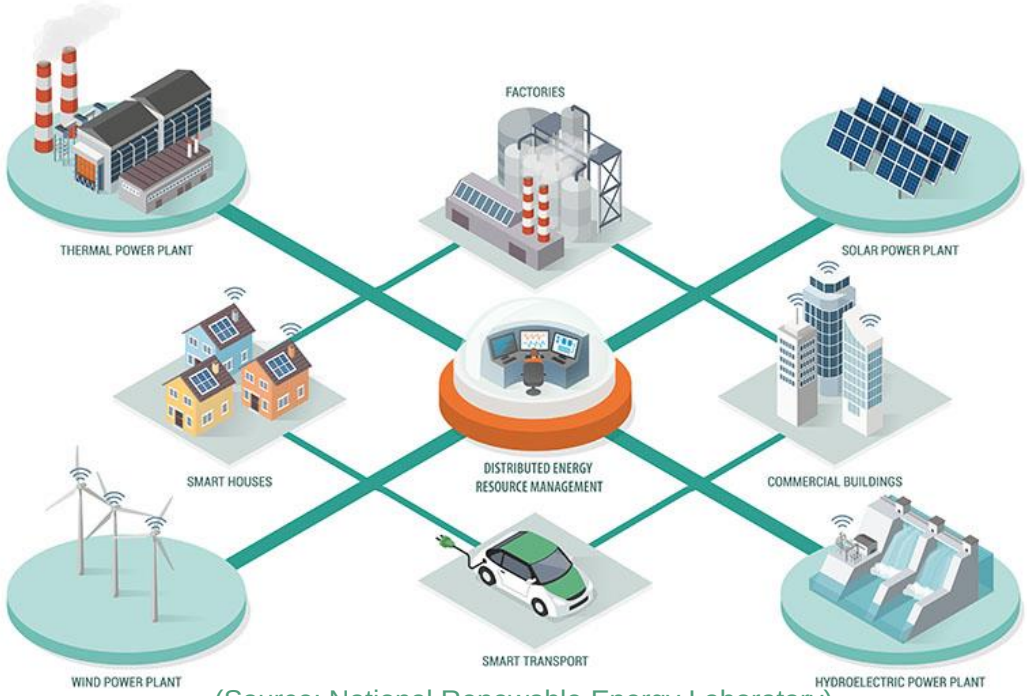
DERs can provide benefits to the electric system if managed and controlled properly.

Enable DER Grid Services

- Study the value of DER and load flexibility as a grid service.
- Compensation fund for dispatchable DERs
- Equitable Transactional Energy Study taking into consideration virtual power plant configuration
- Higher compensation for EJ communities

Customer Benefits

- Compensation fund to promote DERs
- Connect up to 10 DERs greater than 500kW
- 5-10MW demand reduction
- Savings of 100-500 MW-Hr
- Benefits EJ and non-EJ Communities



(Source: National Renewable Energy Laboratory)

DER as a Grid Service

DERs have the ability to provide value to the reliable operation of the electric system. This study is designed to develop the use cases and compensation for DERs which provide capacity or voltage support to the system when the system needs it.

FERC Order 2222

Allowing all customers to participate in the wholesale energy market

FERC Order 2222 Implementation

- Remove barriers for DERs to connect
- Allows DERs to participate in wholesale markets – same as large facilities
- Opens up wholesale market to new sources of energy
- Lowers wholesale price of electricity

Customer Benefits

- Reduce capacity constraints that drive supply price, lower supply costs
- Reduce GHG emissions
- Defer system investment
- Allows all customers to participate in market
- Benefits EJ and non-EJ Communities

(ISO-NE Control Room)

FERC Order 2222

FERC ordered that all DERs that allows aggregators of solar, wind, electric vehicles, battery storage, and other distributed energy resources (DER's) to compete in regional wholesale electricity markets. Up to this point only large generators had the ability to enter the wholesale market.

Open Q&A
(45 Minutes)