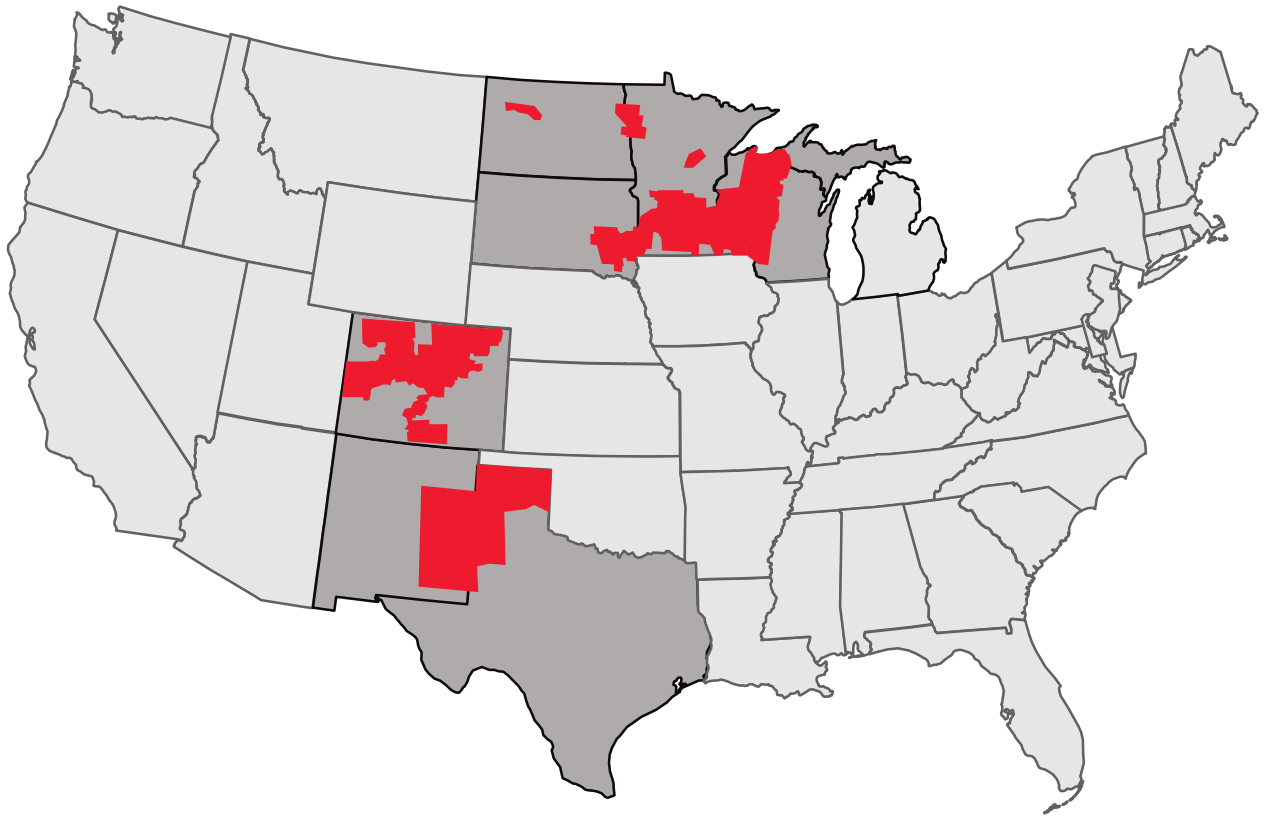
INTEGRATED DISTRIBUTION PLANNING AT NORTHERN STATES POWER COMPANY – MINNESOTA

Jody Londo | Regulatory Policy Manager

May 13, 2022

Xcel Energy



Serving eight states

3.7 million electricity customers

2.1 million natural gas customers

Nationally recognized leader:

Wind energy

Energy efficiency

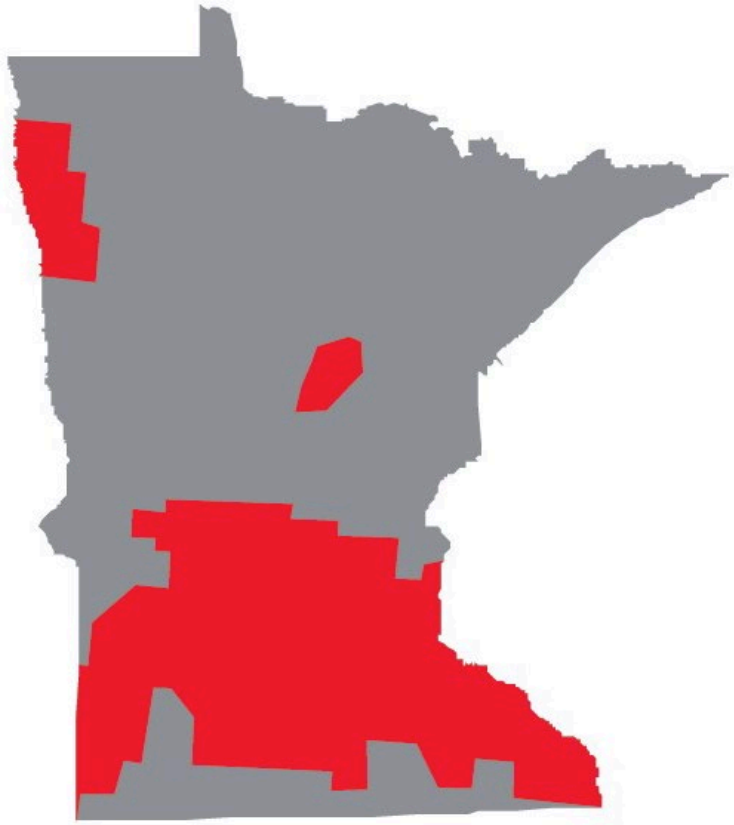
Carbon emissions reductions

Innovative technology

Storm restoration

2020 Data

Powering Minnesota



1.3 million Electric Customers

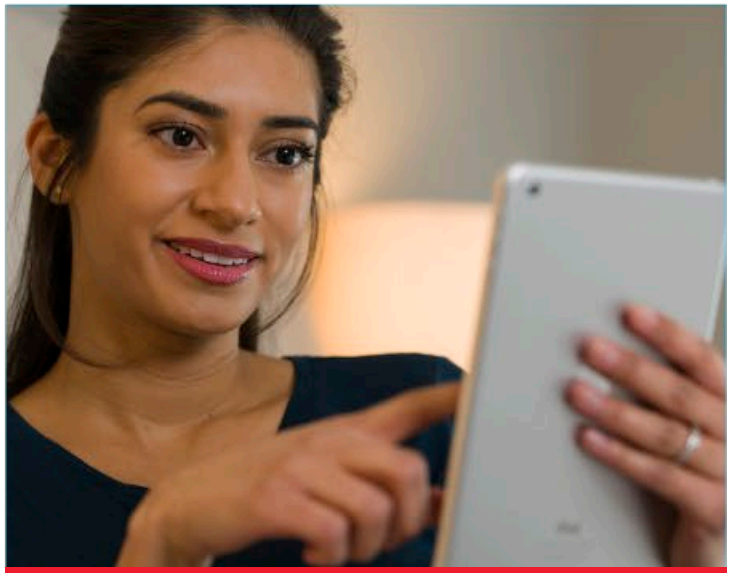
472,000 Natural Gas Customers

99.9% Electric Reliability

Xcel Energy Priorities

Lead the Clean Energy Transition

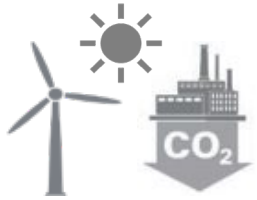
Enhance the Customer Experience



Keep Bills Low

Xcel Energy's Comprehensive Clean Energy Strategy

Clean energy across all the ways we power people's lives



100% Carbon-Free Electricity

Net-Zero Natural Gas

1.5 Million EVs

Our Energy Goals

Safe

Clean

Reliable

Affordable

DISTRIBUTION PLANNING FRAMEWORK

Xcel Energy®

Integrated Distribution Planning in Minnesota

- The Minnesota Public Utilities Commission established integrated distribution planning (IDP) reporting requirements as an outcome of its Grid Modernization proceeding
- Xcel Energy was the first utility to submit an IDP (in 2018)
- Full IDP requirement is biennial, with a smaller report due annually
- Enabling statute also allows utilities operating under a multi-year rate plan to seek “certification” of eligible grid modernization investments
    - If certified by the Commission, utilities can seek cost recovery through a rate Rider.

Minnesota IDP Objectives

- **Maintain and enhance the safety, security, reliability, and resilience of the electricity grid, at fair and reasonable costs, consistent with the state's energy policies,**
- **Enable greater customer engagement, empowerment, and options for energy services,**
- **Move toward the creation of efficient, cost-effective, accessible grid platforms for new projects, new services, and opportunities for adoption of new distributed technologies, and**
- **Provide the Commission with the information necessary to understand Xcel Energy's short- and long-term distribution system plans, the costs and benefits of specific investments, and a comprehensive analysis of customer cost and value.**

XCEL ENERGY 2021 MINNESOTA IDP

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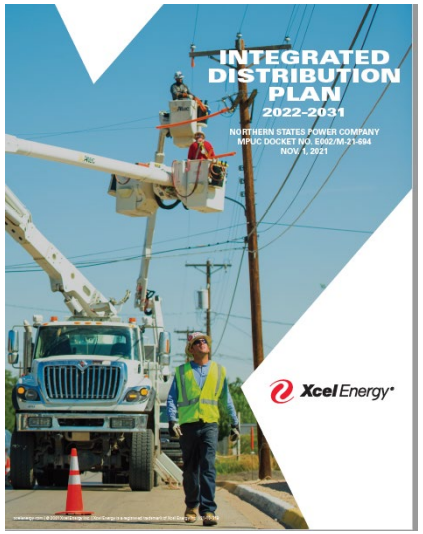
Snapshot – 2021 NSPM Integrated Distribution System Plan

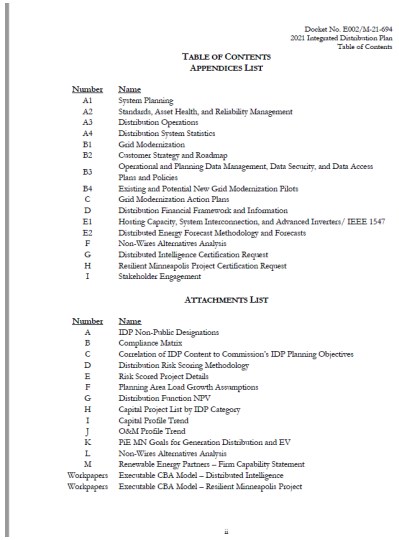
The Company's Integrated Distribution Plan provides insight and data on how the Company plans its system, reflected through several key documents and methodologies:

IDP PLAN



~40
PAGES

APPENDICES AND ATTACHMENTS



Docket No. E002/M-21-694
2021 Integrated Distribution Plan
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B2	Customer Strategy and Roadmap
B3	Operational and Planning Data Management, Data Security, and Data Access Plans and Policies
B4	Existing and Potential New Grid Modernization Pilots
C	Grid Modernization Action Plans
D	Distribution Financial Framework and Information
E1	Hosting Capacity, System Interconnection, and Advanced Inverters/ IEEE 1547
E2	Distributed Energy Forecast Methodology and Forecasts
F	Non-Wires Alternatives Analysis
G	Distributed Intelligence Certification Request
H	Resilient Minneapolis Project Certification Request
I	Stakeholder Engagement

ATTACHMENTS LIST

Number	Name
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B	Compliance Matrix
C	Correlation of IDP Content to Commission's IDP Planning Objectives
D	Distribution Risk Scoring Methodology
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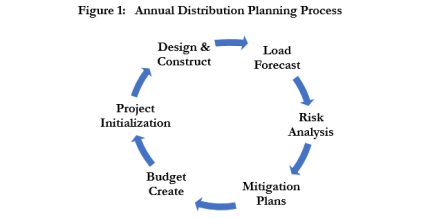
K	PE MN Goals for Generation Distribution and EV
L	Non-Wires Alternatives Analysis
M	Renewable Energy Partner – Firm Capability Statement
Workpapers	Executable CBA Model – Distributed Intelligence
Workpapers	Executable CBA Model – Resilient Minneapolis Project

16 APPENDICES
17 ATTACHMENTS
~550 PAGES

ANNUAL SYSTEM PLANNING APPROACH

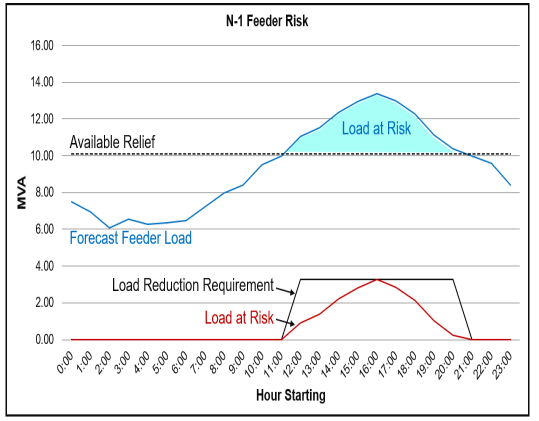


As part of our annual distribution planning process, we thoroughly review existing and historical conditions, including:

- Feeder and substation reliability performance,
- Any condition assessments of equipment,
- Current load versus previous forecasts,
- Quantity and types of DER,
- Total system load forecasts, and
- Previous planning studies.

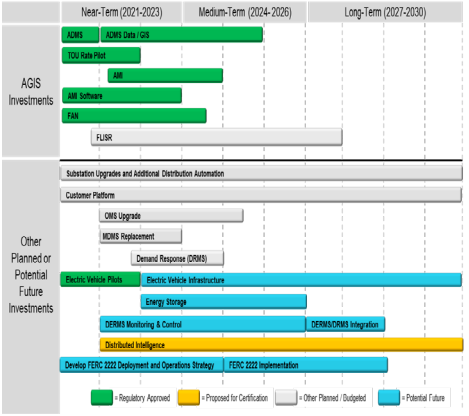
~1,600
FEEDERS AND SUBSTATIONS ASSESSED

NEW NWA METHODOLOGY PROPOSED



ADDITION OF STACKED VALUES PLUS MORE FOCUSED COST-EFFECTIVENESS TEST

GRID MODERNIZATION – NOW TO 2030



FOUNDATIONAL PROJECTS UNDERWAY WITH MORE PROPOSED

Within these documents, we provided information responsive to over 75 requirements.

The Minnesota Distribution System and Plan

BY THE NUMBERS

$537M AVERAGE ANNUAL DISTRIBUTION BUDGET
OVER 5 YEARS

150+ GRID NEEDS
IDENTIFIED OVER 5 YEARS

14 CANDIDATE NON-WIRES PROJECTS
ANALYZED FOR 2021

13.4M KVA DISTRIBUTION SUBSTATION CAPACITY

15,000 MILES OVERHEAD CONDUCTOR

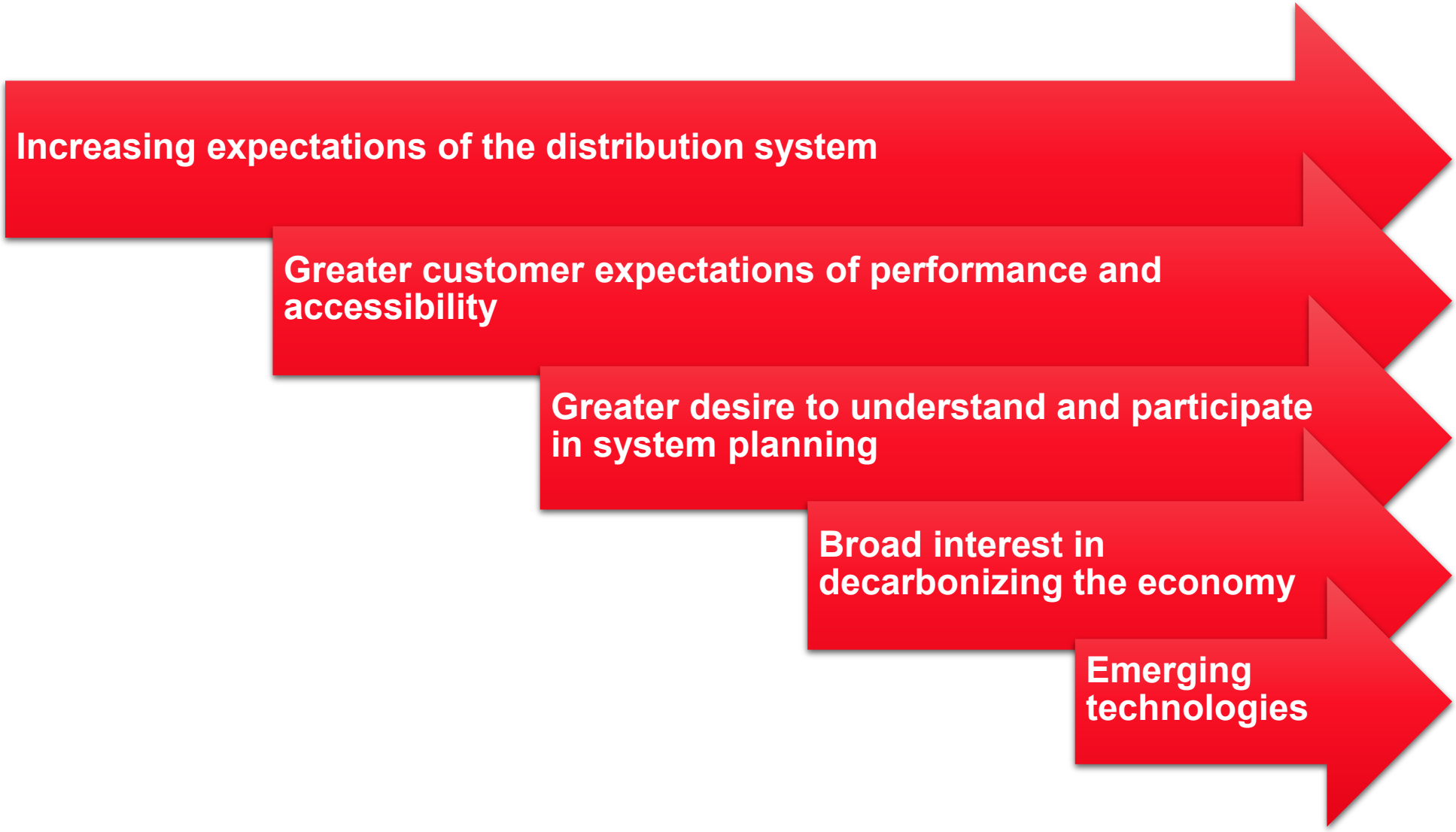
12,000 MILES UNDERGROUND CABLE

142 MW ROOFTOP SOLAR
FROM **7,760** PROJECTS WITH **42** MW FROM **1,325** APPLICATIONS IN QUEUE

811 MW COMMUNITY SOLAR GARDENS
FROM **407** PLUS **555** MW (**565** APPLICATIONS) IN QUEUE

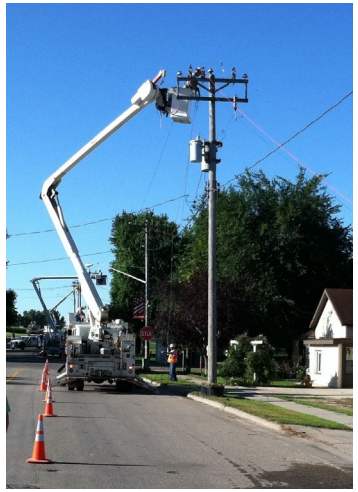
740 MW OF DEMAND RESPONSE FROM **460,000** CUSTOMERS

Drivers – Distribution Business Evolution



Distribution Strategic Priorities

Fundamental Distribution Planning – *Annual Process*



Design & Construct

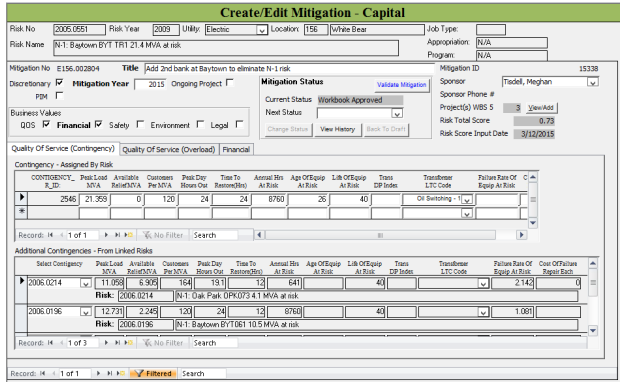
Project Details

Budget Create

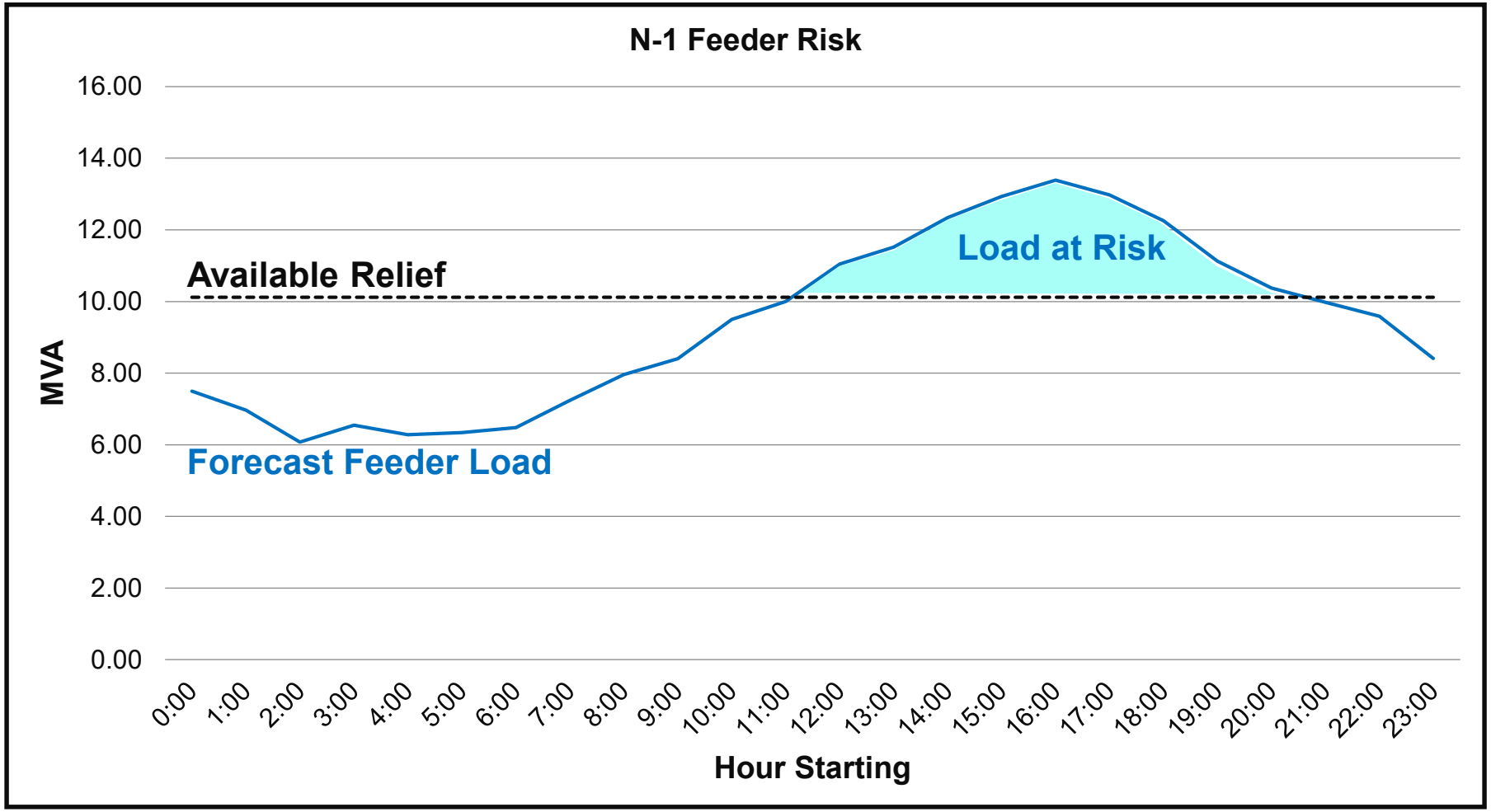
Mitigation Plans

Risk Analysis

Load Forecast



Illustrative Example – System Planning Risk Analysis

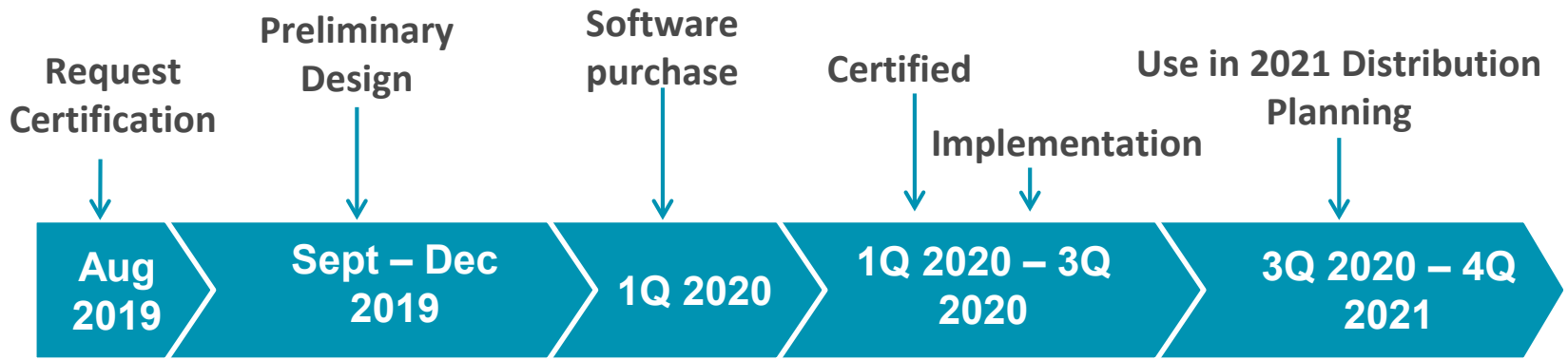


Distribution System Planning Tools

	Planning Process Component						
Tool	Forecast	Risk Analysis	Mitigation Plans	Budget Create	Initiate Construction - EDP Memo	Long-Range Plans	Hosting Capacity
Synergi Electric			X			X	X
LoadSEER	X	X				X	
MS Excel		X		X		X	
CYMCAP		X					
GIS			X			X	X
SCADA	X						
WorkBook		X	X	X	X		
PI Datalink	X						
DRIVE							X

Advanced Planning Tool – *History and Overview*

- Implemented LoadSEER, developed by Integral Analytics
- Certification grid modernization investment – 2020



- Needed to aid in developing more granular load forecasts and distribution plans that allow for enhanced analysis
  - Increasing DER adoption and electrification requires more granular understanding of grid conditions
  - Need for system to be more dynamic, so must plan for more than just meeting peak loads
  - Scenario development and analysis
  - Able to integrate data source inputs and with other Company planning efforts

KEY INPUTS – LOAD AND DISTRIBUTED ENERGY RESOURCE FORECASTING

Distributed generation, battery storage, electric vehicles, demand response, energy efficiency

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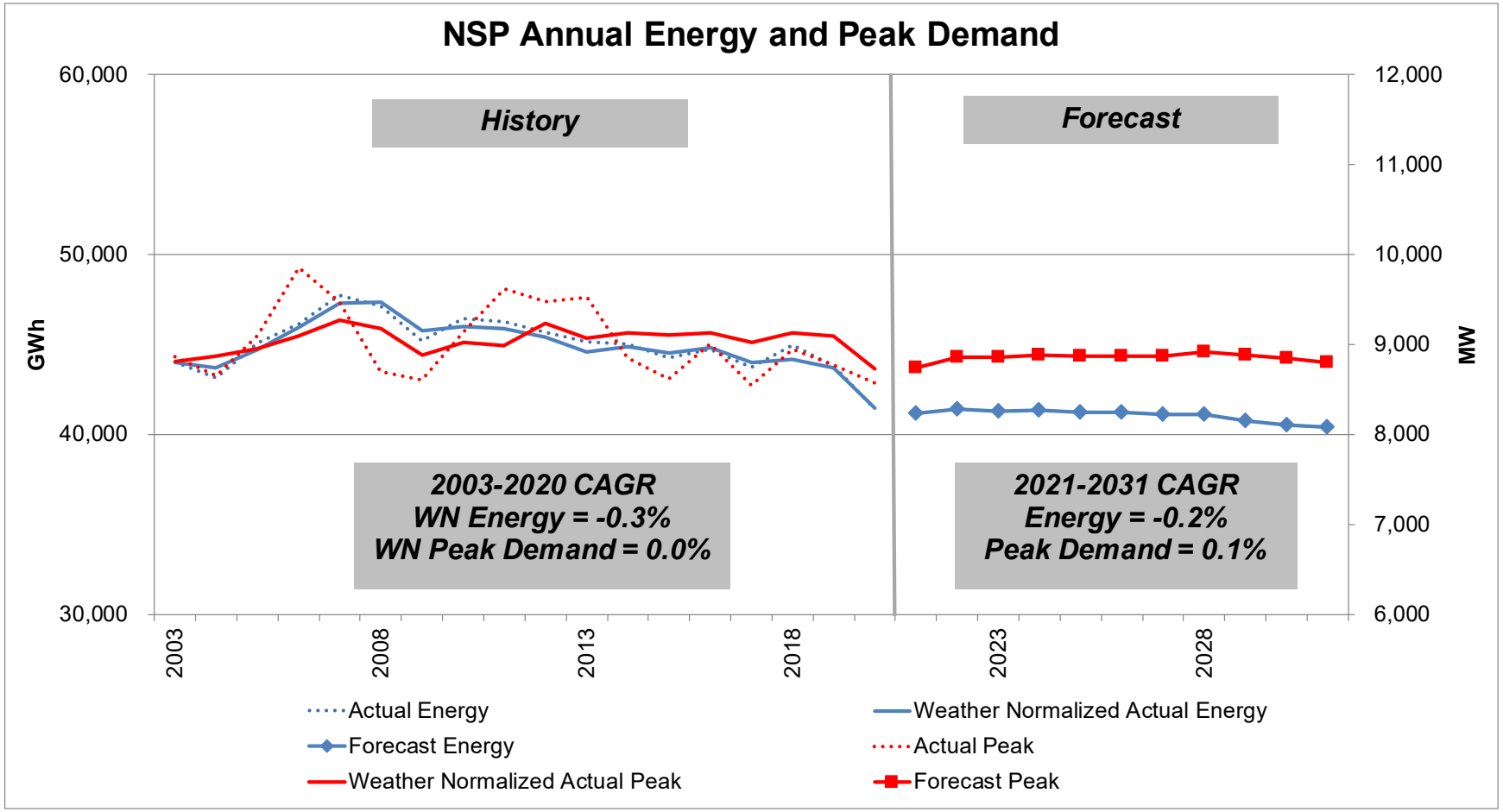
Corporate Load Forecast – *Fall 2020*



DER – *Minnesota IDP*

For purposes of the IDP, DER is defined as:

> ***Supply and demand side resources that can be used throughout an electric distribution system to meet energy and reliability needs of customers; can be installed on either the customer or utility side of the electric meter.***

IDP Requirements – DER Forecasting

- **Develop base-case, medium and high case DER scenarios**
  - Reasonable mix of DER adoption, aggregated or bundled services
  - Assume geographic dispersion across the Xcel distribution system
- **Provide methodologies and details**
- **Describe how IDP is aligned with Integrated Resource Plan inputs**
- **Describe processes and tools, system impacts and benefits, type of system upgrades**
- **Solicit input from stakeholders on DER forecasts**

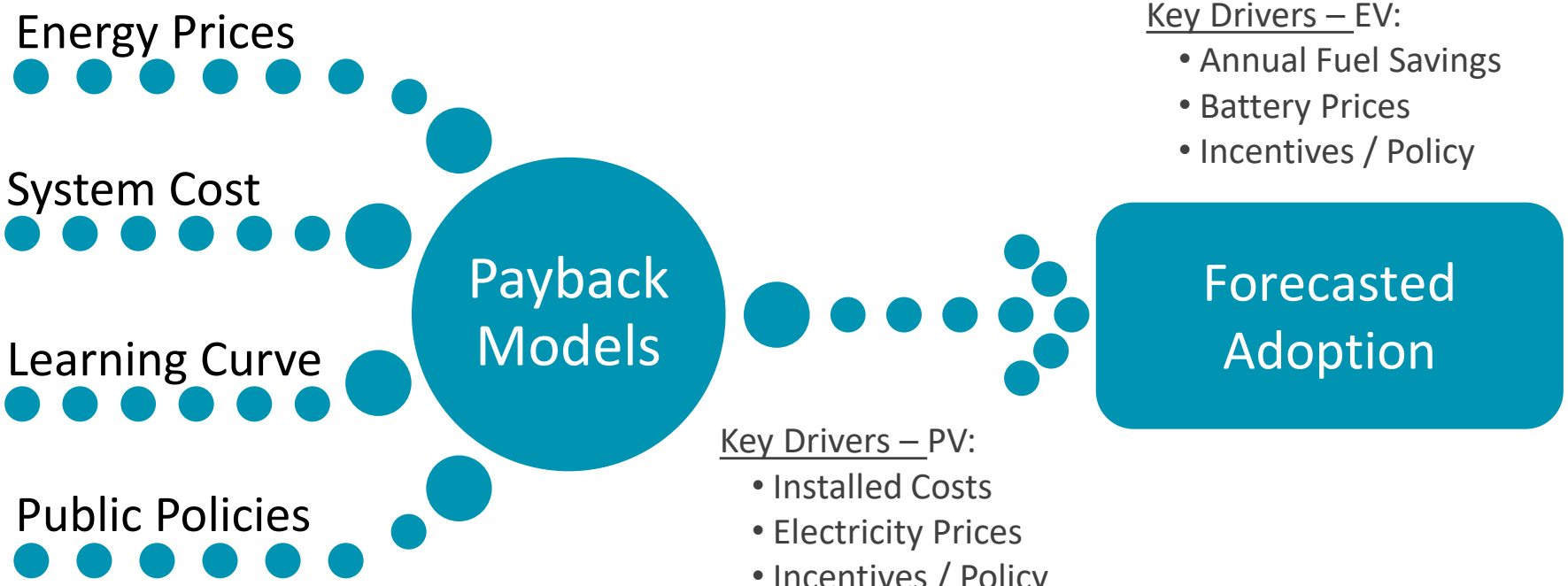
Docket E002/CI-18-251, MPUC Order dated August 30, 2018

Forecasting EV and PV – *Models*

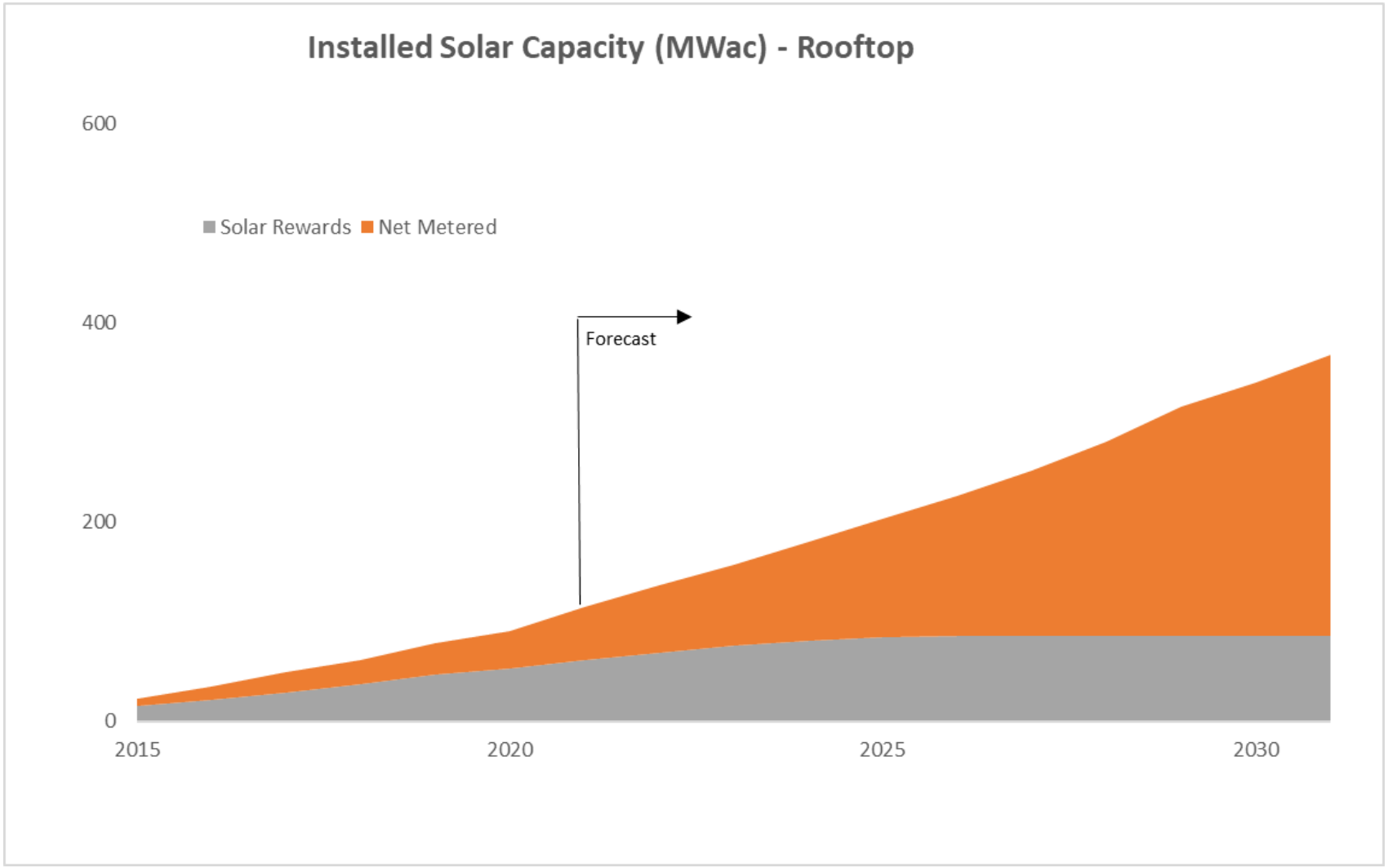
Technology Curves / S shaped market adoption curves

Historical Sales → Modeling → Forecasted Adoption

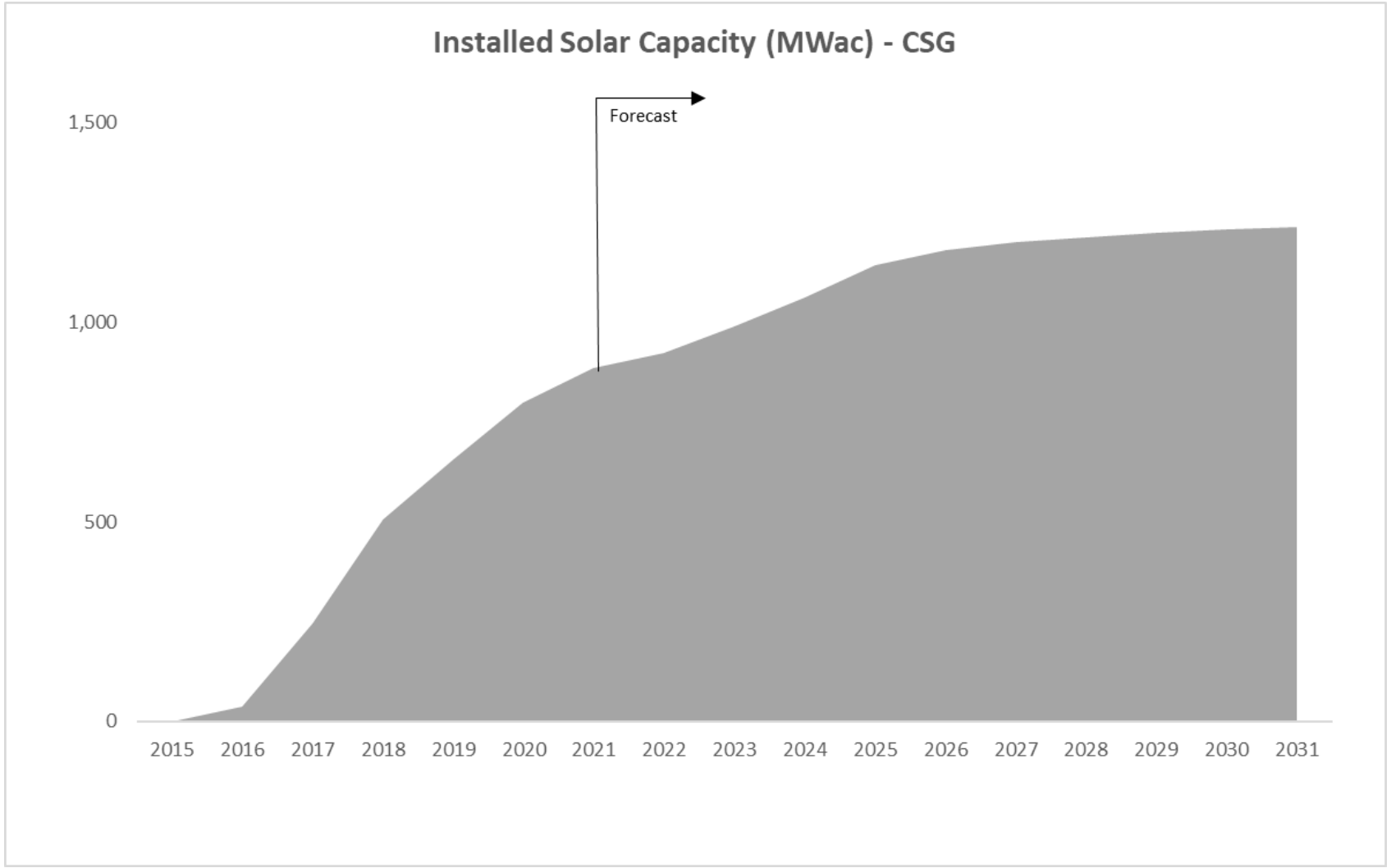
Economic Models — EV & PV adoption payback year



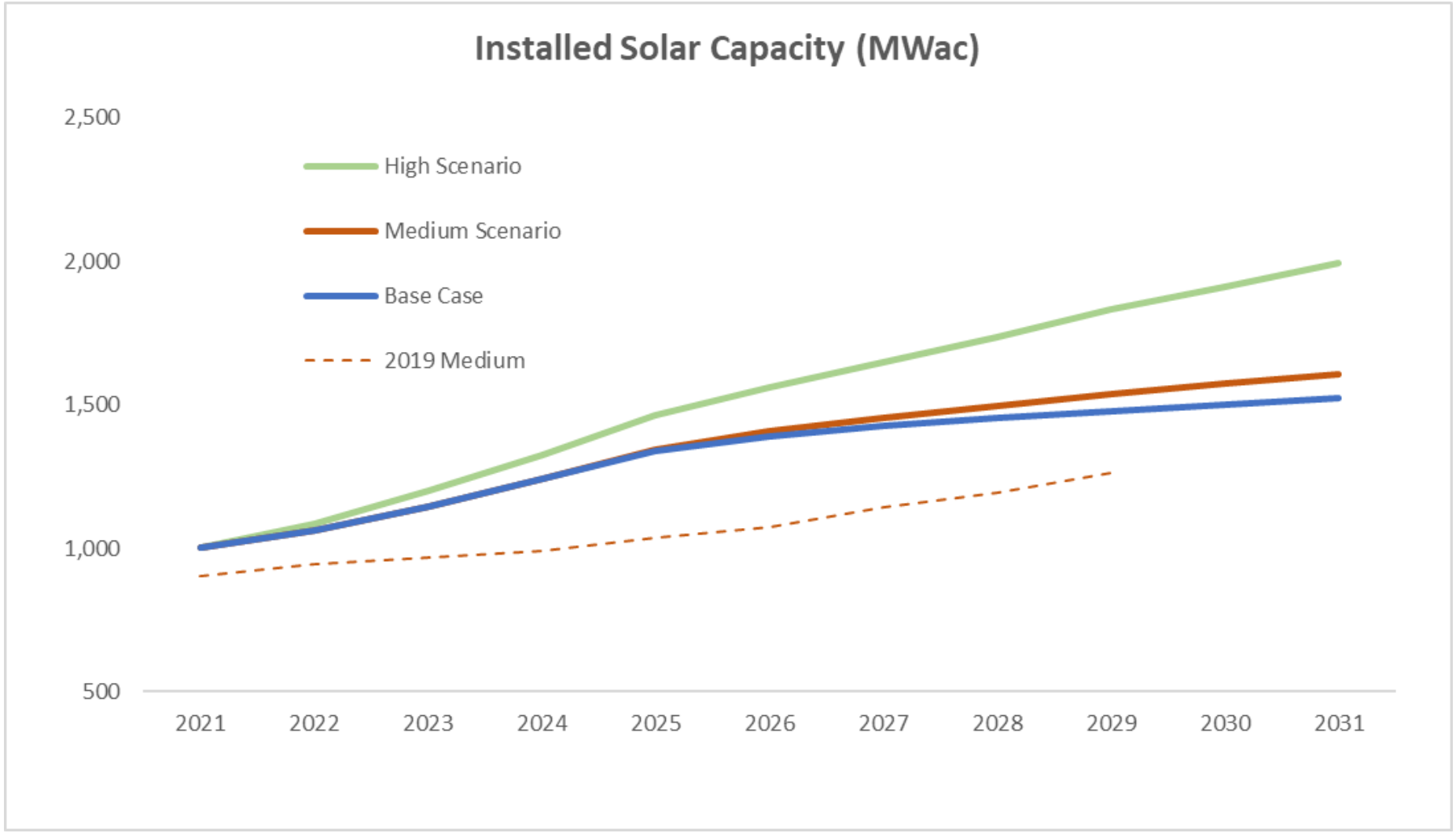
DER Forecasting – *Rooftop Solar*



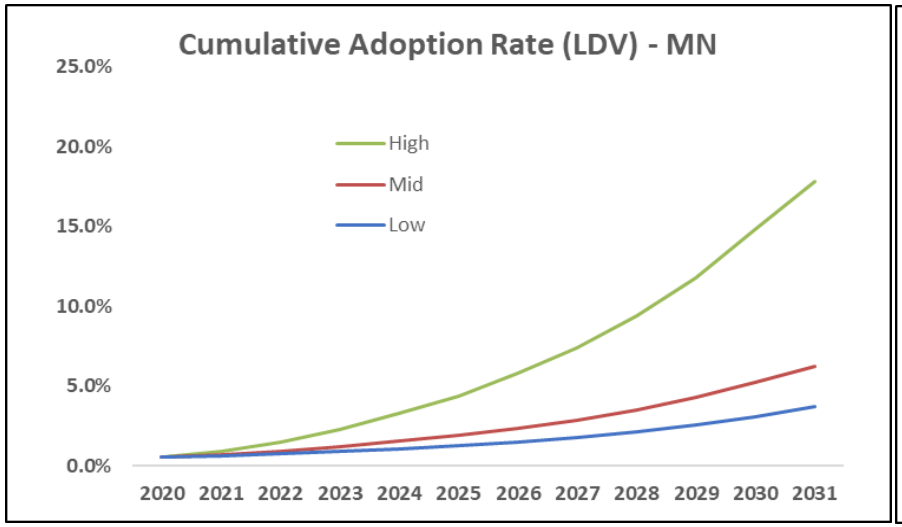
DER Forecasting – *Community Solar Gardens*

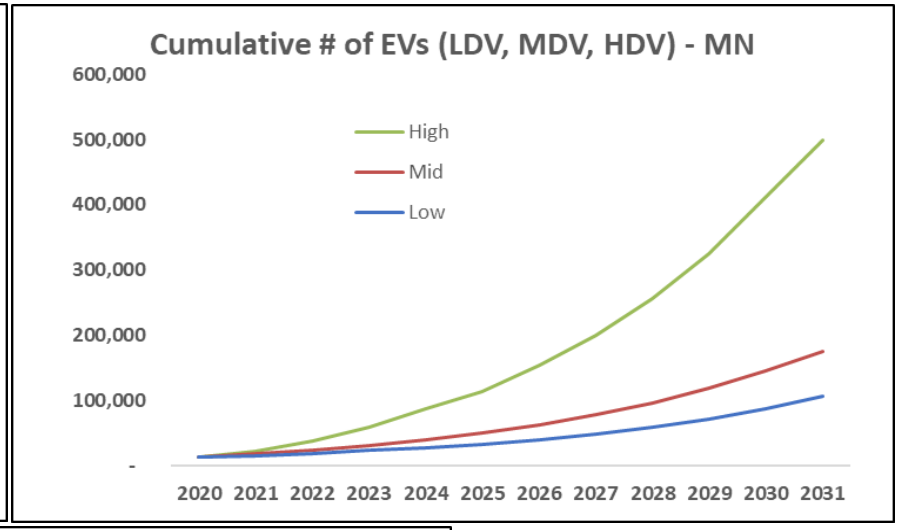


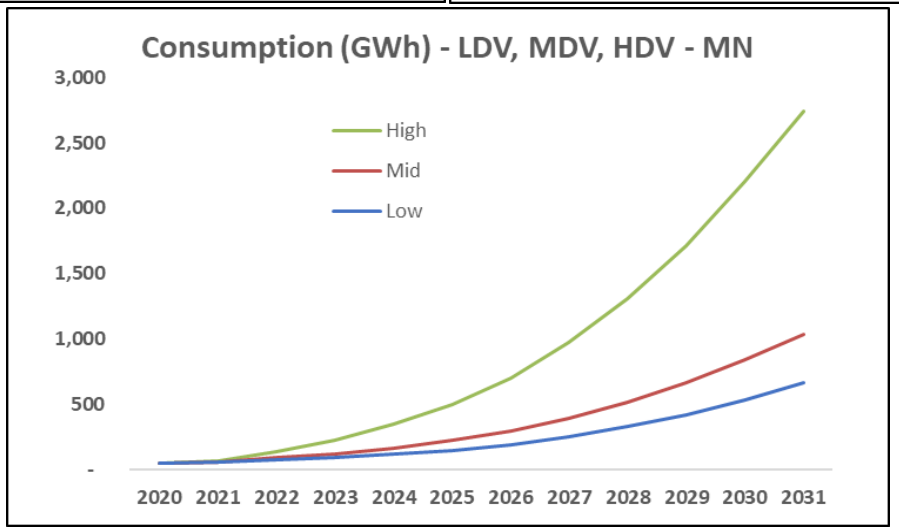
DER Forecasting – *PV Scenarios*



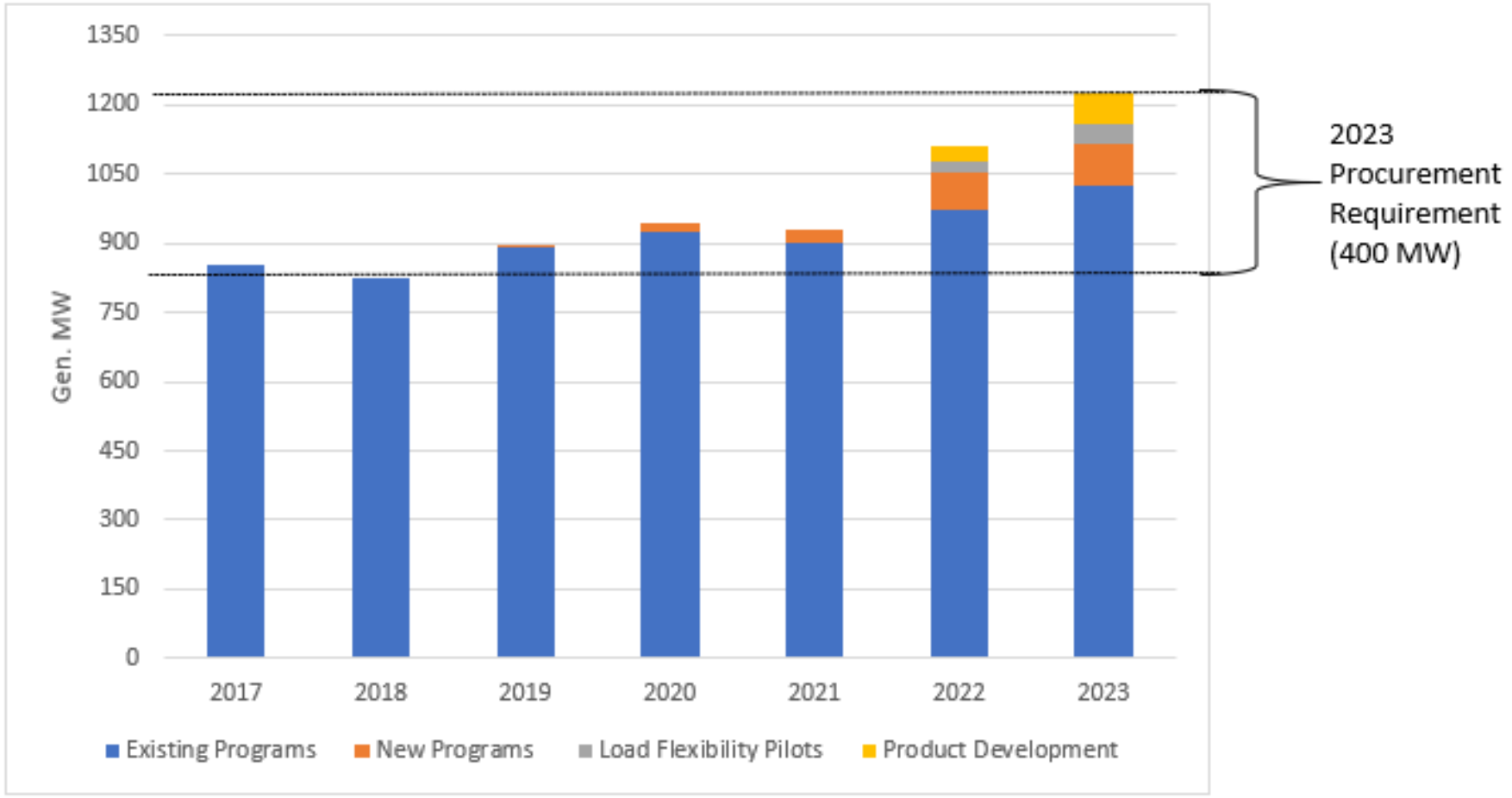
DER Forecasts – *Electric Vehicles*





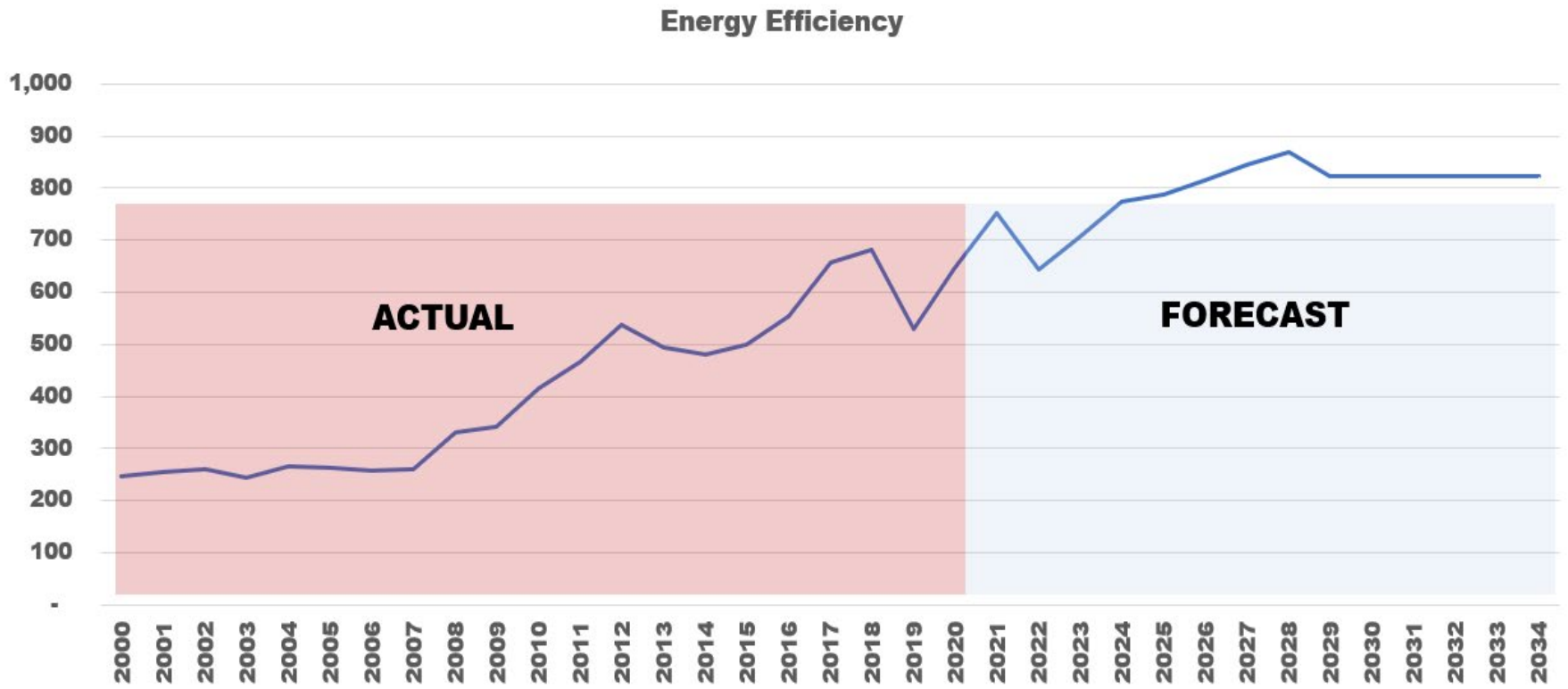


DER Forecasts – *Demand Response*



DER Forecasts – *Energy Efficiency*

Increase in Energy Efficiency ~780 GWh per year average



NSPM DISTRIBUTION CAPITAL SNAPSHOT

5-Year Historic Actuals and 5-Year Forward Budgets

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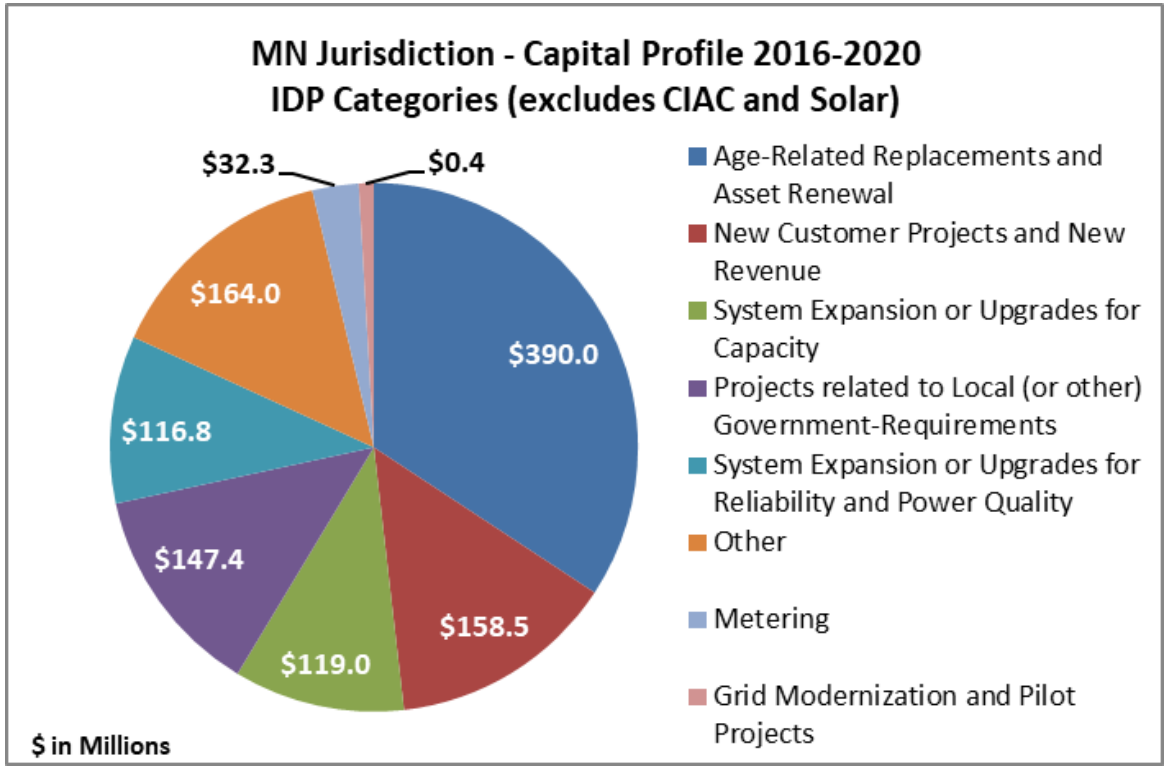
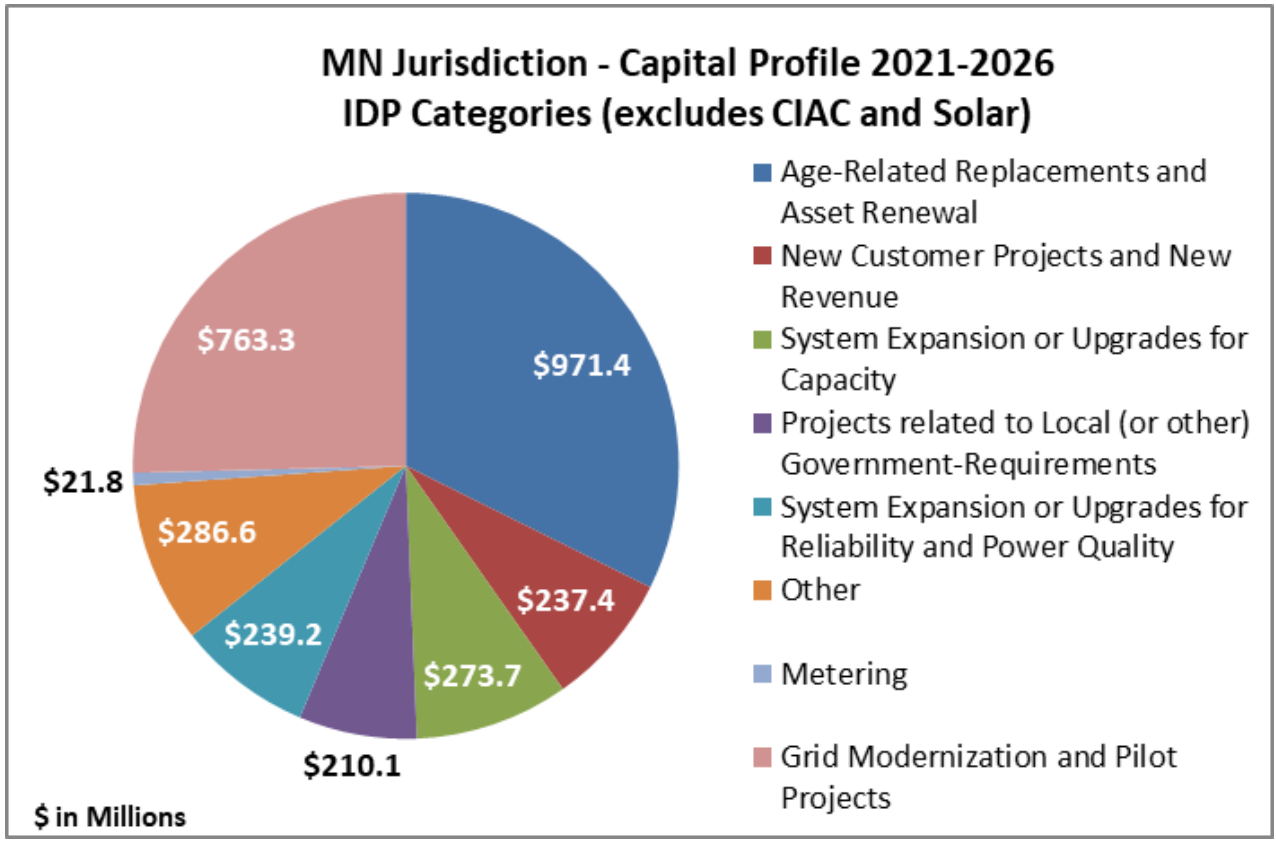
IDP Investment Categories

- System Expansion or Upgrades for Capacity
- Age-Related Replacements and Asset Renewal
- System Expansion or Upgrades for Reliability and Power Quality
- New Customer Projects and New Revenue
- Grid Modernization and Pilot Projects
- Projects related to local (or other) government-requirements
- Metering
- Other

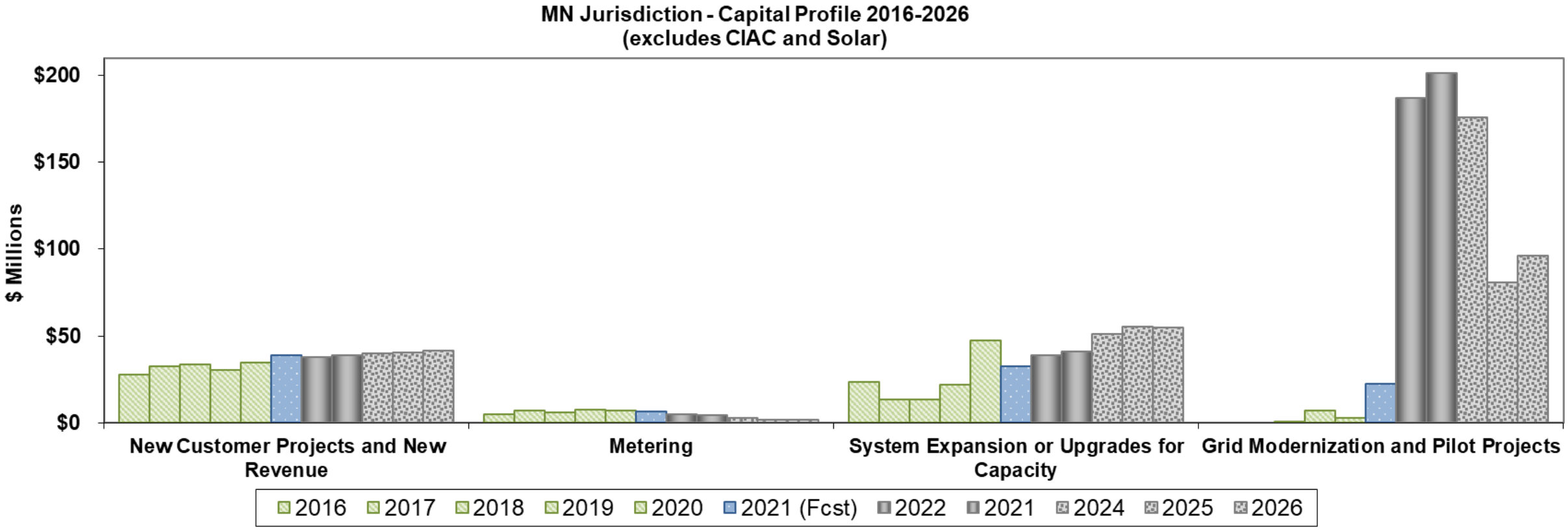
Capital Budget – *IDP Investment Categories*



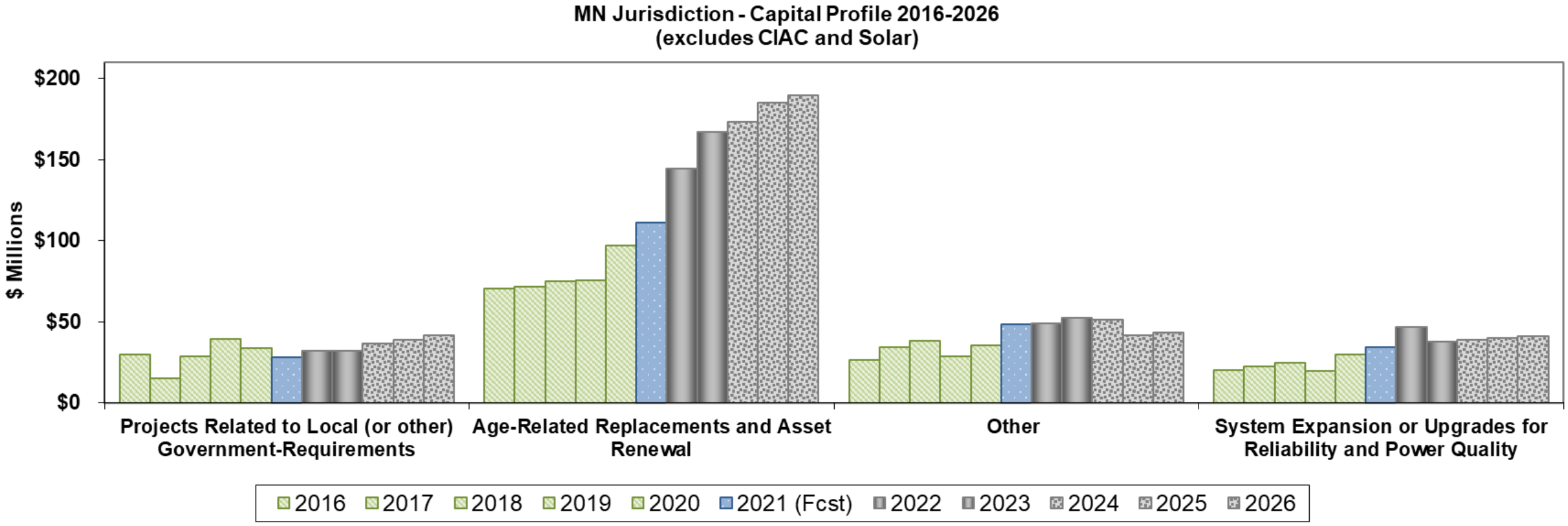


*The Advanced Planning Tool (APT) was previously represented in Other but has since moved to a different business area (Business Systems) and is no longer represented in Distribution.

Capital Budget – *Trend by Category*



Capital Budget – *Trend by Category (cont'd)*



NON-WIRES ALTERNATIVES ANALYSIS

Plus exploration of stacked values with stakeholders

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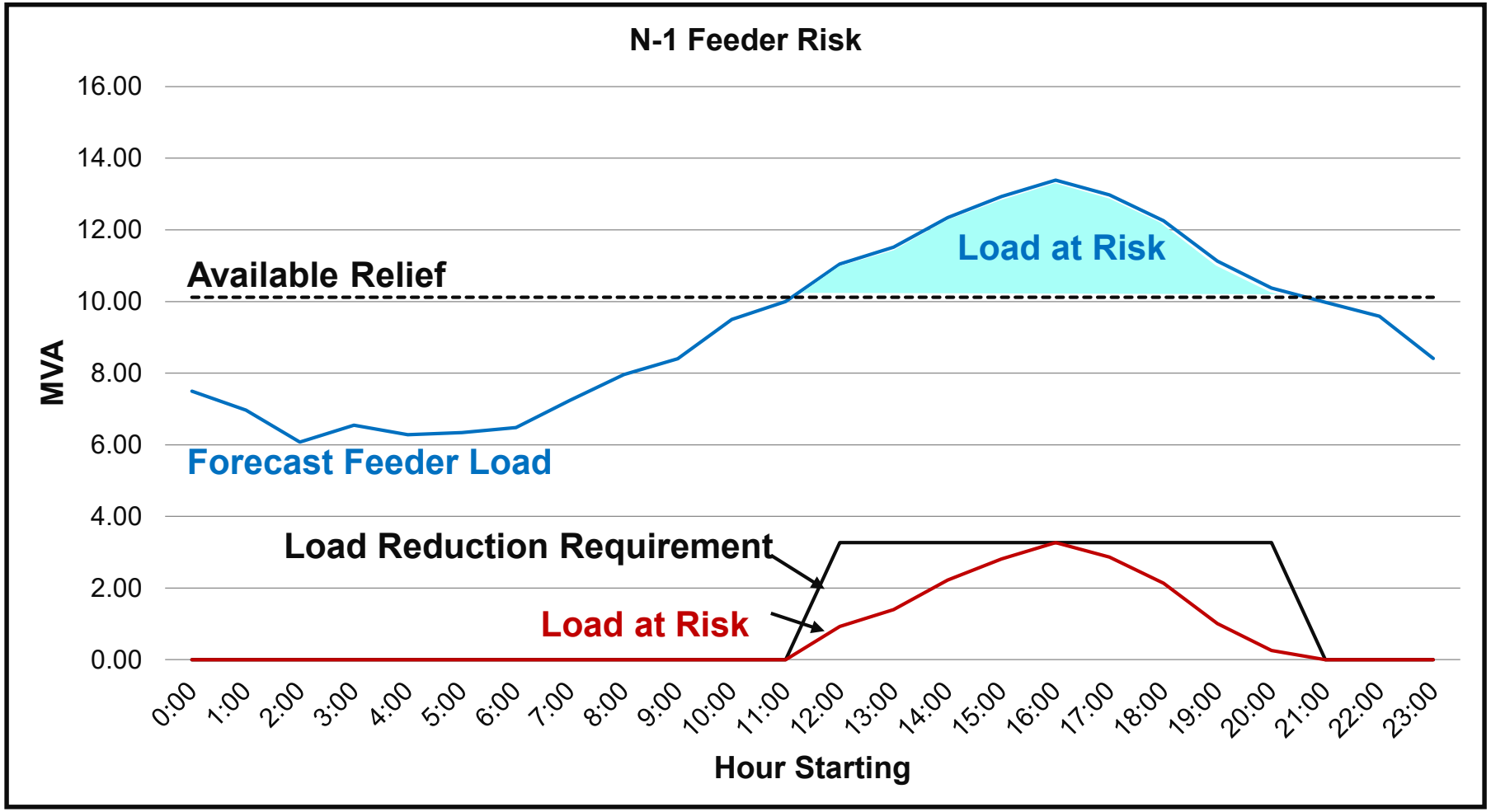
IDP Requirements and Commitments – *NWA*

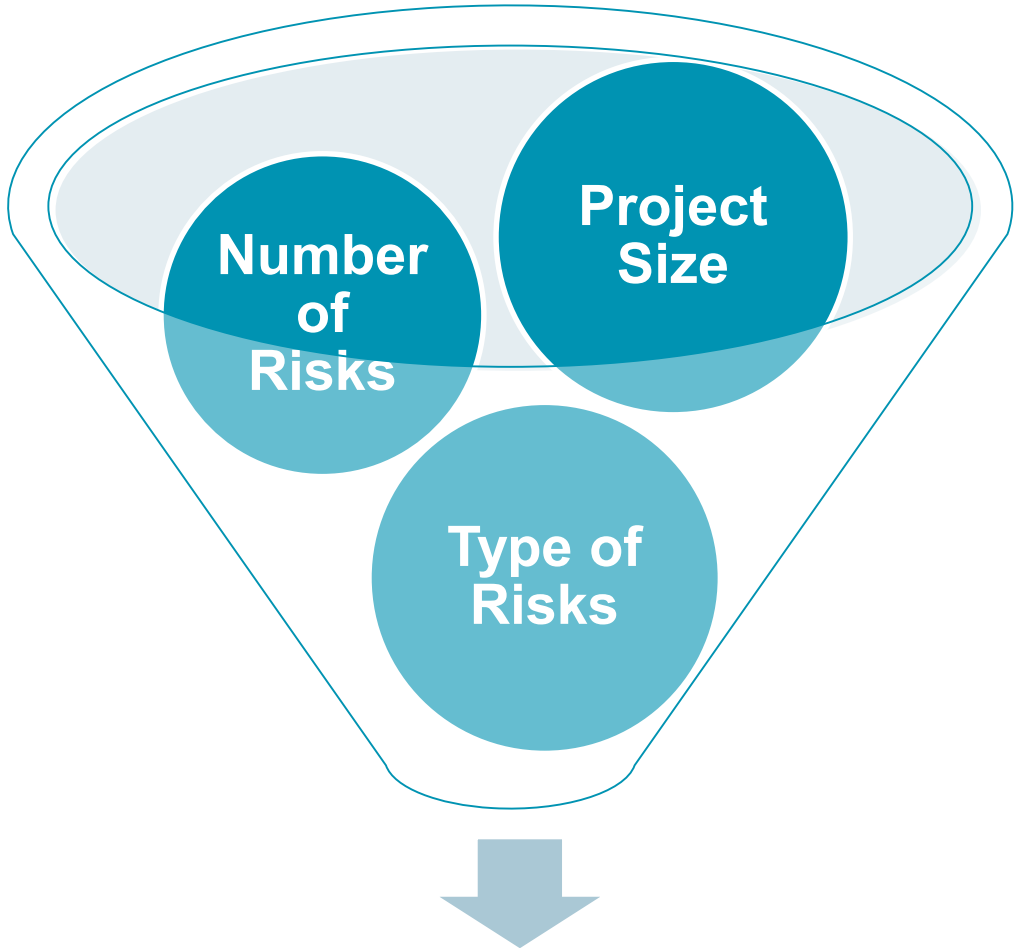
Base IDP Requirements for NWA:

- **Xcel must file an annual update of baseline financial data and non-wires alternatives analysis.**
- **For any distribution project in the current year or 5-year budget that costs $2 million or more, provide an analysis on how non-wires alternatives compare in terms of viability, price, and long-term value. Provide the following information:**
  - Project types that would lend themselves to non-traditional solutions (i.e., load relief or reliability)
  - The timeline needed to consider alternatives to traditional project types
  - Cost threshold of any project type that would need to be met to have a non-traditional solution reviewed
  - A discussion of the proposed screening process for potential non-wires alternatives
- **Xcel must engage stakeholders in further advancing the Company's NWA Analysis, including, but not limited to, screening criteria, analysis methodology and assumptions, and NWA evaluation parameters.**
- **2021 Commitments (in 2019 IDP proceeding) – The Company will consider a broader set of values and revenue streams in future NWA analyses and continue working with stakeholders on NWA analysis.**

Illustrative Example – Load Reduction Requirement

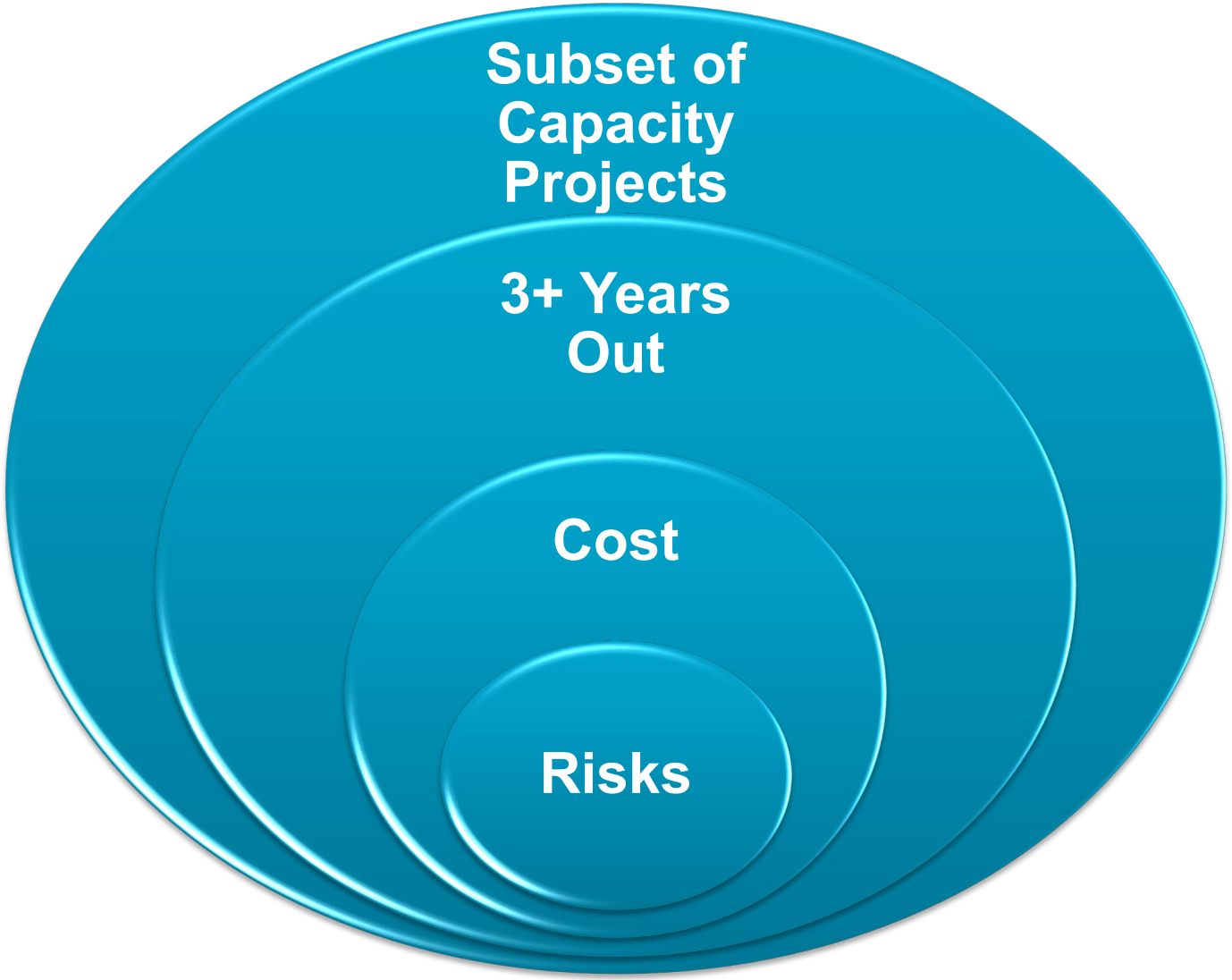


Identifying Candidate Projects – *Assessing NWA Project Viability*

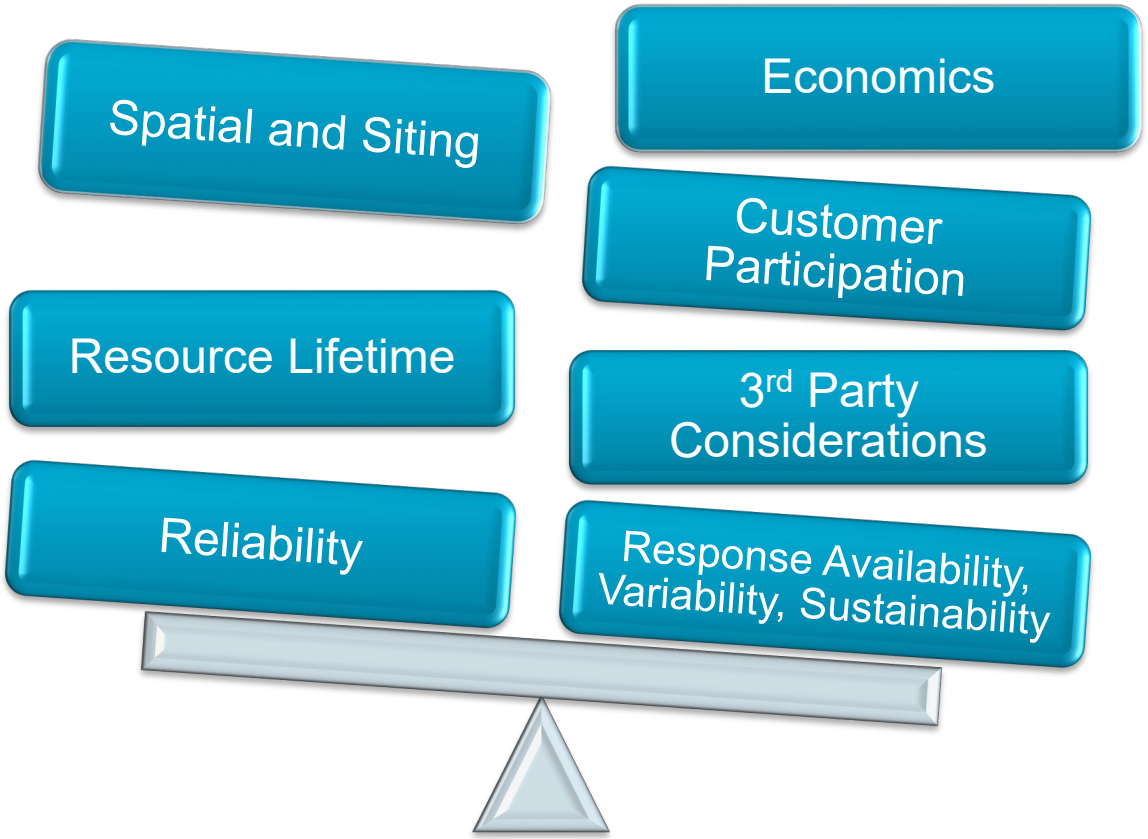


Potentially Viable Projects

Project Viability Analysis



NWA Analysis Balancing Act



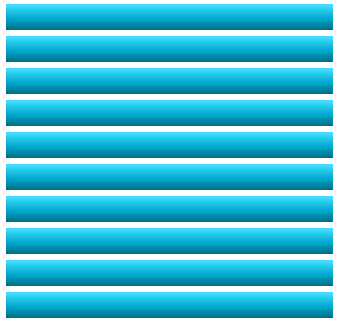
Stakeholder Feedback

- General support for continuing expansion of NWA analysis to include additional stacked values
- Stakeholders had an opportunity to emphasize which stacked values are most relevant to an NWA analysis
- Interest in NWA pilot projects
- A majority indicated that they would participate in an RFI/RFP if issued for an NWA project

Proposed NWA Process Overview

Identify System Risks

Develop Traditional Projects



Apply Screening Filters

1. Size: >$2M in cost
2. Type: Capacity
3. Timing: Year 3+

Considered in Cost/Benefit Screening

- Avoided Energy Generation
- Avoided Generation Capacity + MISO Reserves
- Avoided Transmission Capacity
- Avoided Transmission Losses
- Avoided Distribution Capacity
- Program Administration
- Interconnection Fees
- Avoided GHG Emissions + Other Environmental

Considered in Detailed Study

- Avoided Distribution System Losses
- Avoided Distribution System O&M
- Distribution System Voltage
- Credit and Collection
- Risk – Utility/Host Customer
- Reliability – Utility/Host Customer
- Resilience – Utility/Host Customer
- Host Customer Non-Energy Impacts
- Resilience – Societal
- Economic & Jobs
- Public Health
- Low-Income Societal
- Energy Security

Stacked Values – Detailed Study

Develop NWAs → NWA Cost Screening → Potential NWAs

NWA Sourcing and Detailed Study

Implement NWAs!

Reshaping our NWA Analysis – *Current vs. Proposed NWA Screening Method*

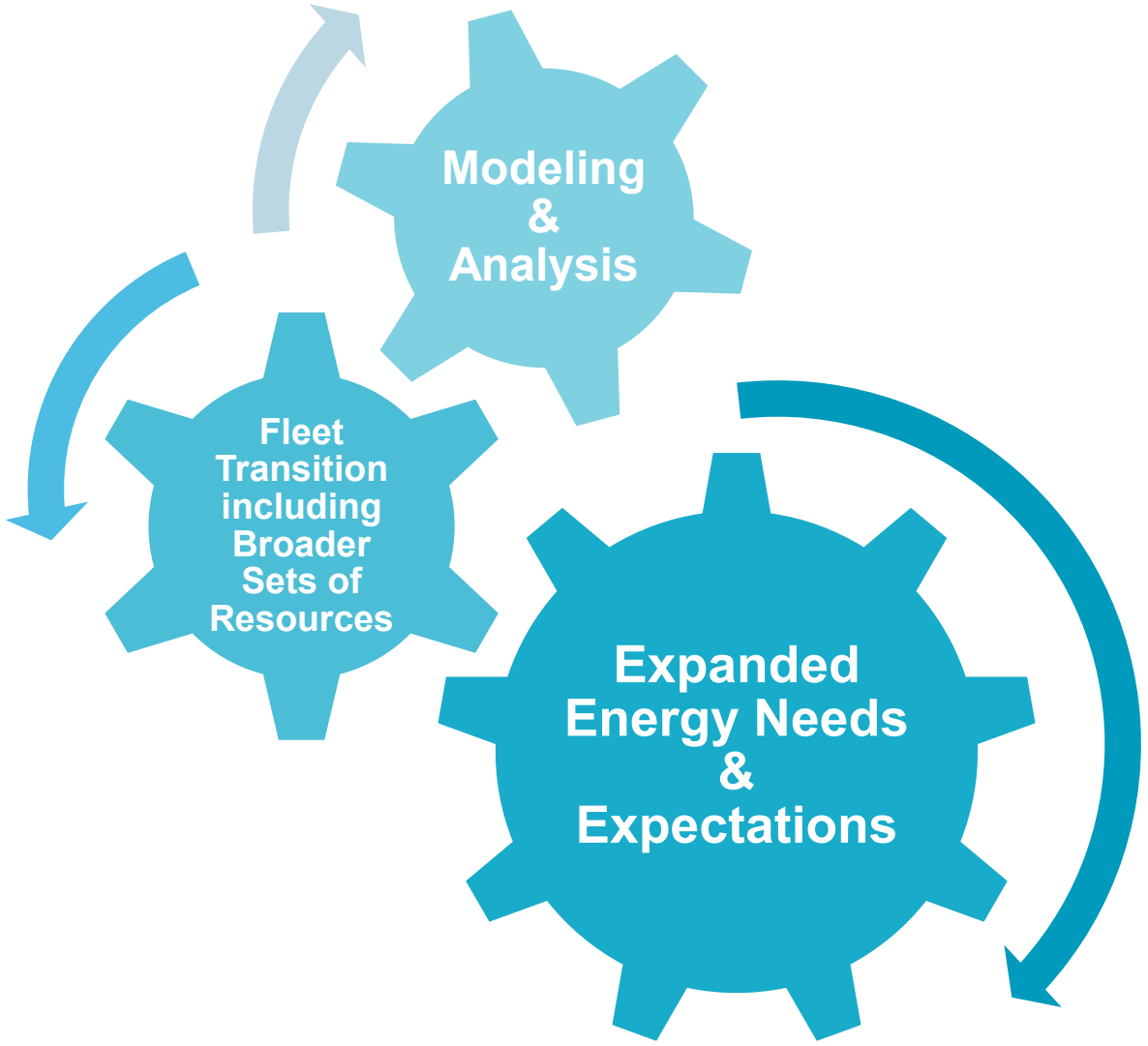
Aspect/Component	Current Method	Proposed Method
Timeframe	Full NWA lifetime	**10-year deferral period***
Ownership Model	Utility ownership	**Load reduction contract or** utility ownership
Load Reduction Requirement	Exact MWh of load at risk on peak day	**Peak output for the duration of the risk**
Stacked Values	No stacked values	**Stacked values included**
Pro-Rating Values	No pro-rating, full values included	**Values pro-rated** for just the load reduction period (ARR split)
Solar Performance	PVWatts TMY simulation for one location in Minnesota	PVWatts TMY simulation for **five locations** in Minnesota

* Subject to change.

INTEGRATED PLANNING

Xcel Energy®

Integrated Distribution-Transmission-Resource Planning



ADVANCED GRID PLANS

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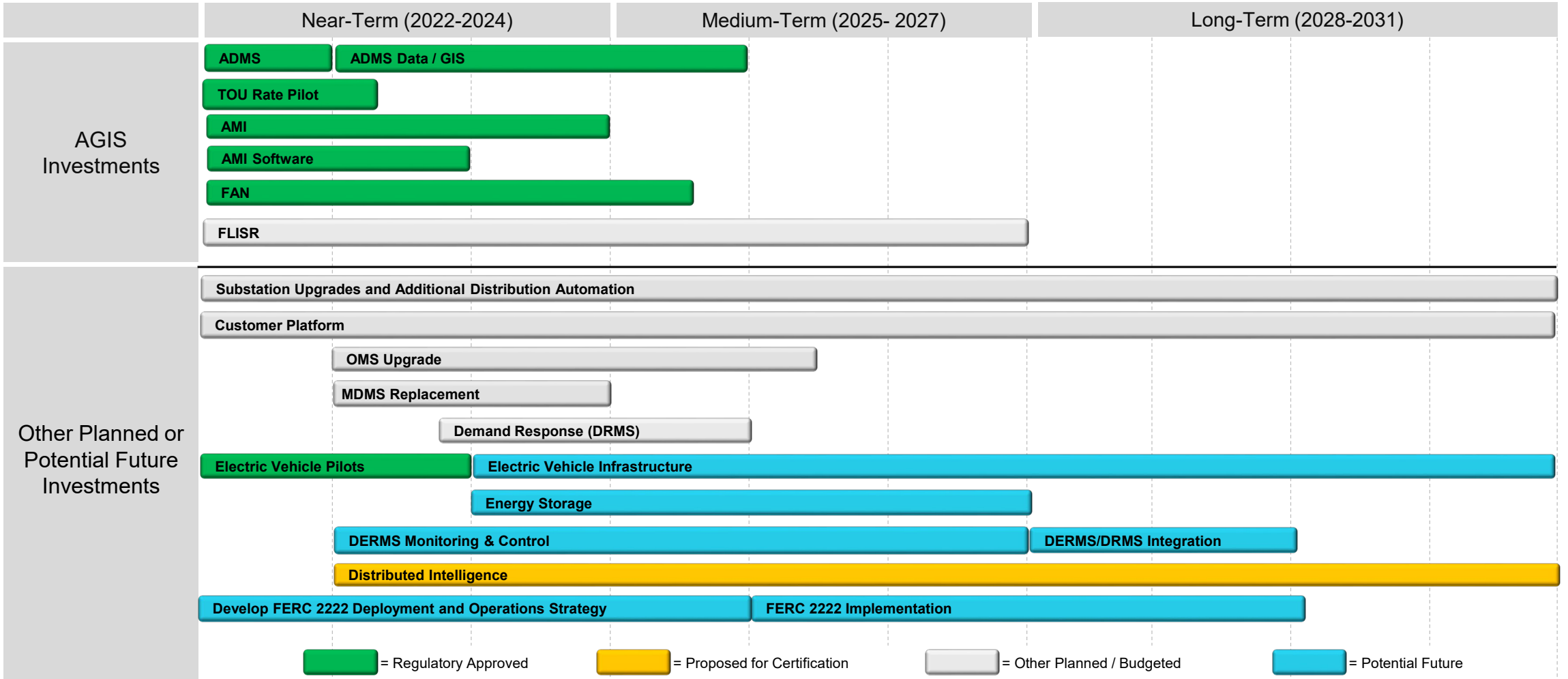
Advanced Grid Plan – Building on a Foundation



Advanced Grid – Overview

GRID VISIBILITY AND CONTROLS		Network	Meters
Advanced Distribution Management System (ADMS)	**Fault Location, Isolation and Service Restoration (FLISR)**	**Field Area Network (FAN) & Home Area Network (HAN)**	**Advanced Metering Infrastructure (AMI)**
			
• Advanced centralized software or the "brains," enhances the operation of the distribution grid • Enables improved reliability, management of DERs, and improved efficiency when operating the grid • Enables enhanced visibility and control of field devices (including customer meters via AMI)	• ADMS provides fault location prediction and the automatic operation of intelligent grid devices • Reduces outage durations and the number of customers impacted by an outage • Enabled by intelligent field devices, FAN, and ADMS	• Two-way communications network • Connects intelligent grid devices and smart meters with software • Enables enhanced remote monitoring and control of intelligent field devices and advanced meters	• Focused on the deployment of smart meters and software • Provides near real-time communication between software and meters • Data and AMI functionality enable new products and services and improves customer experience

Advanced Grid – ADMS

- Certification granted 2016
- 2016 –2021 deployment timeframe
- Deployment of ADMS software and hardware
- Software in production October 2020
- Three distribution control centers in Minnesota
  - Go-live for first two April 2021
  - Go-live for third September 2021
- Enables improved reliability, management of DER and efficiency when operating the grid
- Enables enhanced visibility and control of field devices

Advanced Grid – AMI

- Certification granted 2020
- Deployment of meters and software
- Planned deployment of 1.4 million AMI meters
  - 2022-2024 deployment timeframe
- Provides near real-time communication to meters
- Enables new products and services for customers
- Enables enhanced planning and operations

Distributed Intelligence

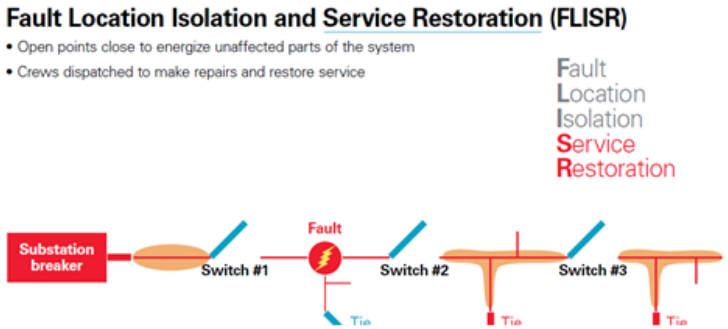
Overview

- **Current generation of AMI meters includes “grid edge” computing capability**
- **Enables local processing of real-time meter information to enhance customer services and grid operations**
- **Potential solution categories:**
  - Reliability
  - Safety and Security
  - Energy insights
  - Controls and Demand Management
  - Electric Vehicles and DERs
  - Grid Optimization

Advanced Grid – FAN

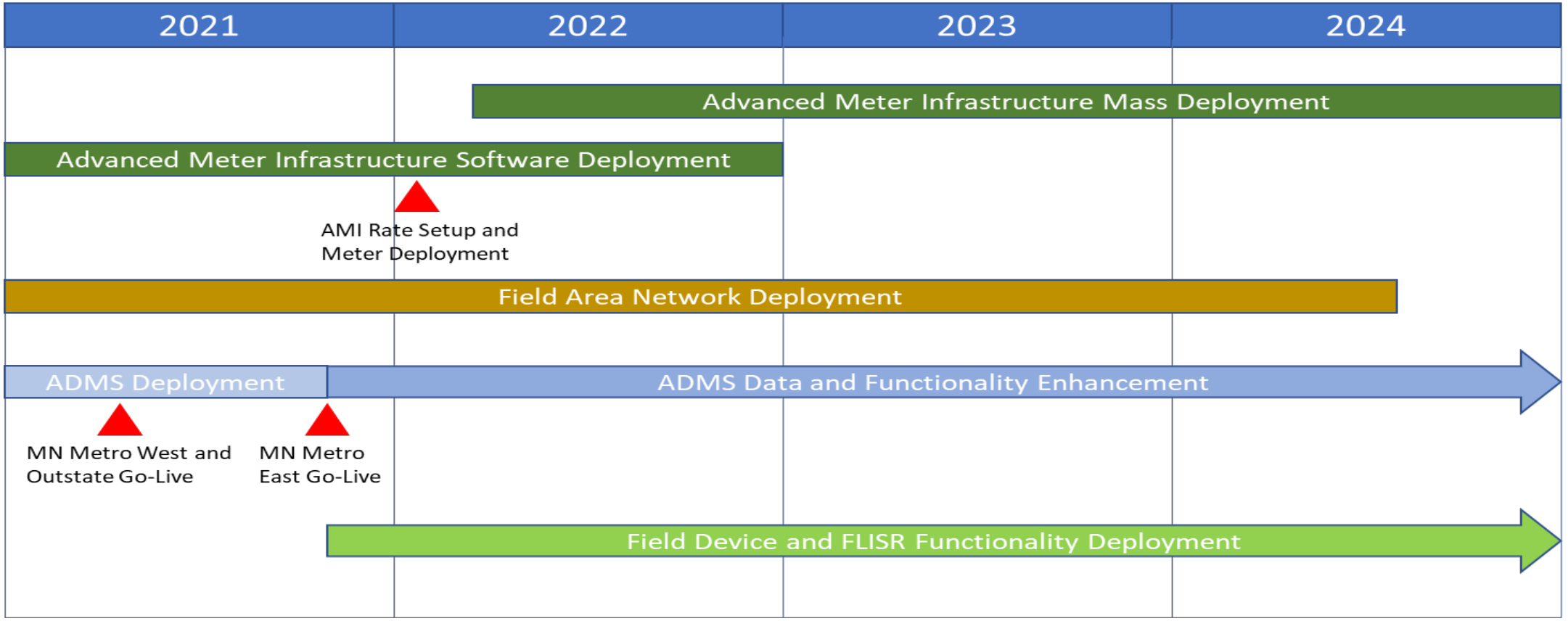
- **Certification approved 2020**
- **Deployment of WiSUN and public cellular**
- **2021 –2024 deployment timeframe**
  - Deployed by geographic area in advance of AMI meters
- **Provides two-way communication**
- **Provides near real-time communication**
  - Between meters and software
  - Between field devices and ADMS

Advanced Grid – FLISR



- **Included in pending Rate Case**
- **Deployment of intelligent field devices**
  - Includes FAN communication
  - Integration with ADMS
- **2021 –2027 deployment timeframe**
- **Enables fault location prediction**
- **Enables automatic restoration**
- **Enhances reliability of the distribution grid**

Advanced Grid – Summary



Customer Products and Services Roadmap – *Advanced Grid*

	DAY ONE (2022)	NEAR TERM (2022-2025)	FUTURE (2025+)
ENHANCE THE EXPERIENCE	• Energy Usage Dashboard • Enhanced Web and Mobile Apps • Enhanced Outage Notifications • Green Button Connect My Data	• Emergency and Safety Notifications • Energy Usage Alerts and Notifications • Personalized Notifications • Power Quality Analysis	• Artificial Intelligence Enabled Notifications • Smart Premise Restoration • Enhanced Microgrid Integration • Smart Safety Disconnect
KEEP BILLS LOW	• Enhanced Communication Options with Behind the Meter Systems (HAN)	• Whole Facility Monitoring • Rate Advisor • Time Varying Rates • Virtual Energy Audits	• Smart Rates • Enhanced Automated Demand Response
CLEAN ENEERGY		• Demand management optimization • Enhanced access to battery storage and electric vehicles • Green notifications and controls • Enhanced DER enablement	

Enabled or enhanced by Distributed Intelligence

Proposed Certification – Resilient Minneapolis Project

Overview

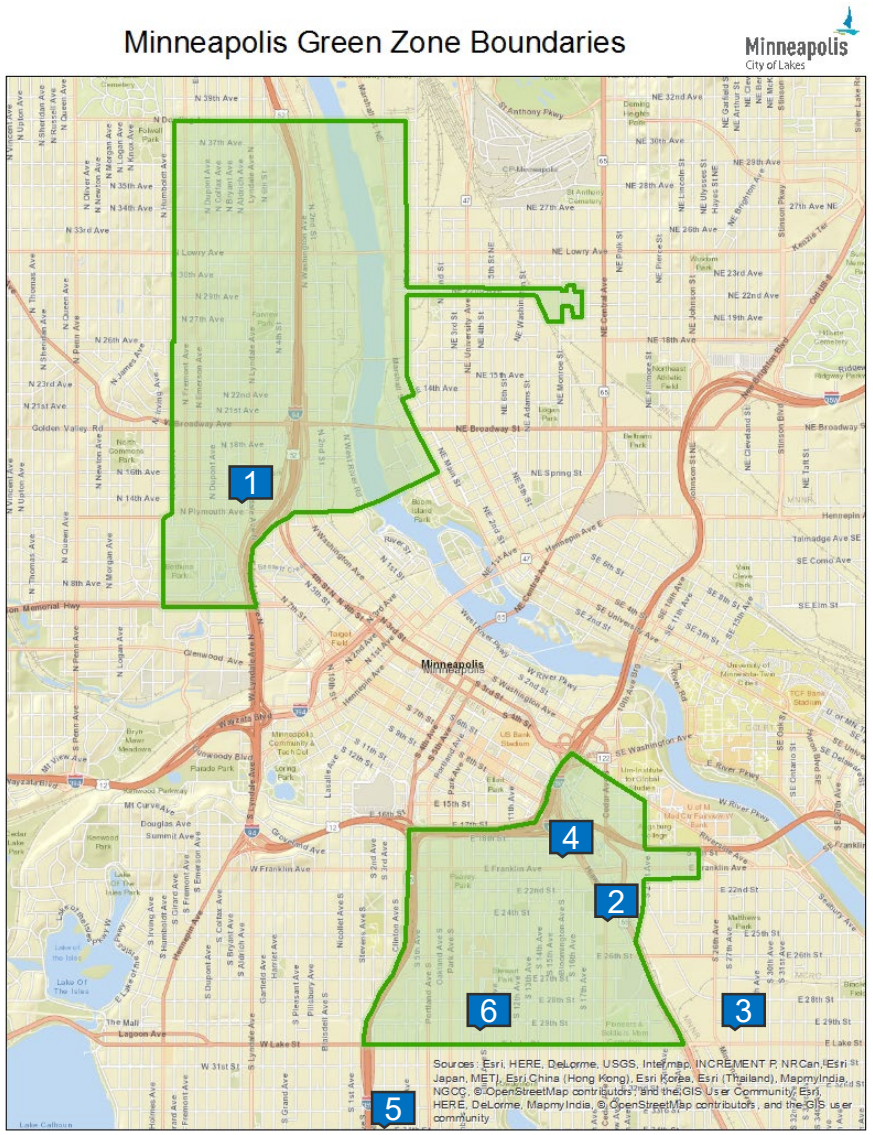
- **Grew out of 2019 IDP Minneapolis NWA pilot request, then proposed in 2020 Relief & Recovery petition**
  - Responding to pandemic and civil unrest → partner with BIPOC-led organizations to improve community resilience at critical sites
- **Responsive to Minnesota IDP objectives**
  - Enhance security, reliability and resilience of grid; enable greater customer engagement, empowerment, and options for energy services; demonstrate how local microgrids can be leveraged for the benefit of all Xcel Energy customers
- **Advances broader equity, energy affordability, emission reduction, and workforce development goals**
- **Total budget of approximately $9 million**

Resilient Minneapolis Project

Application Process

1. Renewable Energy Partners:
   North Minneapolis Community Resiliency Hub
2. Native Sun Community Power Development:
   Little Earth of United Tribes
3. Seward Redesign Inc:
   Downtown Longfellow Community (Coliseum Building)
4. Minneapolis American Indian Center
5. Sabathani Community Center
6. Friends of Global Market
   Midtown Exchange Campus

- **Formal application process with scoring criteria and weights**
- **Review by internal and external reviewers with deep relationships in these communities**
- **“Co-creation” process with selected applicants**



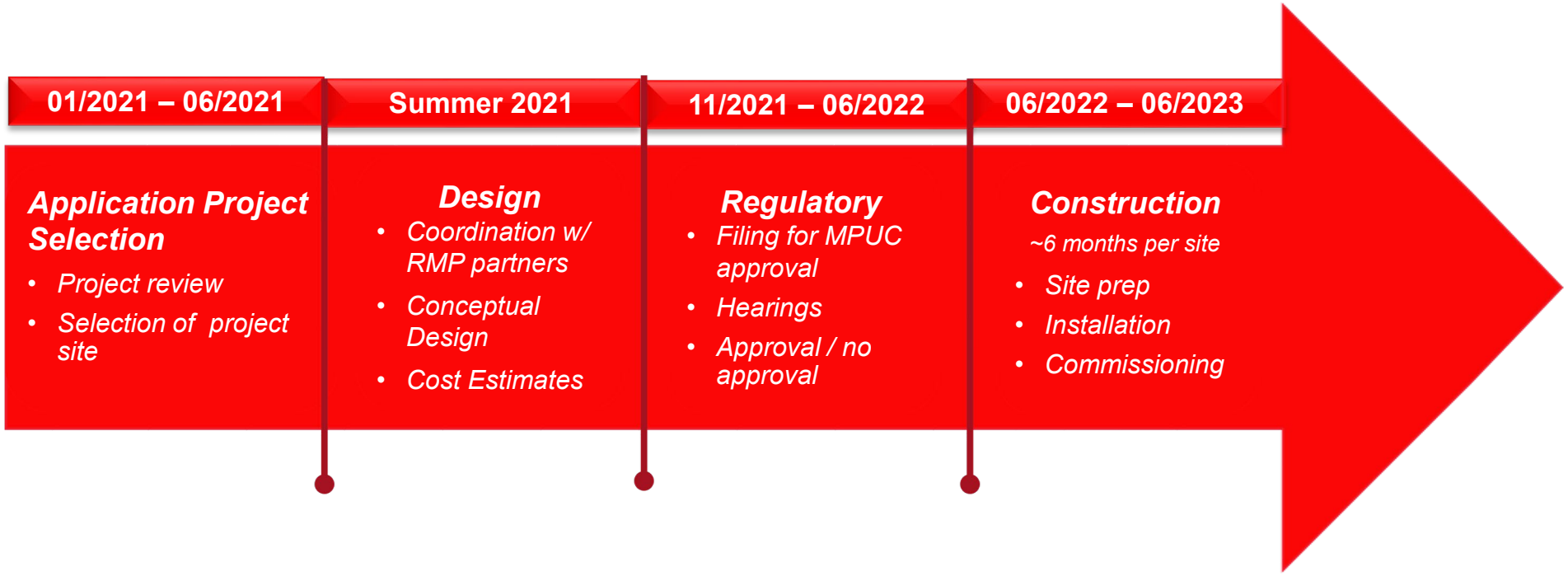
Resilient Minneapolis Project

Common characteristics across 3 sites

- **All include solar, battery systems, and microgrid controls to provide resiliency in outages and deliver a range of grid services**
  - Bulk system capacity, local distribution system support (peak shaving, ancillary services, hosting capacity), price arbitrage, emission avoidance
- **BIPOC career training and workforce diversification**
- **Some sites implementing additional measures (HVAC, efficiency, etc.) that address energy affordability**
  - These costs not included in request for certification, but working with applicants on how to fund

Resilient Minneapolis Project

TIMELINE AND NEXT STEPS



Note: Timeline is approximate and subject to change as it depends on discussions with partners as well as the regulatory process which has no set approval timeline.

Lavelle A. Freeman - System Planning, Director

Juan F. Martinez – Distribution System Planning, Manager

Approach to scenario analysis/forecasting methods – 05/13/22

ADVANCED DISTRIBUTION SYSTEM PLANNING

Agenda

- Background and Challenges
- Distribution Planning Approach
- MA Planning Areas
- Combined Profiles (Forecasting Methods)
- Consideration for Mitigation

EVERSOURCE ENERGY

We serve approximately:

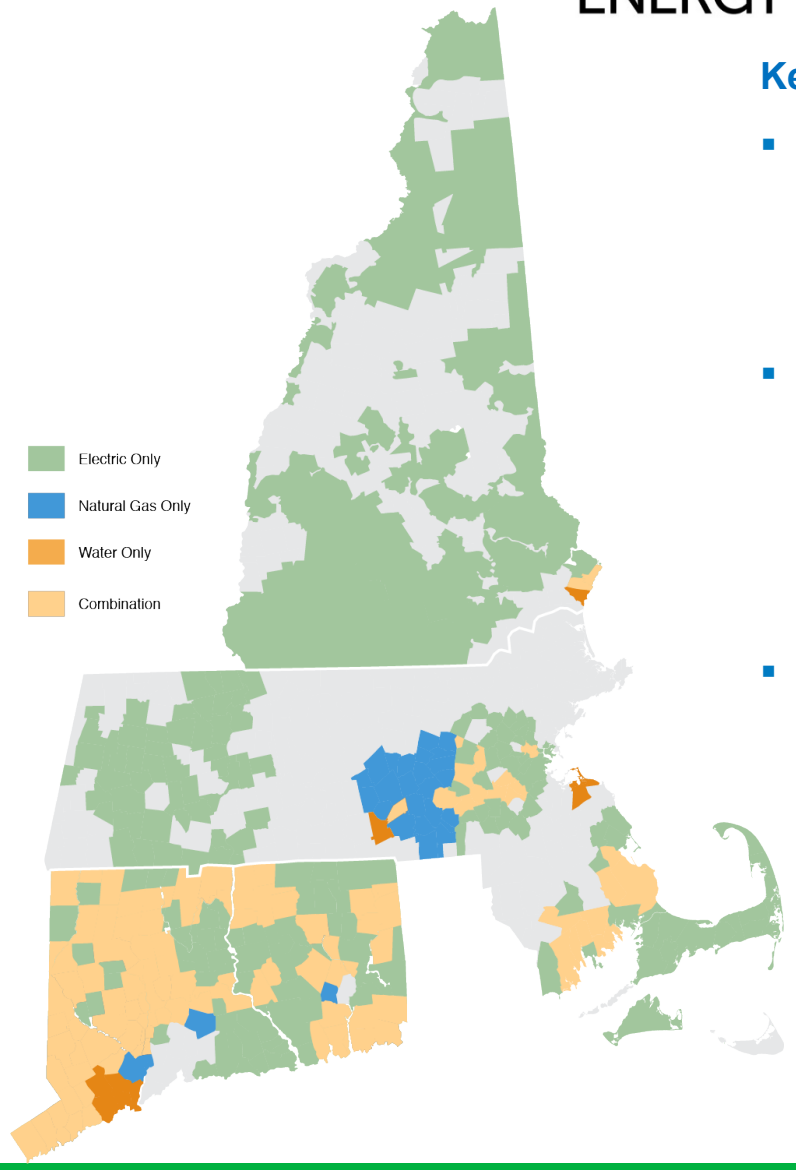
- **227,000** water customers in 59 New England Communities
- **525,000** gas customers in 123 New England Communities
- **3.2 M** Electricity customers in 499 New England Communities

We operate more than:

- **4,250** circuit miles of transmission lines
- **72,000** pole miles of distribution lines
- **575** substations
- **6,450** miles of natural gas pipelines
- **3,600** miles of water mains

Clean energy:

- Solar (70 MW) and growing
- Offshore wind (Oersted partnership)



Key Electric Distribution Planning Priorities

- New Hampshire
  - Least Cost Integrated Planning – challenge to harmonize planning criteria with economic and operational drivers
- Connecticut
  - Reliability and Resiliency Planning – new framework released May 20th, 2022
  - Integration of NWA Solutions into Distribution Planning
- Massachusetts
  - DER growth and long-term system assessment (20-75)
  - Support for projected electrification demand
  - System expansion in urban/suburban areas

Challenges in the Next 20 Years - Require granular, high-fidelity analytics and tools

- Retirement of traditional generation and expansion of inverter-based technology including significant growth in offshore wind and DER
  - Transient analysis required at the substation level
  - 8760 analysis required to understand full impact of DER over the load cycle
- Integrated long-term planning for capacity and reliability
  - Load growth driven by new sectors: Electrification, Gas Conversion, Electric Vehicles and Industry Shift
  - Advanced forecasting tools needed to predict new load growth patterns
- Climate adaptation and mitigation strategies
  - Resiliency plans to harden OH and coastal areas and reduce outage duration
  - New design and construction standards to address impacts of climate change

Approach to Bottoms-Up Integrated T&D Planning

EVERSOURCE

Identify new or expand existing D Stations
Establish incremental DER and Firm Capacity Enabled

Identify Distribution Constraints

Distribution Net Load Forecasting

Transmission Net Load Forecasting + New Generators - Retirements

Identify Transmission Constraints

Identify new Transmission Solutions

Eversource Distribution System Planning Overview

Goal of Distribution Planning

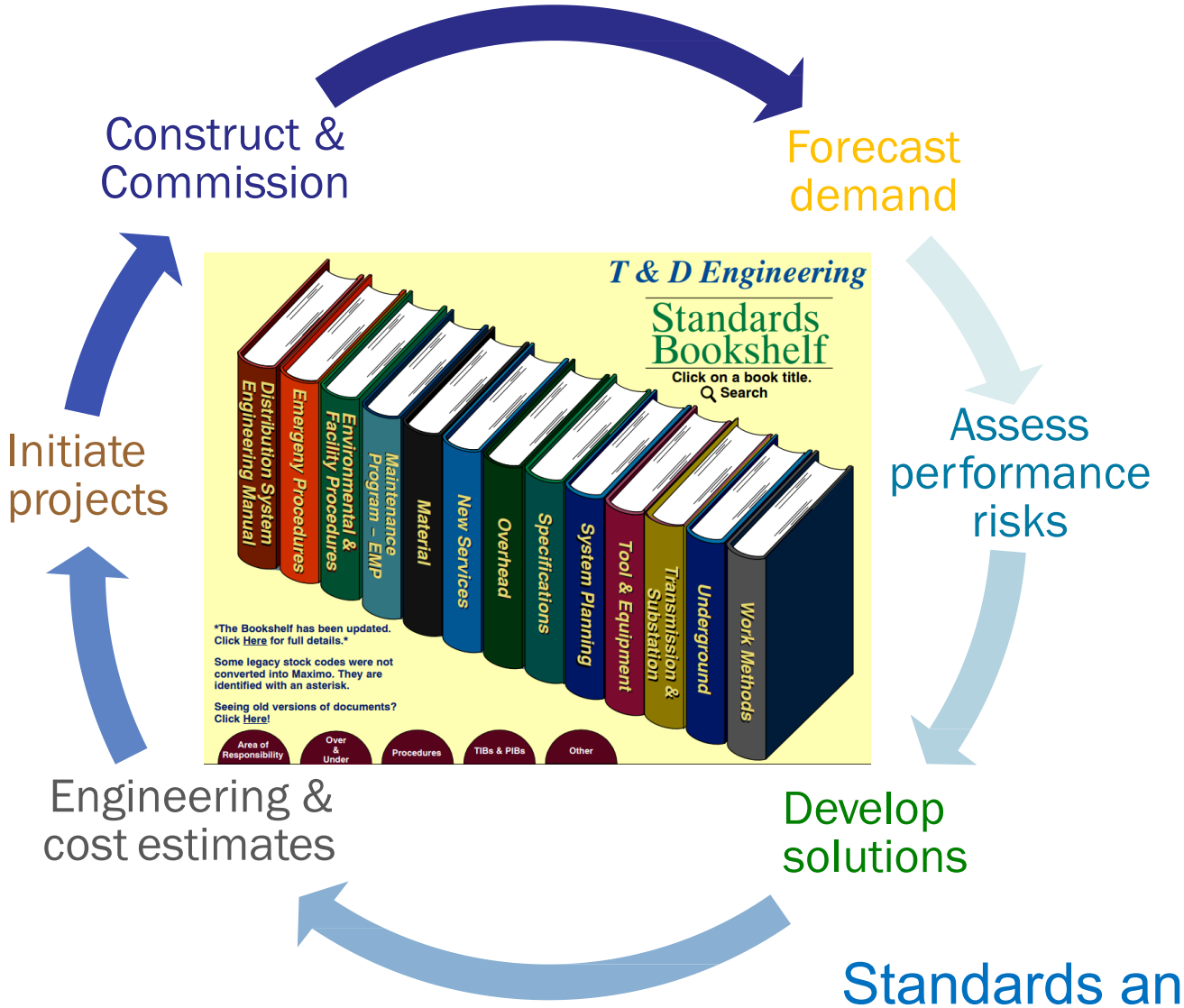
Provide orderly, economic expansion of equipment and facilities to meet future demand with acceptable system performance

- Ensure sufficient 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 exist

… and do it all for the lowest possible cost

EVERSOURCE

“Annual” Distribution Planning Process



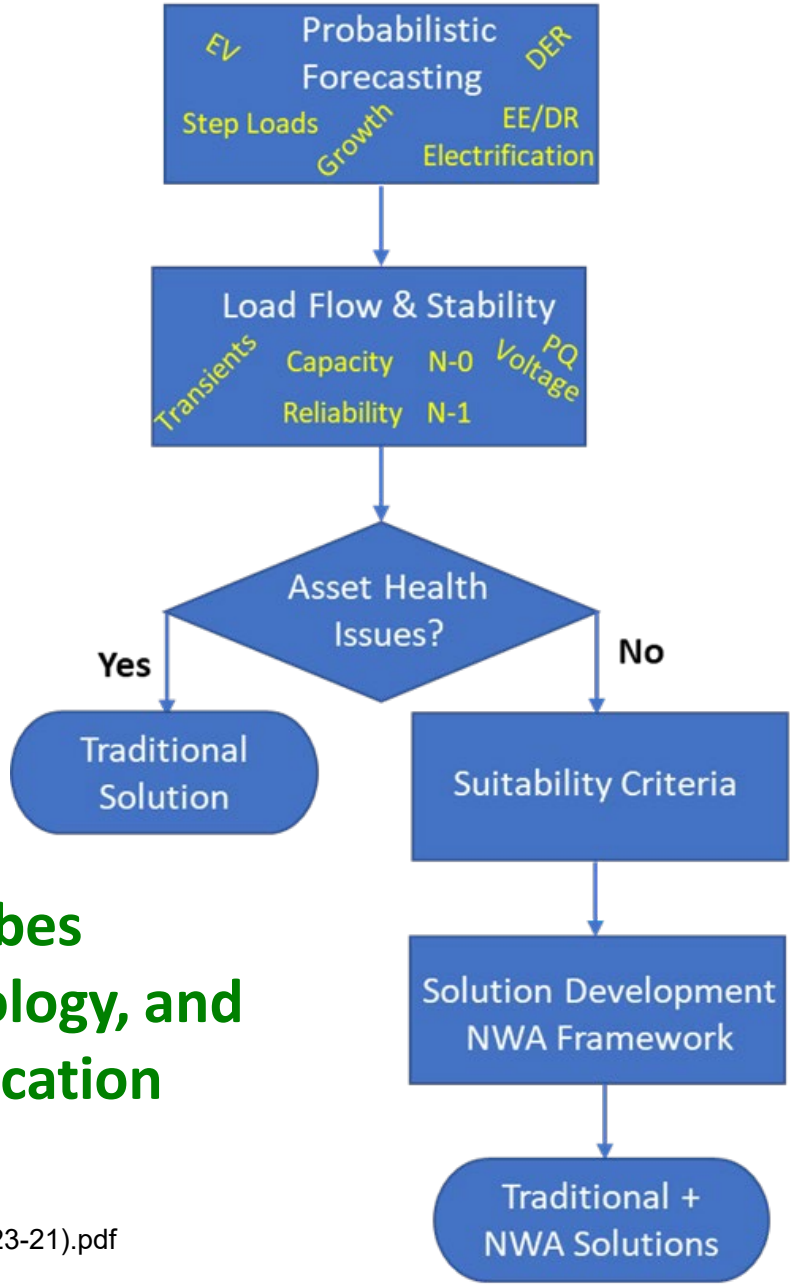
- Proactively identify existing and anticipated capacity deficiencies/constraints that could lead to violations
  - During normal (N-0) operating conditions
  - During emergency (N-1) conditions
- Identify corrective actions
  - Traditional distribution expansion
  - Non-wires alternatives (NWA)
- Estimate costs and determine best engineering option based on:
  - Design criteria and operational requirements
  - Benefit-cost analysis

Standards and criteria are the foundation of our planning and engineering

EVERSOURCE

Distribution Solution Development Process

- **Advanced Forecasting** – incorporates likelihood of adoption of certain technologies by customer types at future times and locations
- **Data Analytics** – leverage traditional and non-traditional input: GIS, solar irradiance, socio-economics, travel patterns, parcel data, etc., to develop advanced models and profiles
- **Tools and Processes** – apply cutting edge tools: LoadSEER, Synergi, PSCAD, NWS Screening Tool, etc., to build representative models, assess performance and develop integrated solutions for load and DER



The Company's Distribution System Planning Guide[1] describes forecasting approach, model development, study methodology, and solution development including Non-Wires Solutions application

EVERSOURCE

[1]Filed 04/23/21 under DPU 20-75, EversourceSystemPlanningProposal(4-23-21).pdf

NWA Framework

Enables Eversource to:

- Identify high profile candidates
- Minimize engineering time on unlikely candidates
- Standardize screening criteria
- Select only solutions with proven and tested technology
- Ensure soundness of financial model

Not intended to:

- Conduct an engineering study
- Develop detailed scope and cost estimates

NWA Screening Tool

Software tool implementing the NWA Framework for fast and repeatable process

In-house development in 2020

Deployed to all three states – all planning engineers trained

NWA Framework

Framework with all assumptions, technical, regulatory, and financial, for the screening process to provide transparency, traceability, and repeatability of process

Open for input and public stakeholder engagement

Filed publicly with regulators in all three jurisdictions

EVERSOURCE

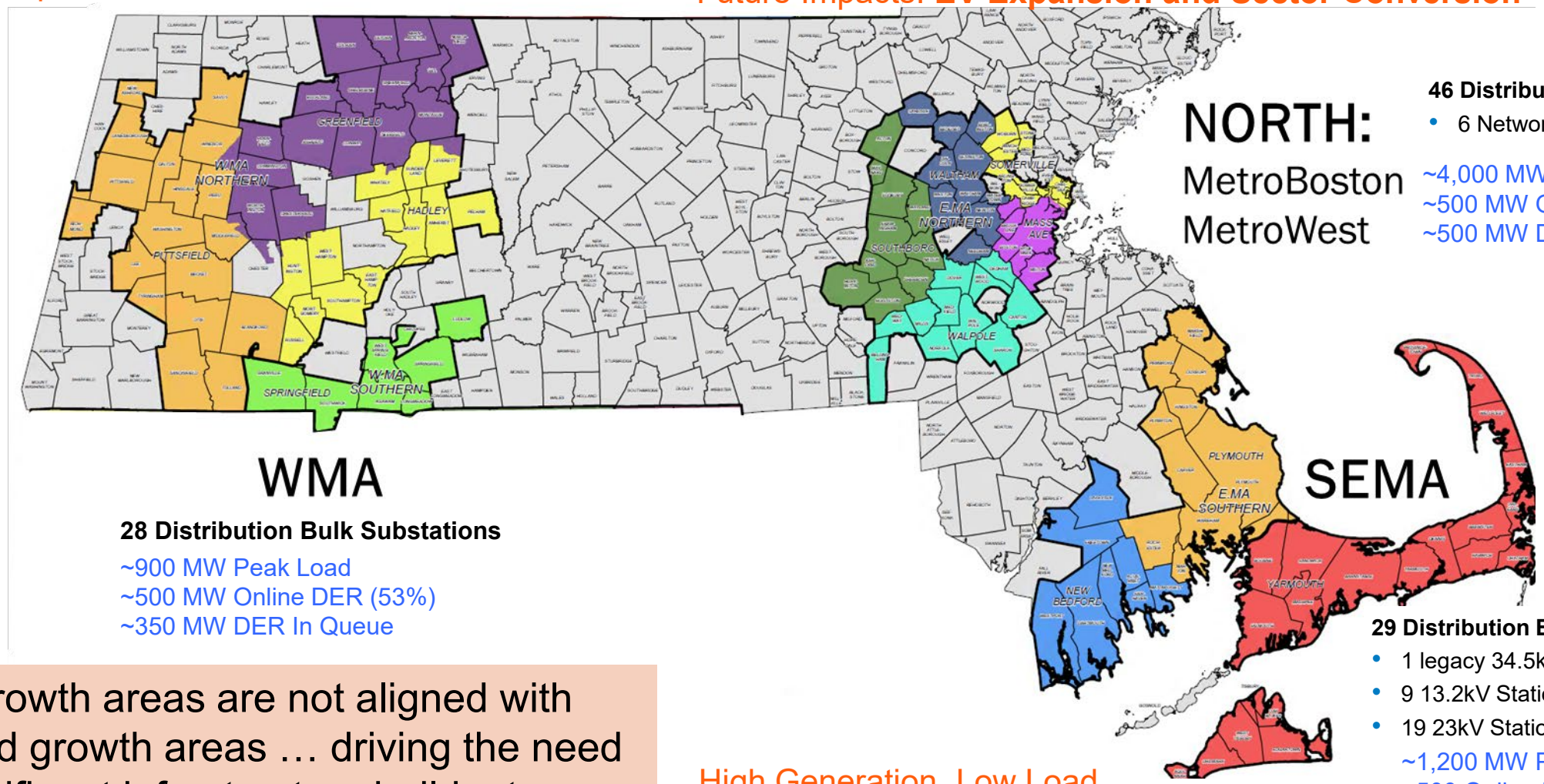
MA Distribution System Planning Process

Massachusetts Planning Challenges

Low Load, Growing Generation
Future Impacts: **DER Growth**

High Load, Low Generation
Future Impacts: **EV Expansion and Sector Conversion**

*All DER MW are as of 2021



NORTH:

MetroBoston
MetroWest

46 Distribution Bulk Stations

- 6 Network Stations

~4,000 MW Peak Load
~500 MW Online DER (13%)
~500 MW DER In Queue

WMA

28 Distribution Bulk Substations

~900 MW Peak Load
~500 MW Online DER (53%)
~350 MW DER In Queue

SEMA

29 Distribution Bulk Stations

- 1 legacy 34.5kV Substations
- 9 13.2kV Station
- 19 23kV Stations

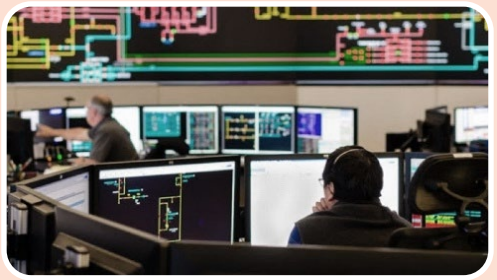
~1,200 MW Peak Load
~500 Online DER (40%)
~1,300 MW DER In Queue

DER growth areas are not aligned with demand growth areas … driving the need for significant infrastructure buildout

High Generation, Low Load
Future Impacts: **Offshore Wind and DER**

Investment in Modern Grid-Enabled Choices

Visibility → **Optimization** → **Enable**



Infrastructure Investments

- Increased transmission and distribution network strength
- Improved regional connectivity
- Modernize aging infrastructure
- Harden against storms, floods, and other threats

Integration Tools

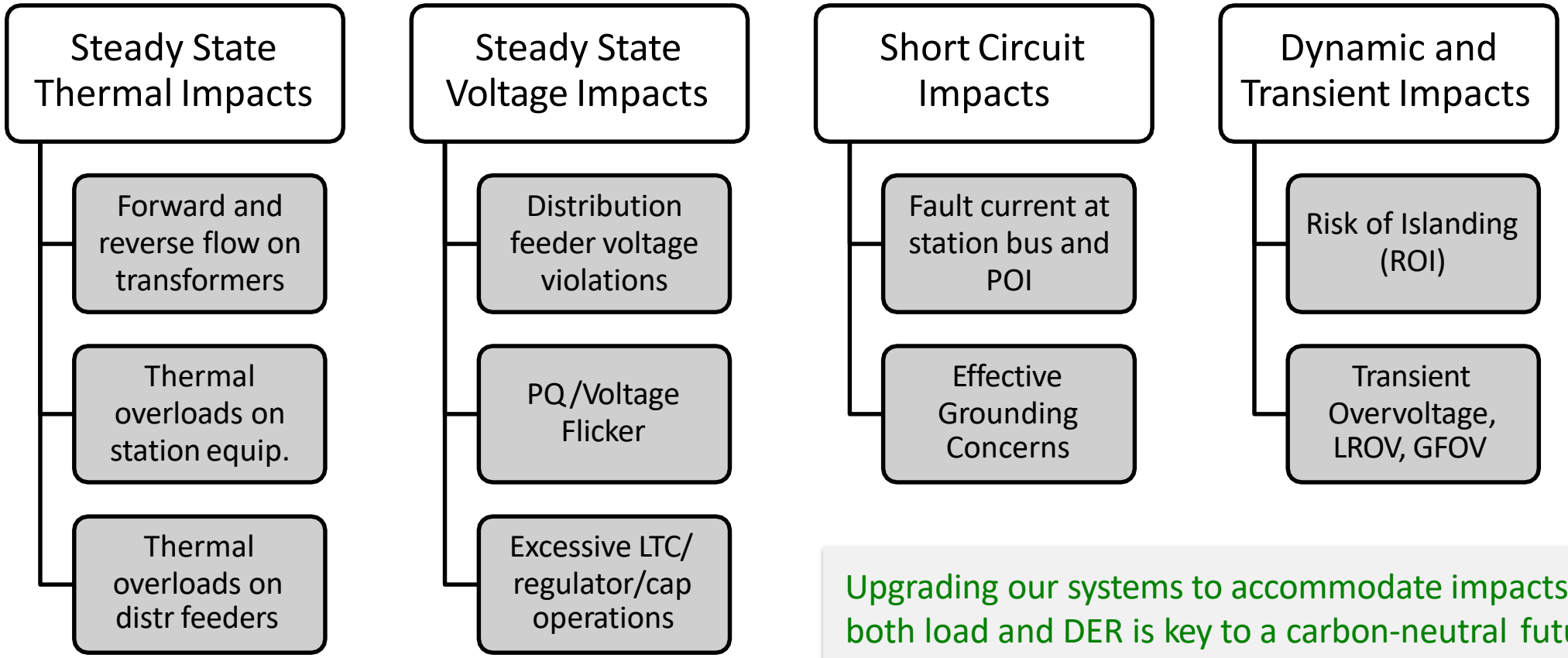
- Improved communications and data
- Tools to manage large volumes of data
- Improved visibility
- Identify locational benefits of resources
- Outage management system

New Technologies

- Energy storage
- Customer-centric platforms
- Microgrids
- Self-Healing Grid
- PQ Solutions (e.g. DVAr, STATCOM)

Integrated Distribution Planning

- **Advanced tools and processes used to assess impact and proactively plan the system to safely, reliably provide service for both load and DER**



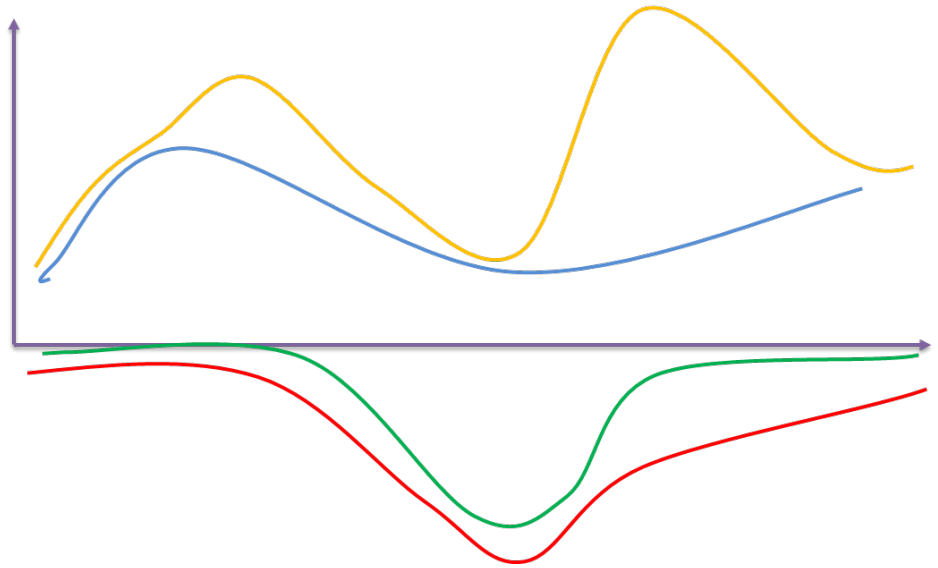
Upgrading our systems to accommodate impacts of both load and DER is key to a carbon-neutral future

EVERSOURCE

INTEGRATED PLANNING
FORECASTING-ANALYSIS-PLANNING

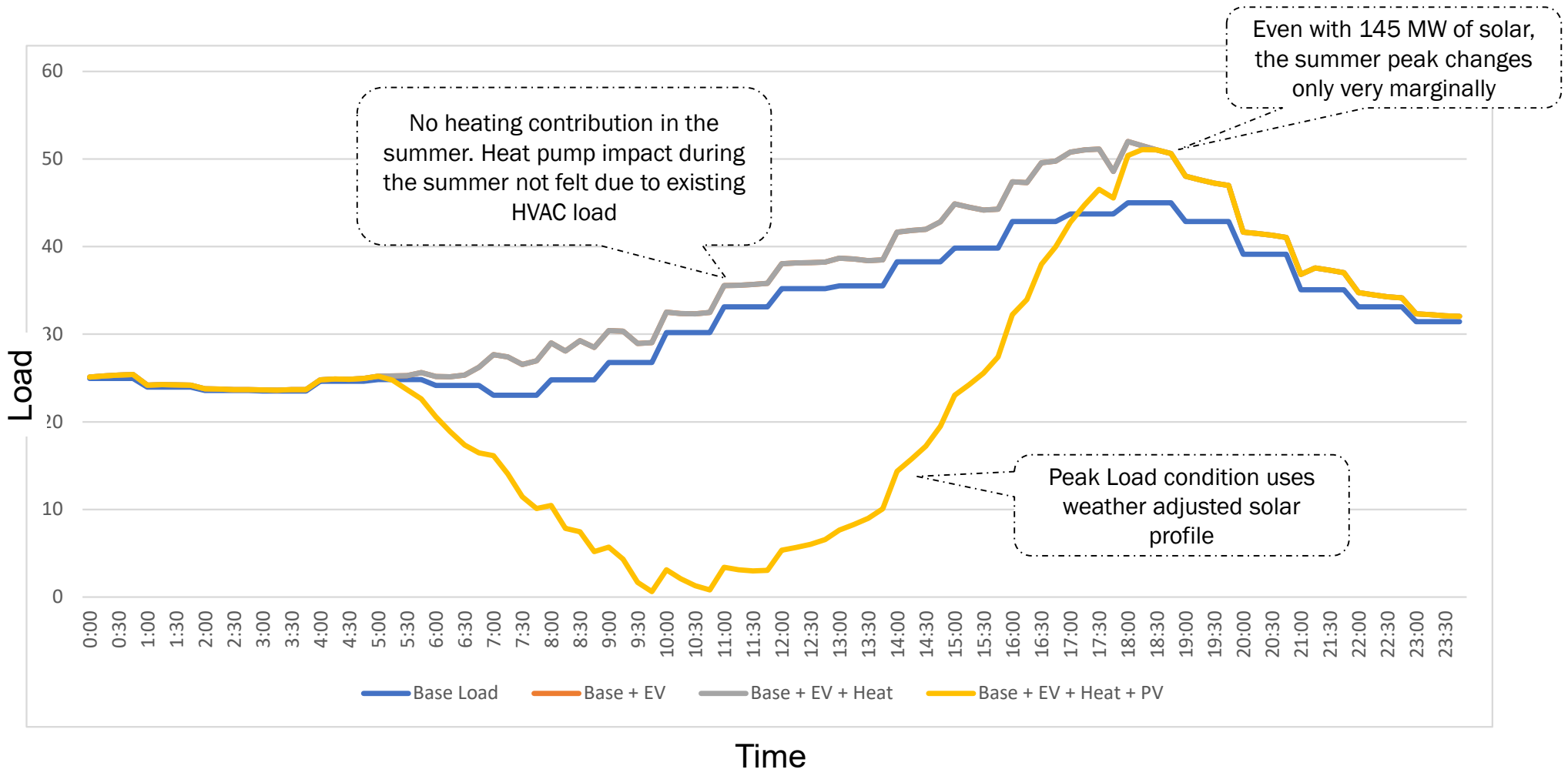
Advanced Forecasting Process

- **Scenario modeling based on high level "forecast"**
  - High-level forecast provided by an external entity, such as state decarbonization pathways
  - Forecast scenario is broken down to regional impacts on the distribution system
  - Bottoms-up metrics and adoption propensities are used to allocate impacts locally
- **Use component modeling approach to build forecasting scenarios**
  - Each component represented as an 8760 profile
  - Component profiles are created for various forecast scenarios
  - System Planning selects component profiles and merges them to create forecast
- **Company forecast components**
  - Trend Load Data
  - Step Load Growth
  - Energy Efficiency
  - DG Adoption
  - EV Adoption
  - Energy Storage
  - Sector Conversion
  - Capacity Reserves

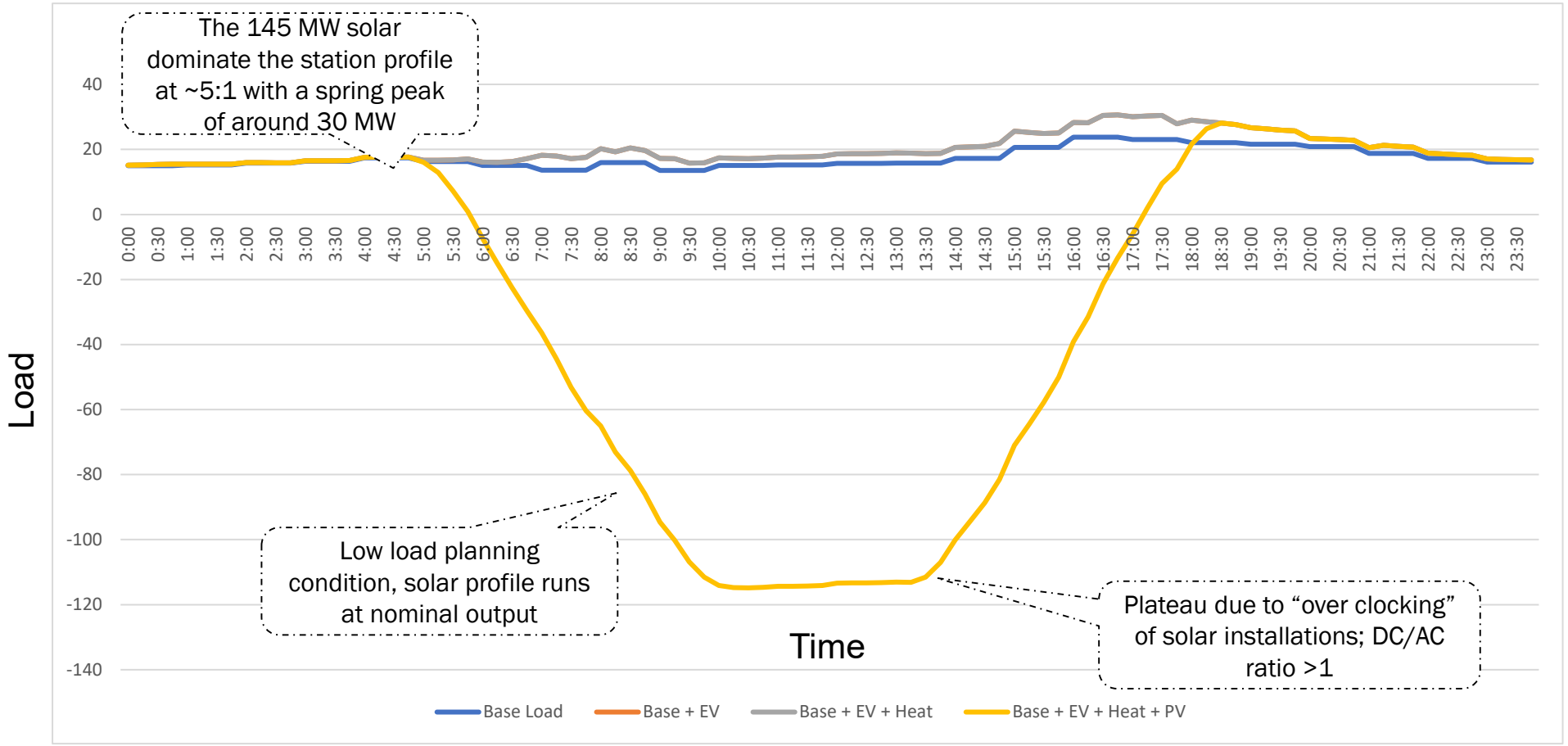


EVERSOURCE

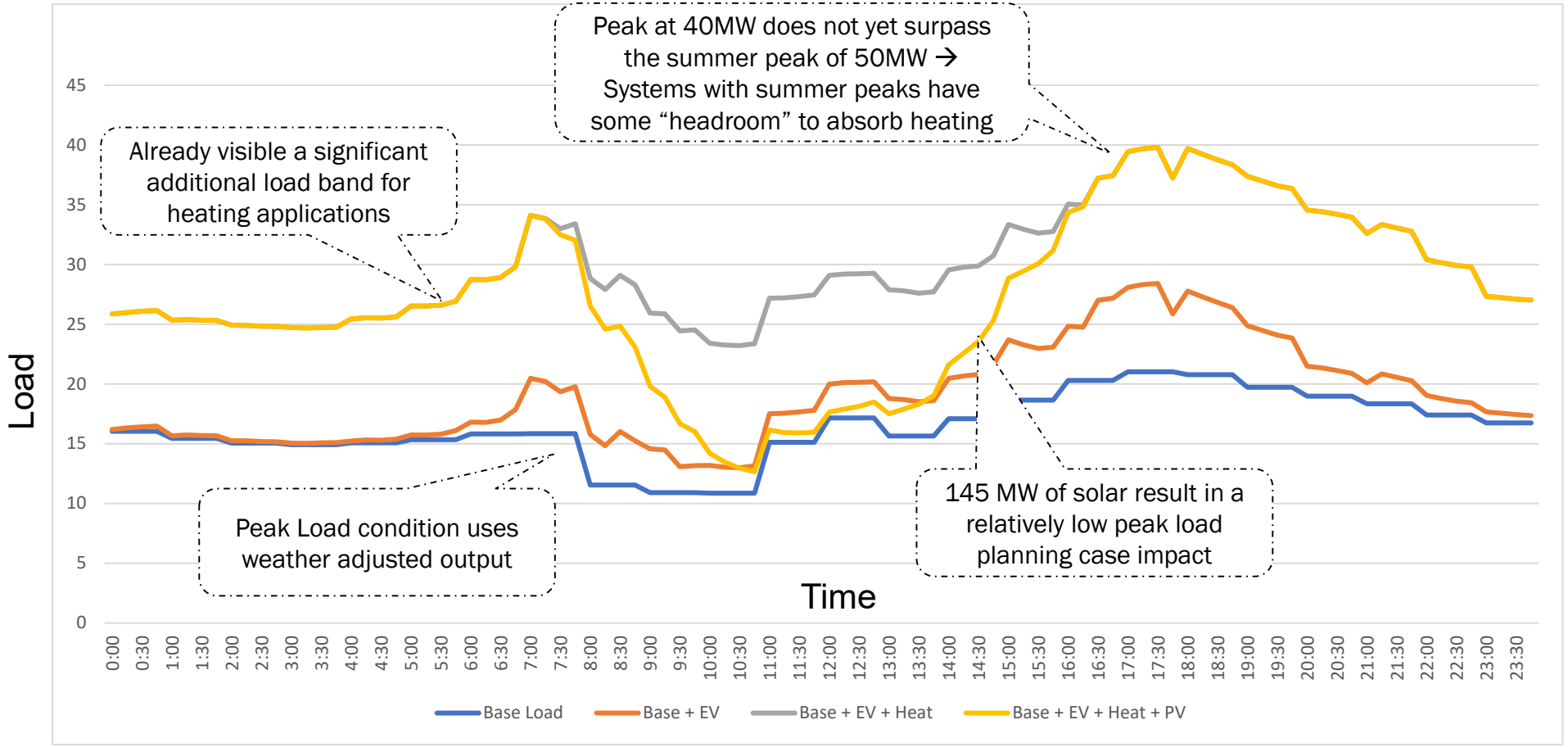
Combined Profile – Summer 2030



Combined Profile – Spring 2030



Combined Profile – Winter 2030
Typical High DER Substation



Multi-Year Modeling Approach for Integrated System Planning

Planning Forecast Requirements

Instead of single peak-hour, a planning forecast now requires 24-hour time-series data

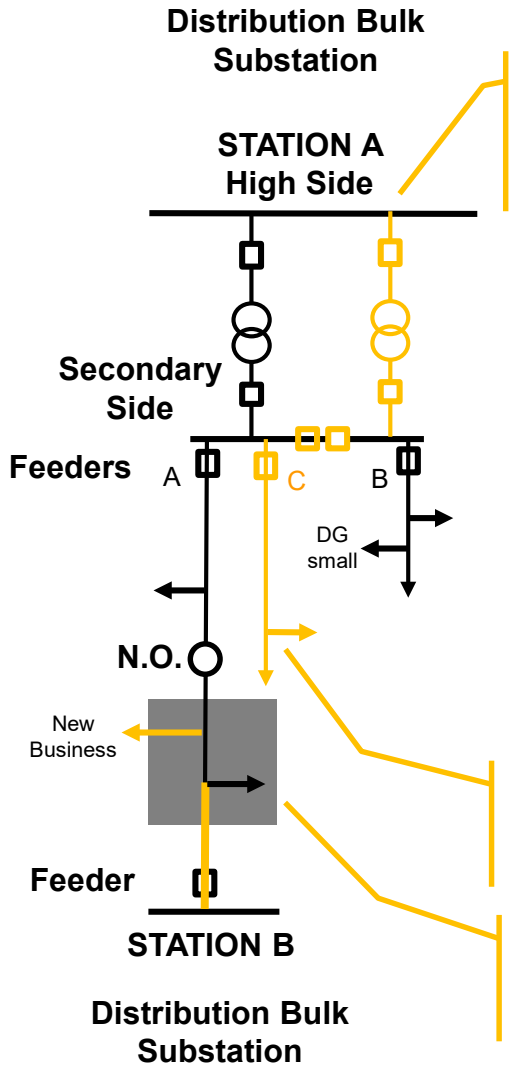
Instead default load profiles, a planning model now requires specific 8760 and 24-hr load profiles by area/substation

Instead of single year 8760 profile, a planning model requires ten-year 8760 profiles that account for Electrification, PV, EE, EV, etc.

Large Load, or Large DER Customers

- Years 1-5, actual new business installations to be modeled at specific locations based on in-service date

- Years 3-10, growth curves required for new business installations without specific locations identified

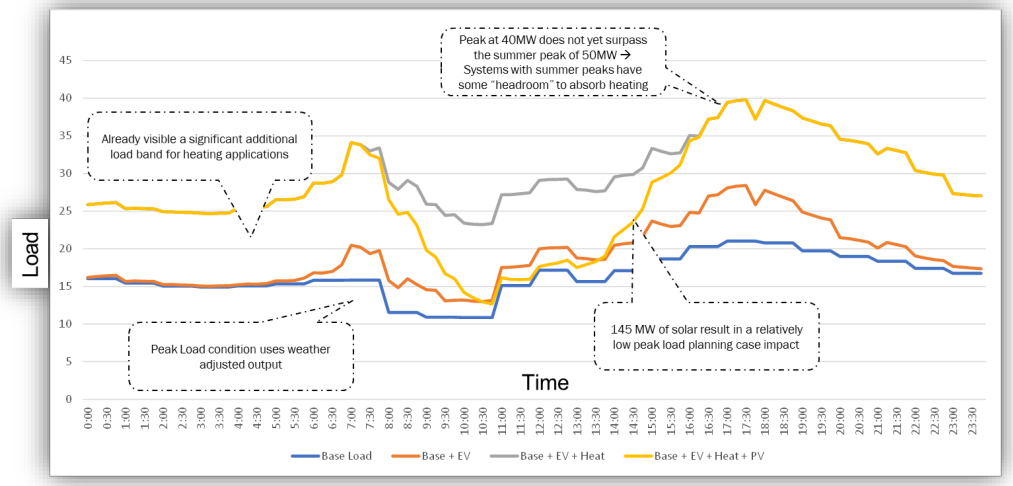


Year 2
Transformer Replacement
Asset Condition

Year 3
New Feeder required for reliability improvement

Year 4
Feeder Upgrade
New business

Combined 8760 Profile by Year used as input to Planning Model

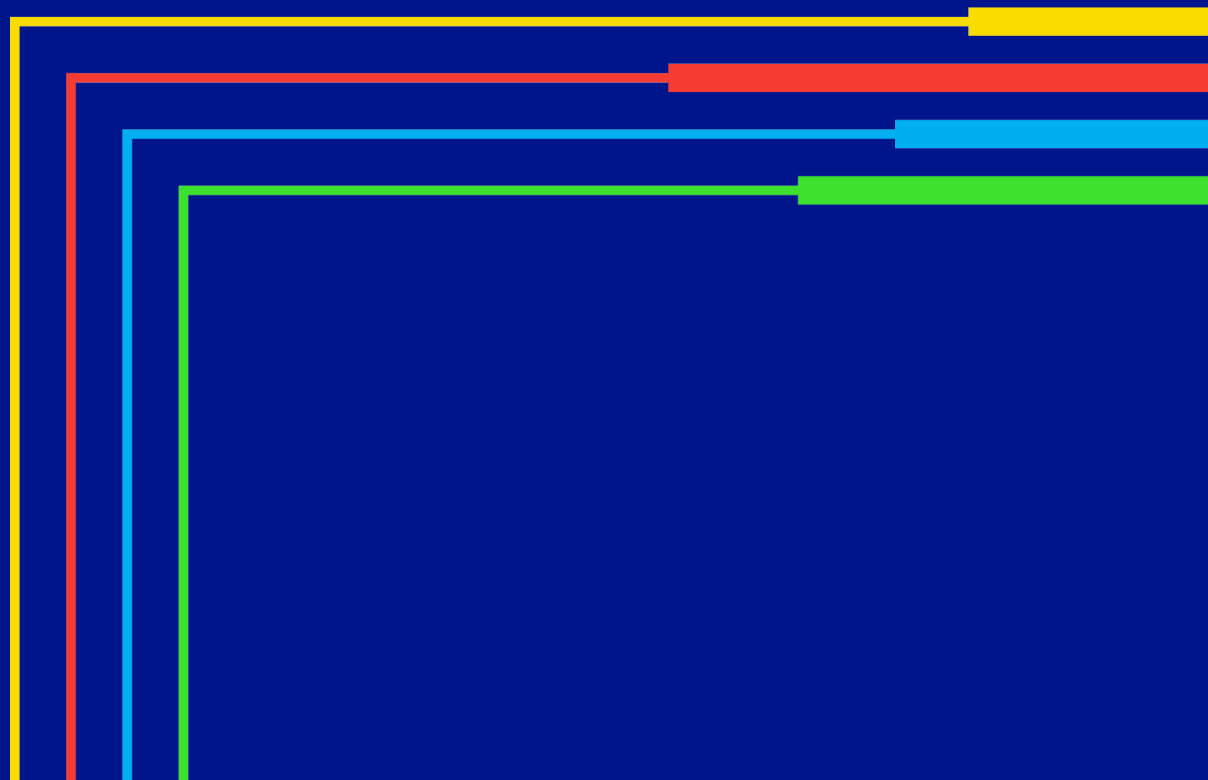


Thank You

QUESTIONS?

Distribution Planning Overview

2022



nationalgrid

What is Distribution Planning?

- Distribution planning is the analysis of historical data with forecasting information to prepare recommendations for National Grid to provide safe, reliable, and efficient electric service
  - Historical Data
    - Physical Characteristics = Asset Condition
    - Electrical Characteristics = Current, Voltage, and Power
  - Analysis
  - Recommendation
    - Infrastructure
    - System modifications or operational guidelines

Why do we plan?

- **SAFE**
  - Maximize safety of workers, equipment, and the public
- **RELIABLE**
  - Proactive (Predictive)
  - Reactive (Historical)
- **EFFICIENT**
  - Maximize use of existing assets
  - Economic expansion
  - Minimize environmental impacts
  - Minimize societal impacts

Planning Analysis Concepts

- Should apply criteria and strategies reviewed by regulatory entity
  - System Performance Criteria (including Asset Condition)
    - Acceptable = Continue to analyze and plan
    - Not Acceptable = Infrastructure Investment or System Modification
- Should allow customer choice – Plan for most significant impact to the system
- Status of System Monitoring
- Comprehensive Plans
- Distribution Planning addresses Capacity, not Energy
  - Discrete and Large
  - Familiarity with cost, schedule, and capabilities

Distribution Planning Overview

- Distribution Planning Criteria
- Distribution Planning process
  - Forecasting
  - Annual capacity reviews
  - Area studies
  - Other planning studies
- Grid Modernization
- Planning Challenges

Distribution Planning Criteria

- Planning criteria is applied in all distribution planning studies
- Sets thresholds and limits intended to identify system needs and initiate investments to address these issues under Normal and Contingency (N-1) conditions
  - Asset condition
  - Thermal loading
  - Voltage
  - Non Wires Alternative Criteria
  - Fault Duty, Protection & Arc flash
  - Reliability
  - Resilience
  - Reactive Power
  - Load Balancing
  - Hosting Capacity

Load Forecasting

- The Company's Electric Forecasting team uses a regression-based core model to forecast summer and winter peak loads on an annual basis
  - 15-year projections
  - Variables considered include historical and forecasted economic conditions, historical peak load data, annual energy sales, and weather conditions based on historical data
  - Predicts forecasted peak demand under a normal and extreme weather scenario
  - The extreme weather scenario is used in planning analyses
  - The forecast of peak load incorporates distributed energy resources (DER), including:
    - energy efficiency (EE) savings
    - solar-photovoltaics (PV) reductions
    - electric vehicle (EV) increases
    - electric heat pumps (EH) decrease in summer and increase in winter
    - demand response (DR) reduction achieved through the prior year
  - Numerous DER scenarios are developed – System planning uses the load with base DER scenario for planning purposes

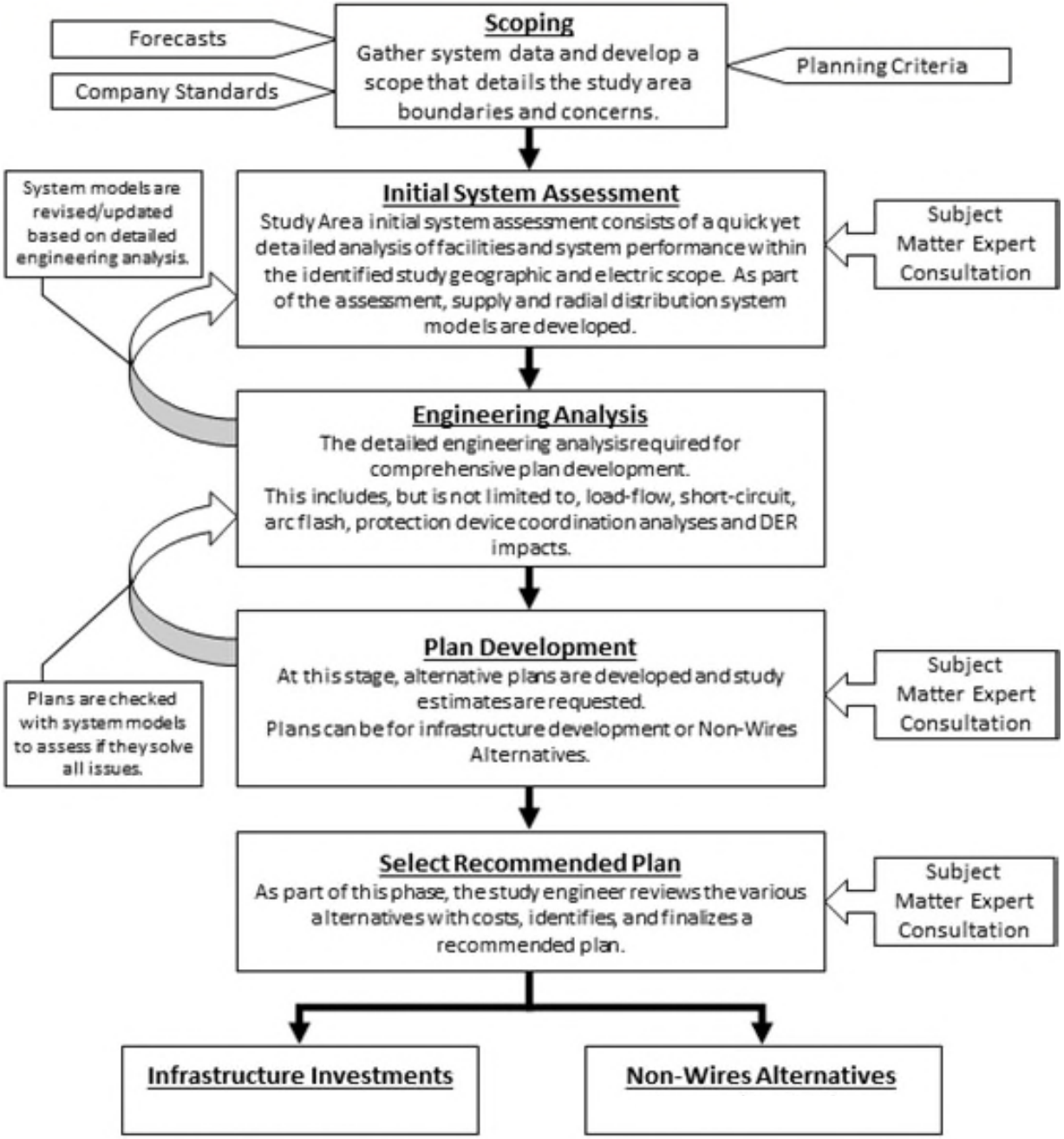
Annual Capacity Review

- Upon completion of the electric annual forecast report, Distribution Planning performs annual capacity reviews on all feeders, transformers and subtransmission lines.
- Analysis uses actual peak load data from the prior year with the forecast information provided in the forecast report.
- Incorporates known “spot loads” – large load customers with a service request or anticipated though community/customer engagement
- Reviews identify thermal capacity constraints and assess the capability of the network to respond to contingencies.
- Results can prompt the need for new projects to address planning criteria violations
- Results inform the prioritization of area planning studies or other existing projects

Area Studies

- Area studies are comprehensive reviews of areas within the Company's service territory that result in long-term infrastructure development recommendations that solve system issues identified over a 10-15 year period
- Area study plans address all issues identified in the study including but not limited to the following issues: asset condition, capacity, protection, voltage, reliability, operational, arc flash, etc.
- Process involves input from subject matter experts across the company
- Alternatives are developed to solve all known issues and the "least cost fit for purpose" option progresses to implementation
- Non Wires Alternatives
  - Screening criteria included in the planning criteria
  - All recommended projects are screened for Non-wires Alternatives

PLANNING STUDY PROCESS

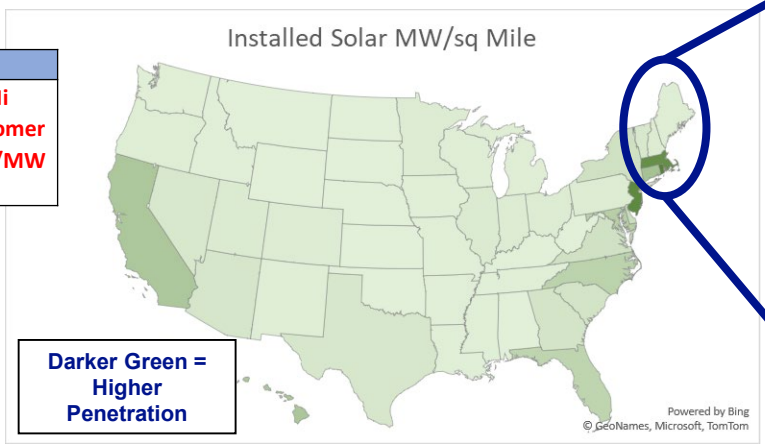


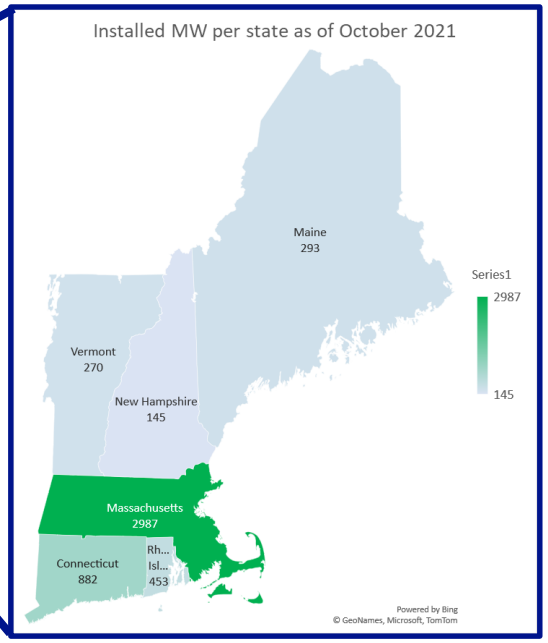
Other planning studies

- Load Interconnection studies
- Generator and Energy Storage System (ESS) Interconnection studies
  - Group studies
  - Transmission Affected System Operator (ASO) studies
- Special Studies/Programs such as new technology assessments, system wide targeted programs etc.
- Annual reliability reviews of distribution circuits

New England Distributed Generation Benchmarking

2021 totals		
NGrid Sq Mi	3870	469.5 kW/Sq Mi
kW installed	1817	1.4 kW/customer
NG customers	1.3M	10.2 ckt mile /MW
NG ckt miles	18451	





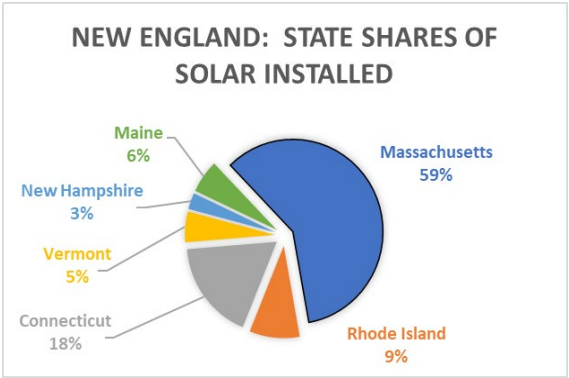
Total Solar Installations between 2010 and Q2-2020

Residential

Rank	Utlity	MWdc
1	PGE	2,530
2	SCE	1,861
3	SDGE	1,028
4	APS	869
5	PSEG	750
6	Duke	500
7	National Grid	482
8	Southern Nevada	380
9	Xcel Energy	372
10	Eversource	358

Non-Residential

Rank	Total Non-residential Solar PV Installed by Utility Territory	MWdc
1	PGE	1,763
2	National Grid	1581
3	Xcel Energy	1,132
4	SCE	934
5	Eversource	831
6	PSEG	650
7	JCP&L	480
8	SDGE	322
9	APS	291
10	New York State Electric and Gas	253



Grid Modernization

1. Why are we doing this?

- To improve system reliability, efficiency, and outage response
- To enable an expanding portfolio of sustainable energy resources delivering on National Grid's Northeast 80x50 Pathway
- To increase network visibility and share key information with customers and market participants

2. What are we doing?

- Enabling increased integration of Distribution Energy Resources (DERs)
- Improving the quality of power delivered through voltage optimization
- Developing new systems and tools for Distribution Control Centers
- Leveraging devices to improve Field Operations situational awareness capabilities
- Improving distribution system planning

3. How will this benefit customers?

- Cleaner, most cost-effective, consistently reliable energy
- More timely and accurate customer service information
- New technologies to track and manage outages
- Increased capacity for interconnection of customers' renewable energy resources

Advanced Grid Technologies

1. Feeder Monitors

- Power quality data will improve the timing of equipment upgrades, validate and improve modelling tools for load types and possibly support real-time ratings.

2. Volt Var Optimization (VVO)

- Control System that manages the quality of the energy delivered to customers
- Provides efficient delivery of power to the customer
- Equipment includes smart controls, voltage regulators, Load Tap Changers, Capacitors, Feeder monitors, and cellular modems

3. Fault Location Isolation & Service Restoration (FLISR)

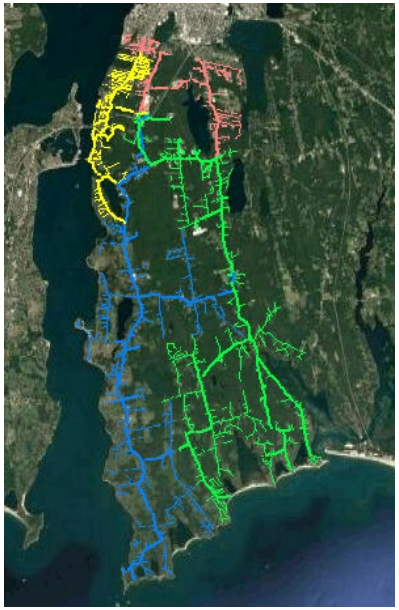
- Real-time scheme-based system that is able to respond to failure conditions on the distribution grid
- A FLISR scheme is between two or more feeders and is composed of local field devices known as Reclosers, Control Boxes, Radios, and Data Concentrators to achieve Distribution Automation
- Adjusts to changing loads and generation without operator intervention
- Minimizes effects of permanent faults

Planning Challenges

- Emerging Issues
  - Distributed Generation (DG) saturation and increased number of Energy Storage System (ESS) applications
  - Need for 8760 forecasts and analysis
  - System Resiliency
  - Climate Change
  - Continued Operational Efficiency
  - Electrification

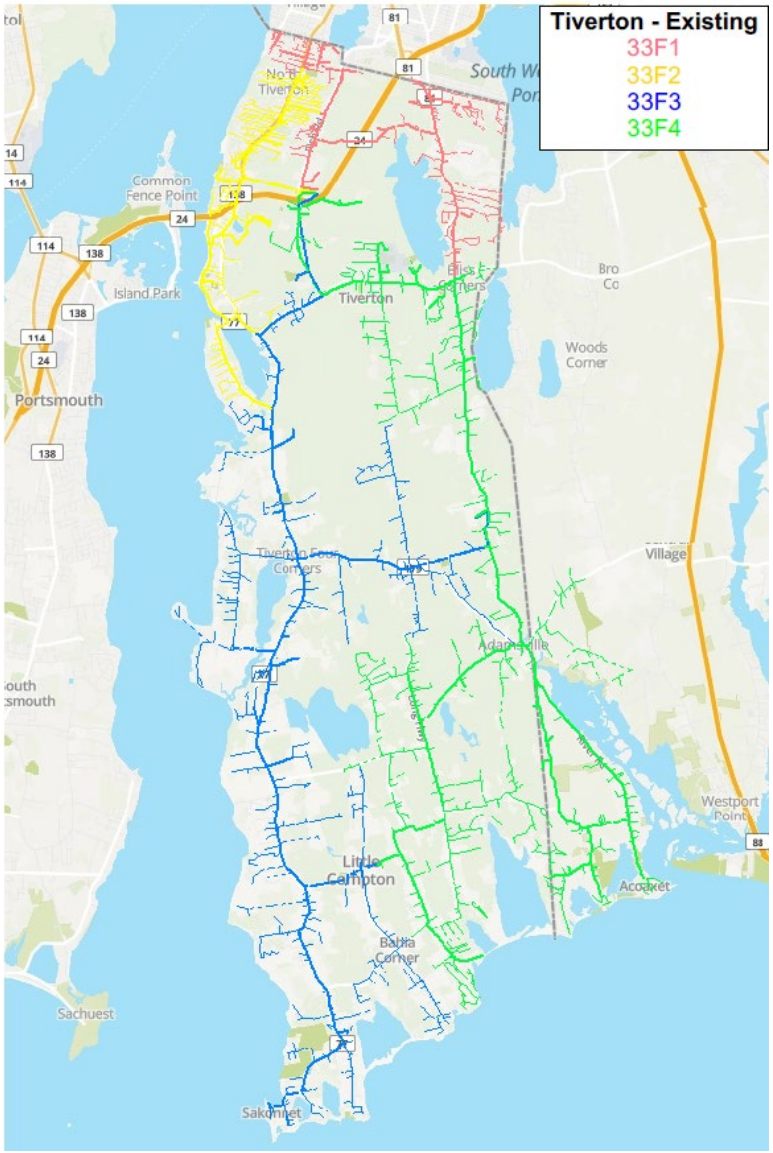
- Emerging Technologies
  - Distributed Energy Resources
  - Advanced Distribution Automation
  - Volt/Var Optimization
  - Advanced Distribution Monitoring
  - Time of use rates
  - Distributed Energy Resource Management System

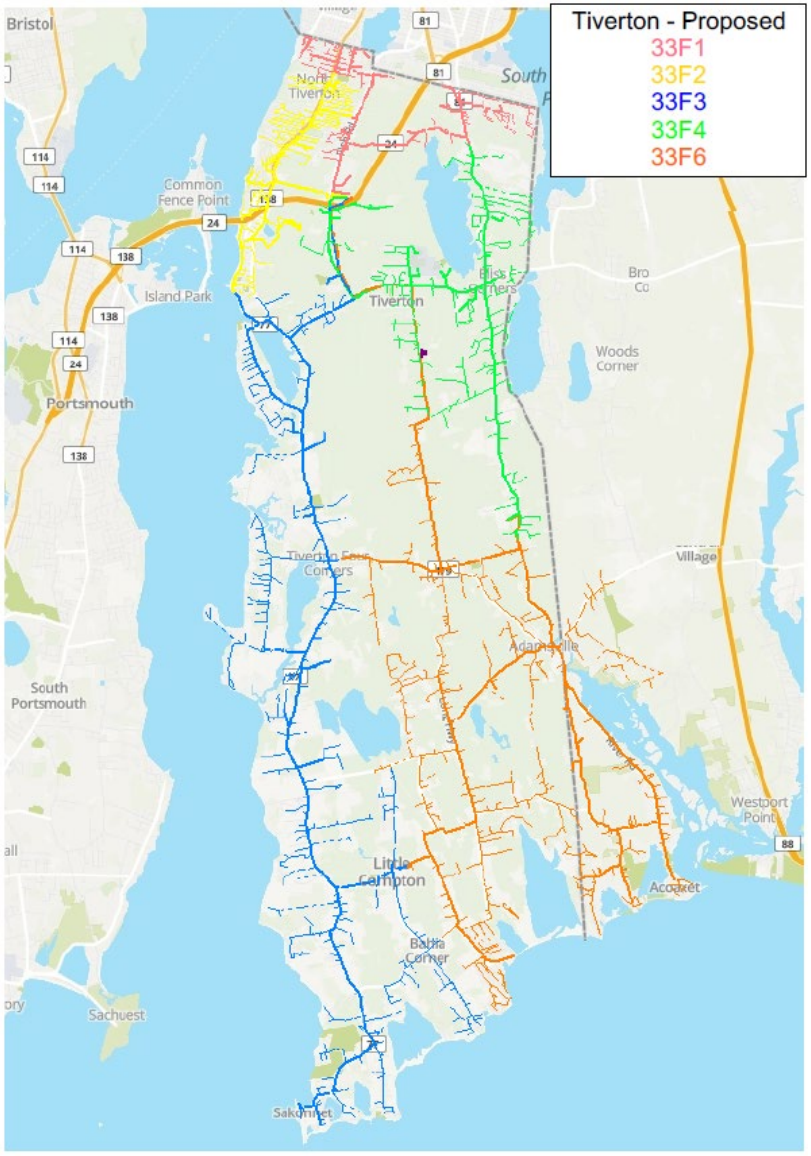
Area Study Example – Tiverton, RI



- Tiverton substation has 4 12.47kV distribution circuits
- All 4 feeders violate our contingency load at risk criteria
- Study developed potential solutions to mitigate this issue
- Recommended plan includes installing a new 5th 12.47kV circuit at Tiverton Substation
  - There are two Distributed Generation (DG) projects currently in design that require the construction of a new 5th Tiverton circuit for interconnection.
  - If the DG project does not proceed, this 5th circuit will still be needed to address the area contingency loading concerns, and the same route would be followed as the least-cost solution. There will be an additional extension to address the contingency issue.
  - DG project is on a different schedule (earlier than the Company project), the DG developer will be responsible for the cost to construct the feeder serving their project.
  - Cost sharing will apply to the shared route portion of work once the 33F6 circuit is being used to serve load as per the Standards for Interconnecting Distributed Generation

Tiverton Feeders Overload & Load-at-Risk





nationalgrid

AVANGRID

2022

Distribution Planning: Innovation & Development Overview

Kimberly Cullen

Agenda

- Who is AVANGRID?
- Traditional Distribution Planning Activities
- New Distribution Planning Responsibilities
- Forecasting
- CYME and Power Flow Analysis
- Distributed Generation (DG) Interest in Maine

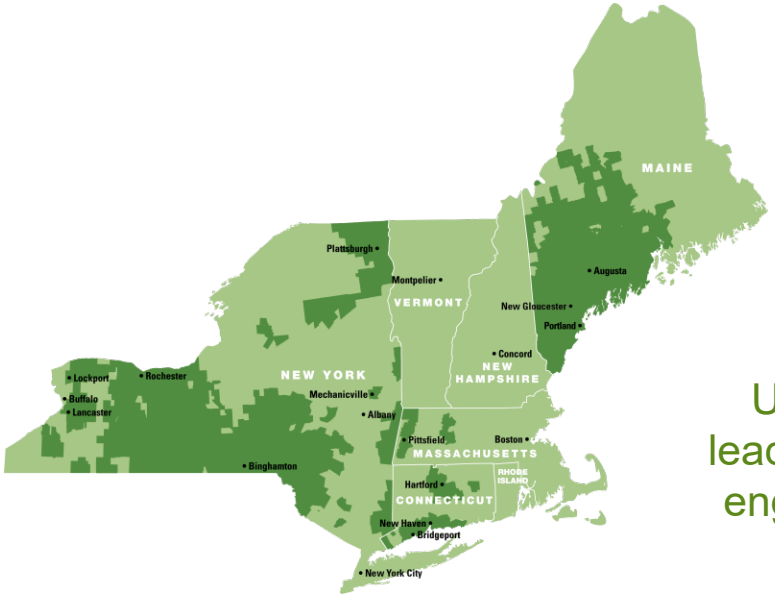
AVANGRID

Avangrid Networks

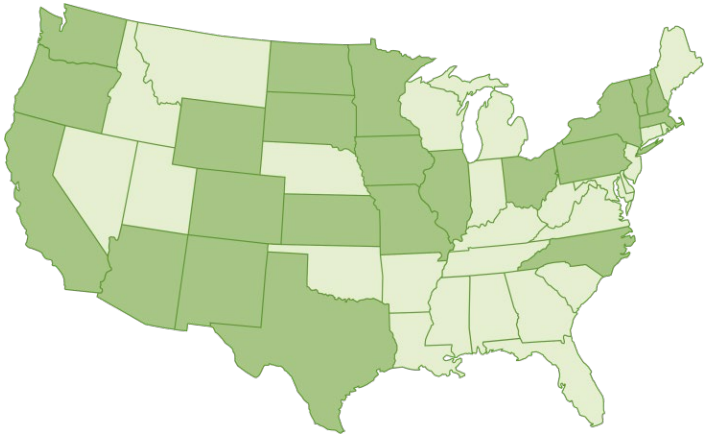
- 8 regulated electric and gas utilities in the Northeast
- 3.3 million customers
- ≈ 1 million smart meters with 1.8 million pending

Avangrid Renewables

- 3rd largest wind energy generator in U.S.
- 53 operating wind farms
- 22 states in U.S.

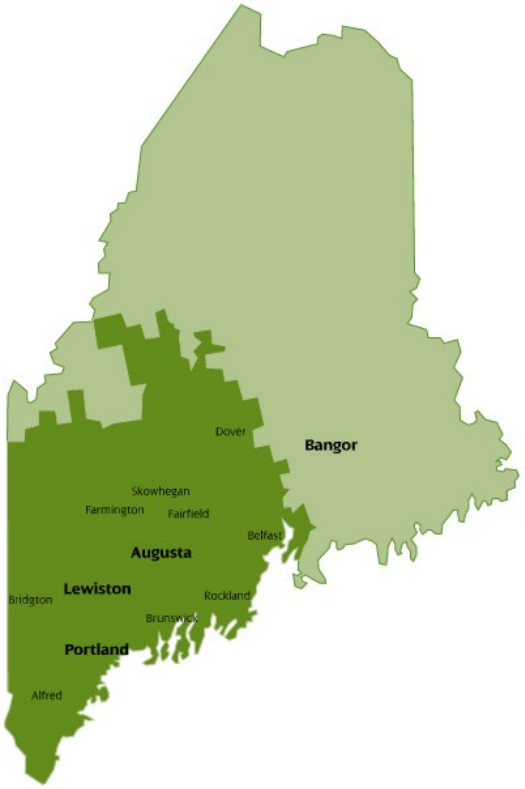


Utility industry leader in customer engagement and satisfaction



Overview of CMP System

- ~631,000 customers
- ~11,000 square miles (17.703 sq. KM)
- 1,809 MW all-time peak (2021)
- 11 Divisions (Work Centers: Alfred, Augusta, Belfast, Bridgton, Brunswick, Dover, Fairfield, Farmington, Lewiston, Portland, Rockland, Skowhegan)
- 204 distribution substations
- 254 transformer banks
- 474 total circuits



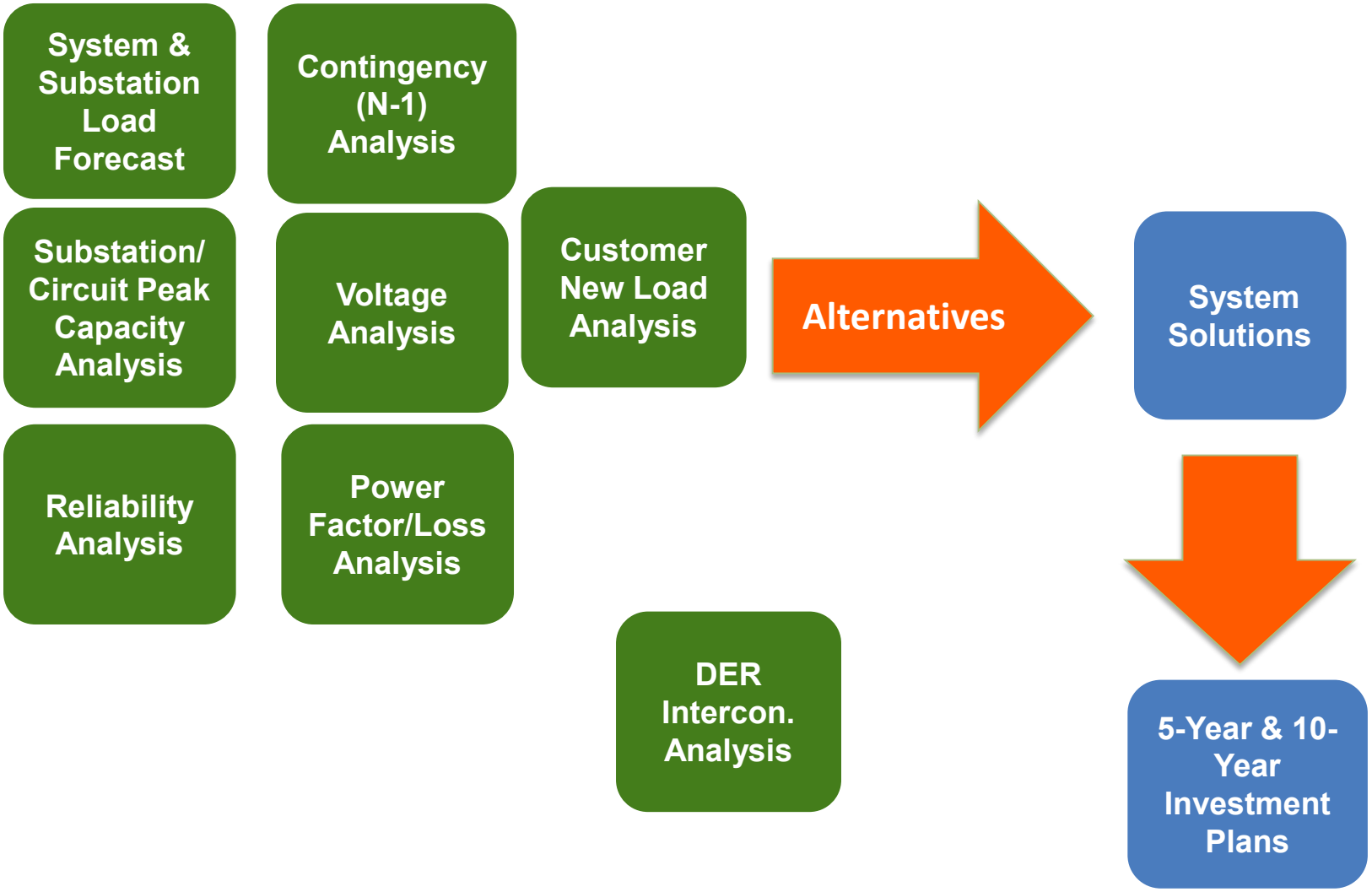
- Approximately 25,000 miles (40,234 KM) of distribution lines
- Downtown Portland supplied by underground network system

Overview of UI System

- ~330,000 customers across 17 Towns
- ~335 square miles (539 sq. KM)
- 1,456 MW all-time peak (2006)
- 28 bulk 13.8 kV substations
- 2 low-voltage 4 kV substations distribution)
- 359 total circuits (14 are 4 kV)

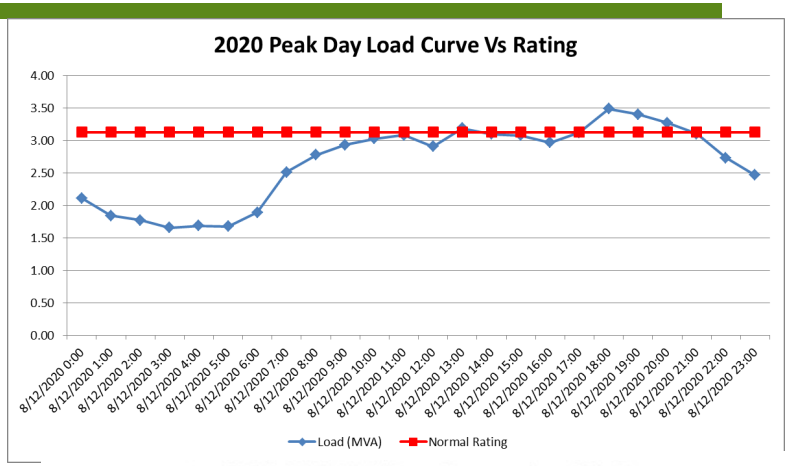
- 3,282 pole-line miles (5,282 KM) of overhead distribution lines and 691 miles (1,112 KM) of underground primary cables
- Downtown New Haven and Bridgeport supplied by underground network systems

Traditional Distribution Planning Activities



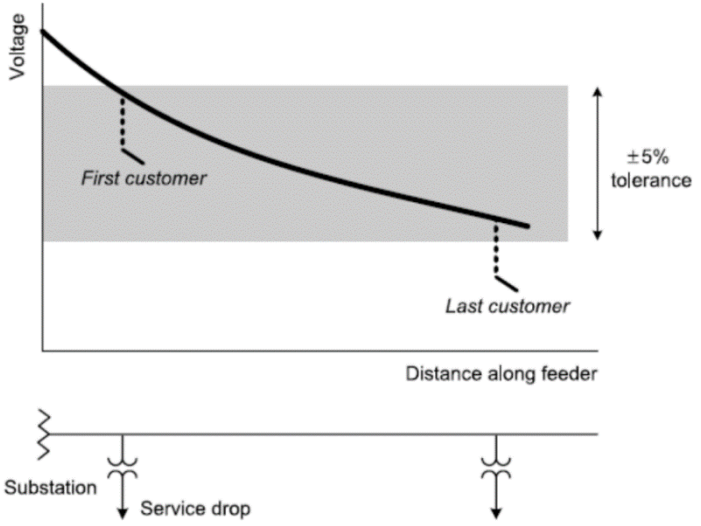
Distribution Planning Traditional Responsibilities

- **Load Serving Capacity Analysis**
  - Analyses performed to ensure equipment, circuits and substations operate within their limits and ensure new customer load can be supplied safely and reliably
- **Reliability Analysis**
  - Availability and quality of power supply at each customer service entrance
  - Indices include SAIDI, CAIDI, SAIFI, MAIFI, FAIFI
- **Voltage/VAR Analysis**
  - Voltage analysis includes circuit and customer service voltage compliance with State and utilities voltage regulations
  - VAR analysis refers to power factor correction



ANSI C84.1 Voltage Ranges for 120 V

	Service Voltage		Utilization Voltage	
	Minimum	Maximum	Minimum	Maximum
Range A	114 (–5%)	126 (+5%)	110 (–8.3%)	125 (+4.2%)
Range B	110 (–8.3%)	127 (+5.8%)	106 (–11.7%)	127 (+5.8%)



Distribution Planning Traditional Responsibilities

Responsible for Planning Infrastructure

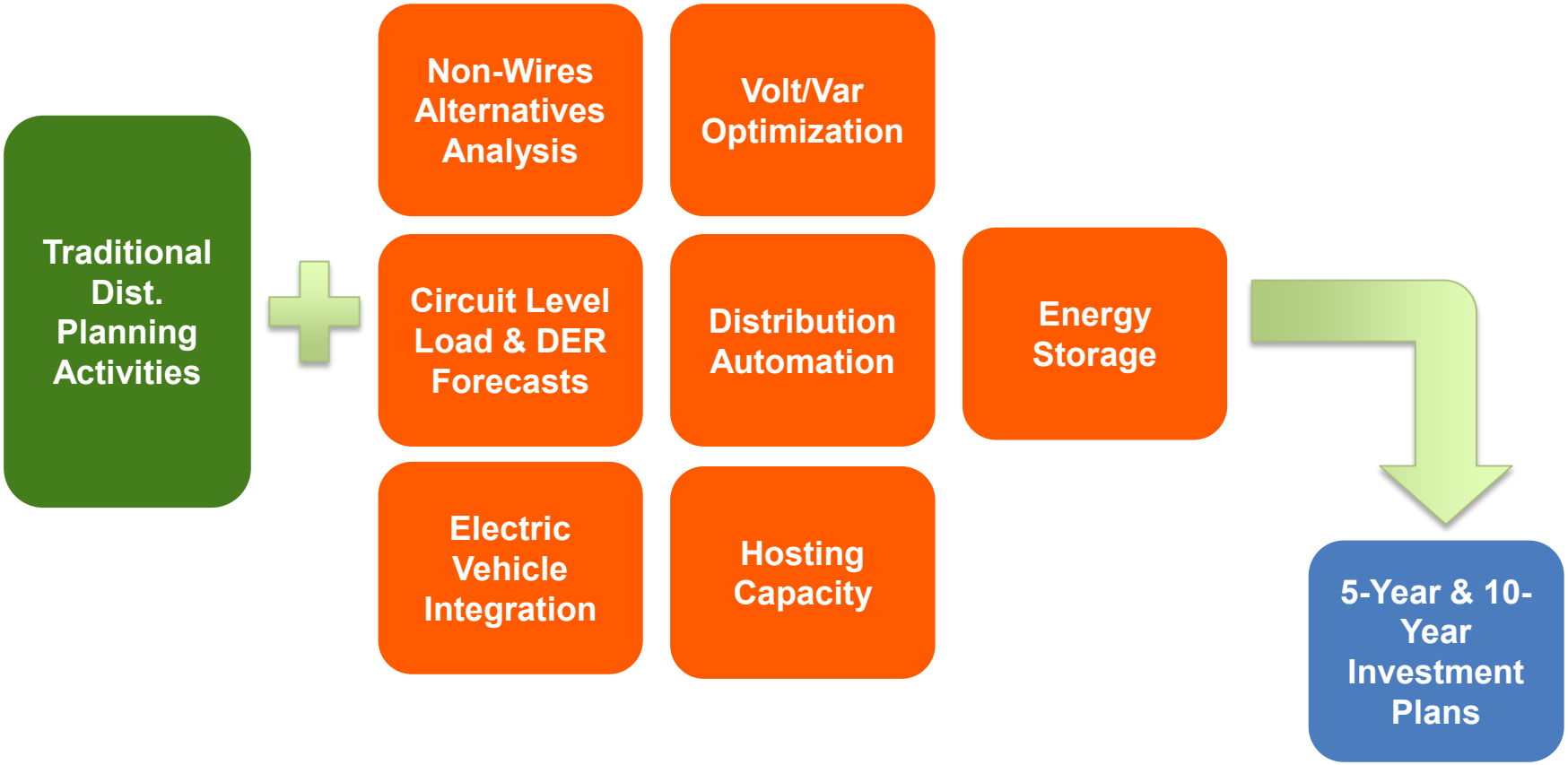
- **Substation**
  - Ensure Adequate Substation Thermal Capacity, and Operation Within Required Voltage Level
  - Projects - New Substations, Substation Expansion, Load Transfers (N-1 Contingency Analysis)
- **Distribution**
  - Ensure Circuits Have Adequate Thermal Capacity, and Operation Within Required Voltage Levels
  - Projects – Circuit reconfiguration &/or upgrades
- **Reliability**
  - Plan Infrastructure To Maintain Reliability Levels
  - Projects – Strategic (Reclosers), SCADA Switches, Line Reconfiguration &/or upgrades
- **Customer / Distributed Generation**
  - Interconnection of Generators to Distribution System

Distribution Planning Practices

Resiliency (reliability index - must include storms)

- Resiliency plans developed by the Company to:
  - Reduce number of outages during extreme weather
  - Provide efficient and effective response when outages do occur.
- Key elements of resiliency plan:
  - Topology improvements to the distribution system (adding ties)
  - Hardening of the infrastructure
  - Automation of the system

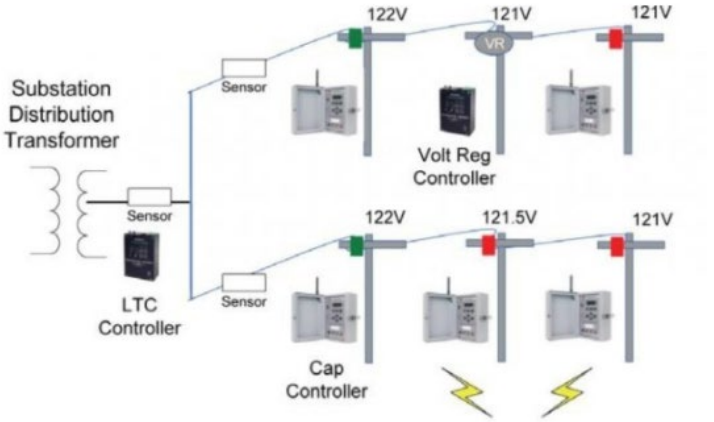
New Distribution Planning Responsibilities



New Distribution Planning Responsibilities

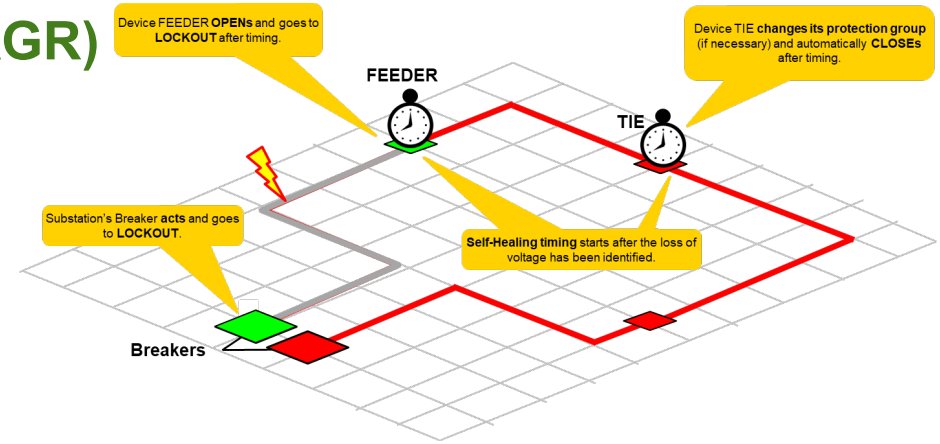
- **Non-Wires Alternative Analysis**
  - LD 1181 - An Act To Reduce Electricity Costs through Non-wires Alternatives (Maine)
  - Non-Wires Alternative Coordinator – State of Maine
- **Energy Storage**
  - Researching pilot opportunities
  - Reduce thermal overloading concerns
  - Microgrid opportunities
- **Volt/VAR Optimization**
  - Distribution Management System
  - More efficient grid operation, by reducing system losses, peak demand and/or energy consumption

R&D

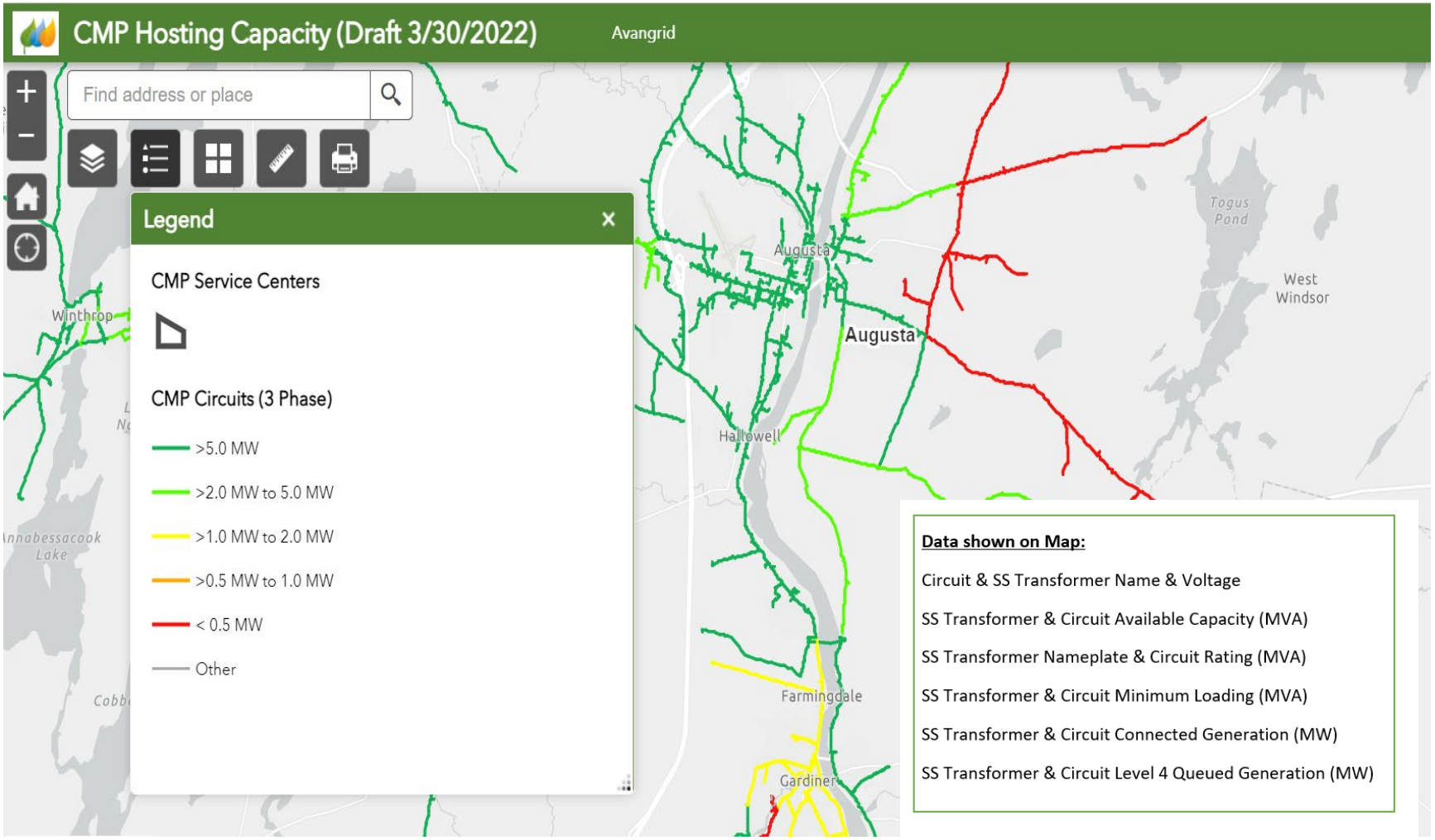


Distribution Automation

- **Worst Performing Service Territory, then Circuit completed first**
- **Customers "zones" within remote control devices**
  - 500 customers and/or "10 miles" (analysis is case by case)
- **Reclosers**
  - Focus on isolating branches
  - Reclosers must coordinate back to substation
- **SCADA Switch**
  - Installed at tie points to let the Network operate remotely
- **Automatic Grid Restoration (AGR)**



CMP Hosting Capacity Maps

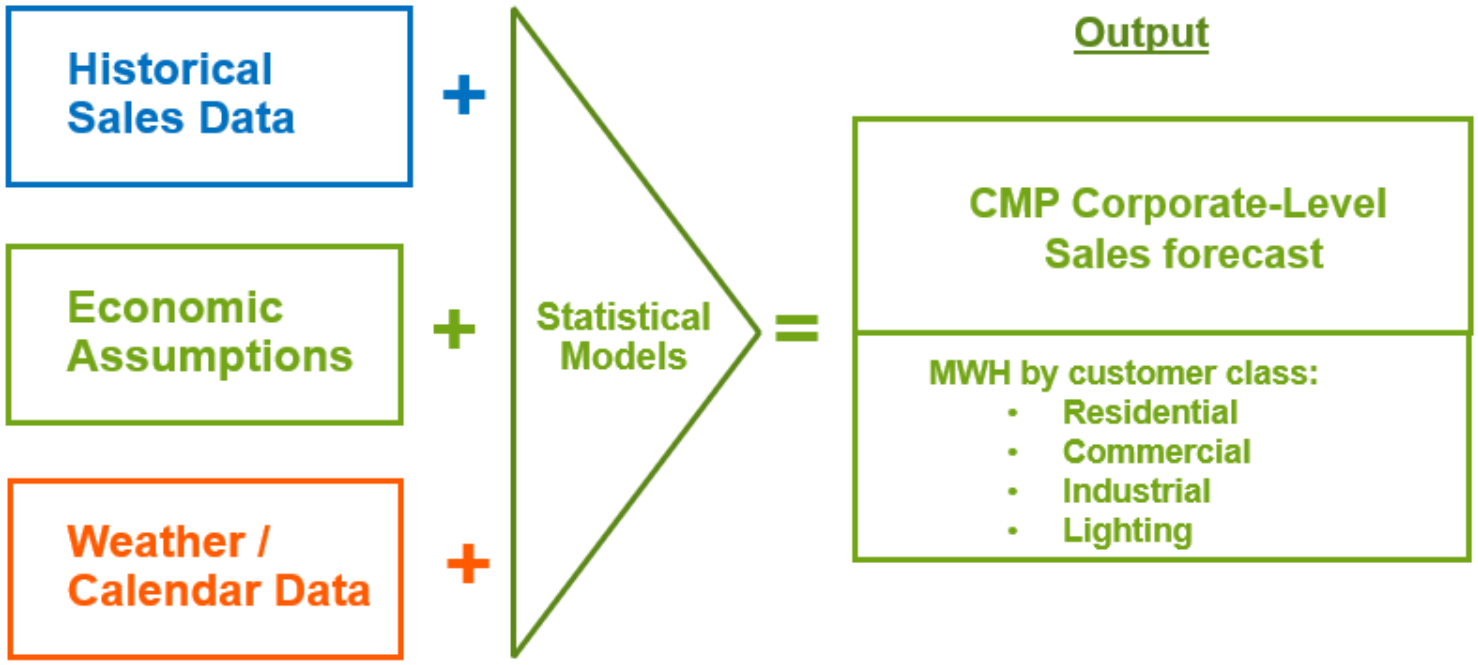


Corporate Level Sales Forecasts

CMP Forecast Process

CMP Corporate-Level Sales Forecasts are developed for each customer class using econometric models

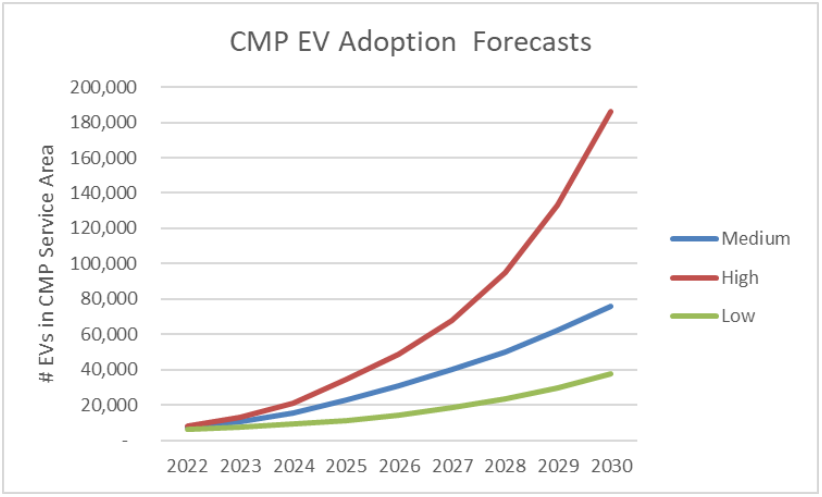
Model Inputs



Forecasting EV Adoption & Load

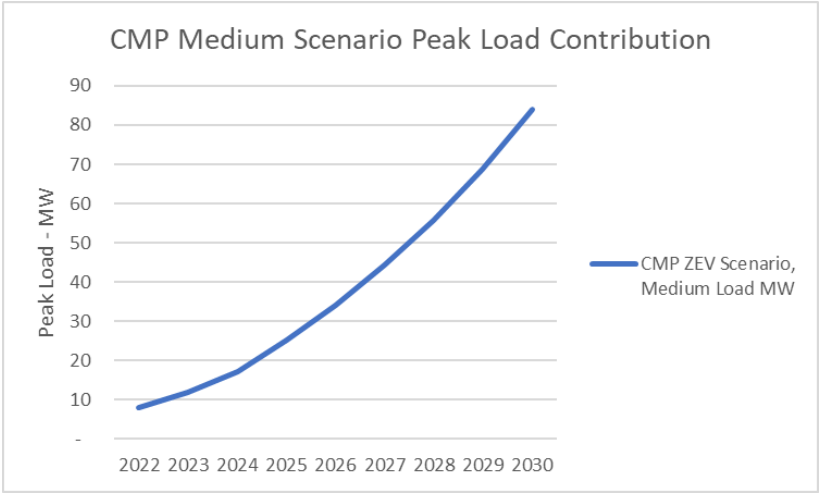
Vehicle Adoption Scenarios

- Medium = Assumes 15% of light-duty vehicle sales by 2025 and 30% by 2030
- High = Aligned with State goals
- Low = 50% of medium scenario



EV Load Forecast

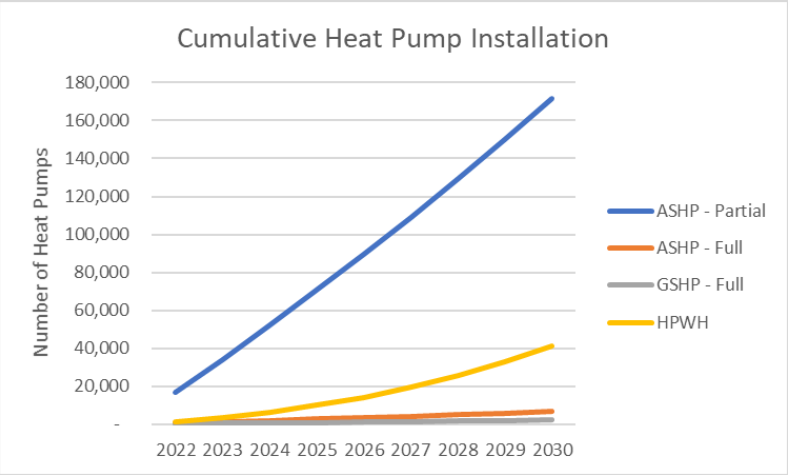
- Forecast uses the medium EV adoption scenario
- Daily load profile based on NREL's EVI Pro Lite tool
- Load is allocated to circuits based on current EV adoption trends



Forecasting Heat Pump Adoption & Load

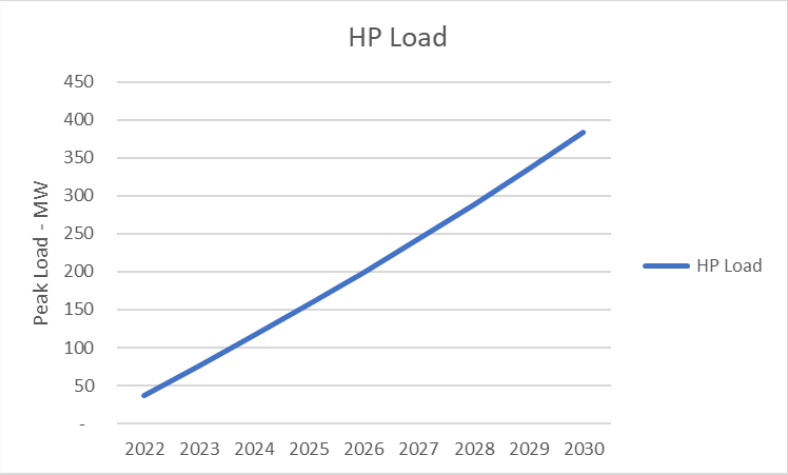
Heat Pump Adoption

- Adoption forecast based primarily on the ISO-NE forecast, which is based on input from Maine



Heat Pump Load Forecast

- Assumes zero net summer load
- Incremental load is toward winter peak
- This is a preliminary forecast
  - Currently studying and developing more sophisticated heat pump load models



Distribution Planning Power Flow Analysis

CYME

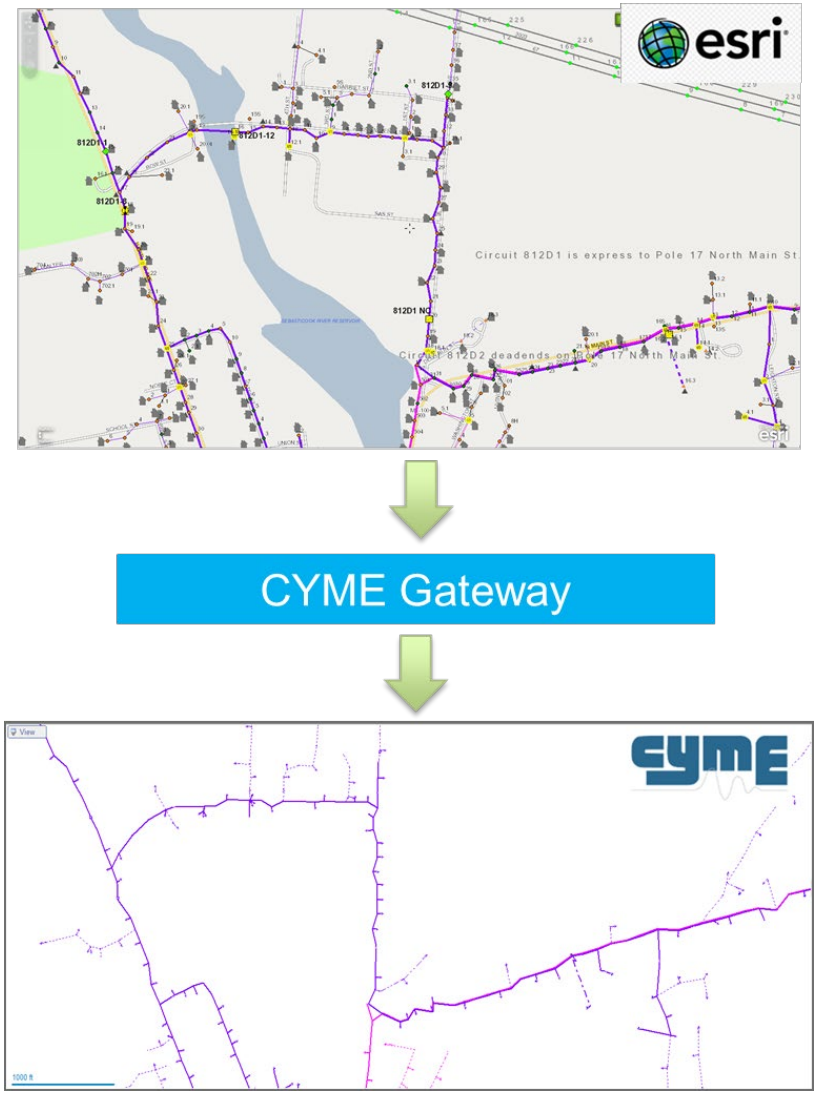
Use Eaton's CYME power flow analysis software for peak and minimum load conditions (static model)

Gateway

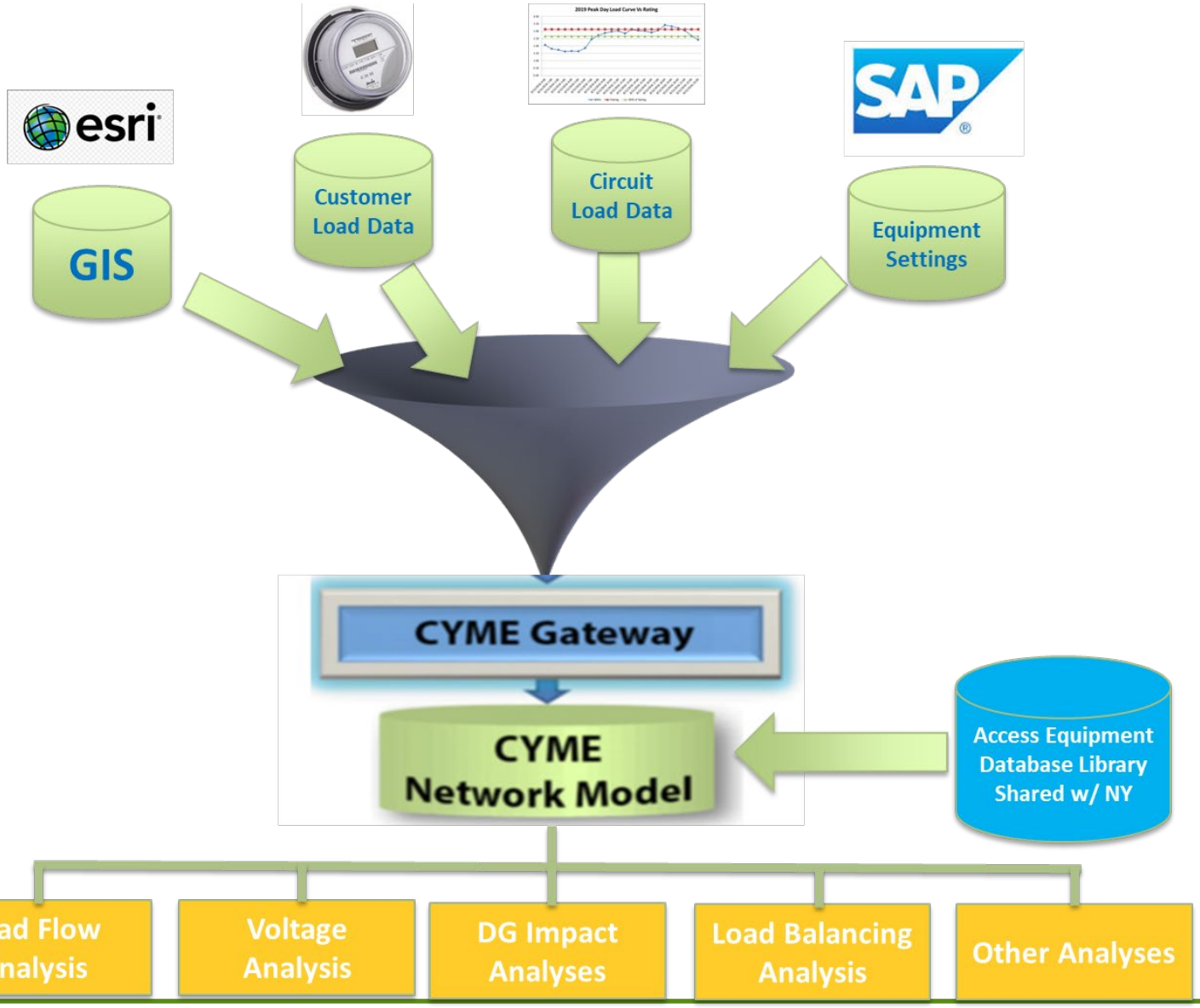
Use CYME Gateway for interface to Company's GIS for electrical connectivity

Load Allocation

Algorithm used to distribute load on a circuit among "spot loads" or transformers. Methodology based on kWh, kW or transformer size.



Distribution Planning Power Flow Analysis



DG Growth in Maine

What is the size of this effort?

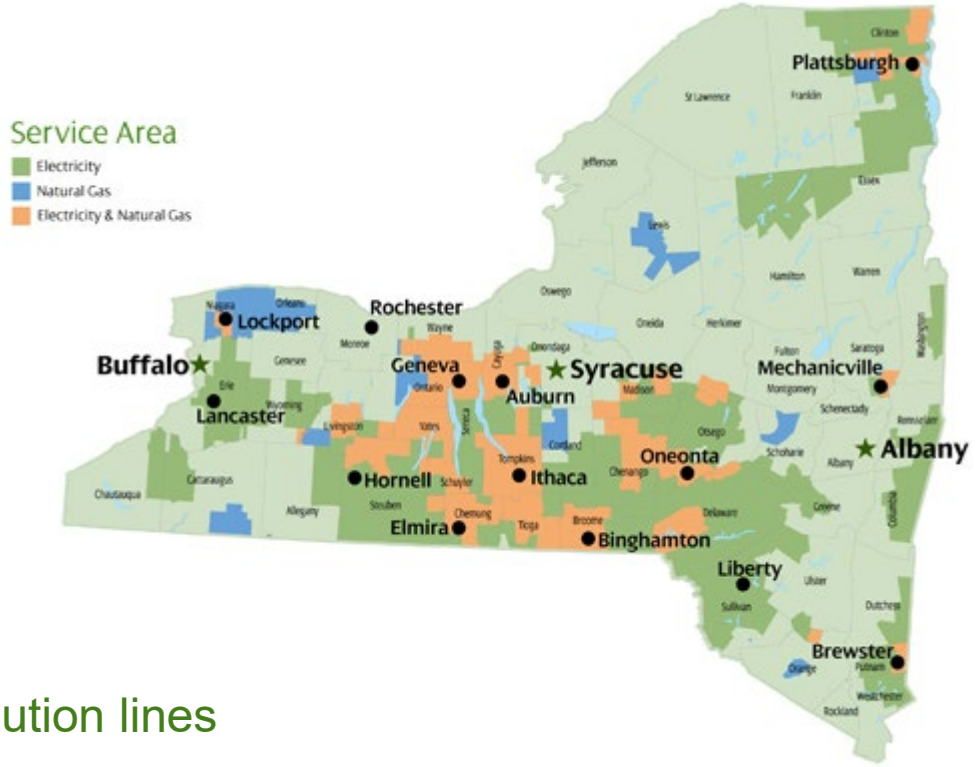
- 715 Applications
- 1,820 MW (surpasses the peak load of CMP)
- 391 Interconnection Agreements
- Over 518 Studies
  - 400 Combined Studies
  - 16 Feasibility studies
  - 96 Restudies
  - 6 Facility Studies
- Supporting the needs of 96 different developers
- Approximately 200 (non-construction) internal and contract resources in place
- Projecting a need of 200 construction crews

Questions?

Extra Slides

Overview of NYSEG System

- ~907,000 electric customers
- ~270,000 gas customers
- ~18,000 square miles
- Serves App. 40% of Upstate New York
- 429 distribution substations
- 963 transformer banks
- 1,389 total circuits



- Approximately 35,000 miles of distribution lines
- Downtown Binghamton and Auburn supplied by underground network system

Overview of RG&E System

- ~385,000 electric customers
- ~319,000 gas customers
- ~2,700 square miles
- Serves areas surrounding City of Rochester
- 156 distribution substations
- 279 transformer banks
- 621 total circuits

- Approximately 8,900 miles of distribution lines
- Downtown Rochester supplied by underground network system