National Association of State Energy Officials

DER INTEGRATION & COMPENSATION INITIATIVE

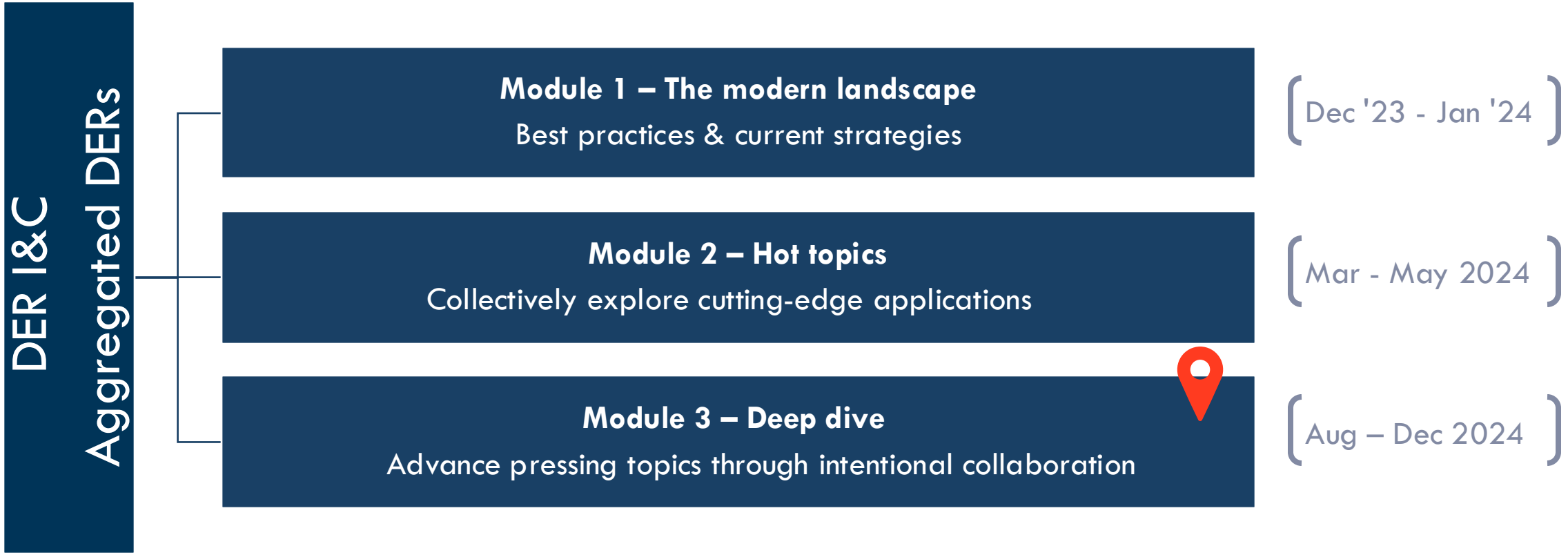
PLANNING FOR A MODERN DISTRIBUTION SYSTEM

WORKSHOP #2

September 17, 2024

Overview of the DER I&C Initiative

The DER I&C Initiative 2023-24 curriculum is designed around three sequential modules



Planning for a Modern Distribution System

Convene and support state members to help build their capacity to effectively plan for and navigate changes across the distribution system.

Objectives:

- Inform key state decision makers
- Raise and evaluate risks and opportunities of options
- Bring different perspectives to the table

Workshop Series Arc

Today's Agenda

Objectives:

- ❑ Expand understanding of the distribution forecasting process and how to interface with a utility's forecast
- ❑ Walk away with at least one actionable guideline or piece of feedback you can provide on a distribution forecast

Agenda:

Time (ET)	Session
2:00-2:10pm	**Welcome:** Overview of today
2:10-2:20pm	**Group Activity:** What questions do you have about load or DER forecasting?
2:20-3:00pm	**Presentation: Load and DER Forecasting,** *Julieta Giraldez*
3:00-3:30pm	**Breakout activity:** Understanding your state's forecasting practices
3:30-3:40pm	**Break**
3:40-4:15pm	**Breakout activity:** Tools for state decisionmakers to engage with utility forecasts and scenarios
4:15-4:30pm	**Reflection, Closing, and what's ahead**

Working Norms

- **Please participate!**
- **Be present**
- **Respect confidentiality**
  - For breakout sessions we will use Modified Chatham House rules: you can say who was there, what was said, but not who said what

Poll

How have you engaged with DER forecasts to date (select all that apply)

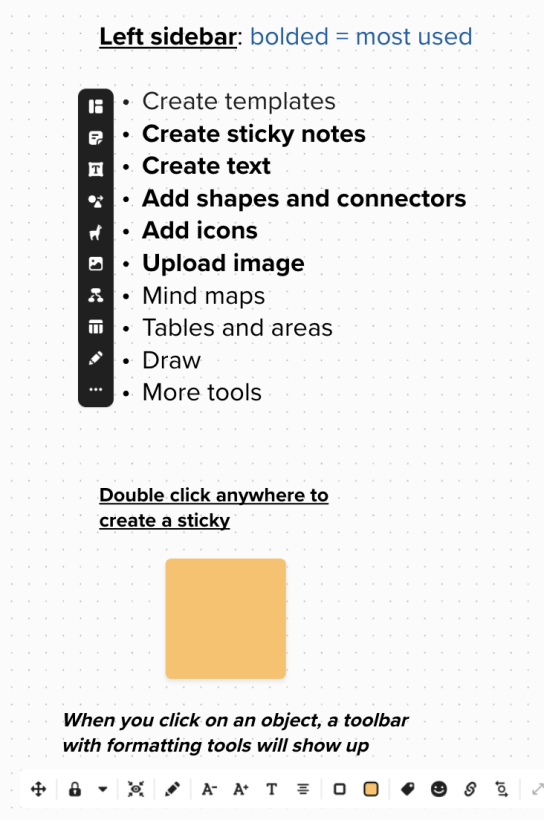
- Seen or engaged with utility distribution-level DER forecast
- Seen or engaged with utility DER forecast (system or territory-wide)
- Engaged in stakeholder meetings on DER forecasting
- Seen or engaged with RTO-wide DER forecasts.
- I have never seen a utility's DER forecast
- Other (please add options in the chat)

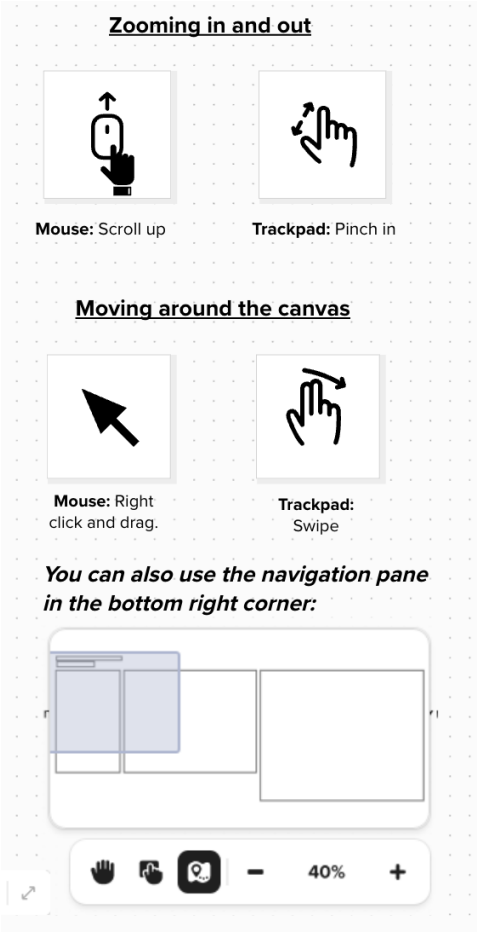
Based on your experience to date with utility forecasting, how would you describe the adequacy of utility forecasts

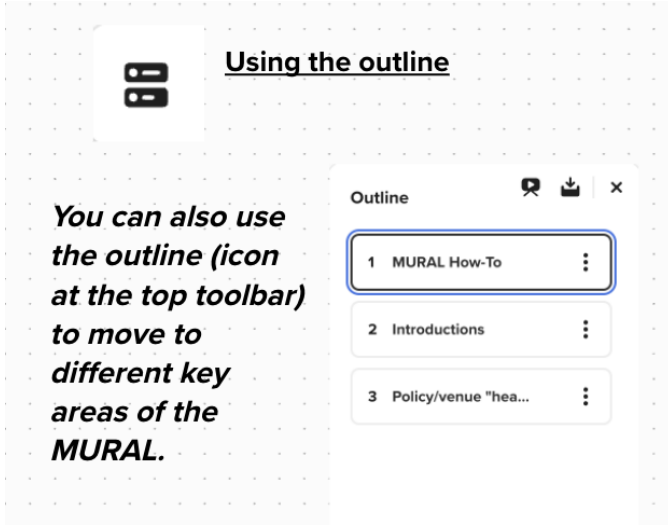
- Utility forecasts are sufficient for modern distribution system planning
- Utility forecasts have been sufficient to date, but are currently unable to accurately account for new technologies and investments
- I don't have sufficient insight into what goes into a utility's forecast to determine if it is sufficient for modern distribution system planning
- Other (please add options in the chat)

MURAL Overview

We'll be using a virtual whiteboarding software known as MURAL. (Link)







Activity: What questions do you have about load and DER forecasting?

- Use MURAL to record questions you have about load and DER forecasting
- You will have an opportunity after Julieta's presentation to ask questions about load and DER forecasts

Load and DER Forecasting

NARUC-NASEO Cohort on Planning for a Modern Distribution System

Presented by Julieta Giraldez, Electric Power Engineers
Prepared for Berkeley Lab

September 17, 2024

This work was funded by the U.S. Department of Energy under Contract No. DE-AC02-05CH11231.

AGENDA

1. **What has changed in load forecasting for distribution planning?**
2. **What is the distribution planning use-case?**
3. **From “base-load” to “net-load”**
   - Base load
   - Economic growth and known new customer business
   - DER forecasting
4. **Future considerations**
   - Scenario planning
   - Climate change and extreme weather impacts

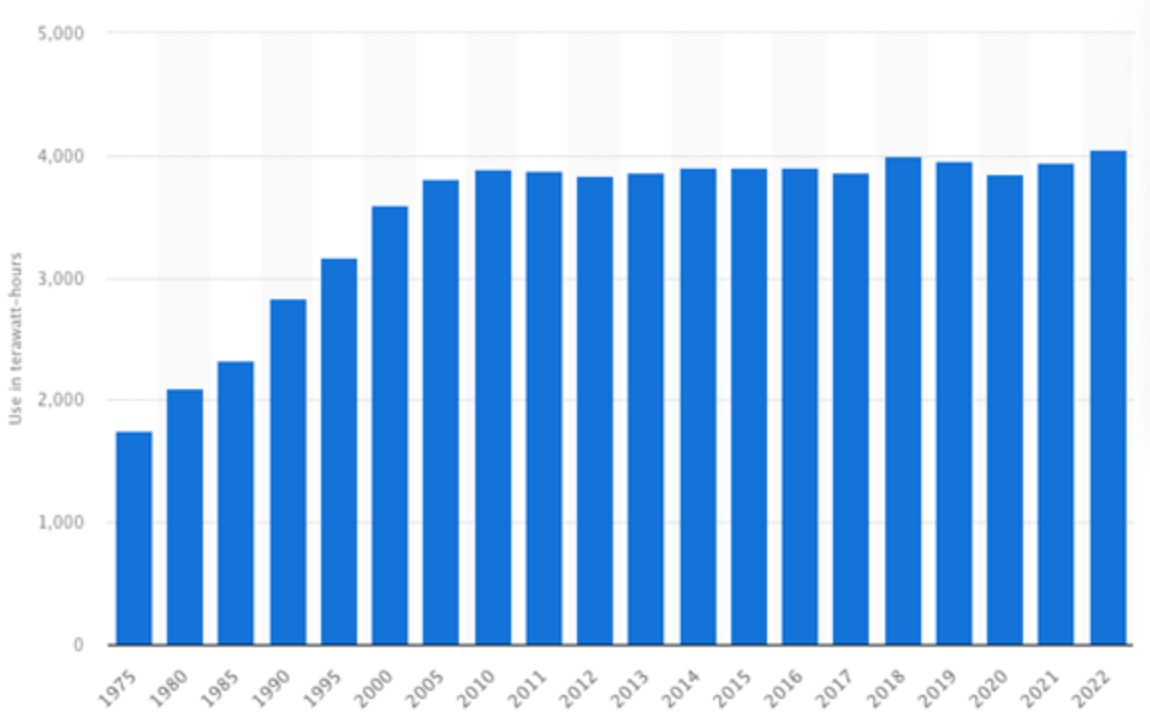
AGENDA

1. **What has changed in load forecasting for distribution planning?**
2. **What is the distribution planning use-case?**
3. **From "base-load" to "net-load"**
   - Base load
   - Economic growth and known new customer business
   - DER forecasting
4. **Future considerations**
   - Scenario planning
   - Climate change and extreme weather impacts

Load Forecasting – What Is the Status Quo?

- **Demand** has been **flat** for the past 20 years
- Utilities had time to **“react”** to local load growth from new customers and businesses
- **Past** consumption was a **good representation** of **future** consumption

Electricity end use in the United States from 1975 to 2022

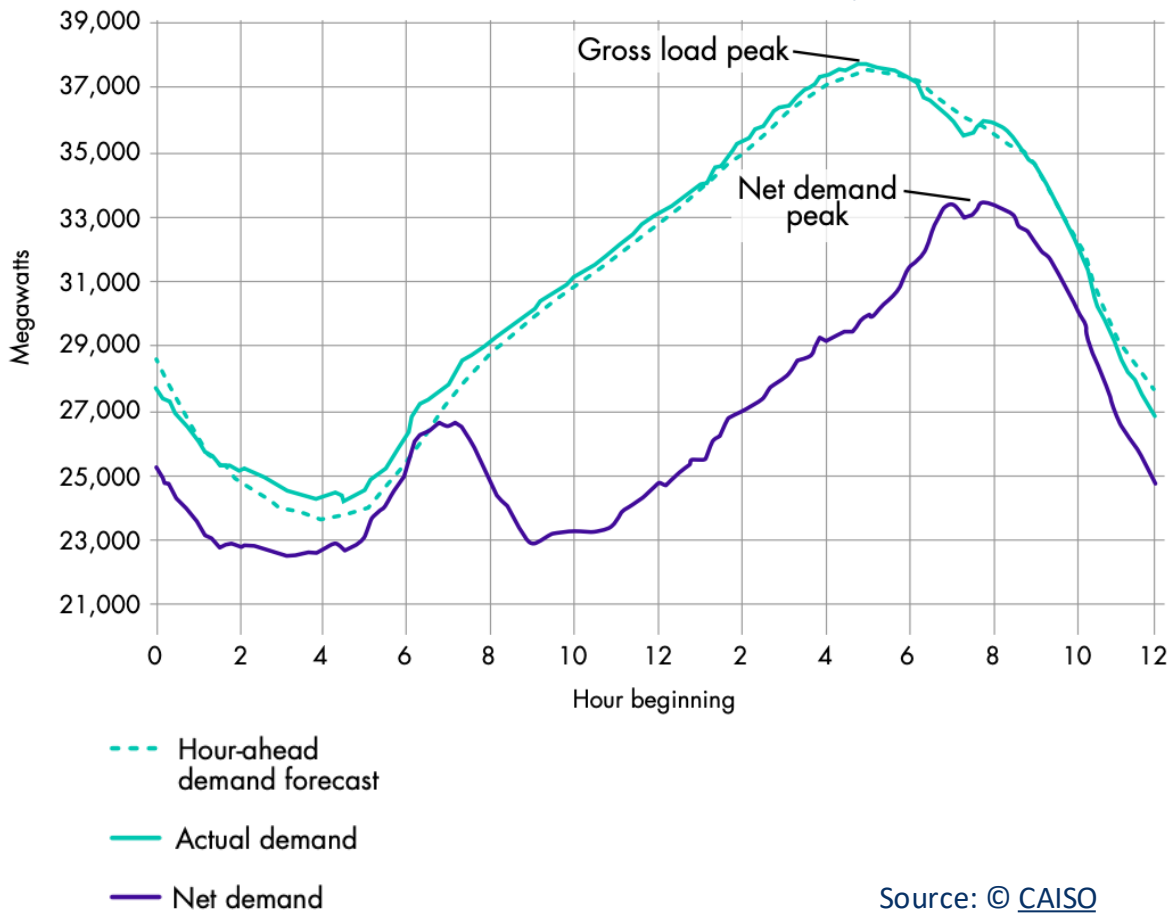


Source: © Statista 2023

Load Forecasting – What Has Changed?

- **Econometric modeling** using historical data (typically load, weather) **is not sufficient** to forecast future load
- **Customers are adopting** new **technologies** behind-the-meter
  - Need to understand *gross load* versus *net load*
  - Need to understand *where* and *when* technologies are being adopted today and in the future
  - *Rapid DER adoption trends* are very different than a new development or business customer
- **Past weather** is **not representative** of future weather

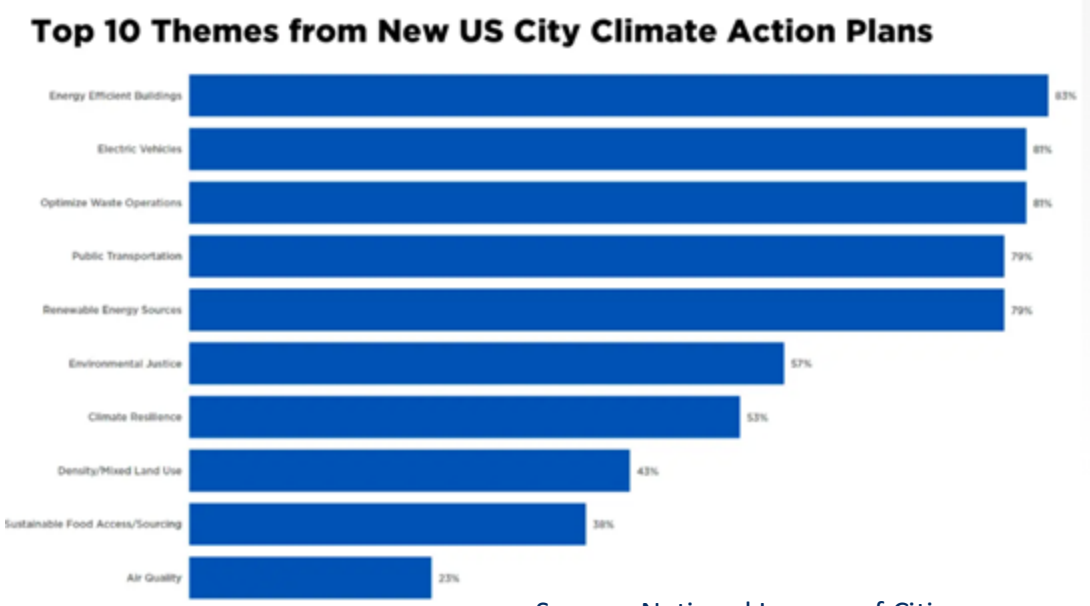
Gross load versus net load example



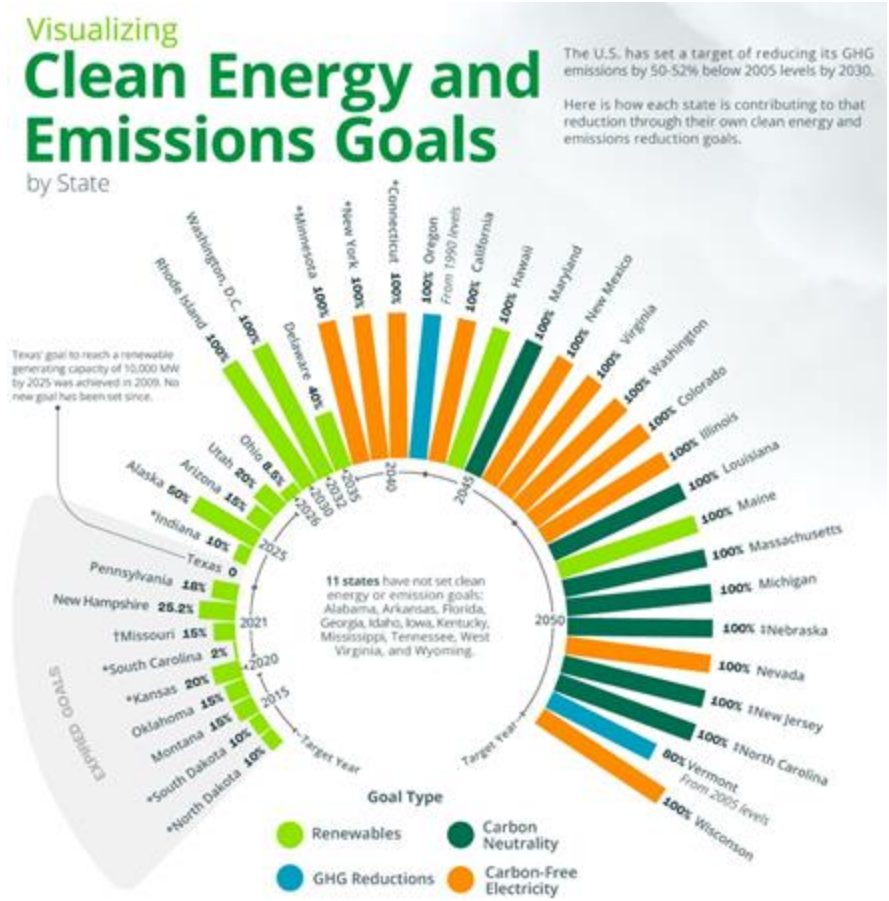
Source: © CAISO

Policy Is Greatly Influencing Load Forecasting

- **DER adoption is heavily influenced by federal/state/local/utility policies and goals**
  - Harder to quantify implications and what is possible
  - Initiatives and programs have to be converted into quantifiable input assumptions on technology adoption, utilization, operation



Source: National League of Cities



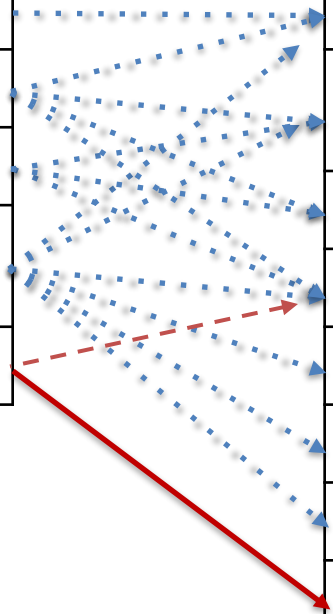
Source: National Public Utilities Council

AGENDA

1. What has changed in load forecasting for distribution planning?
2. **What is the distribution planning use-case?**
3. From “base-load” to “net-load”
   - Base load
   - Economic growth and known new customer business
   - DER forecasting
4. Future considerations
   - Scenario planning
   - Climate change and extreme weather impacts

Who Performs Load Forecasting?

Forecasters
Research organizations
State energy offices
Independent system operators
Utilities – load forecasting departments (typically, the rates department)
Utilities – distribution planning department

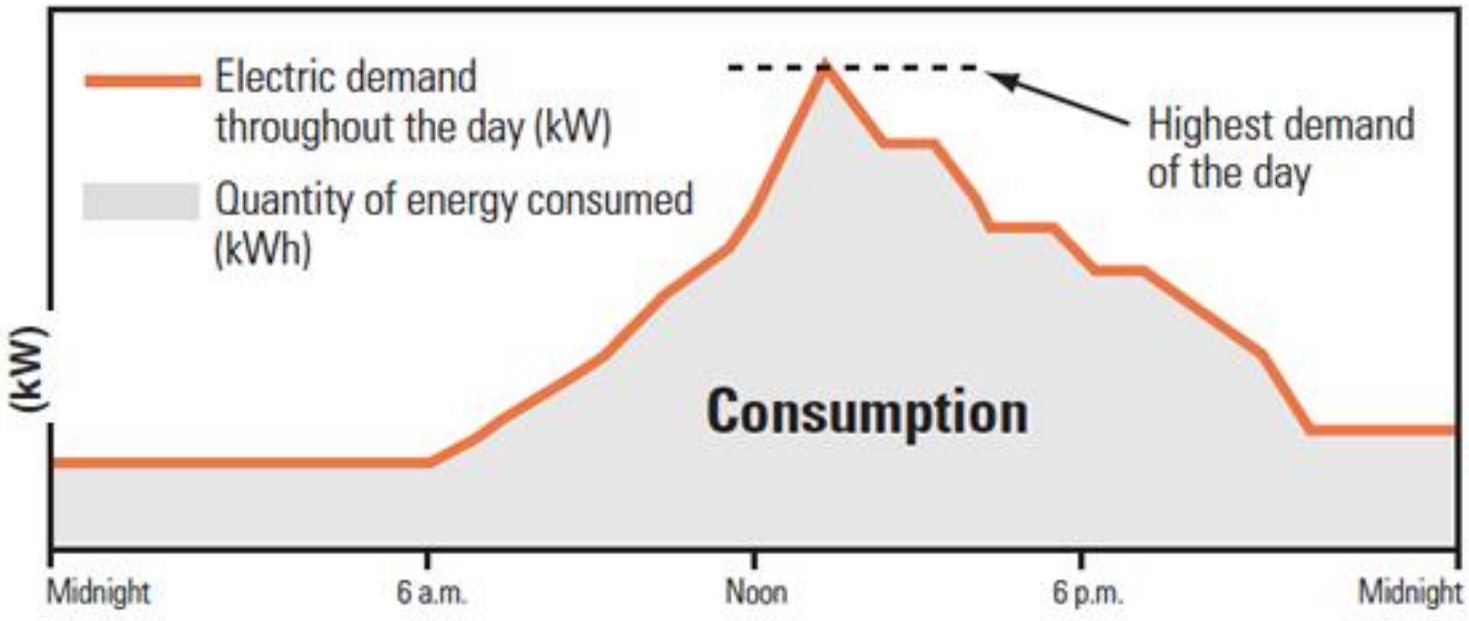


Use Cases
National and state studies
Integrated resource planning, renewable portfolio standard plan
Resource adequacy
Transmission planning
Rate design
Corporate forecast & revenue projections
Procurement
Distribution planning

Distribution planning has traditionally not used the forecast from the load forecasting department.

Peak versus Energy Load Forecasting

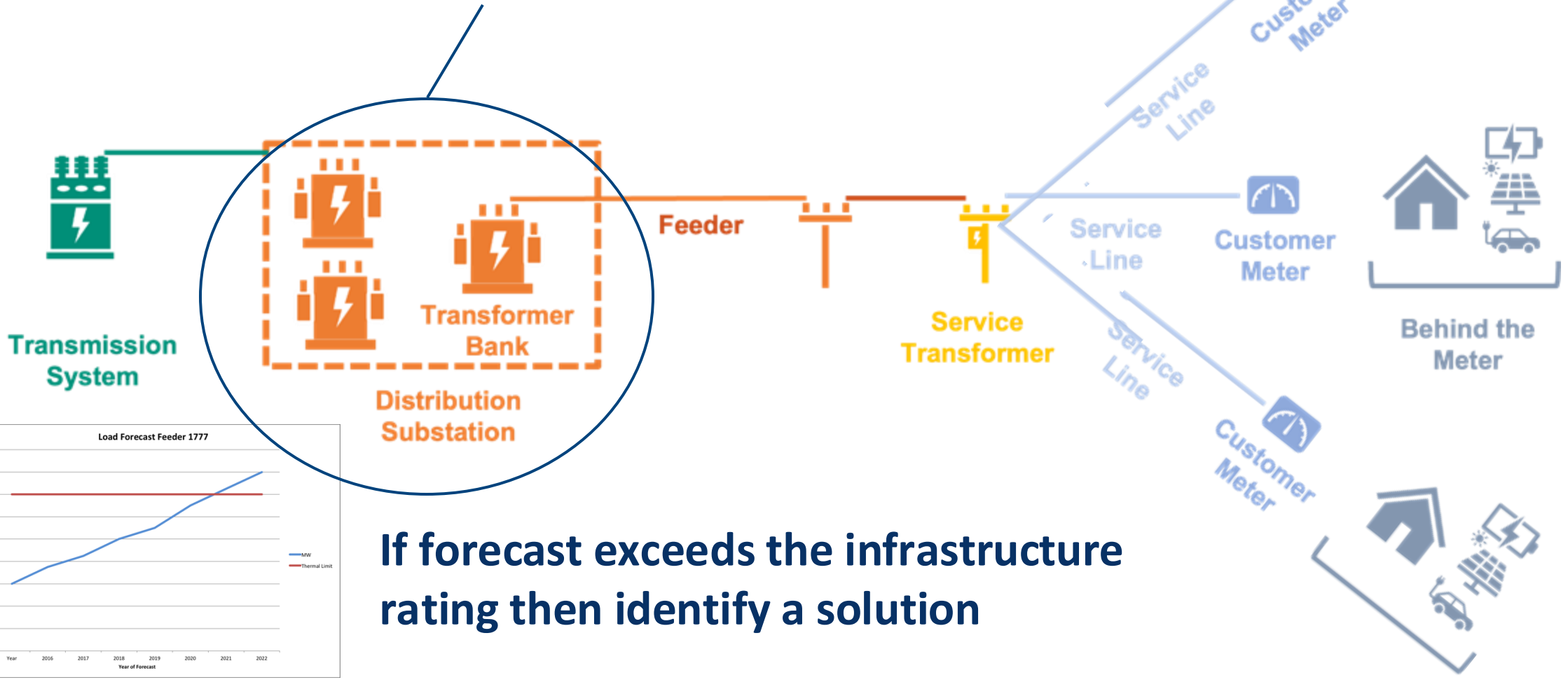
- Load forecasting departments at utilities typically forecast energy and demand separately
- **Distribution Planning** has traditionally only been concerned about **substation/ feeder peak load** to determine how big the infrastructure needs to be

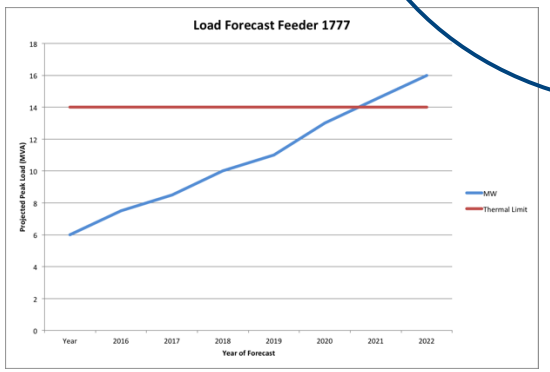


Source: We Energies

Use-Case: Capacity Planning

"Long-Term" Capacity Planning (5-10 years): thermal evaluation at the substation or feeder-head level.





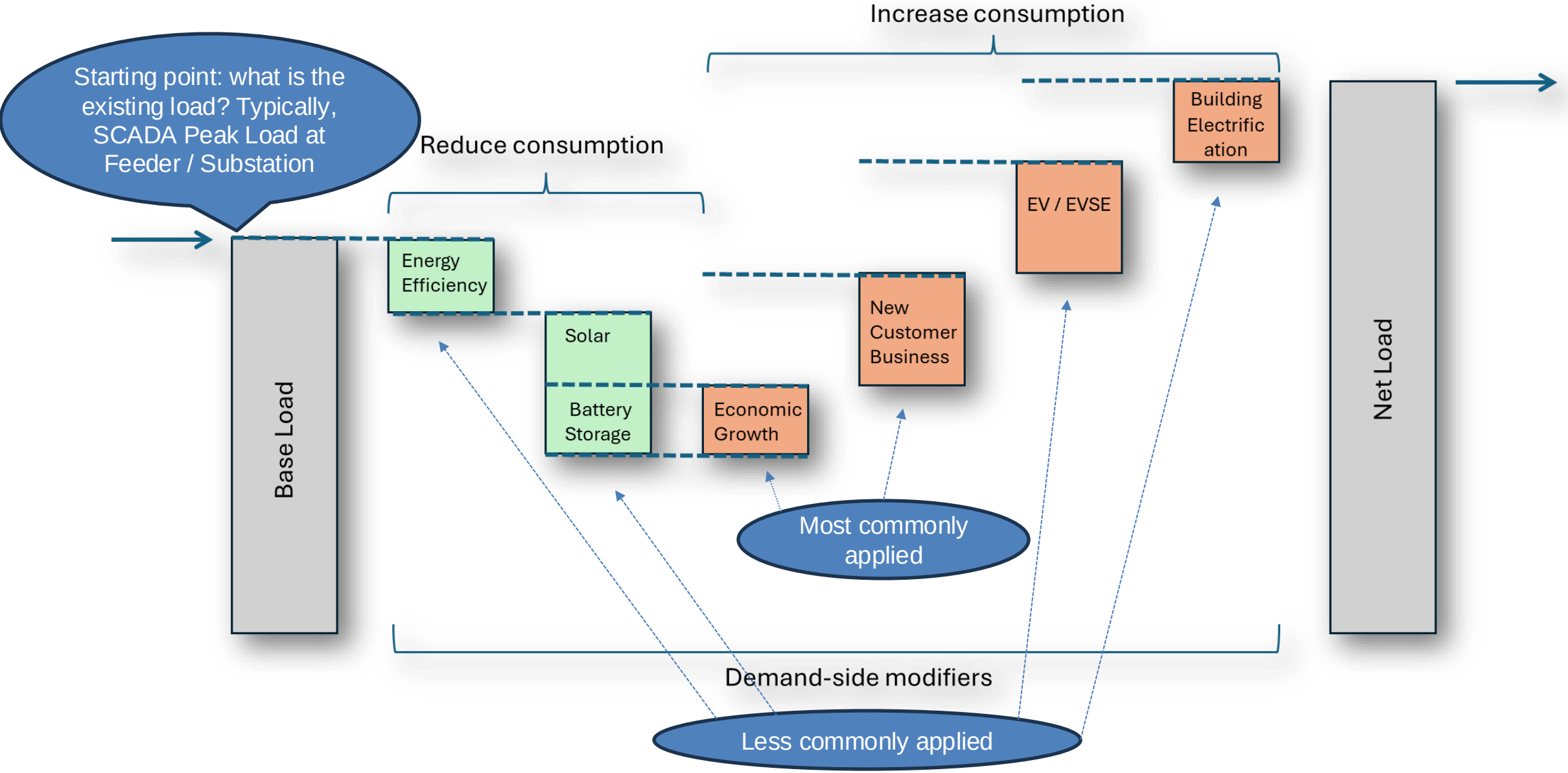
If forecast exceeds the infrastructure rating then identify a solution

Source: Adapted from Kevala and Distribution System Planning 101

AGENDA

1. What has changed in load forecasting for distribution planning?
2. What is the distribution planning use-case?
3. **From "base-load" to "net-load"**
   - Base load
   - Economic growth and known new customer business
   - DER forecasting
4. Future considerations
   - Scenario planning
   - Climate change and extreme weather impacts

From Base Load Forecasting to Net-Load Forecasting



Questions to Ask regarding Base Load Forecasting

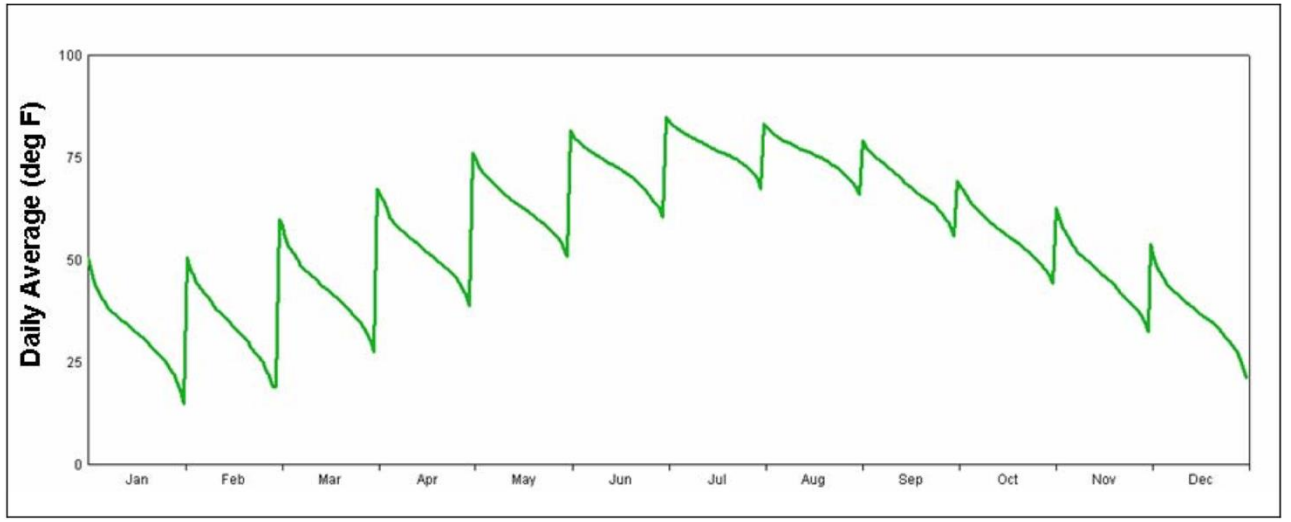
- How is SCADA data cleaned or processed?
- Is the load weather normalized?

Questions to Ask regarding Economic Growth

- Where is the percent growth assumption coming from?
- Do you perform econometric trend analysis? If so, what variables and data are used in the model?

Weather Normalization

- **Weather normalization is a process that adjusts actual energy or peak outcomes to what would have happened under normal weather conditions**
  - Normal weather is also used to develop the base forecast of future energy use
  - Weather normalization is used to increase the expected load in the future
- **Actual weather data varies from year to year and it is chaotic every year**
  - There are annual cycles, but within each cycle, there are bursts of warm and cool weather

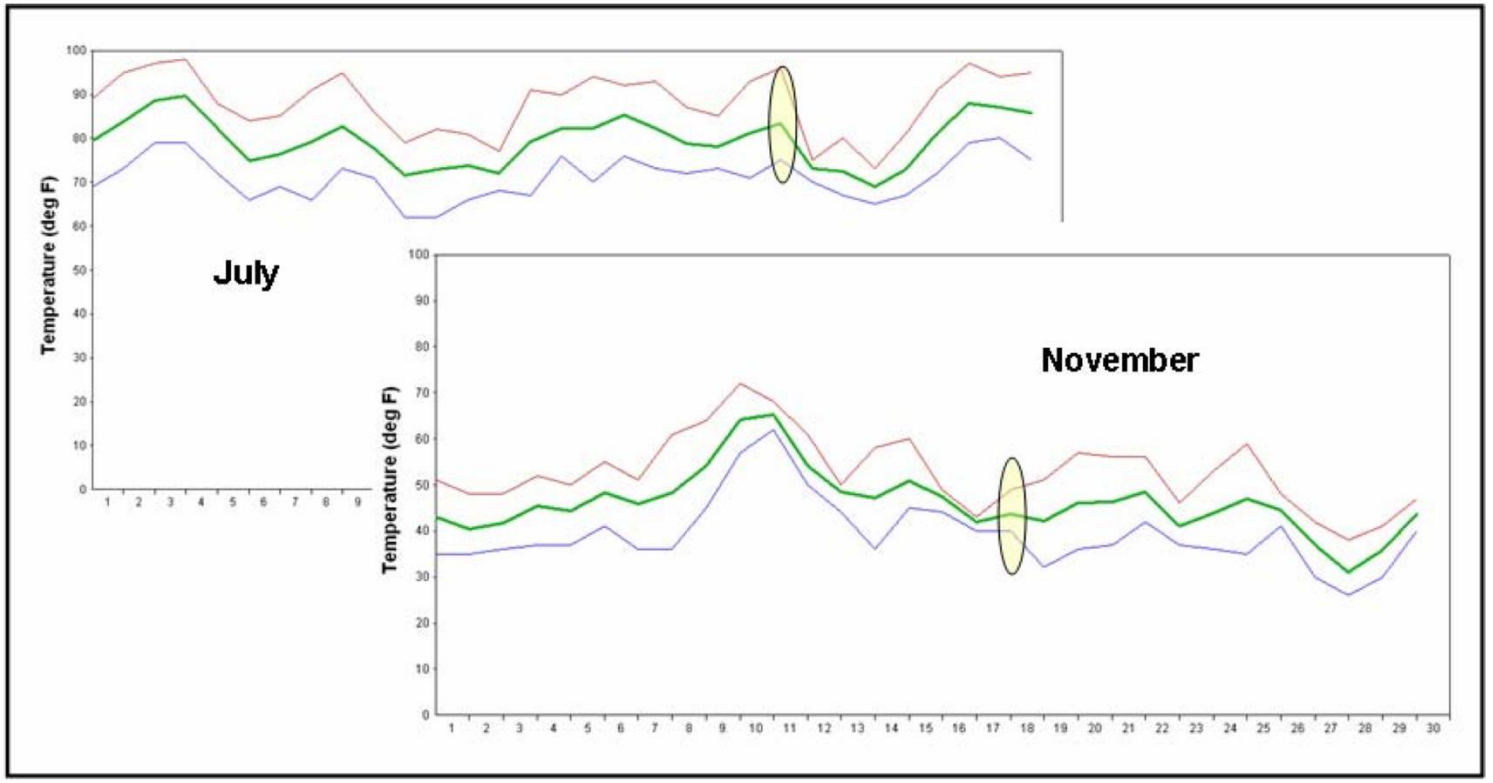


Source: Itron. Example of weather normalization, ranking the data within each historical season and then averaging across days in the season.

- **Peak loads are driven by strings of extremely hot days in summer and extremely cold days in winter. It is impossible to predict exactly when these patterns will occur, but they do occur every year**
  - In some years, the extremes are more extreme than in other years
  - In some years, the extremes occur on weekends and do not affect peak energy use

Peak Producing Normal Weather

- **Peak producing weather is not necessarily the weather on the hottest day in summer or the coldest day in winter**
  - Prior day weather matters as well as the timing of weekend days and holidays
- **To define normal peak producing weather by month or by season, identify actual system peak days, and use the weather on these days and on preceding days.**



Source: Itron

Questions to Ask Regarding New Customer Business Load Additions*

- **How are large load additions defined and tracked?**
  - For example, new C&I development, upgrades to existing sites, large multi-unit residential developments, grid-charging battery storage, or EV charging sites ~ > 500 KW
  - Tend to be heterogeneous, and do not lend themselves to trending based on history
  - Heavily reliant on customer-provided information
- **Increasing concern in many states on proactive planning for step-loads due to economic development, transportation electrification and data centers**

* Also called “Step-Loads,” “Planned Loads” or “Known Loads

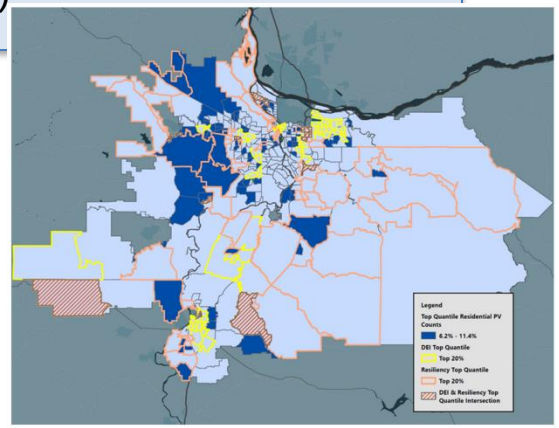
DER Forecasts – Methodology Design Elements

DER Disaggregation Techniques

Source – Forecasting Load on Distribution Systems with DERs

Proportional Allocation

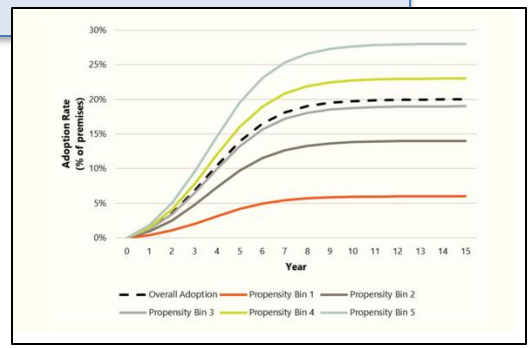
- Allocates system-level DER forecast to individual circuits using specific local distribution data
  - Proportional to Load
  - Proportional to # of Customers
  - Proportional to Existing DER
- Another approach is to use adoption patterns of one technology (e.g., PV) to drive adoption for another (e.g., energy storage)



Solar PV Locational Adoption PGE

Propensity Models

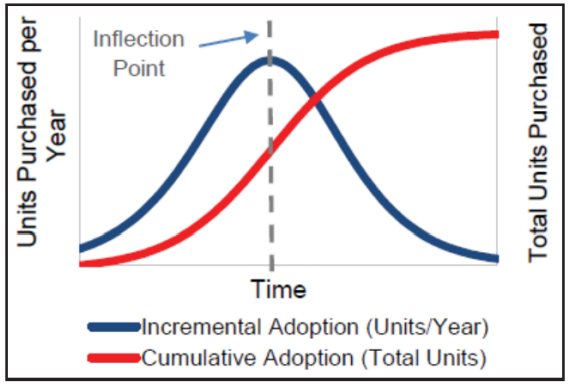
- Propensity models use customer characteristics to compute a propensity score. Based on the score, a fraction is computed as the ratio of the score for that area divided by the sum of scores across all areas.
- For example, the propensity model can be estimated using ZIP code data where the models relate historical adoption to customer characteristics in each ZIP code.
- Statistics- based (Regression and ML)



PGE Propensity Scoring Results

Adoption Model

- This uses a bottom-up adoption approach based on adoption patterns and estimated adoption model parameters.
- These models are S Curve-based. They forecast technology adoption based on characteristics of early adaptors, market factors, and adoption rates, applied to the remaining potential.



Generalized S-Curve Model
Source SCE DFWG Progress Report

Source PGE Load and DER forecast

Questions to Ask Regarding DER Forecast

- Where do the targets **for DERs come from**?
- What **DERs are explicitly forecasted** and modeled in the peak load forecast?
- Is 8,760 hourly behavior modeled or value contribution to adjust peak load?
- What are the behavioral assumptions to determine DER profiles?

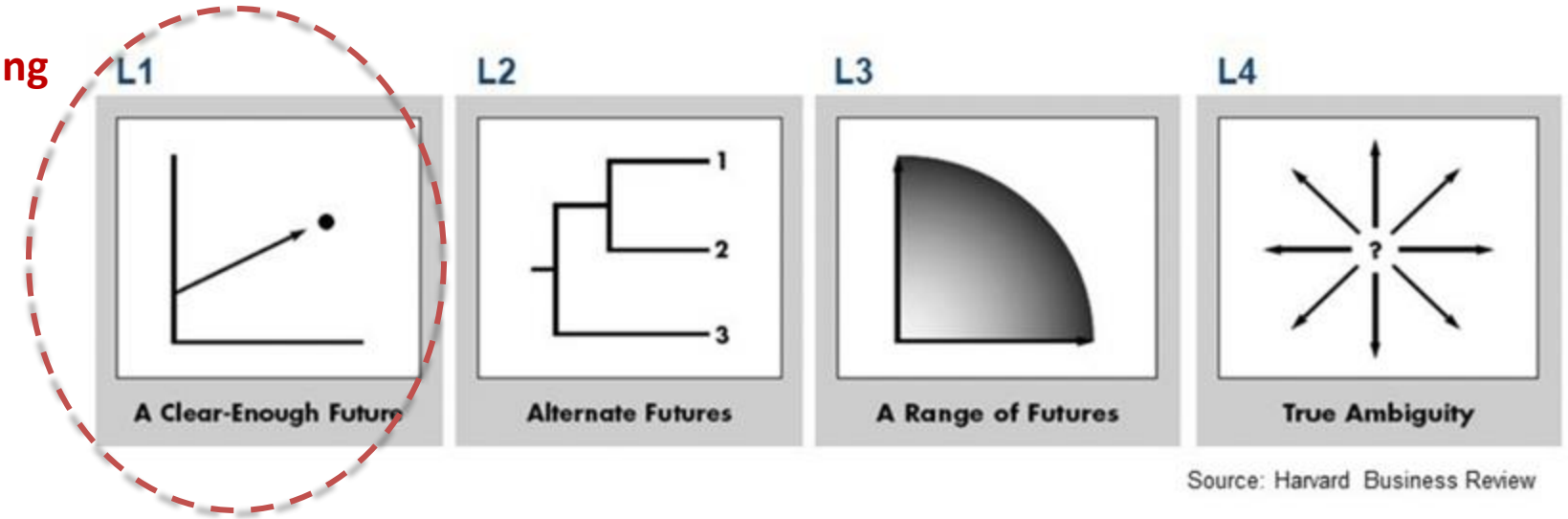
AGENDA

1. What has changed in load forecasting for distribution planning?
2. What is the distribution planning use-case?
3. From “base-load” to “net-load”
   - Base load
   - Economic growth and known new customer business
   - DER forecasting
4. **Future considerations**
   - Scenario planning
   - Climate change and extreme weather impacts

Policy Is Greatly Influencing Load Forecasting

- **Need to plan for longer time horizons**
  - Distribution planning has typically looked 3-5 years ahead
  - Long lead time on grid assets and transmission constraints are increasing the pressure on distribution planning
- **Need to consider multiple scenarios**

Distribution Planning



Source: Harvard Business Review

Scenario Modeling

Scenario modeling

- Examines how different variables could shape future DER adoption and subsequent **system needs as a whole**
- Attempts to forecast for **multiple potential pathways** in order to **inform investment plans**
- Varying factors like technology adoption rates, economic conditions, and policy changes provide a range of possible outcomes.
    - Example: Solar adoption under varying compensation structures

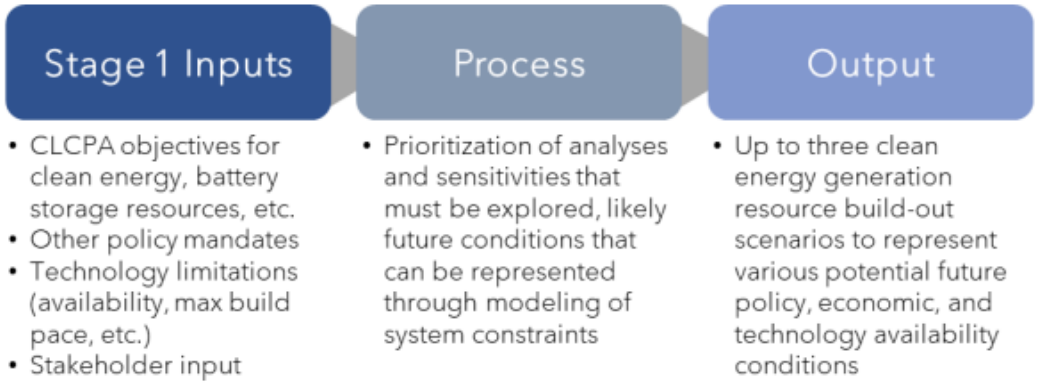
Key Components of Scenario Modeling

- **Adoption Rates -** Analyzing how quickly consumers might adopt various DER technologies under different circumstances.
- **Technological Developments -** Considering advancements in DER technologies and their potential effects on adoption and efficiency. For instance, developments in EV technologies have greatly impacted EV uptake and consumer behavior changes.
- **Policy and Regulatory Changes** - Assessing the impact of potential future policy shifts, building code requirements, and other regulatory changes.
- **Market Dynamics** - Understanding how changes in energy prices, consumer preferences, and economic conditions could influence DER growth.
- **Incentive Structure** – Assessing how different incentive and pricing changes can impact DER growth, including time of use rates and PV and EV incentive programs.

General Goals

- **Identify "no regret" investments -** Focus on actions and investments that will be beneficial across most/all potential future scenarios
- **Prepare for the future** - Prepare for longer-term needs that may arise, "future-proof" when making investment decisions.
- **Facilitate goal achievement -** Make investments necessary to facilitate reaching goals where appropriate

NY Coordinated Grid Planning Process
Stage 1 – Build-Out Scenarios



Source: [Link]

Future Weather

- Statistical load forecasting based on historical load and weather events will miss extreme future weather events

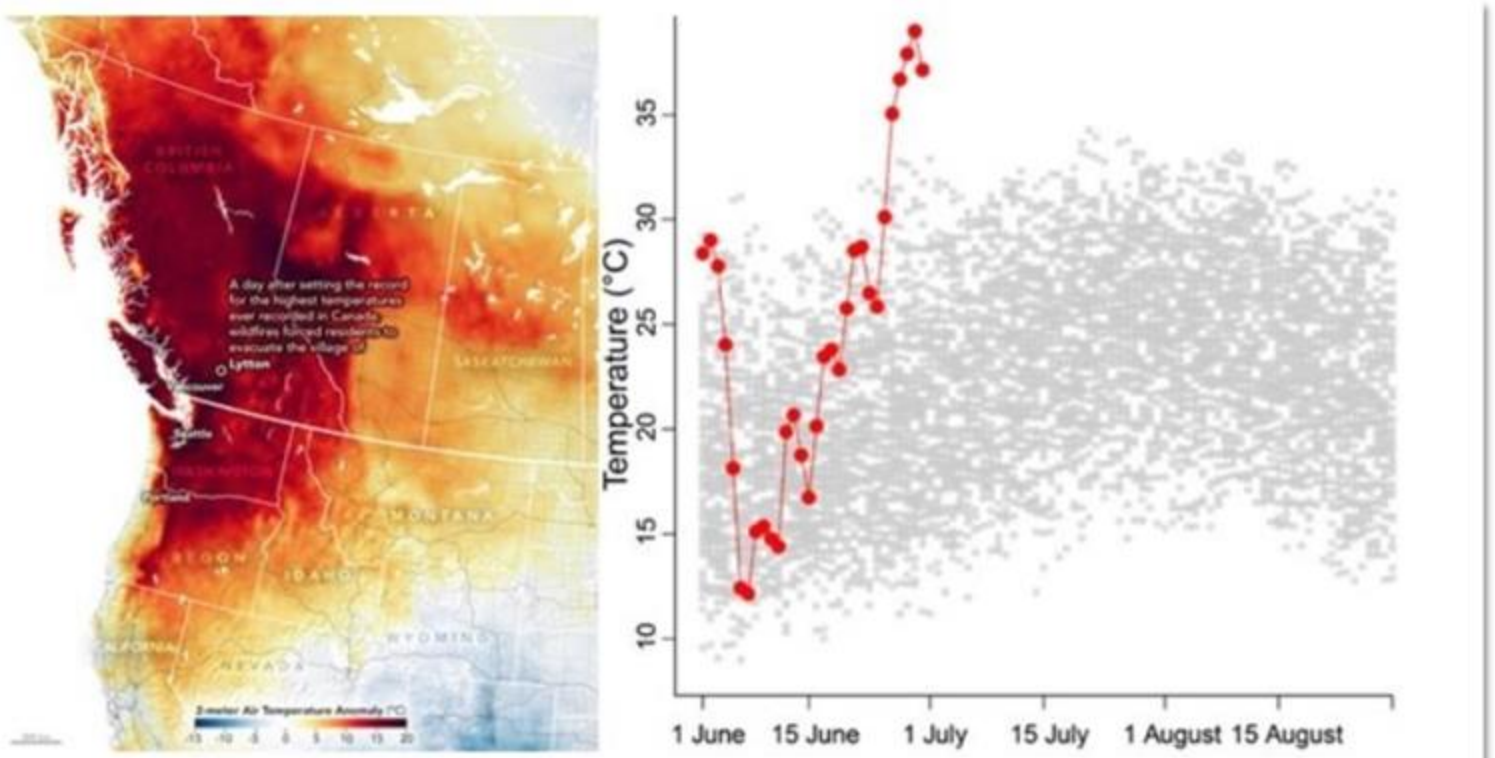


Figure1: (left) Temperature anomalies during the 2021 Pacific Northwest heatwave (NASA 2021) and (right) area-average temperatures in 2021 (red) compared to the period 1950-2020 (grey dots) in ERA5 reanalysis (plot by Erich Fischer).

Questions to Ask

- Do you perform a **single point peak load forecast**, or do you consider a range of **scenarios** and **probabilistic methods** to determine infrastructure needs?
- What **weather data** is used in your distribution planning load forecast? Does it include the **effects of climate change**?

Best Practices

- **Best practices / Low-hanging fruit improvements**
  - Weather normalize the peak load
  - Map customer counts by service class to substations/circuits to apply load and DER growth rates by service class
  - Use DER / technology adoption models
  - Use load-shapes or directly leverage customer AMI
  - Perform 8760 forecast of load and DER versus impact to peak load only
  - Forecast multiple scenarios to proactively identify infrastructure that might be at risk of over or under prediction

Thank you!

jgiraldez@epeconsulting.com

Q&A

- Use the chat function to type out your answer
- Use the “Raise Hand” feature on Zoom to elevate your question
- Come off mute to ask your question

Breakout Overview

- **Breakouts until 4:15 pm**
  - Breakout 1: 3-3:30 pm
  - Break: 3:30 – 3:40 pm
  - Breakout 2: 3:40 – 4:15 pm

Breakout 1

Assigned breakouts:

- You will be assigned to a room with ~8 other participants to discuss how your states' forecasts compare to best practice and think through how you would like forecasting to advance in your state

Break
See you at the :43!

Breakout 2

Self-select breakouts:

- **Join the breakout group covering the topic that's most relevant to your work today or in the future**
- *Try to have ~8-10 people in a breakout. If you see one is crowded, please select another. We will provide a summary of what all breakouts covered after the workshop!*

Breakout Group Topic	Breakout Group Name	Mural Label
Distribution Load Forecasting	Group 1: Load Forecasting	Group 1: Load Forecasts (Jeff)
Distribution DER Forecasting (1)	Group 2: DER Forecasting (1)	Group 2: DER Forecasts 1 (Kirsten)
Distribution DER Forecasting (2)	Group 3: DER Forecasting (2)	Group 3: DER Forecasts 2 (Avery)
Distribution Scenarios	Group 4: Scenario Development	Group 4: Scenarios (Cara)
Distribution Load Forecasting (2)	Group 5: Load Forecasting	Group 5: Load Forecasts 2 (Stephanie)

What's Ahead

- We will send out a workshop "report-out", summarizing what we have covered today along with today's slides and additional resources folks can access
- Next workshop is on Thursday October 10, 2-4:30 pm ET
  - We will cover tools and analyses relevant to evaluating key distribution plan decisions

Thank you for joining today!

Upcoming members-only NARUC-NASEO Events:

In person:

- NARUC Cybersecurity Training for State Regulators
  September 24-26, 2024 - Philadelphia, Penn.
- NASEO 2024 Annual Meeting
  September 29-October 2, 2024 - New York Hilton Midtown, New York, New York
- National Council on Electricity Policy Annual Meeting
  October 29-30, 2024 – Phoenix, Arizona
- NARUC 2024 Annual Meeting
  November 9-13, 2024 – Anaheim Marriott Anaheim, California

CONTACT US

Kirsten Verclas
Senior Managing Director, Electricity and Energy Security
NASEO
kverclas@naseo.org

Danielle Sass Byrnett
Senior Director, Center for Partnerships & Innovation
NARUC
dbyrnett@naruc.org

Rodney Sobin
Senior Fellow
NASEO
rsobin@naseo.org

Jeff Loiter
Technical Director, Center for Partnerships & Innovation
NARUC
jloiter@naruc.org

www.naruc.org/core-sectors/energy-resources-and-the-environment/der-integration-compensation/