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Northwest **Power** and **Conservation** Council

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August 6, 2024

MEMORANDUM

TO: Council Members

FROM: Steven Simmons

SUBJECT: Overview of the New Long-Term Load Forecasting Model

BACKGROUND:

Presenter: Steven Simmons, Senior Energy Forecasting Analyst
Michael Russo, Senior Forecast Consultant, Itron Inc.

Summary: This presentation will provide an overview of the new, long-term load forecasting model, and review upcoming data updates.

In June of 2023, Council contracted with Itron Inc. to develop a new forecasting model. The project kicked off in the fall of 2023 and has now been delivered. This model provides a significant upgrade in load forecasting capabilities at the Council. In particular, the tool set will enhance analysis of regional load growth stemming from electric vehicles and data centers, as well as provide significantly finer locational analysis.

Relevance: Per the Northwest Power Act, as part of its regional power plan, the Council is required to develop and include “a demand forecast of at least twenty years...”. In addition to producing the long-term demand forecast, data from the load forecast is used to inform the energy efficiency and demand response potential assessments, capital expansion modeling, the market price forecast, and the resource adequacy studies.

Workplan: B.1.1 Update load forecasting capabilities to better reflect the current power system.

Background: The Council's 2021 Northwest Power Plan identified several dynamic changes taking place across the west that impact our power system. In particular the potential for large future load growth from the electrification of buildings and vehicles and emerging data center growth. Given this dynamic change and the potential interactive effects, the 2021 Power Plan called on the Council to develop new load forecasting tools that would improve modeling of this interaction.

More Info: For further background, please see the following presentations to the Council:

https://www.nwcouncil.org/fs/18658/2024_03_p2.pdf

https://www.nwcouncil.org/fs/18575/2024_01_p3.pdf

https://www.nwcouncil.org/fs/18335/2023_06_6demand.pdf

https://www.nwcouncil.org/fs/18252/2023_04_2.pdf

Long Term Load Forecasting

August 13, 2024

Steven Simmons

Michael Russo

Tomás Morrissey



Northwest **Power** and
Conservation Council

AGENDA

1. Introduction and background
2. Mike Russo from the Itron Energy Forecasting Group
3. Overview of the new forecasting tool set
4. Next work and wrap up

Demand Forecasting at the Council

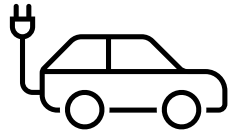
The Northwest Power Act specifies that the Power Plan include a ***demand forecast of at least twenty years***

Load Forecasts are used in many of our analytical and planning processes

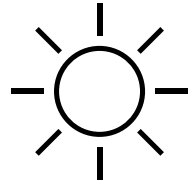
1. Energy Efficiency
2. Resource Adequacy
3. Wholesale Electric Price
4. Capital Expansion

The forecast is used to help evaluate what resources best meet regional needs, with an emphasis on conservation as a resource

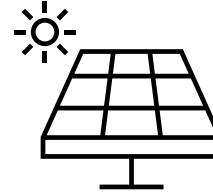
The Evolving Demand Picture



Electric cars, trucks, buses - growing demand + charging impacts on winter & summer peaks



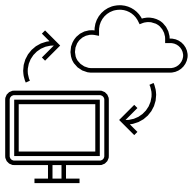
More air conditioning units and energy use - summer peaks



Decline in PV cost - seeing growth in rooftop solar in the NW



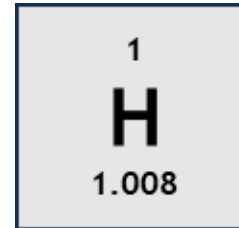
Demand under climate change scenarios



Data centers & chip fabrication driving energy demand growth



Building electrification & heat pumps - energy and winter peaks



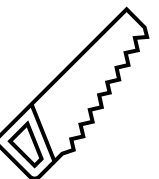
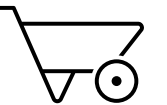
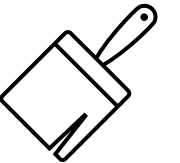
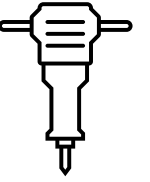
Potential for new energy demand required to produce green hydrogen



Uneven demand growth and locational value

RE-MODEL REQUIRED

- March of 2023 – completion of the project to identify and select a new forecasting tool suite with
 - Long-term annual and monthly end-use forecasting with hourly capability
 - Ability to incorporate new demand trends
 - Finer geographic resolution
 - Streamlined process and software to allow more frequent forecast cycles and sustainability
 - Strong technical support and an established user base
- June of 2023 - authorization to contract with ITRON Inc. to provide a new forecasting framework to support long-term electricity demand forecasting
- September 2023 project kickoff
- July 2023 – forecasting suite in place



- Done
- In progress
- Starting soon
- Not yet started

Milestone 1

- Weather zones by BA
- Weather response functions by BA
- Normal weather by BA
- Typical weather by BA

Milestone 2

- Residential end-use indices by building type
- Commercial end-use indices by building type

Milestone 3

- Industrial intensities by market segment
- Data Center indices by BA
- Behind the Meter Solar (PV) forecast of capacity by BA
- Electric Vehicle Forecast by BA

Milestone 4

- Monthly SAE Model by BA
- Apply Energy Efficiency Estimates
- Annual end-use forecast by building type and BA

Milestone 5

- Hourly end-use forecast by BA
- Forecast reports
- Training



ITRON FORECASTING SERVICES

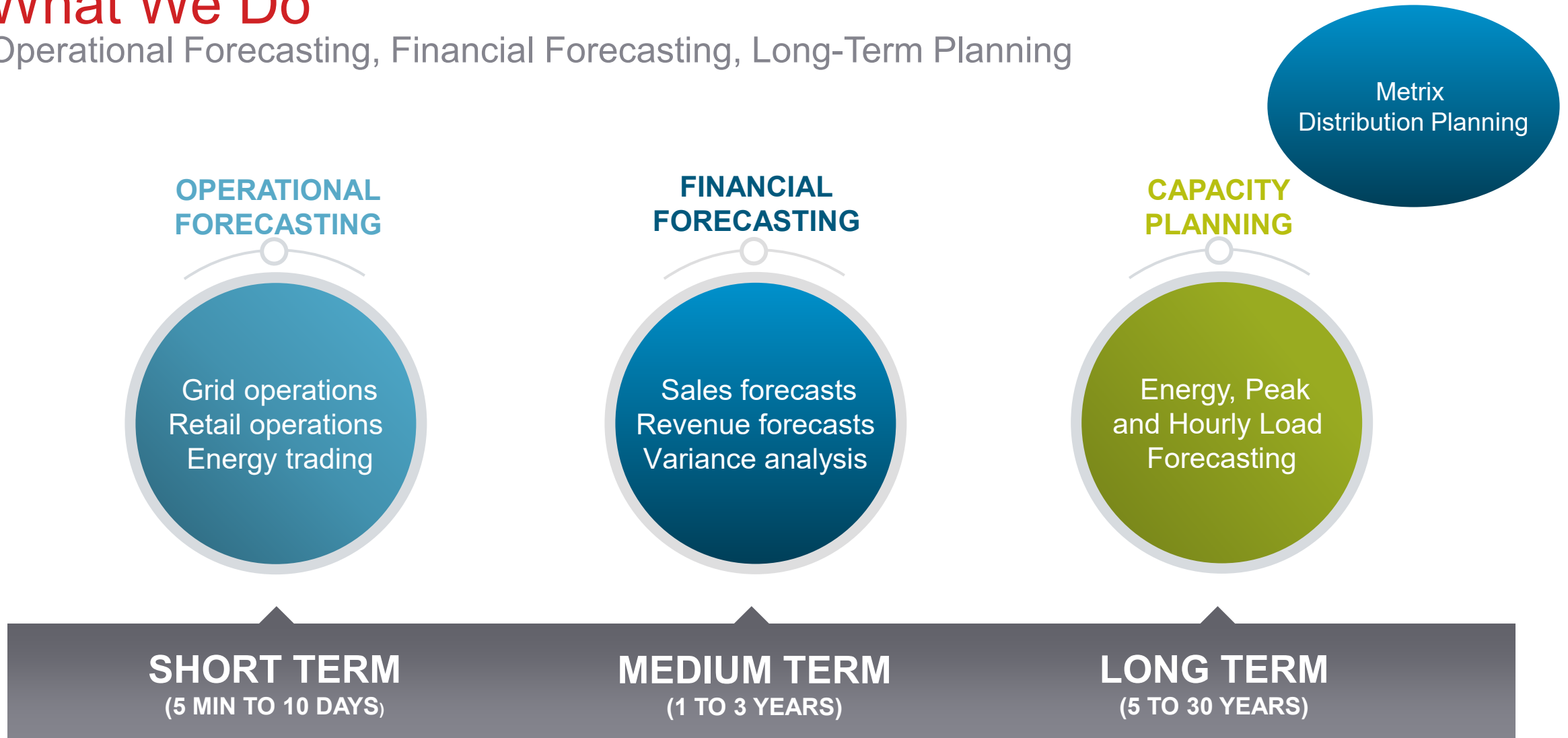


Itron Forecasting Solutions

Software, Services, Customers

What We Do

Operational Forecasting, Financial Forecasting, Long-Term Planning



What We Provide

Software, Services, Expertise



SOFTWARE

Automated Forecasting System

- » High frequency forecasting
- » High volume forecasting

Statistical Package

- » Time series modeling
- » Widely used for energy forecasting

Time-series Database

- » Manage data and forecasts
- » Transform and organize data

Load Research System

- » Sample Design
- » Sample Expansion



SERVICES

Forecast Process Review

Forecast Process Update

Support and Training

Staff Supplementation

Forecast Outsourcing

Forecasting as a Service

Subscription Services



EXPERTISE

Statistics

Economics

Energy data

End-use data

Load research

Hourly modeling

Time series analysis

Industry best practices

Who Are Our Customers

North America	North America	North America	North America	North America	APAC/EMEA
AEP	City of Palo Alto	Eversource	Midwest ISO	Puget Sound Energy	AEMO
AESO	City of Roseville	Exelon Corporation	Minnesota Power	Regiona of Peel	British Gas
Alabama Power company	Clark Public Utilities	First Energy	Mississippi Power and Light Company	Sacramento Municipal Utility District	CEZ
Alectra Utilities	CMEEC	Flathead Electric Coop	Missouri Public Service Commission	San Diego Gas & Electric	ENGIE
Allegheny Electric Cooperative Inc.	ComEd	Florida Power & Light	Missouri River Energy	San Francisco Public Utilities Commission	Ergon
Alliant Energy	Con Edison	FortisAlberta Inc.	MRES	SaskPower	Eskom
Ameren	Constellation	GDF Suez North America	Municipal Gas Authority of Georgia	SCANA	GRTgaz
Associated Electric Cooperative Inc.	Consumers Energy	GDS Associates, Inc.	National Grid	SDG&E	Hydro Tasmania
Austin Energy	Cooperative Energy	Georgia Power	NB Power Corporation	Silicon Valley Clean Energy	Tenaga Nasional Berhad
Avangrid	CPS Energy	Grant County PUD	Nebraska Public Power District	Snohomish Puplic Utilty District	Uniper Benelux
Avant Energy	Dairyland Power Cooperative	Great River Energy	New York ISO	South Mississippi Electric Power	Vattenfall
B.C. Hydro Power & Authority	Distributie Energie Oltenia SA	Hawaiian Electric Co.	New York ISO	Southern Company	
Baltimore Gas & Electric Company	Dominion Energy	Hetch Hetchy Water & Power	Noble Americas Energy Solutions LLC	SOUTHSTAR ENERGY	
Barbados Power & Light	DTE Energy	Hoosier Energy Rural Electric Coop.	Northern California Power Agency	Tampa Electric Company	
Basin Electric Power Cooperative	Duke Energy	Hydro One	Nova Scotia Power, Inc.	Tennessee Valley Authority	
BC Hydro	Duquesne Light	Hydro Ottawa	NPPD	The Barbados Light & Power Co. Ltd.	
Bear Valley Electric	East Kentucky Power Cooperative	Hydro Quebec	NRG Energy	TXU Energy	
BG&E	East Texas Electric Cooperative	Idaho Power	NV Energy	Union Gas Ltd.	
Big Rivers Electric Corporation	EDESUR (Dominican Republic)	IESO	NYSEG	United Illuminating Company	
Bonneville Power Administration	Electric Reliability Council of Texas	Illinois Municipal Electric Agency	Omaha Public Power District	Vectren Corporation	
Burlington Electric Department	ElectriCities	Indianapolis Power & Light Company	Oncor Electric Delivery Co.	Vermont Public Power Supply Authority	
California ISO	Empire District Electric Company	ISO New England	Ontario Power Generation, Inc.	Wabash Valley Power Association	
Calpine	Enbridge Gas Inc.	Kansas Electric Power Cooperative	Orlando Utility Commission	WAPA	
CenterPoint Energy	Energy Future Holdings/Luminant	Lakeland Electric	Otter Tail Power Company	WEC Energy	
Central Electric Power Cooperative, Inc.	Energy Harbor LLC	LG&E	Owensboro Municipal Utilities	Xcel Energy	
Central Hudson Gas & Electric	Energy Services Group	Liberty Utilities	PacifiCorp	Yukon Electric	
Central Main Power	Enersource	Los Angeles Dept of Water & Power	PJM		
Central Municipal Power Agency Services	ENMAX	Luminant Energy Company LLC	PNGC Power		
City of Concord, NC	Entergy	Manitoba Hydro	Portland General Electric		
City of Lakeland	Evergy	MidAmerican Energy	PPL		

Forecasting Products

Itron Statistical Forecasting Engine

MetrixND

MetrixND is Itron's statistical forecasting application. It is used as a desk-top application and as a calculation engine through its automation interface.

Tested & Proven Forecasting Methods

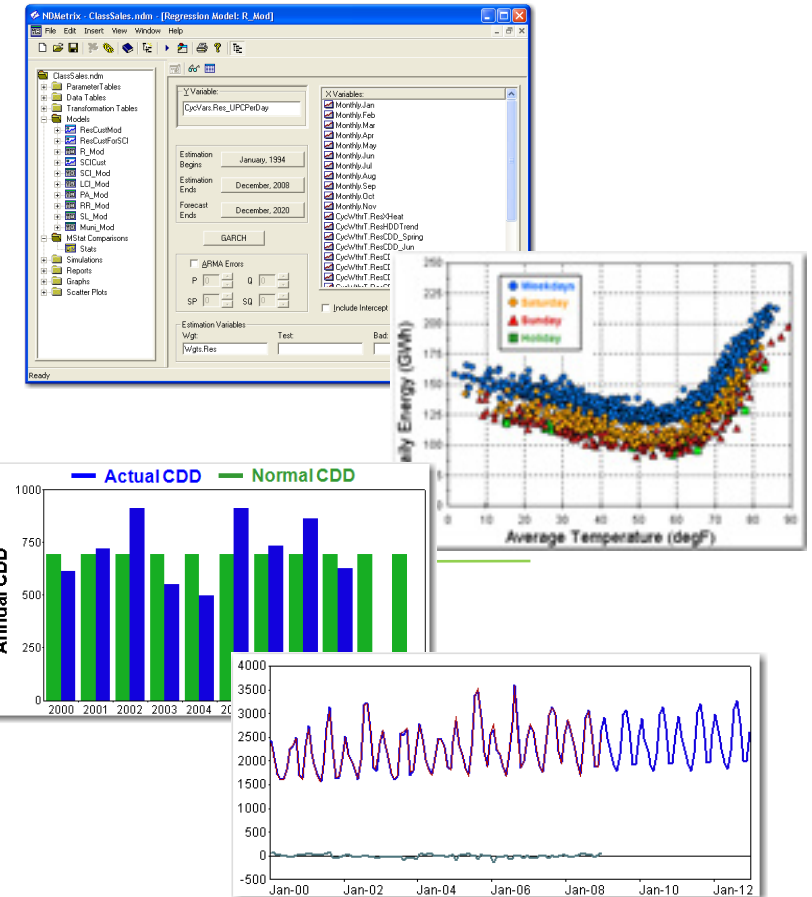
- » Exponential Smoothing, Time Series (ARIMA)
- » Multivariate Regression with time series errors
- » Neural Networks with time series errors

Improved Forecast Accuracy & Data Analysis

- » Tailor models to fit the problem and data
- » Create transformed variables on the fly
- » Include ARMA error correction in regression and neural networks
- » GARCH option quantifies forecast volatility

User Interface to Organize Forecast Processes

- » Explorer type folders, multiple windows in workspace
- » Multiple data frequencies (annual to sub hourly)
- » Single-click graphical analysis
- » Integrates with Existing Databases



Used By: Energy forecasters for hourly, sub-hourly, daily, weekly, monthly and annual models of loads, prices, generation & revenue.

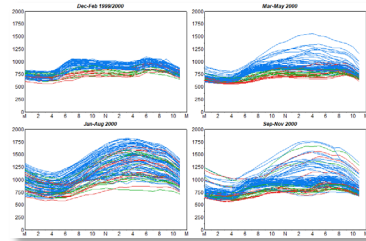
Long-run Load Shape Toolkit

MetrixLT

MetrixLT is a desk-top application for long-term load-shape modeling using bottom-up logic.

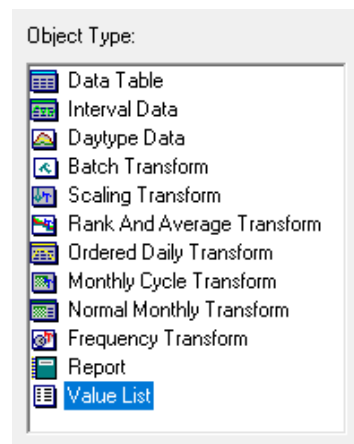
Key Features

- » Interval data tables
- » Interval data transforms
 - Form based
 - Calibrate & combine
 - Scale to system
- » Cycle transforms
- » Normal weather: smooth and scenario



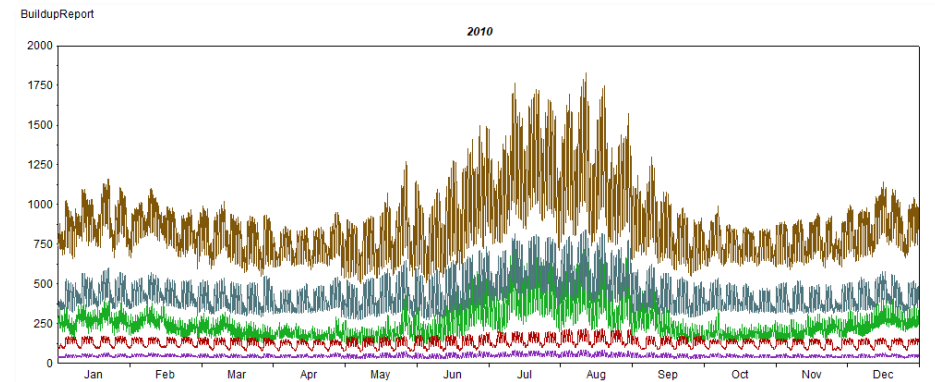
Objects

- » Data tables
- » Interval data tables
- » Form-based transforms
- » Normal weather
- » Cycle transforms
- » Frequency transforms
- » Reports



Use Cases

- » Weather processing
 - Compute normal weather
 - Rotate weather scenario
 - Compute billing month weather
- » Bottom-up hourly forecasts
 - Calibrate to monthly MWh, MW
 - Adjust for losses
 - Combine across classes
 - Technology scenarios
- » Top-down hourly forecasts
 - Calibrate class load to MWh
 - Scale to system load forecast
- » Frequency transforms
 - Interval to daily, monthly, ...
 - Find peaks and CPs
- » Interfaces
 - Import from MetrixND, XLS, ...
 - Data source for MetrixND



Used By: Energy forecasters and system planners for long-run hourly load-shape modeling.

Itron Load Research System

LRS

System to develop efficient statistical samples and to estimate customer load profiles with the greatest possible accuracy and confidence.

Sample Design

- » Design efficient Load Research samples
- » Track and maintain samples

Sample Data Analysis

- » Visual inspection, statistics reports
- » Screen data and mark intervals for exclusion
- » Model based validation and filling

Sample Expansion

- » Mean per unit, combined ratio, separate ratio estimates
- » Domains analysis for user-defined domains of study
- » Population averages, totals, precision, confidence

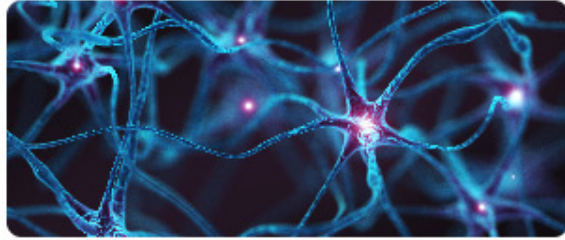
Analysis of Expansion Results

- » Combine, aggregate, and calibrate to system totals
- » Simulate profiles with normal weather (in MetrixND)



Used By: Utilities who need rate class profiles for rate analysis, rate-case filings, forecasting, marketing, and settlements.

Webinar Presentations



June 4, 2024

Retrospective on Neural Networks

ONLINE



September 24, 2024

**Integrating Building Electrification
Impacts into Long-term Load
Forecasts**

ONLINE



February 13, 2024

**The Ins & Outs of Net Load
Forecasting at the Edge | at noon
PST**

ONLINE

- » Statistically Adjusted End-use Methodology and Trends (Oct 2023)
- » Regression Methods from A to Z (May 2023)
- » Electric Vehicle (EV) Load Shapes (Mar 2023)
- » Modeling Climate Change (Aug 2022)
- » Short Term Forecasting Stability vs. Accuracy - Controlling the Sun in North America (May 2023)

Long-term Energy Forecasting Subscription Service

Energy Forecasting Group (EFG)

- » Annual Subscription Service
 - Monitor and analyze EIA end-use forecasts and technology trends
 - Maintain nine-census regional spreadsheets for Statistically Adjusted End-use Models
 - Residential and Commercial saturation and efficiency data
 - Electricity and gas by U.S. region
 - Incorporate EIA updates
 - Maintain/adjust historical saturation and efficiency data
 - Annual updates
 - Annual Energy Survey Report
 - Annual meeting focused on SAE modeling and forecasting topics
 - Forecast workshops and Online Presentations
- » Started in 2001
- » 60 U.S. and Canadian member companies

Energy Information Administration: Annual Energy Outlook Forecast

Residential

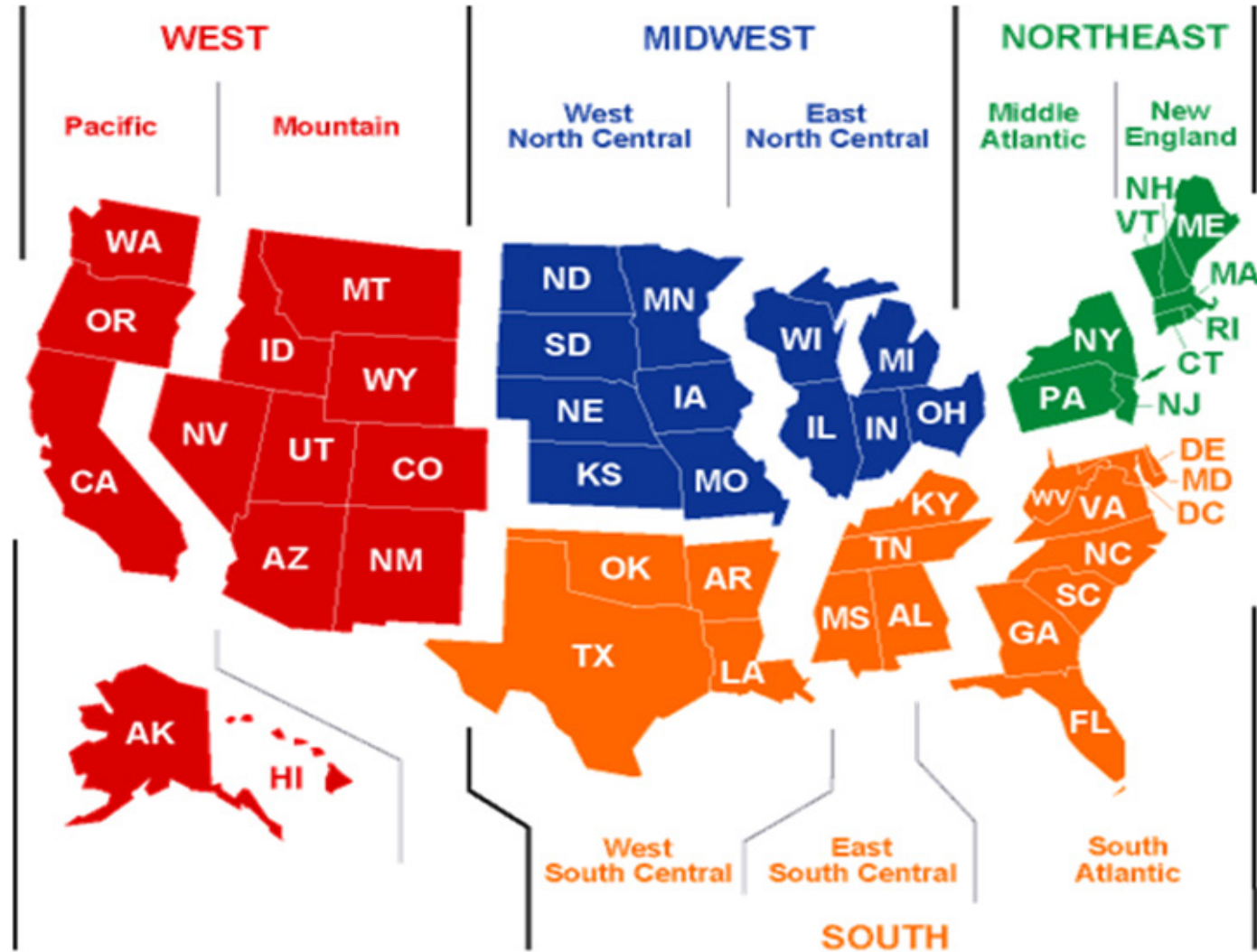
- Number of households
- Number of units per end-use
- Consumption by end-use
- Average stock efficiency
- Housing shell efficiency
- Average square foot

Commercial

- Building type SqFt
- End-Use consumption by building type
- Average stock efficiency

Industrial

- Consumption and employment by North American Industry Classification System



THANK YOU



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www.itron.com/forecasting





FORECAST FRAMEWORK OVERVIEW

FORECAST STRUCTURE

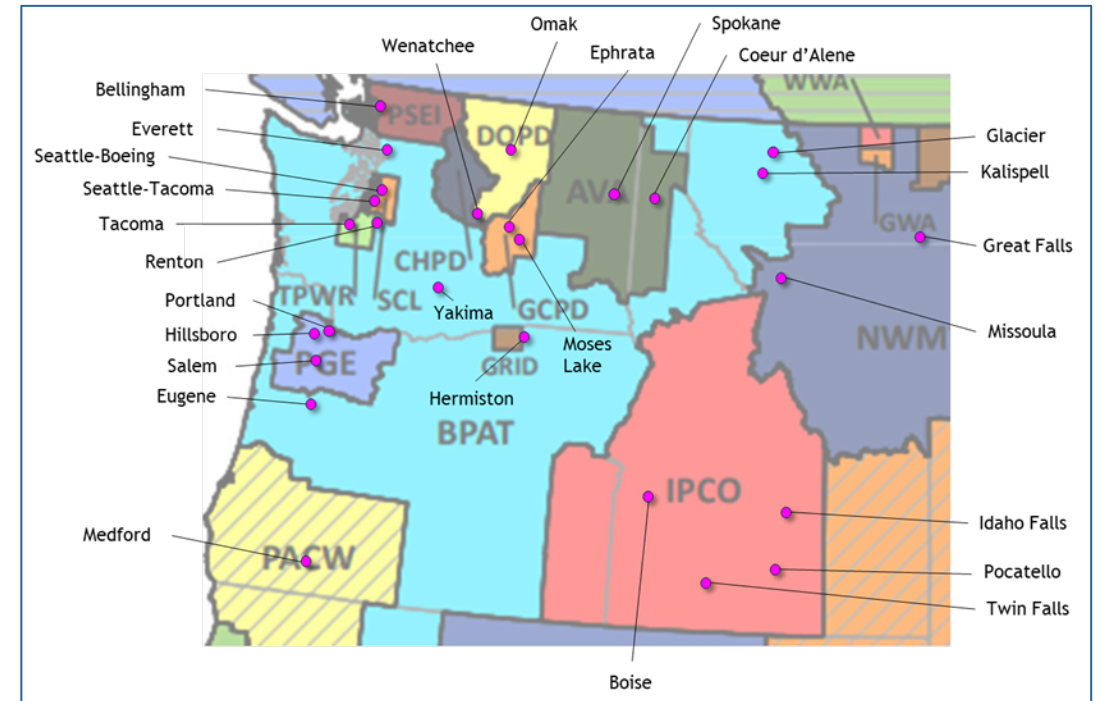
Produces an annual, monthly and hourly forecast of load across 20+ years for the region and individual balancing authorities

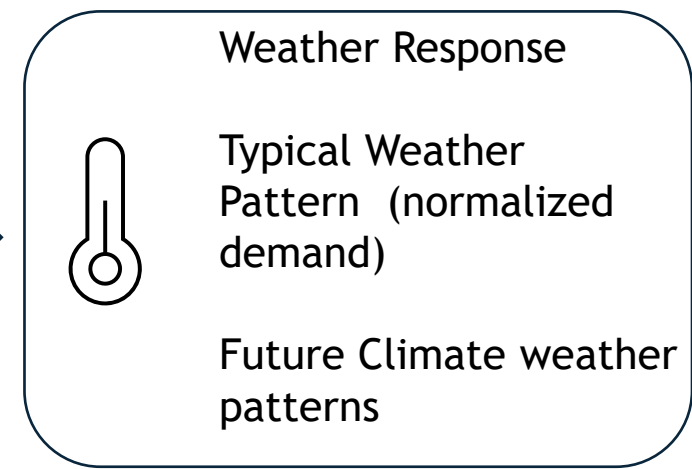
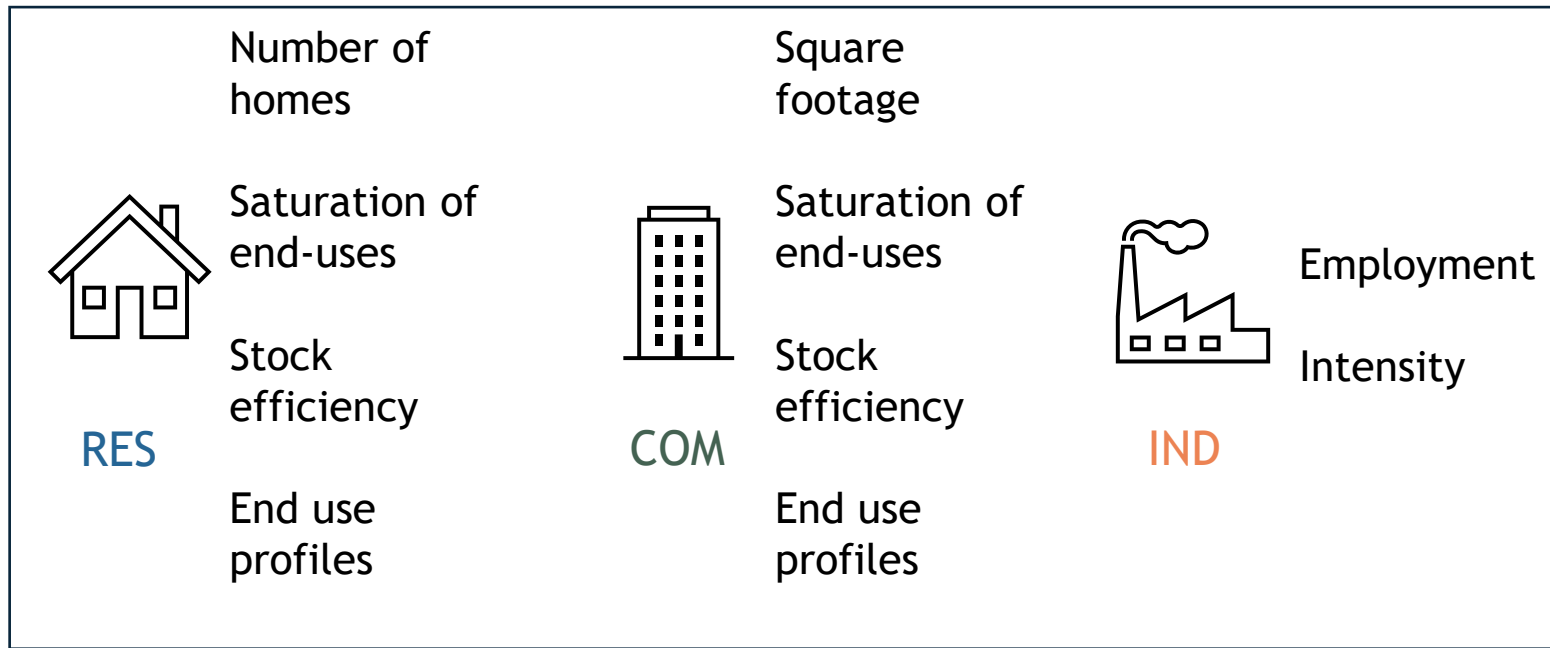
13 BAs

27 Weather Stations

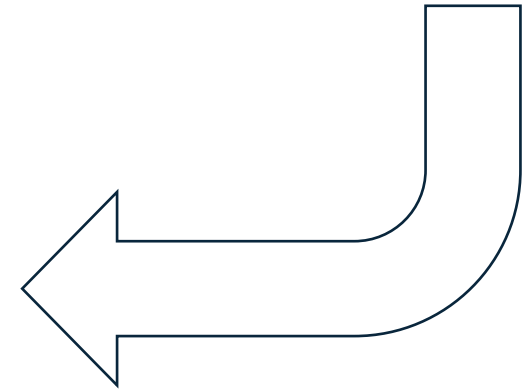
3 Base Sectors
Residential
Commercial
Industrial

4 Special Sectors
Electric Vehicles
Data Centers
Electrification
Rooftop Solar

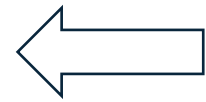


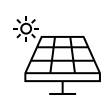




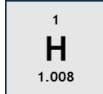


Baseline Demand

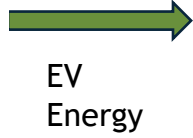
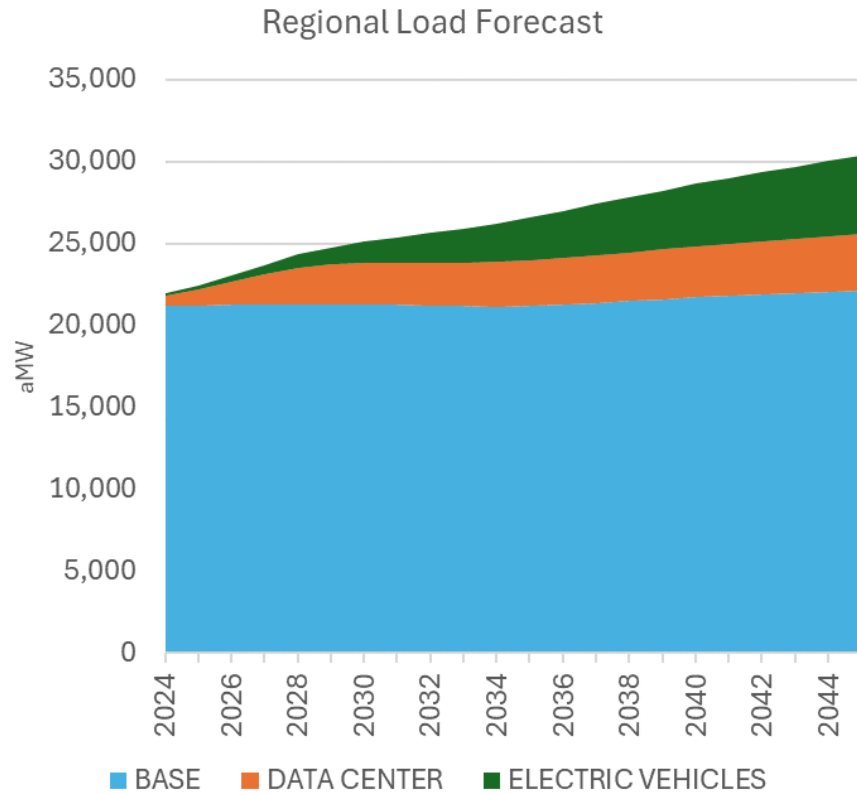


Demand

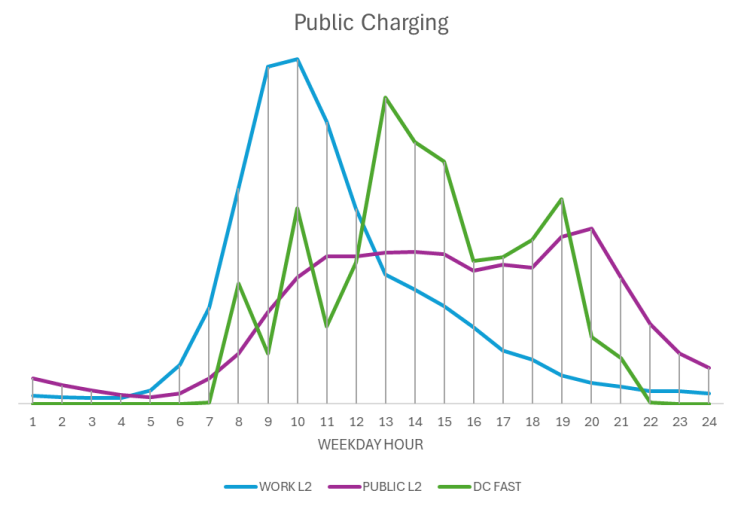
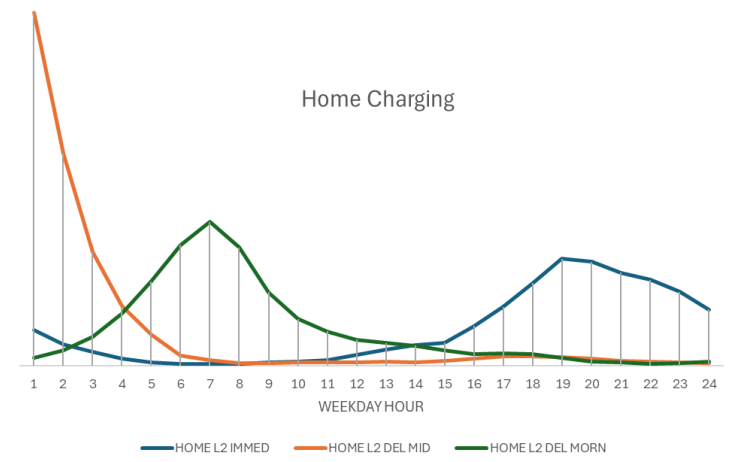
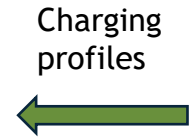


	rooftop solar		electric vehicles
	energy efficiency		data centers
	building electrification		hydrogen production

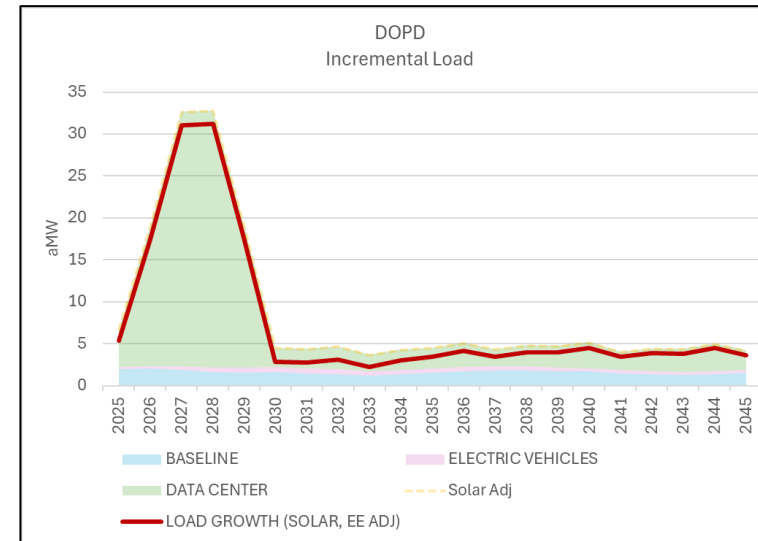
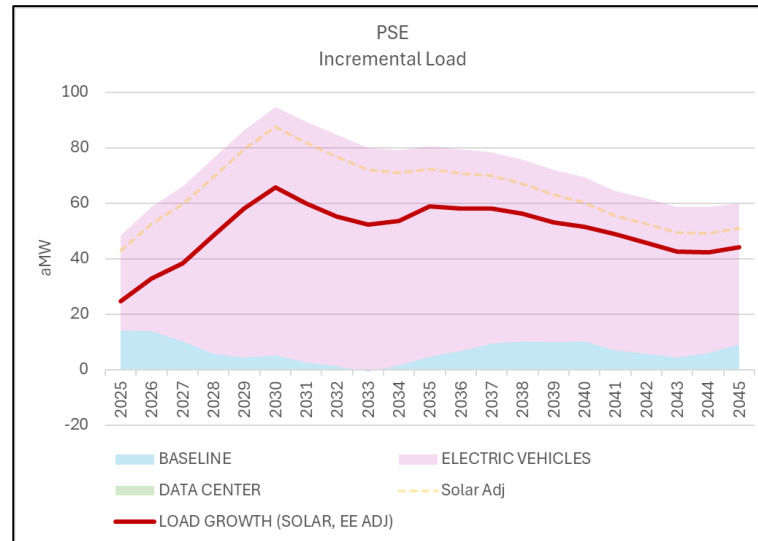
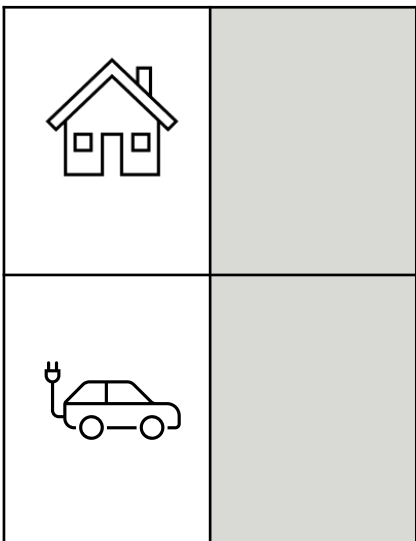
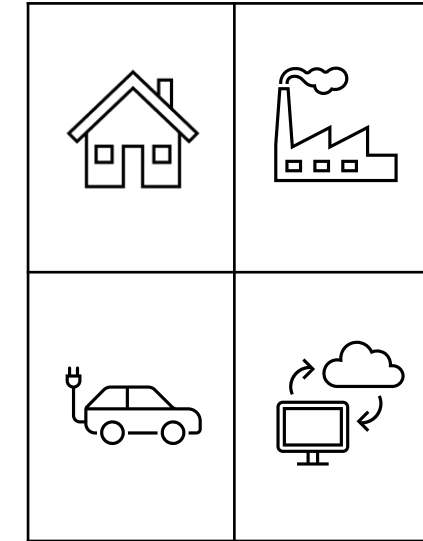
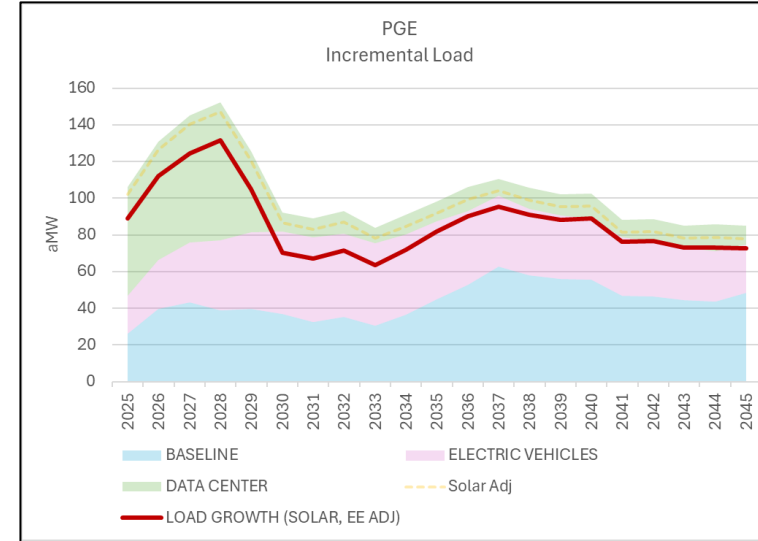
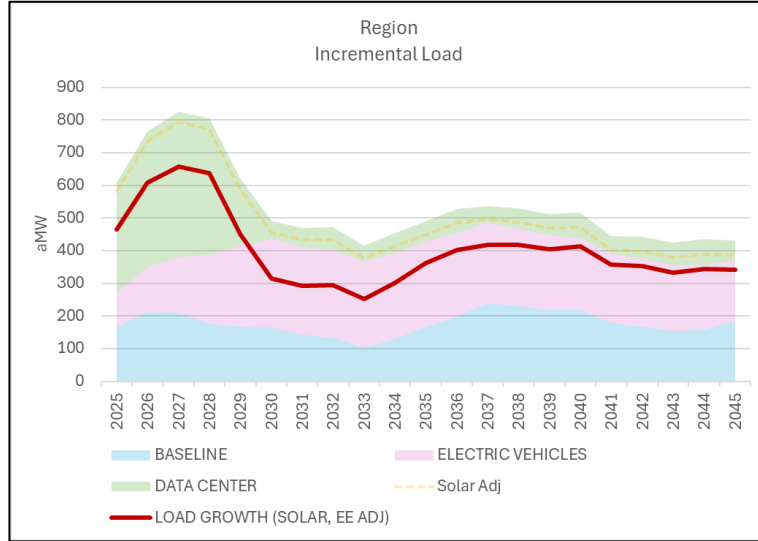
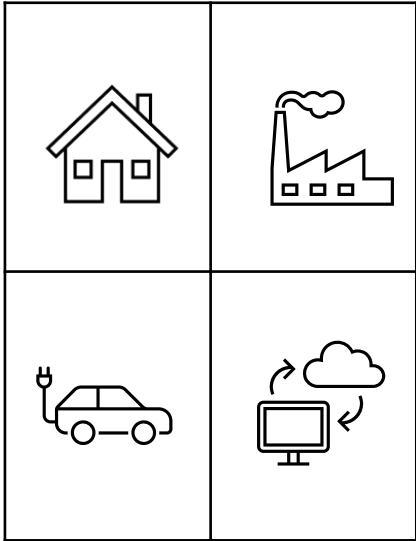
Electric Vehicles



- ### Allocation of input EV demand
- Home Immediate
 - Home Delay Midnight
 - Home Delay Morning
 - Workplace
 - Public
 - DC Fast

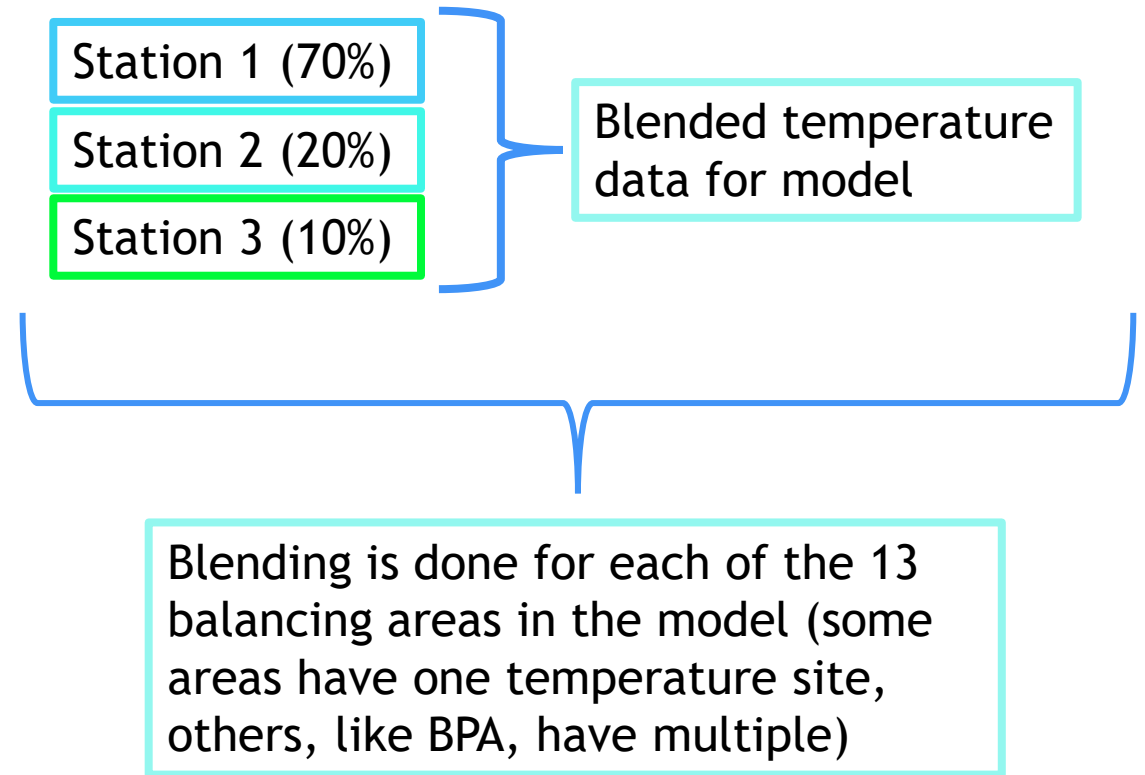


EXAMPLES of DEMAND GROWTH



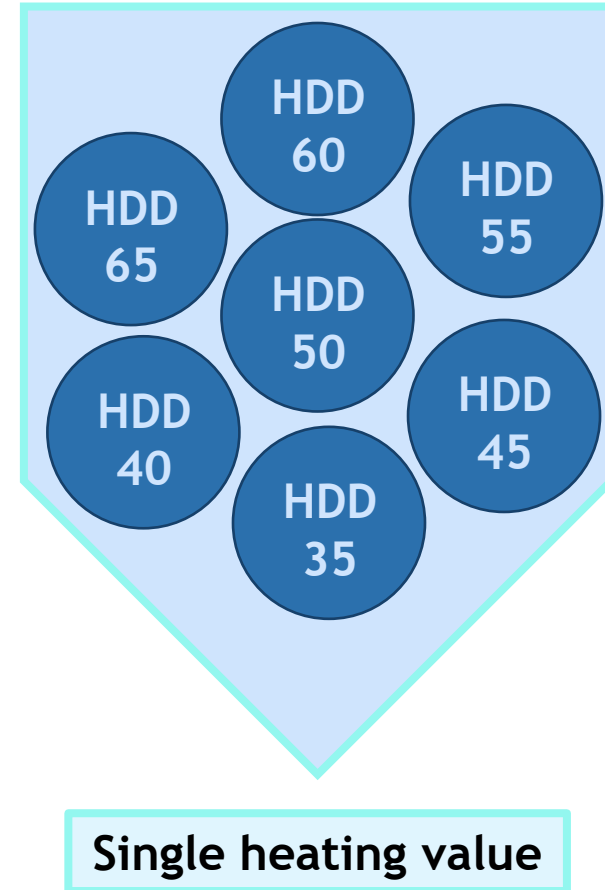
Temperature inputs

- The model is created using historical data, including historical weather data
- For creating load forecasts we use projected future data, including climate model temperature data
- The Council Climate & Weather Advisory Committee provides input into what future temperature data to use



Temperature inputs, cont.

- The model uses multiple heating-degree-day (HDD) and cooling-degree-day (CDD) inputs
 - Degree day values are used in load forecasting models since load response to temperatures are non-linear
- The CDDs and HDDs are weighted into a cooling variable and a heating variable for use in the model





Next Work - Updates

BASELINE UPDATES

- Recent hourly load data by BA
- Economic projections:
Employment, GSP, Real Person Income \$,...
- Building Projections:
Residential housing units
Commercial square footage
- End Use Projections:
saturation (like # of heat pumps,...)
efficiency
- Industrial
employees, intensity
- Weather - recent history for the weather stations
- Climate Model Weather Projections

OTHER KEY UPDATES

- Data Center Demand
- Electric Vehicle Demand
- Electric Vehicle Charging Profiles
- Rooftop Solar installations
- Additional building electrification
- Hydrogen production loads