CASCADE NATURAL GAS CORPORATION®
A Subsidiary of MDU Resources Group, Inc.

In the Community to Serve®

Integrated Resource Plan Targeted Technical Advisory Group Meeting #2

MAY 20, 2026

MICROSOFT TEAMS/TELECONFERENCE

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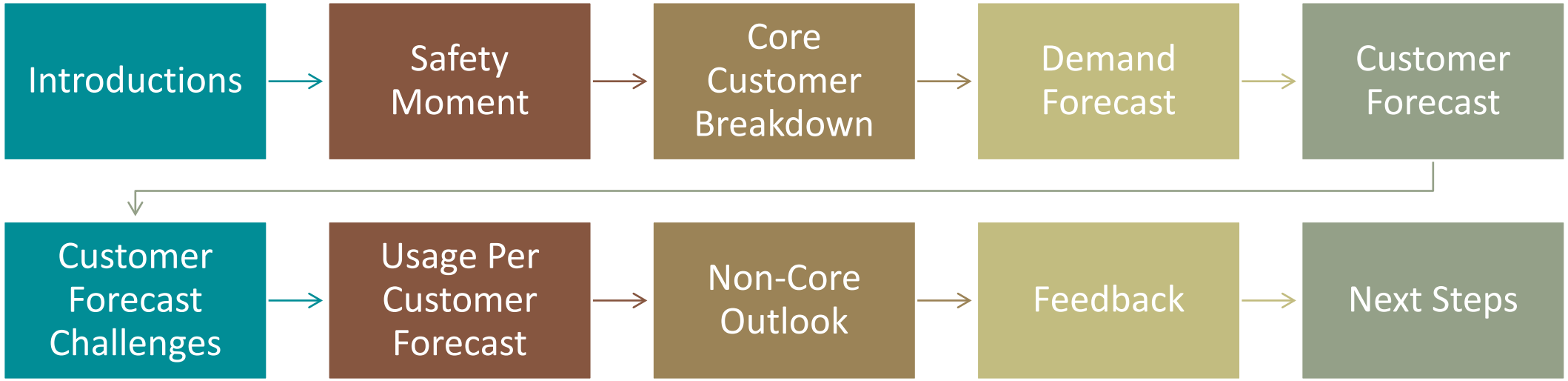
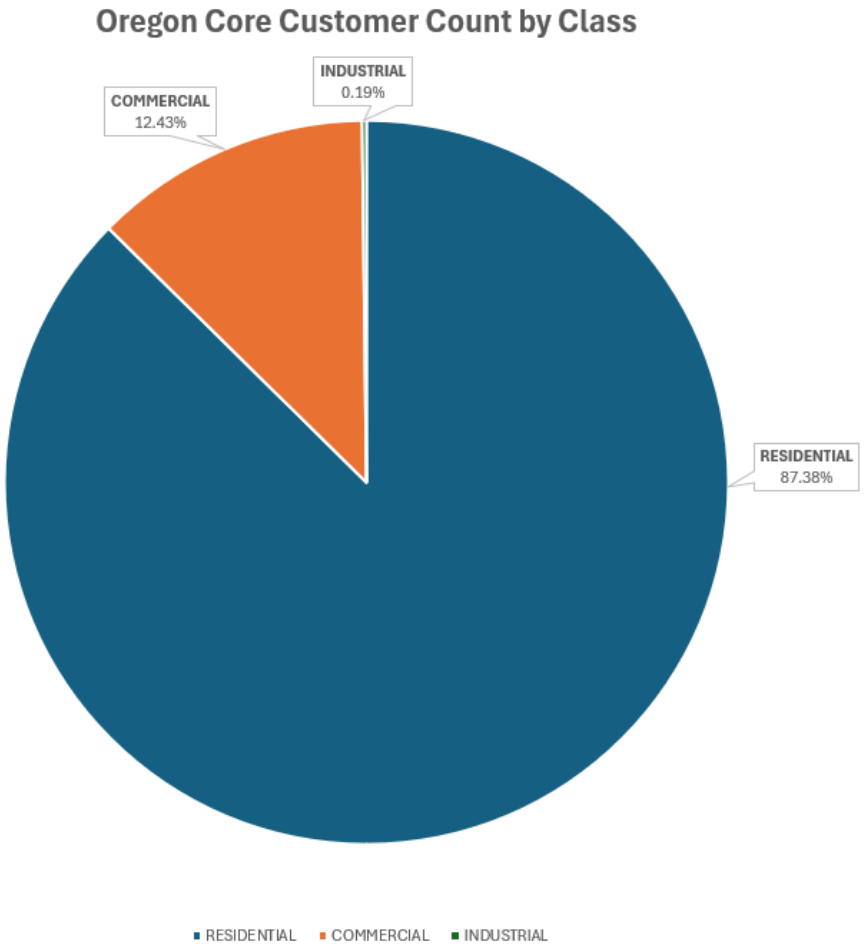
Agenda

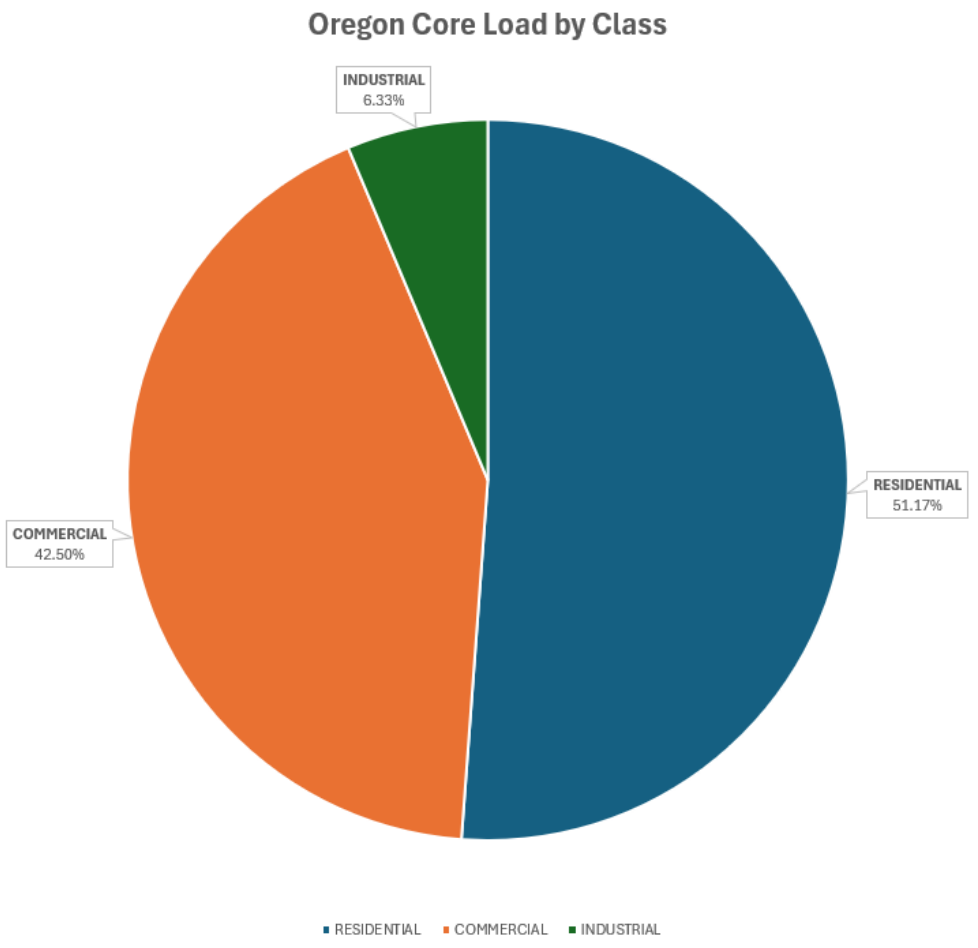

Introductions
Safety Moment
Core Customer Breakdown
Demand Forecast
Customer Forecast
Customer Forecast Challenges
Usage Per Customer Forecast
Non-Core Outlook
Feedback
Next Steps

Safety Moment

Core Customer Breakdowns

OR Core Customers & Load Breakdown - 2025





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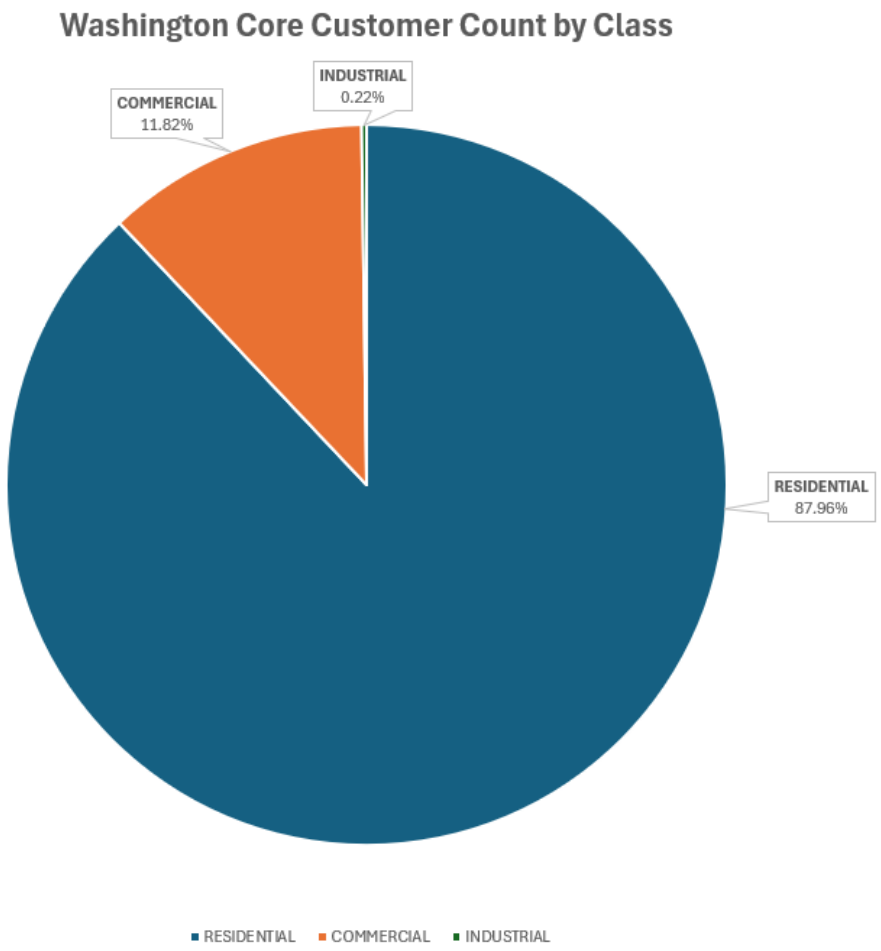
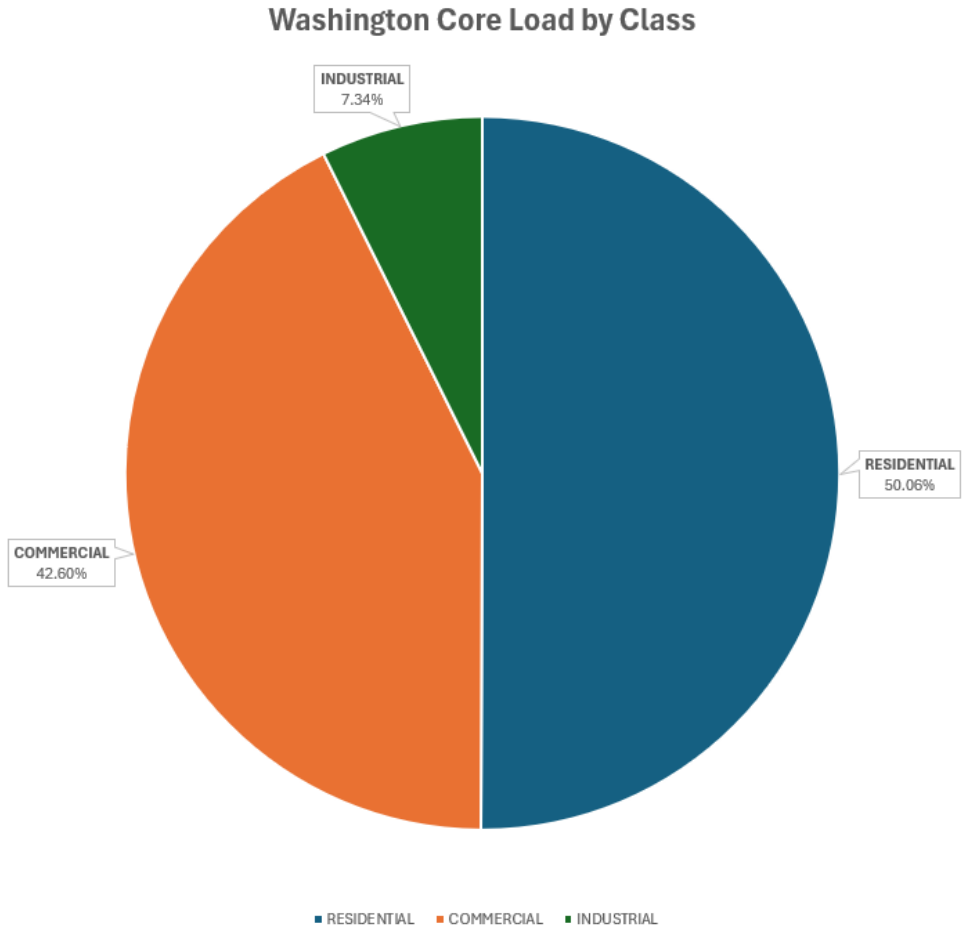
WA Core Customers & Load Breakdown - 2025





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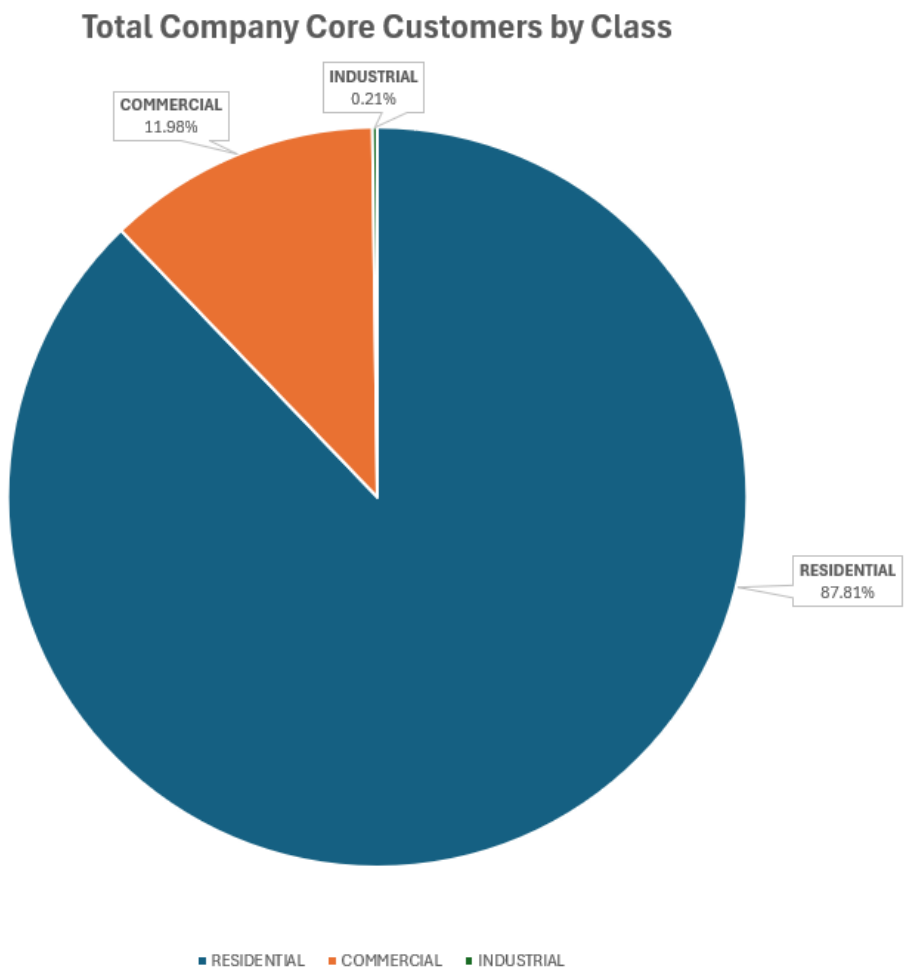
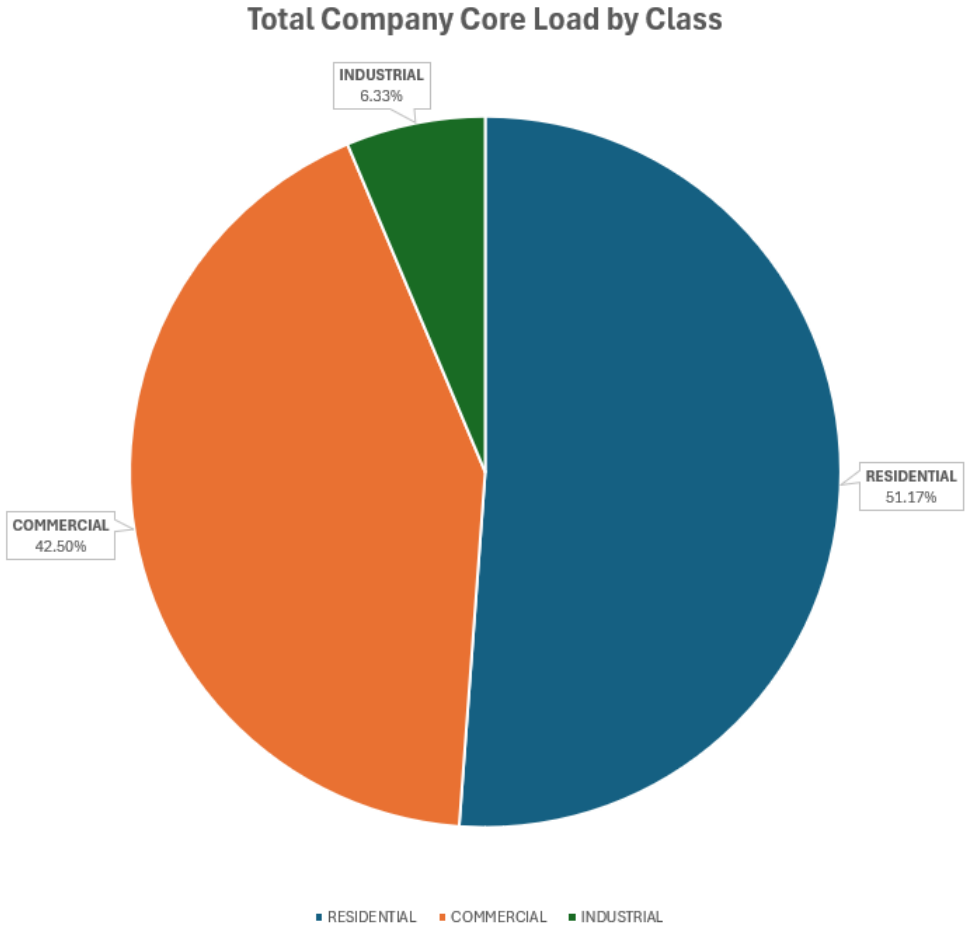
Total Core Customers & Load Breakdown Class Level - 2025





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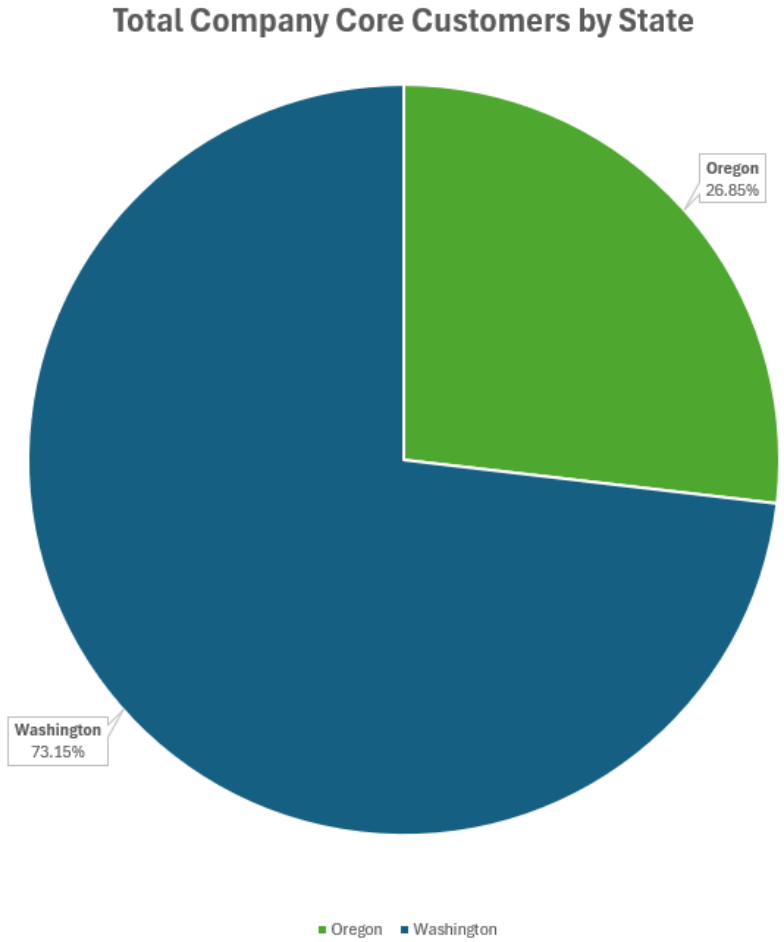
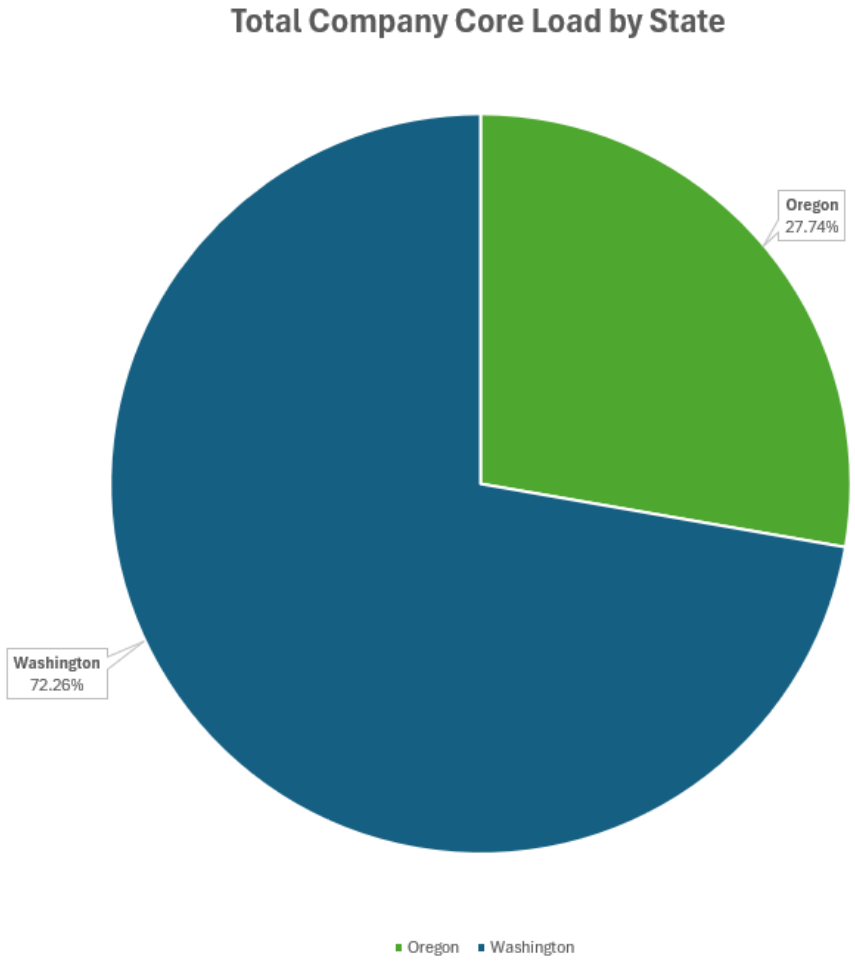
Total Core Customers & Load Breakdown State Level - 2025





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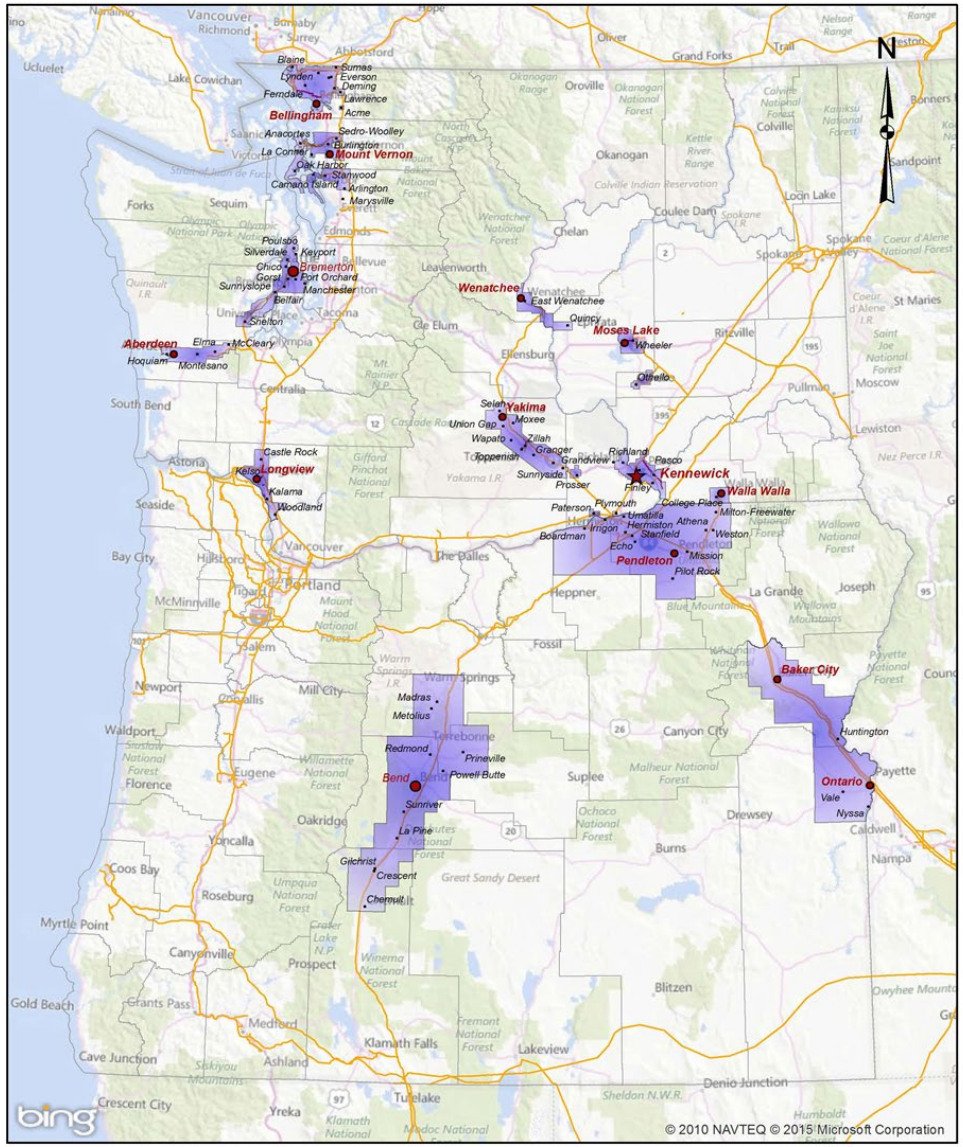
Demand Forecast



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Service Boundaries

Communities
- N
- District Office
- Region Office
- General Office

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Demand Forecast

- The Cascade demand forecast developed for the IRP is a forecast of core customers and their usage, including peak demand, for the next 20+ years.

- The demand forecast combines the usage-per-customer (UPC) forecast and the customer count forecast by multiplying the two to get total demand.

- Demand is forecasted:
  - At the pipeline zone level;
  - At the rate schedule level;
  - At the daily level; and
  - Out to 2050 for decarbonization planning.

Key Definitions: Model Evaluation Metrics

- **AICc: The Akaike Information Criterion (corrected)**
  - A measure of the relative quality of statistical models for a given dataset that adjusts for small sample sizes. Among a set of candidate models, AICc compares models and supports model selection (lower is better).
  - AICc = AIC + extra penalty when sample size is small, so it's less likely to pick an overly complex model.
  - *Less Technical:* A "score" for models. It balances two things: how well the model fits the data and how complicated the model is. A lower AICc usually means a better choice because it fits well without being unnecessarily complex, especially when you don't have tons of data.

- **WMAPE: Weighted Mean Absolute Percentage Error**
  - WMAPE measures total error as a percentage of total actual volume, so high-usage periods count more than low-usage periods.
  - *Less Technical:* WMAPE is like asking: "How wrong was the model overall, compared to how much we actually had?" High usage days count more than lower usage days.

- **SMAPE: Symmetric Mean Absolute Percentage Error**
  - A scale-free accuracy metric for forecasts that reports error as a percentage, using both the actual and forecast values in the denominator (to reduce extreme % errors). "Symmetric" because it normalizes by the average magnitude of actual and forecast, which can make it less sensitive than MAPE when values vary widely. (Still can behave oddly when both values are near zero.)
  - *Less Technical:* Error as a percent that's more symmetric and stable because it scales the error by both the actual and the forecast.

- **MAE: Mean Absolute Error**
  - A straightforward accuracy metric: the average absolute difference between forecasts and actuals, in the same units as the data.
  - *Less Technical:* MAE is the average amount the model missed by, ignoring whether forecasts were too high or too low—just how far off it was in absolute terms.

Key Definitions: Model Types

- **ARIMA: Auto-Regressive Integrated Moving Average**
  - A type of model fitted to time series data. In time-series regressions, residuals often are not independent—they can be correlated over time. ARIMA is used to model that time dependence, either for the series itself or for the regression errors.
  - ARIMA(p,d,q)(PDQ) combines:
    - AR(p): current value depends on past values. AR(P) is seasonal version;
    - I(d): differencing to remove trends/non-stationarity. I(D) is seasonal version;
    - MA(q): current value depends on past forecast errors. MA(Q) is seasonal version.
  - *Less Technical:* ARIMA is a way to predict what comes next in the data over time by looking at what happened before, smoothing out big trends, and correcting for past mistakes in predictions.

- **ETS: Error, Trend, Seasonal**
  - A class of time-series forecasting models that represent a series as a combination of level, optional trend, and optional seasonality, updated over time using exponential smoothing. ETS models are especially useful when the data show stable seasonal patterns and gradual changes over time.
  - ETS models are state-space exponential smoothing models.
  - They specify:
    - an error type (Additive or Multiplicative),
    - a trend component (None / Additive / Damped),
    - a seasonal component (None / Additive / Multiplicative).
  - The model updates unobserved "states" (level/trend/season) each period with smoothing and generates forecasts by projecting those states forward. ETS is typically strongest when patterns are well-captured by smooth changes rather than complex autocorrelation structures (where ARIMA can sometimes excel).
  - *Less Technical:* ETS is a forecasting method that learns the baseline, how it's going up or down, and any repeat patterns (like winter vs. summer). It updates those guesses each time new data arrives, giving more weight to recent data than old data.

Key Definitions: Core Model Inputs

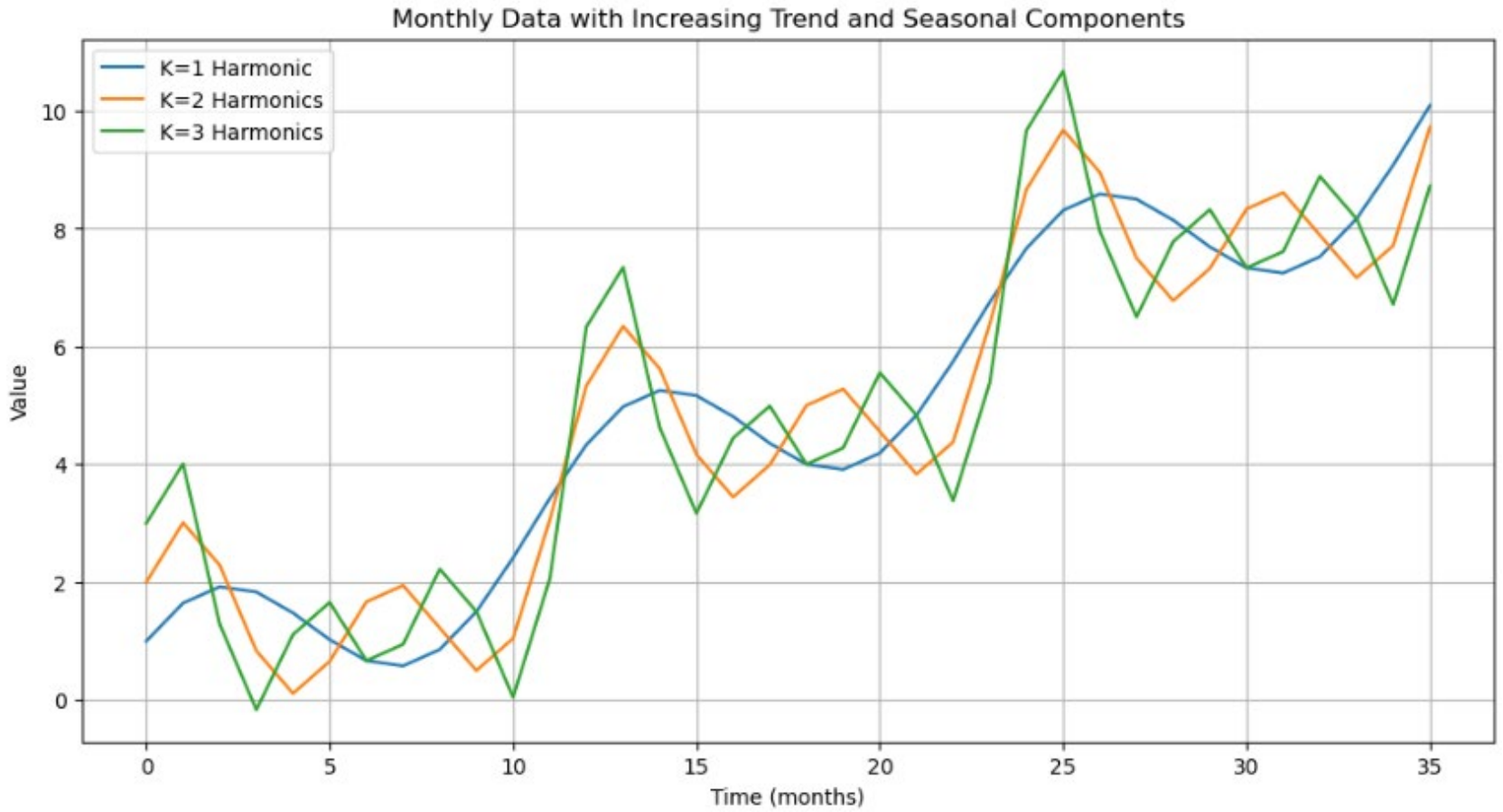
- **Fourier Terms**
  - A way to model smooth, repeating seasonal patterns by adding sine/cosine wave predictors to a model (often used as exogenous regressors inside ARIMA/TSLM).
  - Two main components are the period and the number of harmonics (each harmonic add two terms: one sine and one cosine).
    - Period (the season length): The periodic nature of the seasonality you want to capture. Can be either: a number = “observations per cycle” (e.g., 7 for weekly seasonality in daily data), or text describing a duration (e.g., "1 year" for annual seasonality).
    - Harmonics (K): How “wiggly” or “spiky” the seasonal shape can be. The maximum order of the Fourier terms (higher K = more sine/cosine pairs = more flexible seasonality).
    - Practical limit: K must not be greater than period/2.
    - Multiple seasonalities (optional but common): You can include more than one set of Fourier terms by adding them separately (e.g., weekly + yearly).
  - *Less Technical:* Fourier terms let a model copy repeating underlying patterns (such as winter usage vs. summer usage) using a few smooth waves. Instead of making a lot of “month” indicators, you use a relatively small set of wave shapes to capture the seasonal patterns.

- **HDD: Heating Degree Day**
  - Weather in terms of how much below a reference temperature (60 degrees in this case) the average temperature is, bounded below by zero.
    - Example: if a day’s average temperature is 50 degrees, then the HDD for that day will be 10 → MAX(60-50, 0) = MAX(10,0) = 10
    - Example: if a day's average temperature is 75 degrees, then the HDD for that day will be 0 → MAX(60-75,0) = MAX(-15,0) = 0
  - *Less Technical:* HDDs add up how “cold” it was compared to a comfortable temperature, so they act like a simple score for how much heating people likely used.

- **Extreme HDD: Extreme Heating Degree Day**
  - Indicator variable equal to 1 when HDD exceeds an “extreme” threshold (e.g., the 98th percentile of HDD values) and is equal to 0 otherwise. This allows for a different relationship on extreme cold events that isn’t enforced on the rest of the days. This helps capture peak events.
  - *Less Technical:* Turns “on” for only the coldest days so the model can treat those differently.

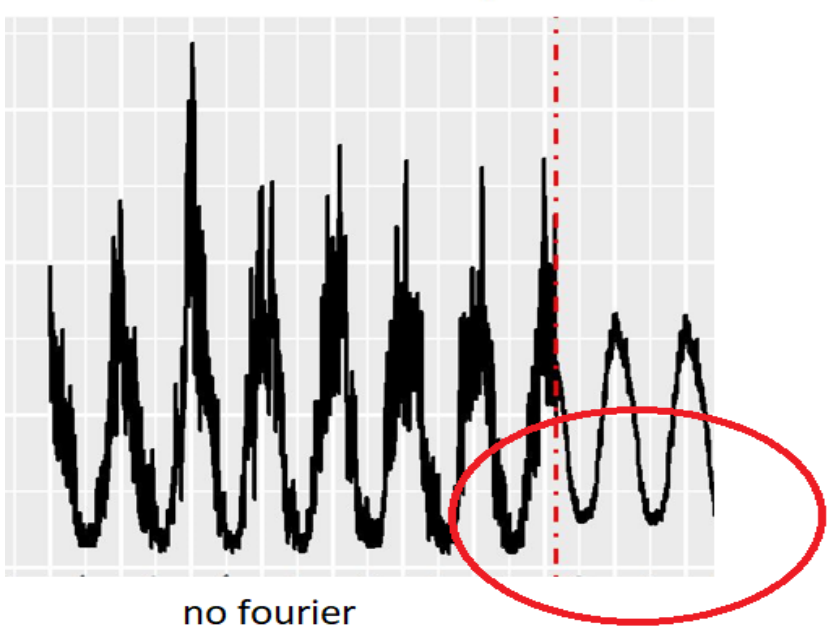
Fourier Terms

- Capture seasonal patterns.
- The first harmonic captures the broad underlying pattern – setting the baseline.
- Increasing the number of harmonics allows model to capture more complicated seasonal behavior (more harmonics = more “wiggles” and/or “spikes” within a period).

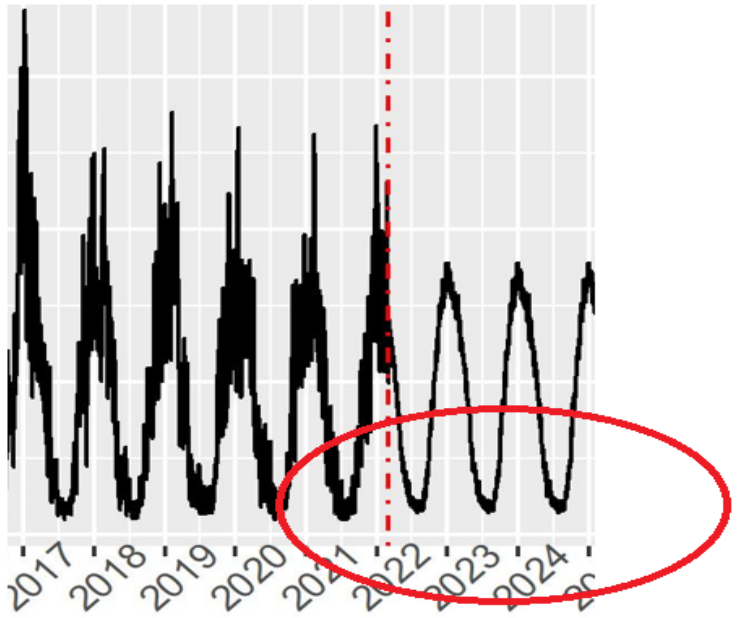


Fourier terms

What do they do exactly?



no fourier



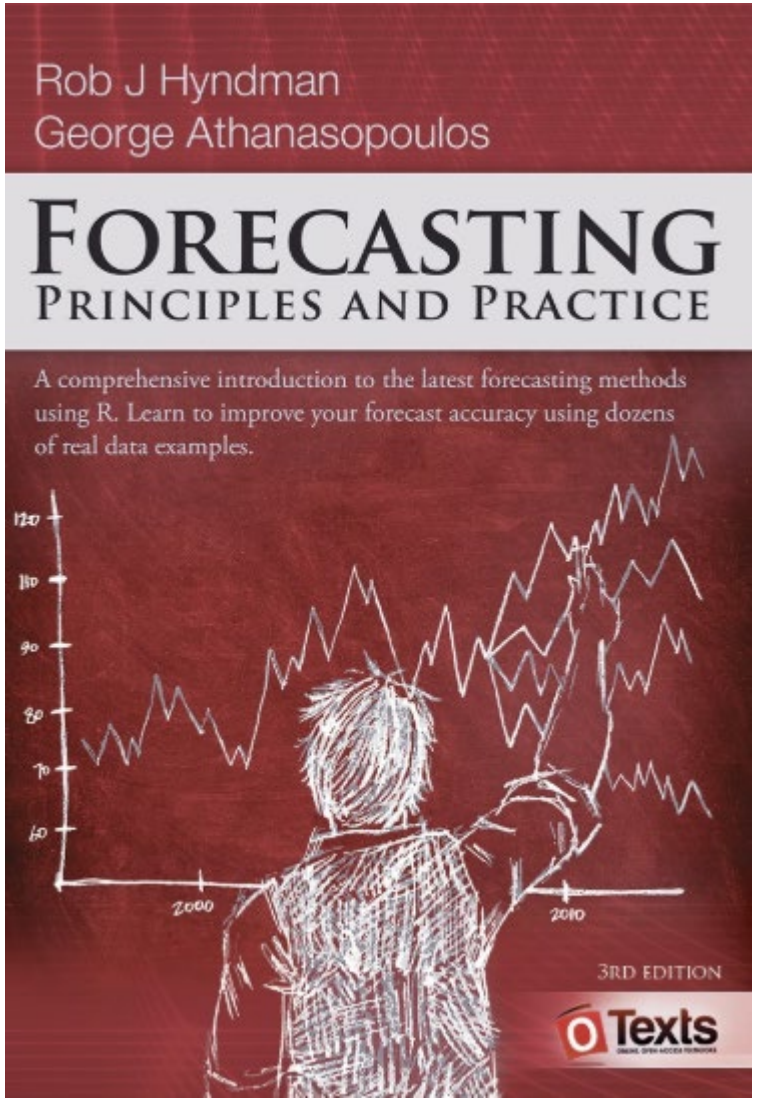
with fourier

R Software

- R is a free software environment for statistical computing and graphics.
- Thousands of packages: A package bundles together code, data, documentation, and tests, and is easy to share with others.
- Allows for large number of complex calculations in reasonable amount of time (i.e., Monte Carlo simulations, entire load forecast, etc.).

Free Resource

- **Forecasting: Principles and Practive (3rd edition)**
  - Rob J Hyndman and George Athanasopoulos
  - Link: [Forecasting: Principles and Practice (3rd ed)]

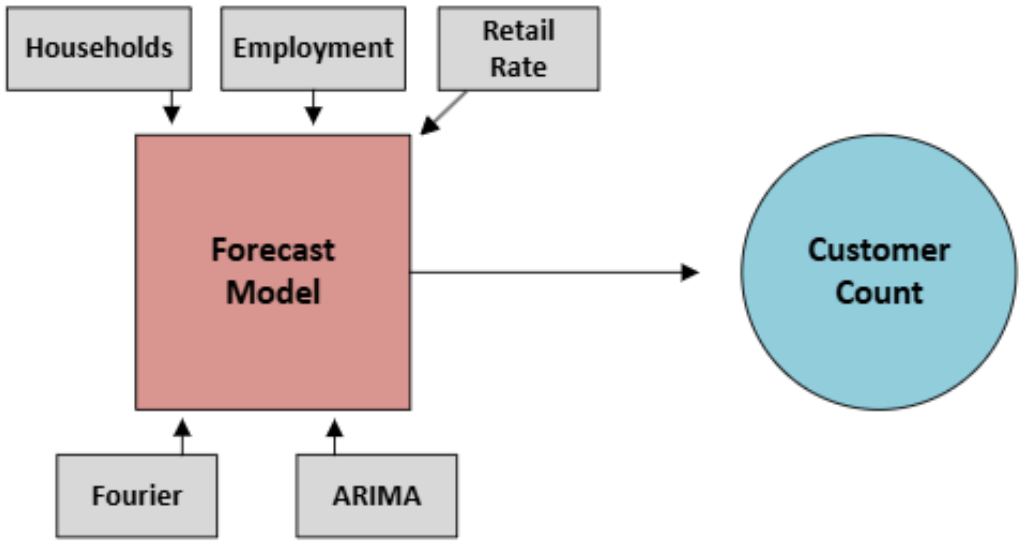


Customer Forecast

Customer Forecast: Previous Method

$$CC^{Z,Class} = \alpha_0 + \alpha_1 HH^Z + \alpha_2 Emp^Z + \alpha_3 \text{Retail Price} + \alpha_4 \text{Income} + \text{Fourier}(K) + \text{ARIMA} \in (p,d,q)$$

- Where:
  - CC = Customer Count;
  - Z = Zone;
  - Class = Residential, Commercial, Industrial, or Interruptible;
  - ARIMA $\in$(p,d,q) = Indicates that the model has p autoregressive terms, d difference terms, and q moving average terms;
  - HH = Households;
  - Emp = Employment;
  - Retail Price = Price customers see on their bill;
  - Income = Average income at the zone level;
  - Fourier(K) = Captures seasonality.
- Start with Linear Model
- Some are Naïve models

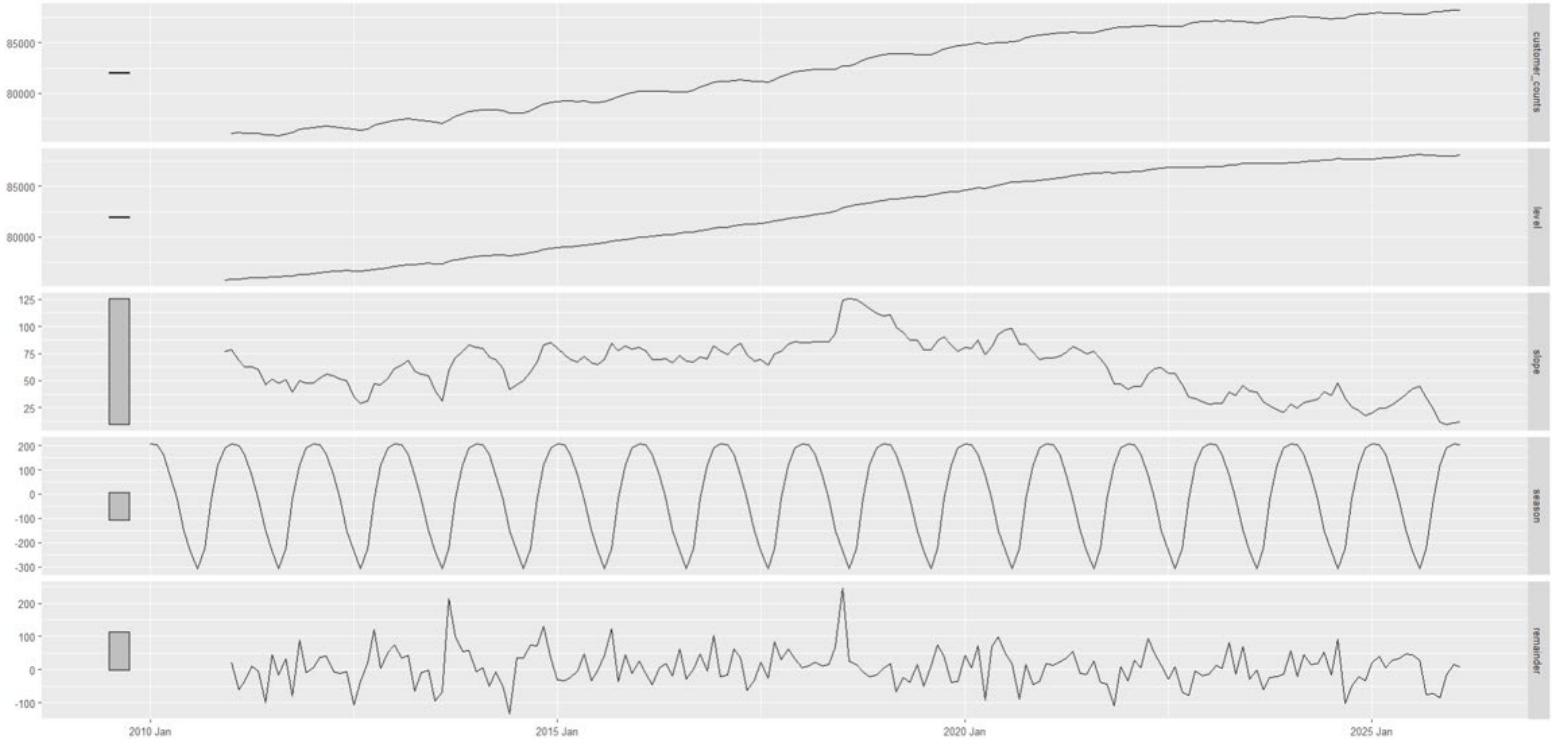


Customer Forecast: Current Approach

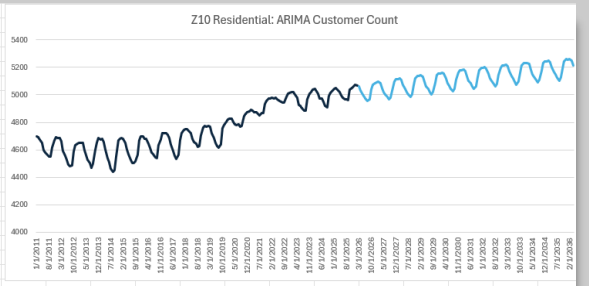
- Using ARIMA model:
  - Randomly selected three zones for residential customers and three zones for commercial customers.
  - Explored the following variables: Fourier terms, trend and trend squared, number of households, employment level, 30-year mortgage rates, building codes, median home price, retail price, line extension allowance, and more with many different combinations.
  - Also looked at customer growth rates as outcome variable.
  - Produced models that perform well on a 1–3 year test set forecast but seem to over-forecast when we move to longer-run actual forecast in most cases.

Customer Forecast: Current Approach

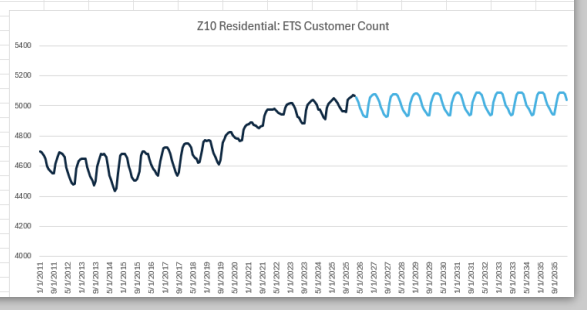
- Using ETS model:
  - Exponential smoothing model (most recent data matters most).
  - Consists of a level/baseline and optional error, trend, seasonality components.
  - Great for series with a trend that evolves smoothly over time and stable (or no) seasonality
    - When true, most of the structure of the time series can be captured by the level and the ETS components.
  - Model performs well on a forecasted test set.
  - Model also performs well on the longer-run actual forecast.



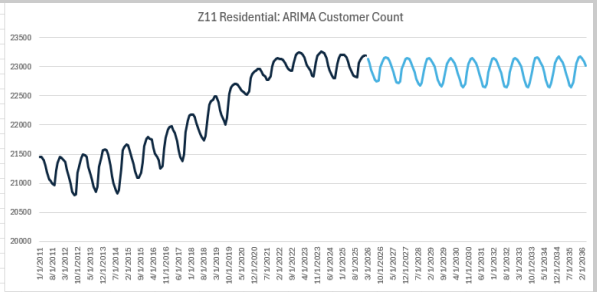

Z10 Residential: ARIMA YoY Growth

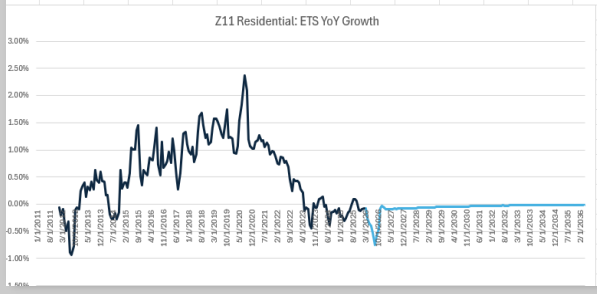

Z10 Residential: ARIMA Customer Count

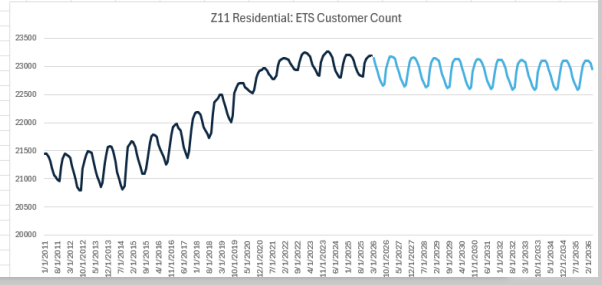

Z10 Residential: ETS YoY Growth


Z10 Residential: ETS Customer Count

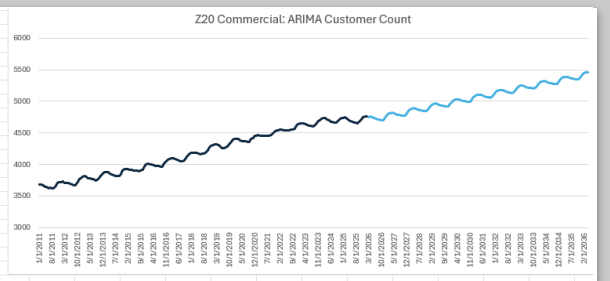

Z11 Residential: ARIMA YoY Growth

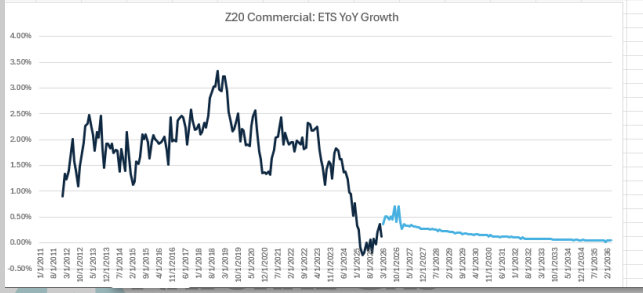

Z11 Residential: ARIMA Customer Count

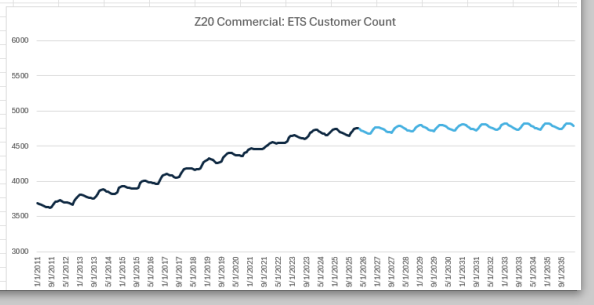

Z11 Residential: ETS YoY Growth

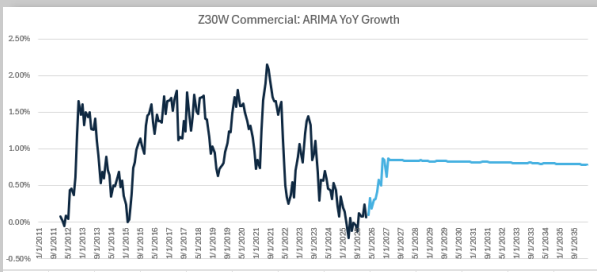

Z11 Residential: ETS Customer Count

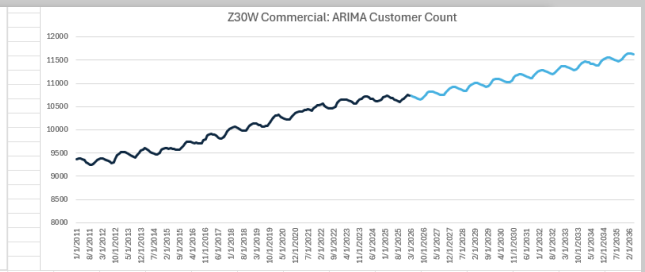

Z20 Commercial: ARIMA YoY Growth

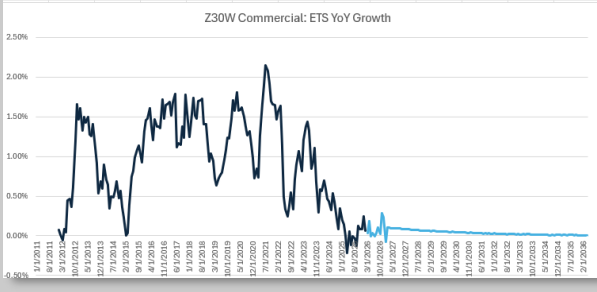

Z20 Commercial: ARIMA Customer Count

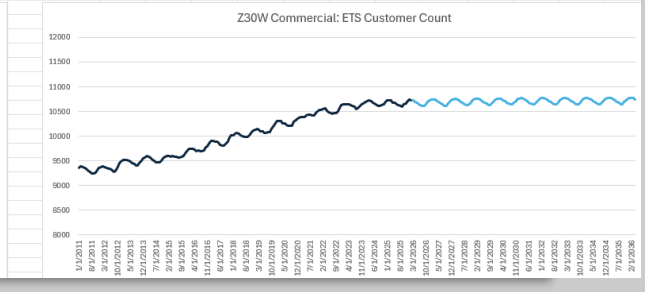

Z20 Commercial: ETS YoY Growth


Z20 Commercial: ETS Customer Count


Z30W Commercial: ARIMA YoY Growth

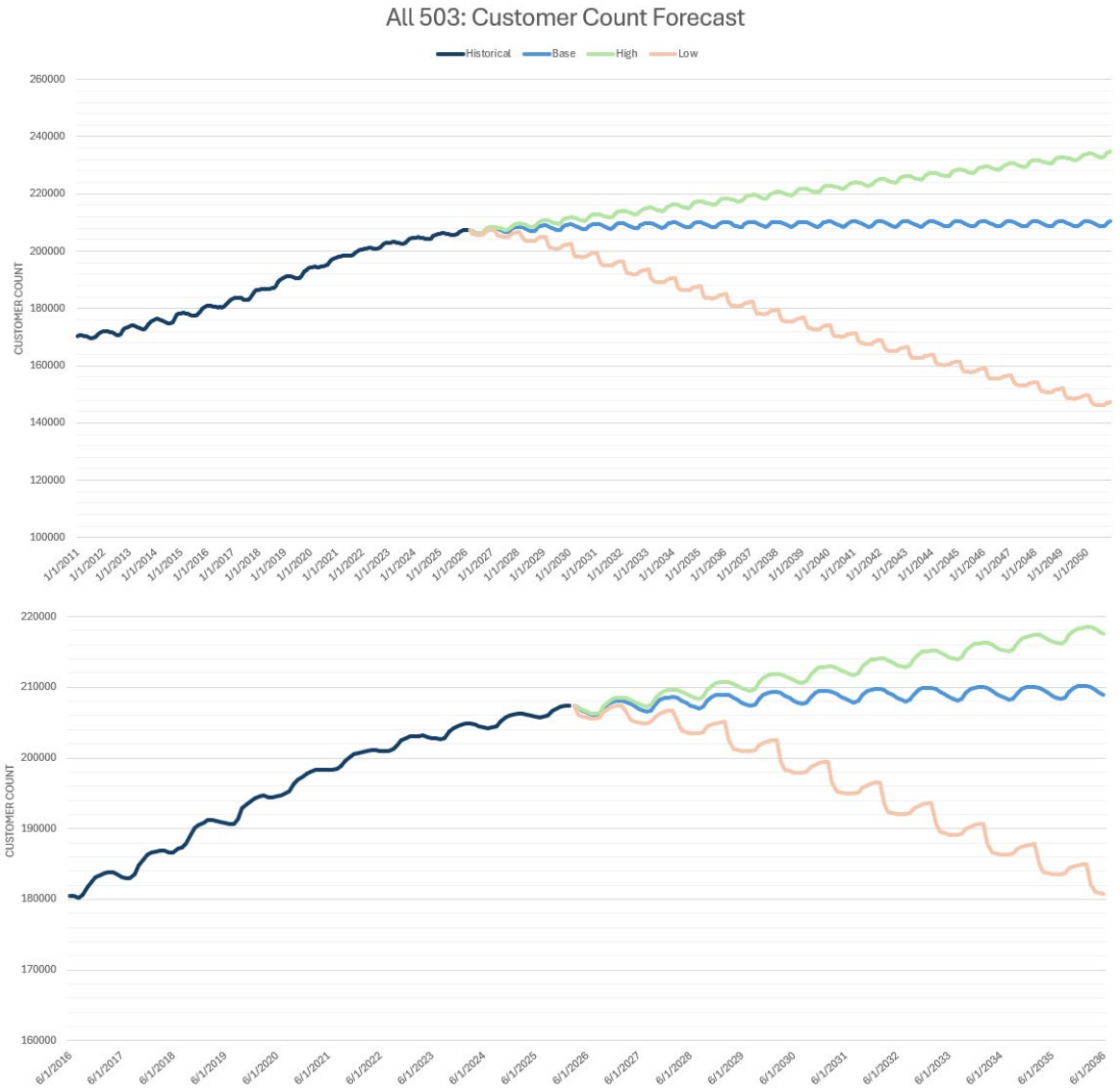

Z30W Commercial: ARIMA Customer Count


Z30W Commercial: ETS YoY Growth


Z30W Commercial: ETS Customer Count

Base, High & Low Customer Growth Scenarios

- **Base Scenario:**
  - Damped trend. Represents slowing growth that eventually levels off.
- **High Scenario:**
  - Recent trend continues (no damping). Represents a scenario where electrification adoption is slower than expected, so new gas hookups remain closer to recent levels and customer growth stays stronger.
- **Low Scenario:**
  - 0% to −1.5% YoY for the first 5 years, then −1.5% YoY thereafter. Represents accelerated electrification that reduces new gas hookups over time and shifts the customer base from flat growth to sustained decline.



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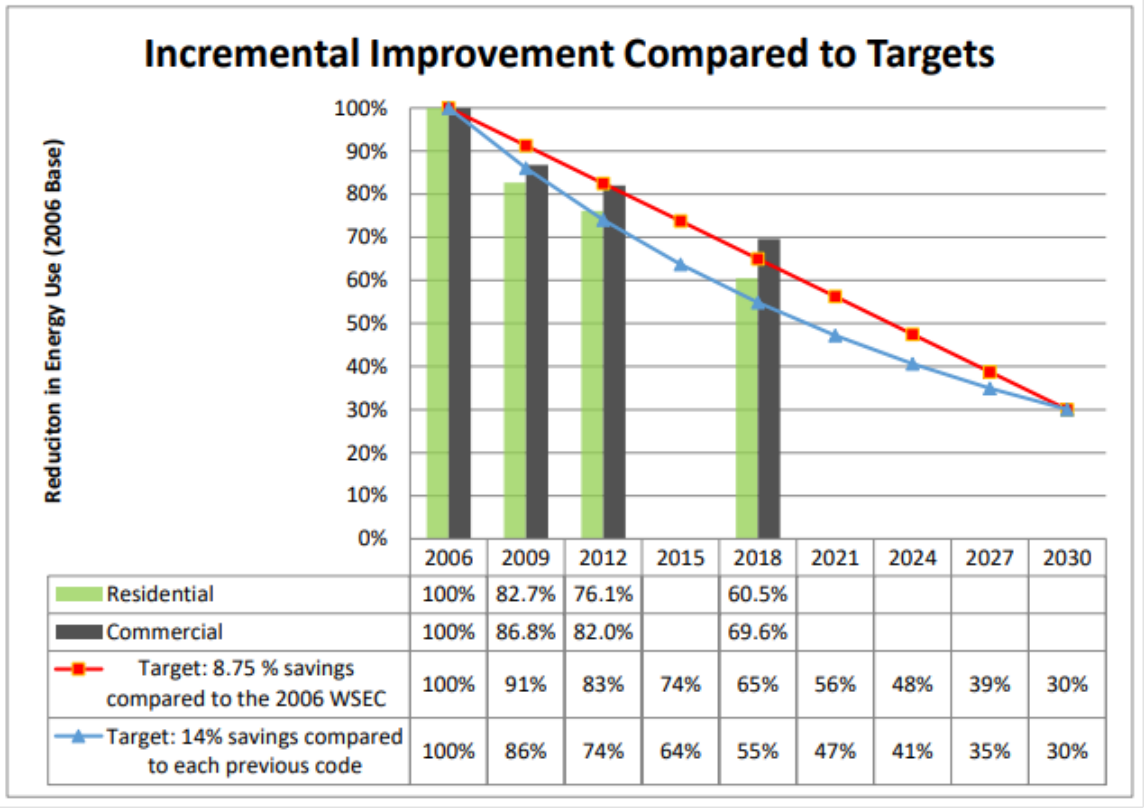
Customer Forecast Challenges

Building Code Impacts (Cont'd)



	2006	2009	2012	2015	2018	2021	2024	2027	2030
Residential	100%	82.7%	76.1%		60.5%				
Commercial	100%	86.8%	82.0%		69.6%				
Target: 8.75 % savings compared to the 2006 WSEC	100%	91%	83%	74%	65%	56%	48%	39%	30%
Target: 14% savings compared to each previous code	100%	86%	74%	64%	55%	47%	41%	35%	30%

Chart Source: Final Cost Benefit Analysis for the 2021 WSEC-R

- Under RCW 19.27A.020(2)(a), the SBCC is directed to "…help achieve the broader goal…" of zero emission homes/buildings. Note that this is a goal, not a mandate. Conversely, RCW 19.27A.160 is an explicit direction to the SBCC to move towards a 70% reduction in annual net energy consumption by 2031. This is a mandate and is clear that the goal is a "net" energy.
- Since RCW 19.27A.020(2)(a), the enacting legislation resulted from 2009 SB 5854. Therefore, the 2012, 2015, 2018, and 2021 code cycles were all likely impacted by the legislation. This chart provides an explanation of how the SBCC has addressed the more explicit legislative direction of RCW 19.27A.160.

WA State Building Codes

Effective March 15, 2024, the 2021 Washington State Energy Codes[1] went into effect.

Each new dwelling unit in a residential building must comply to the WSEC. Each dwelling must meet the required number of credits (ex. Small dwellings must have 5 credits).

The new building codes have made it impractical for new residential and commercial buildings to use natural gas.

TABLE R406.2
ENERGY EQUALIZATION CREDITS

System Type	Description of Primary Heating Source	Credits	
		All Other	Group R-2[a]
1	For combustion heating equipment meeting minimum federal efficiency standards for the equipment listed in Table C403.3.2(5) or C403.3.2(6)	0	0
2	For an initial heating system using a heat pump that meets federal standards for the equipment listed in Table C403.3.2(2) and supplemental heating provided by electric resistance or a combustion furnace meeting minimum standards listed in Table C403.3.2(5)[b]	1.5	0
3	For heating system based on electric resistance only (either forced air or Zonal)	0.5	-0.5
4[c]	For heating system using a heat pump that meets federal standards for the equipment listed in Table C403.3.2(2) or C403.3.2(9) **or** Air to water heat pump units that are configured to provide both heating and cooling and are rated in accordance with AHRI 550/590	3.0	2.0
5	For heating system based on electric resistance with: 1. Inverter-driven ductless mini-split heat pump system installed in the largest zone in the dwelling, **or** 2. With 2kW or less total installed heating capacity per dwelling	2.0	0

1 HTTPS://SBCC.WA.GOV/STATE-CODES-REGULATIONS-GUIDELINES/STATE-BUILDING-CODE/ENERGY-CODE

Line Extension Allowances

- The amount of upfront construction cost a natural gas utility is willing to fund to extend its distribution system to a new customer or development, with any remaining cost paid by the customer.
- Washington - Current 2025 policy adopted March 5, 2025, per Order No. 05 in UG-240008, allows the NPV of margin over a defined timeframe; that timeline diminishes to zero as of March 1, 2027.
- Oregon – Under review in the current Oregon general rate case UG 525.

Oregon: Customer Count Impacts

- Oregon has joined eight other states in a Memorandum of Understanding to accelerate the use of heat pumps in residential construction.[1] The states have a shared goal for heat pumps to meet at least 65% of residential-scale heating, air conditioning, and water heating shipments by 2030, and 90% by 2040 across the participating states.
- Oregon's Building Codes Division is planning rulemaking to update the residential energy code in summer and fall 2026. If approved, the updated code will require energy-efficient heat pumps in newly constructed homes if the home plans to have air conditioning.
  - Sources: Building Codes Division : Oregon Residential Specialty Code Adoption : Codes and standards : State of Oregon, BCD - Technical Summary
- Bend is developing a "climate pollution fee" for gas appliances in new residential construction to discourage gas in new buildings and fund electrification incentives (it would not apply to existing buildings).
  - Source: Electrification Policy - City of Bend

1 HTTPS://WWW.NESCAUM.ORG/DOCUMENTS/2.7.24-NESCAUM-MOU-PRESS-RELEASE.PDF

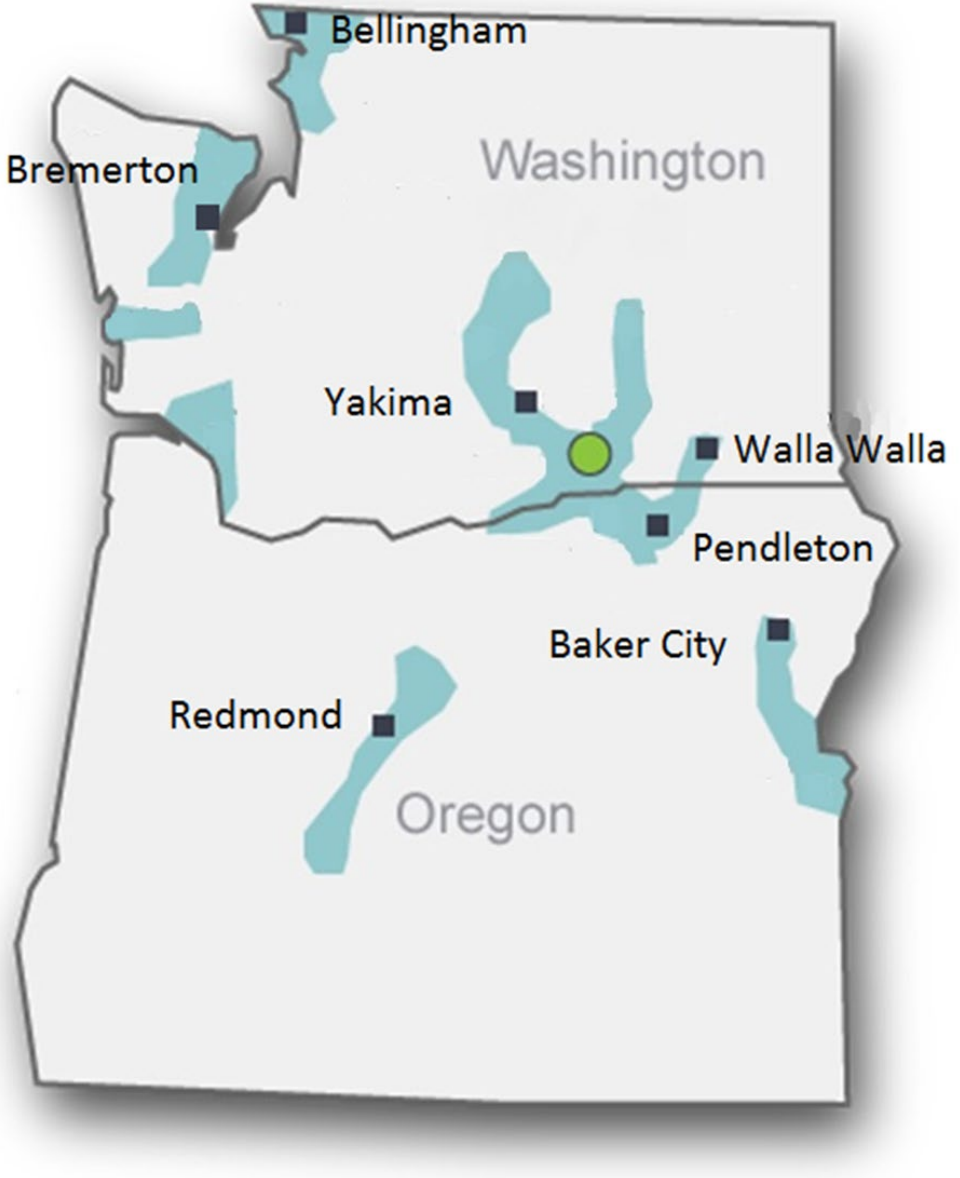
Usage Per Customer (UPC) Forecast

Fixed Network Gas Meter Data

- Customer-level meters (one per customer location).
- Daily usage data is transmitted automatically (reduces need for in-person reads).
- Makes aligning HDDs to actual usage easier – helps with upc forecasting.
- Implementation of these meters is still ongoing.

Weather Locations

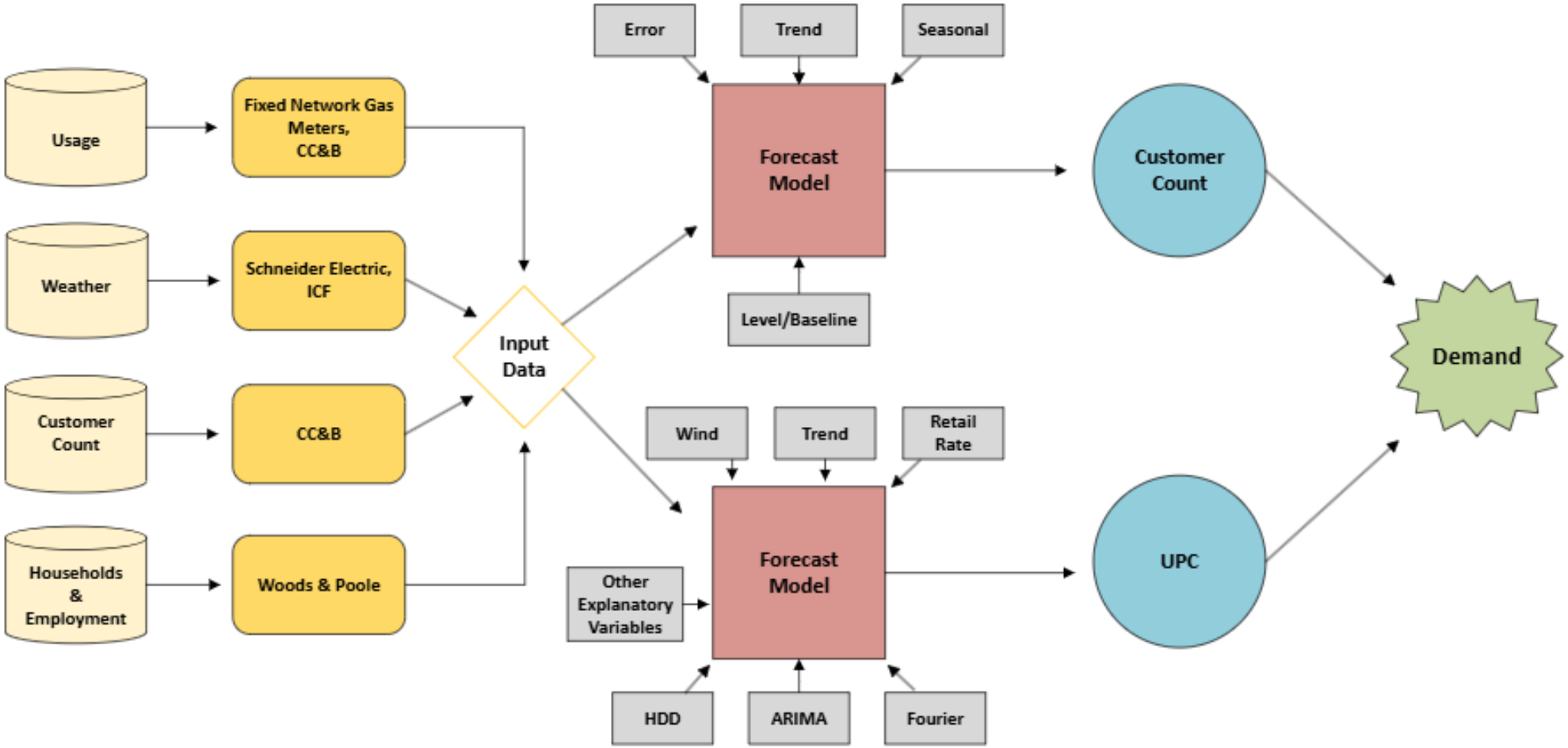
- The seven weather locations are shown on the map.
- Cascade's service territory is shaded in aqua.
- Each citygate and loop is assigned to a weather location.

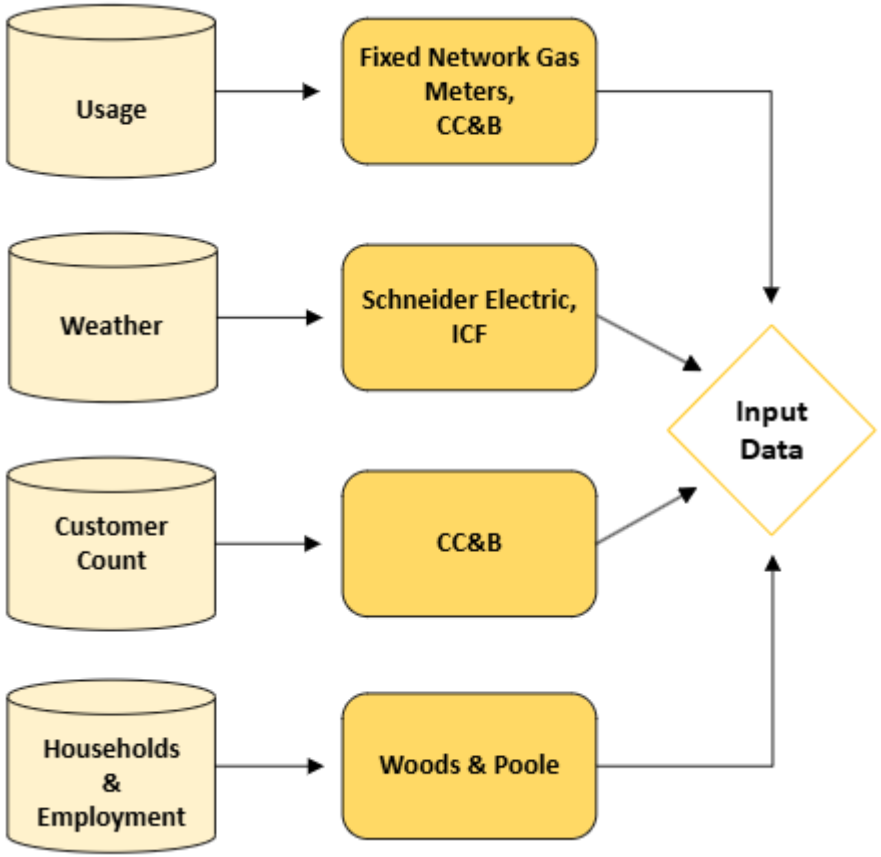


Weather Normals & Climate Change Impacts

- Cascade utilized climate modeling approaches in the previous IRP where the Company used the SSP 3-7.0 and SSP 2-4.5 projections. These approaches were used to avoid under planning for other carbon compliance mitigating options.
- For the 2027 IRP, Cascade has contracted with ICF.
  - ICF will provide additional SSP 5-8.5 projections that represent daily HDD time series data for the planning horizon.
  - HDD projections will use Coupled Model Intercomparison Project Phase 6 (CMIP6) Localized Constructed Analogs version 2 (LOCA2) statistically downscaled global climate models.
    - Global models that are “translated” to local models using historical weather data.
  - Projections will use an ensemble of 20+ climate models and two future greenhouse gas emissions scenarios. We use Shared Socioeconomic Pathway (SSP) 2-4.5, 3-7.0, and 5-8.5, where SSP 5-8.5 is a more aggressive temperature increase scenario, to characterize future climate change uncertainty.

WA & OR General Process





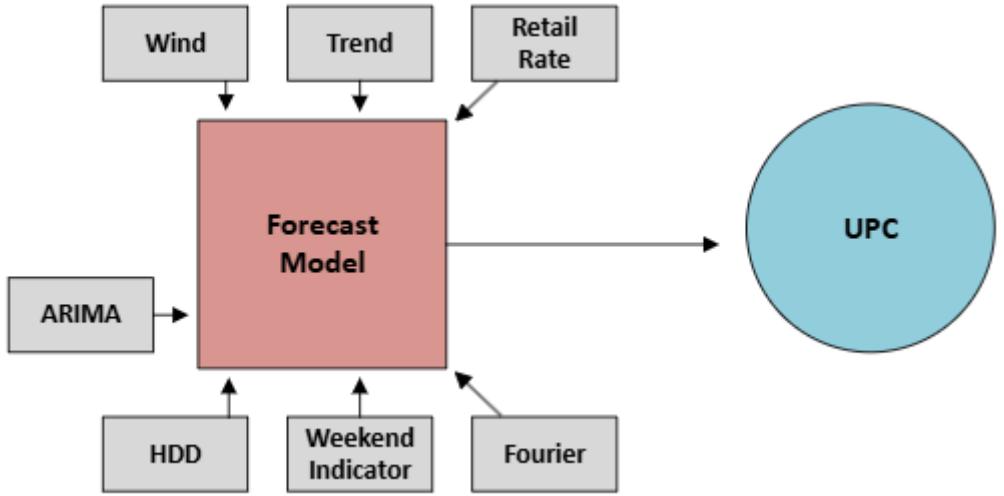
WA & OR Inputs

- Cascade uses data from the following sources:
  - Historical usage data from the fixed network gas meter data or our Customer Counts & Billing Data (CC&B).
  - Weather data from Schneider Electric (historicals) and ICF (projections).
  - Households and employment data at county level from Woods & Poole.
  - Historical customer counts from our CC&B data.

Current UPC Forecast Model

$$UPC^{Z,Class} = \alpha_0 + \alpha_1 HDD^{Z,M} + \alpha_2 I_w + \alpha_3 WIND^{Z,M} + \alpha_4 \text{Retail Price} + \text{Trend} + \text{Fourier}(K) + \text{ARIMA} \in (p,d,q)$$

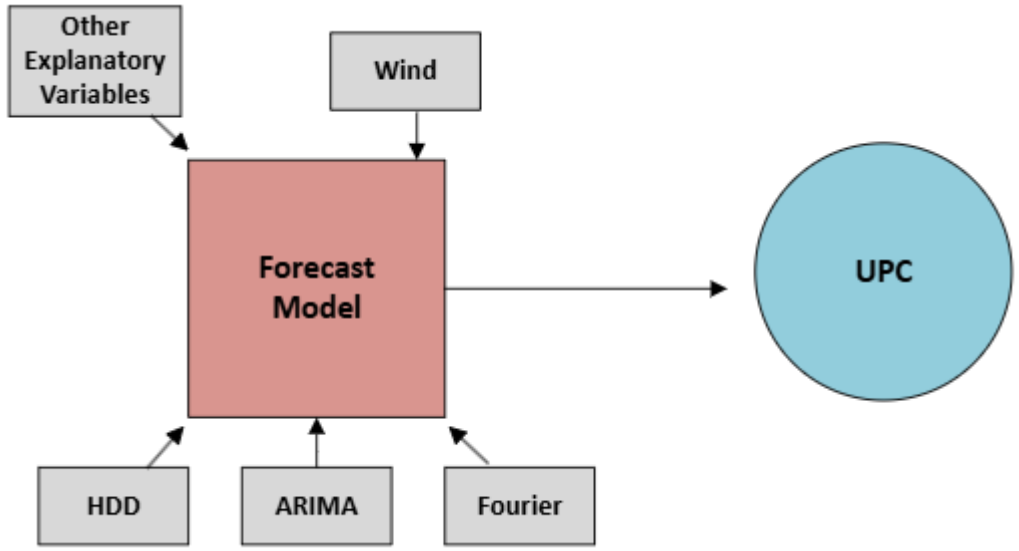
- Where:
  - UPC = Therm usage divided by customers;
  - Z = Zone;
  - Class = Residential, Commercial, Industrial, or Interruptible;
  - HDD = Heating Degree Days;
  - M = Month specific weather data indicators;
  - I_w = Indicator variable set to 1 if it is a weekend;
  - T = Trend variable (increases by 1 for each day forecasted);
  - WIND = Daily average wind speed;
  - Retail Price = Price customers see on their bill.



Potential UPC Forecast Model

$UPC^{Z,Class} = \alpha_0 + \alpha_1 HDD^Z + \alpha_2 Extreme\_HDD + \alpha_3 WIND^Z + Fourier(K) + ARIMA \in (p,d,q)(PDQ)$

- Where:
  - UPC = Therm usage divided by customers;
  - Z = Zone;
  - Class = Residential, Commercial, Industrial, or Interruptible;
  - HDD = Heating Degree Days (broken into groups based on month);
  - Extreme_HDD = indicator that turns “on” once temperature crosses certain coldness threshold (helps capture peak days);
  - WIND = Daily average wind speed;
  - Others also checked.



Non-Core Outlook

Non-Core Outlook

- Cascade forecasts the non-core out to 2050.
- Unlike the core, non-core (or transportation) customers are customers who schedule and purchase their own gas, generally through a marketer, to get gas to the citygate. The customer then uses Cascade's distribution system to receive the gas.
- Cascade's transportation customers include all types of industrial customers. It includes farms that may not use any gas during the winter to food manufacturers that average 800,000 therms per month throughout the year.
- Cascade also serves six electric generation customers in Washington and one in Oregon. Those seven customers project to use approximately 800,000,000 therms in 2027.

Transportation Customers

- Cascade's transportation customer forecast increased from the previous forecast. The current forecast projects the customer count to be 254 in 2027. Cascade's industrial managers are working closely with potential industrial customers.
- Cascade projects the transportation customers, excluding electric generation, in Washington and Oregon to consume approximately 521 million therms in 2027.

Feedback for Cascade?

- 860-090-0060(6)(b) - The utility must include in the assessment reasonable upper and lower bounds on resource needs based on key planning uncertainties.
- Do you have comments or ideas that Cascade should consider regarding the Customer and Demand Forecast?

Process Item	Date	Process Element
Targeted-TAG	Wednesday, June 10, 2026	Avoided Cost
Targeted-TAG	Wednesday, July 1, 2026	Energy Efficiency
Targeted-TAG	Wednesday, July 22, 2026	Equity in the IRP
Targeted-TAG	Wednesday, August 12, 2026	CCA/CPP Compliance Modeling
Targeted-TAG	Wednesday, September 2, 2026	Distribution System Planning
Targeted-TAG	Wednesday, September 23, 2026	Resource Integration
TAG 1	Wednesday, October 14, 2026	Process, Key Points, IRP Team, Timeline, Regional Market Outlook, Planned Scenarios and Sensitivities, Stakeholder Engagement, Demand and Customer Forecast and Non-Core Outlook, Drilling down into segments of demand forecast. Upstream Pipeline presentation.
TAG 2	Wednesday, November 18, 2026	Respond to TAG 1 Feedback, Distribution System Planning, Alternative Resources, Price Forecast, Avoided Costs, Current Supply Resources, Transport Issues, Carbon Impacts, Energy Efficiency, Bio-Natural Gas, Preliminary Resource Integration Results.
First Draft	Wednesday, December 16, 2026	
Comments Due	Wednesday, January 20, 2027	
TAG 3	Wednesday, February 10, 2027	Respond to TAG 2 feedback, Final Integration Results, finalization of plan components, Proposed new 2- to 4-year Action Plan
Final Draft	Friday, March 12, 2027	
Comments Due	Friday, April 9, 2027	
TAG 4 (if needed)	Wednesday, April 28, 2027	
Final Complete By	Wednesday, May 19, 2027	
File	Friday, May 21, 2027	

2027 IRP Schedule

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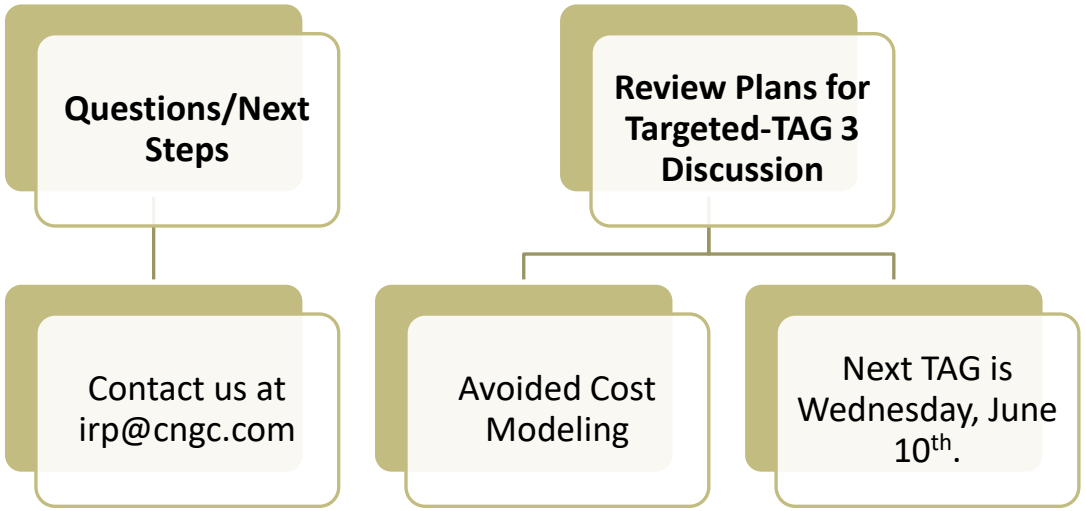

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Integrated Resource Plan Targeted Technical Advisory Group Meeting #2

MAY 20, 2026

MICROSOFT TEAMS/TELECONFERENCE

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