Natural Gas Integrated Resource Plan

Technical Advisory Committee (TAC) # 2

May 3, 2022

Virtual TAC Meeting Reminders

- Please mute mics unless speaking or asking a question
- Raise hand or use the chat box for questions or comments
- Respect the pause
- Please try not to speak over the presenter or a speaker
- Please state your name before commenting for the note taker
- This is a public advisory meeting – presentations and comments will be documented and recorded

2023 – Avista Natural Gas IRP

Major Milestone	Date	Topics
TAC 1	Wednesday, February 16, 2022	RNG Discussion, Compliance To EO 20-04, Policy, Peak Day Weather Planning Standard
TAC 2	Tuesday, May 3, 2022	Use Per Customer, Planned Scenarios, Customer Forecast, Current Supply Side Resources, Plexos Model Overview, Baseline Demand Projections
TAC 3	Wednesday, June 22, 2022	Customer Survey Results,CCA Overview, Distribution
TAC 4	Tuesday, August 23, 2022	Future Supply Side Resource Options, CPA, Demand Response
TAC 5	Tuesday, October 25, 2022	Final Results / Stochastics, Scenario Results
Draft Feedback Due	Wednesday, February 1, 2023	
File	Friday, March 31, 2023	

Agenda

Item	Time
2023 Timeline / Agenda Overview	9:00am – 9:10am
Customer Forecast	9:10am – 9:40am
Use per Customer	9:40am – 10:10am
Break	10:10am – 10:20am
Current Supply Side Resources	10:20am – 11:00am
Plexos Model Overview	11:00am – 11:30am
Proposed Scenarios	11:30am – 12:00pm

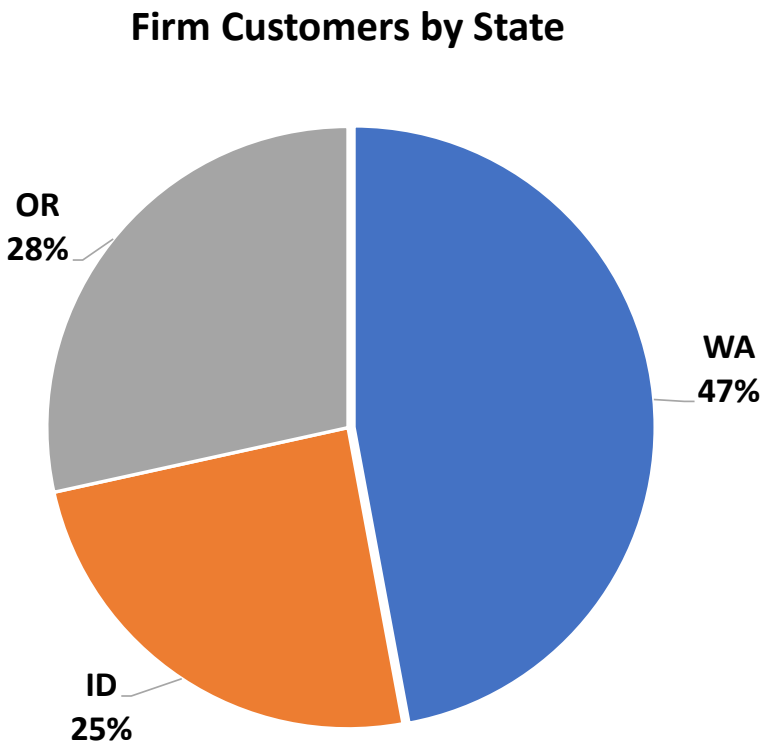
2023 IRP Long-Run Customer Forecast: Natural Gas

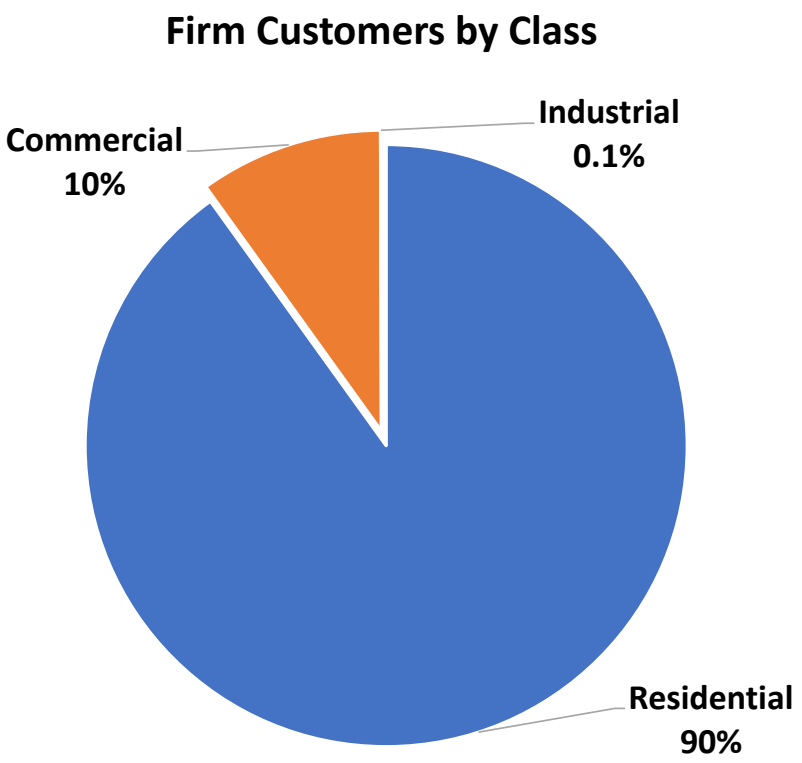
Grant D. Forsyth, Ph.D.

Grant.Forsyth@avistacorp.com

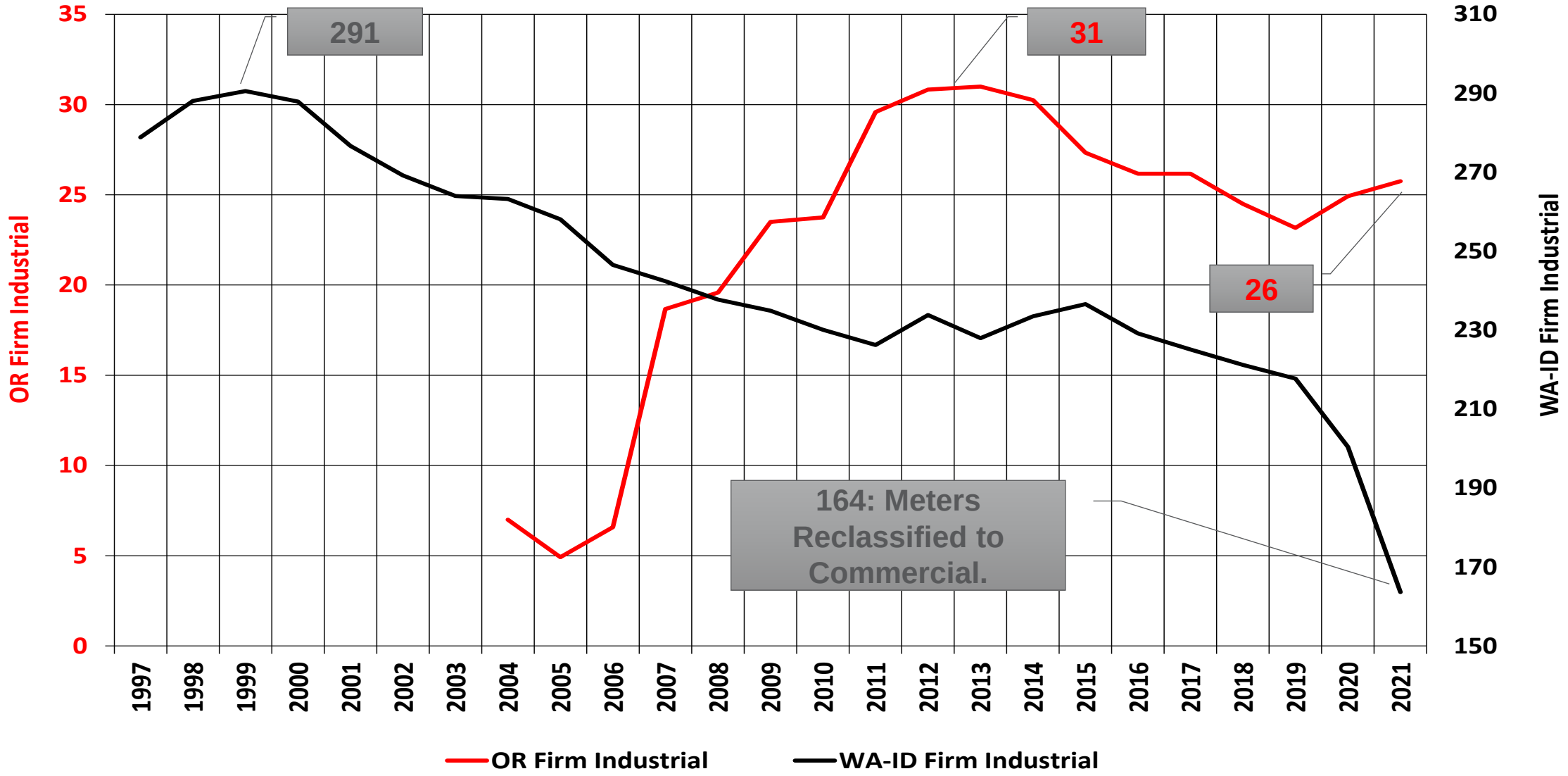
Chief Economist

Firm Customers (Meters) by State and Class, 2021





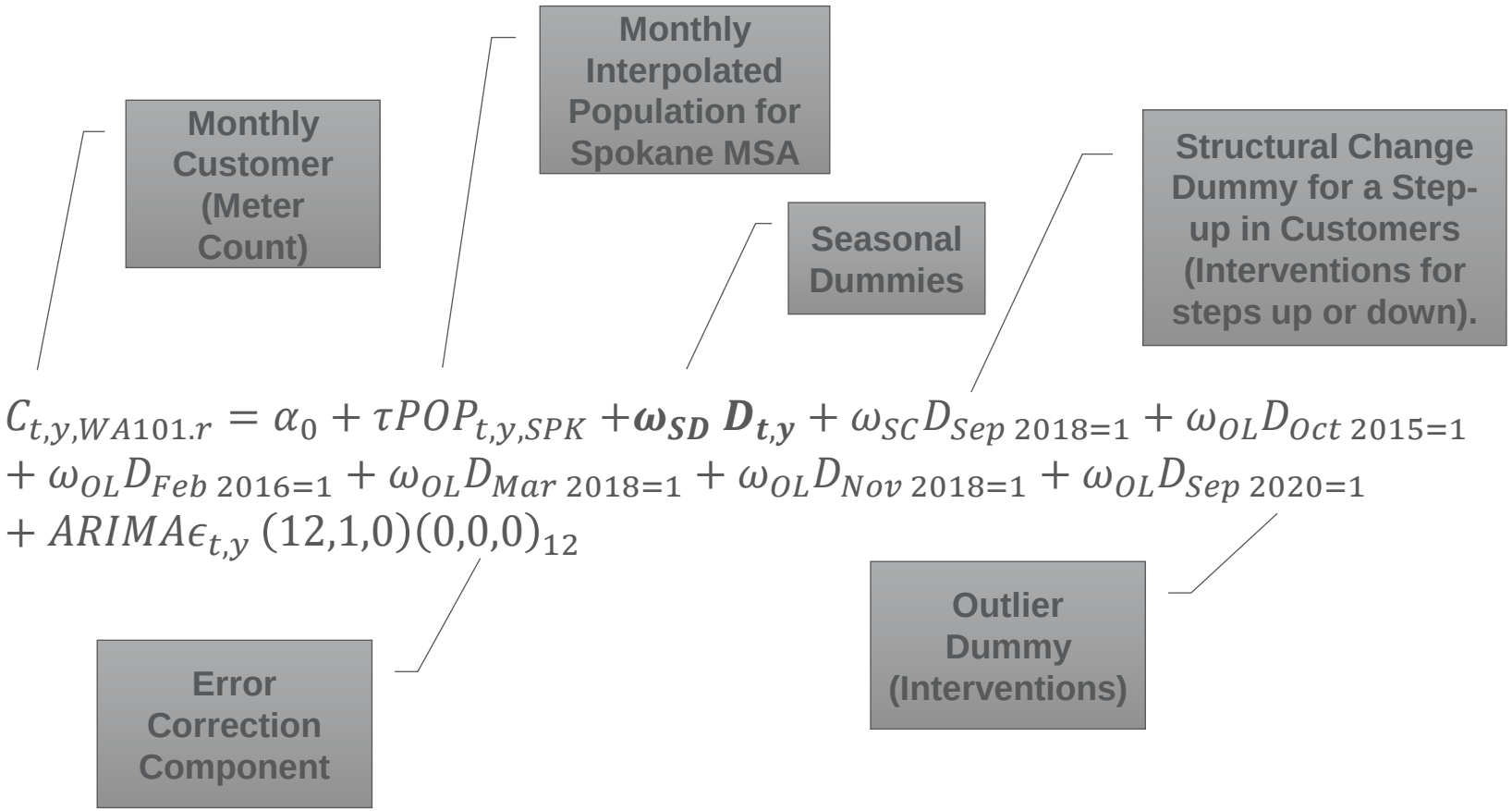
System Firm Industrial Customers, 1997-2021



Customer Forecast Models

- Forecast models are structured around each schedule, in each class, by jurisdiction. In the case of OR, this is done individually for each of Avista's service islands.
- Time series transfer function models (models with regressions drivers and ARIMA error terms).
- Simple time series smoothing models (for schedules with little customer variation).
- Same models used for the bi-annual revenue model forecast pushed out to 2045. The forecasts for this IRP were generated from the "Spring 2022" forecast completed in March 2022.
- Customer forecasts are sent to Gas Supply for inclusion in the PLEXOS model.
- Example of transfer function model: WA sch. 101 residential customers…

Transfer Function Model Example



Getting to Population as a Driver, 2022-2026 & 2027-2045

2022-2026 For Spokane, WA; Kootenai, ID, and Jackson+Josephine, OR

Average GDP Growth Forecasts:
- WSJ, FOMC, Bloomberg, etc.
- Average forecasts out 5 full calendar years.

GDP

Non-farm Employment Growth Model:
- Model links year y, y-1, and y-2 GDP growth to year y regional employment growth.
- Forecast out 5 full calendar years.
- Averaged with IHS employment growth forecasts.

EMP

Regional Population Growth Models:
- Model links regional, U.S., and CA year y-1 employment growth to year y county population growth.
- Forecast out 5 full calendar years for Spokane, WA; Kootenai, ID; and Jackson+Josephine, OR.
- Averaged with IHS growth forecasts.
- Growth rates used to generate population forecasts for use in regression models—important driver for main residential and commercial schedules.

Kootenai and Jackson: IHS population growth forecasts for 2027-2045

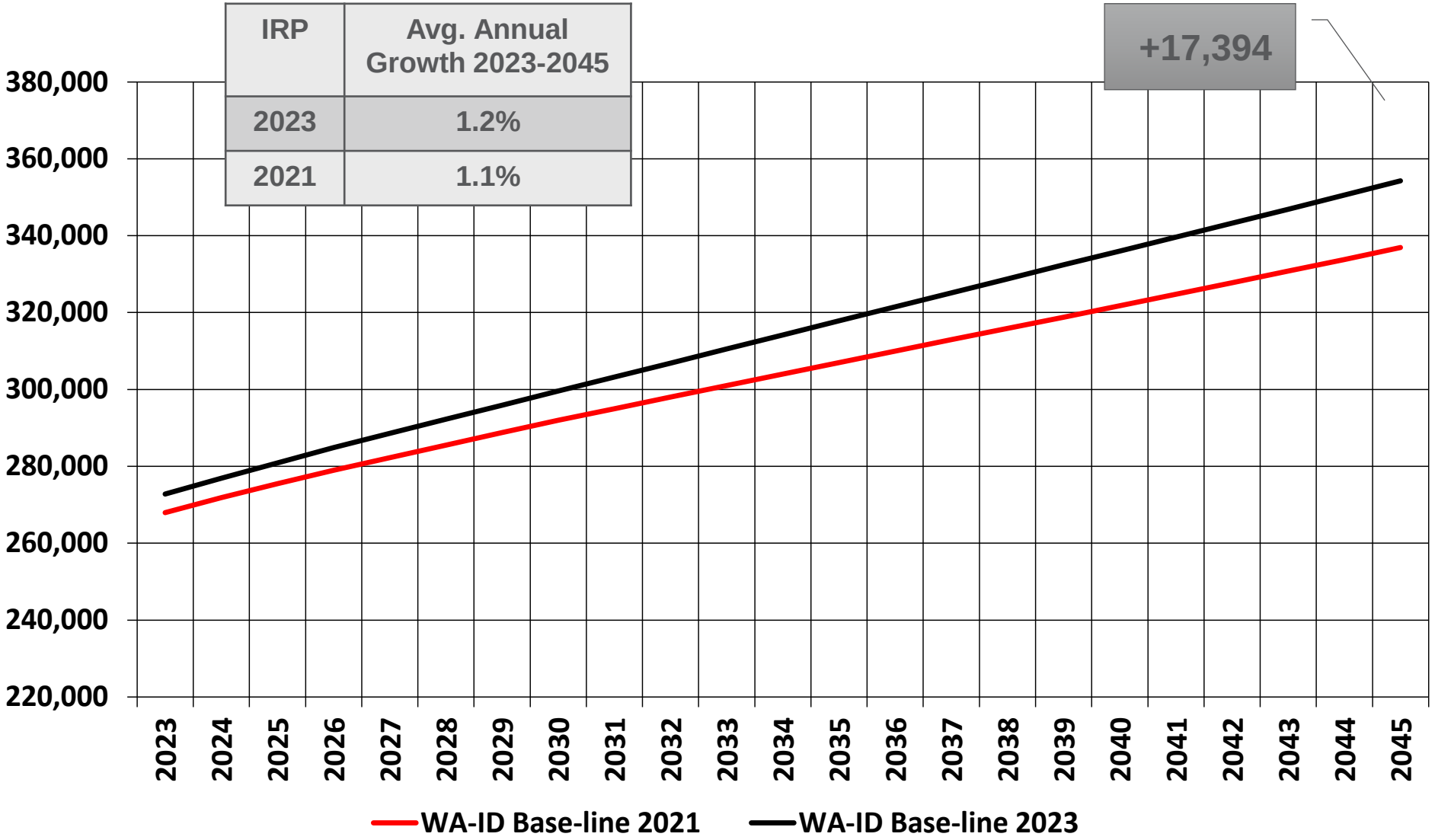
Spokane: IHS population growth forecasts for 2027-2045

OR Douglas, Klamath, and Union counties: IHS population growth forecasts for 2027-2045

Monthly Interpolation assumes: $P_N = P_0 e^{rN}$

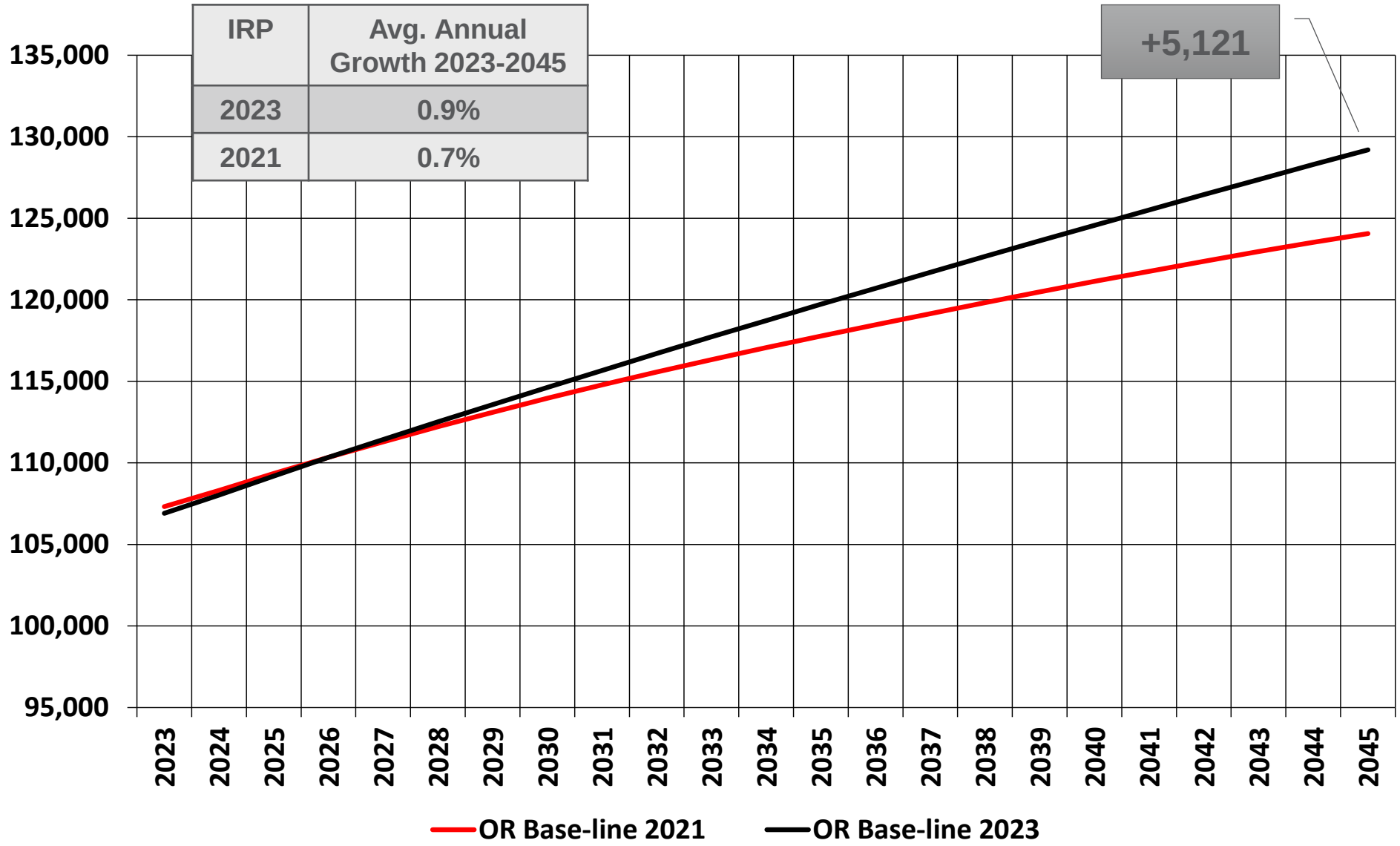
WA-ID Region Firm Customers (2023-2045)

IRP	Avg. Annual Growth 2023-2045
2023	1.2%
2021	1.1%



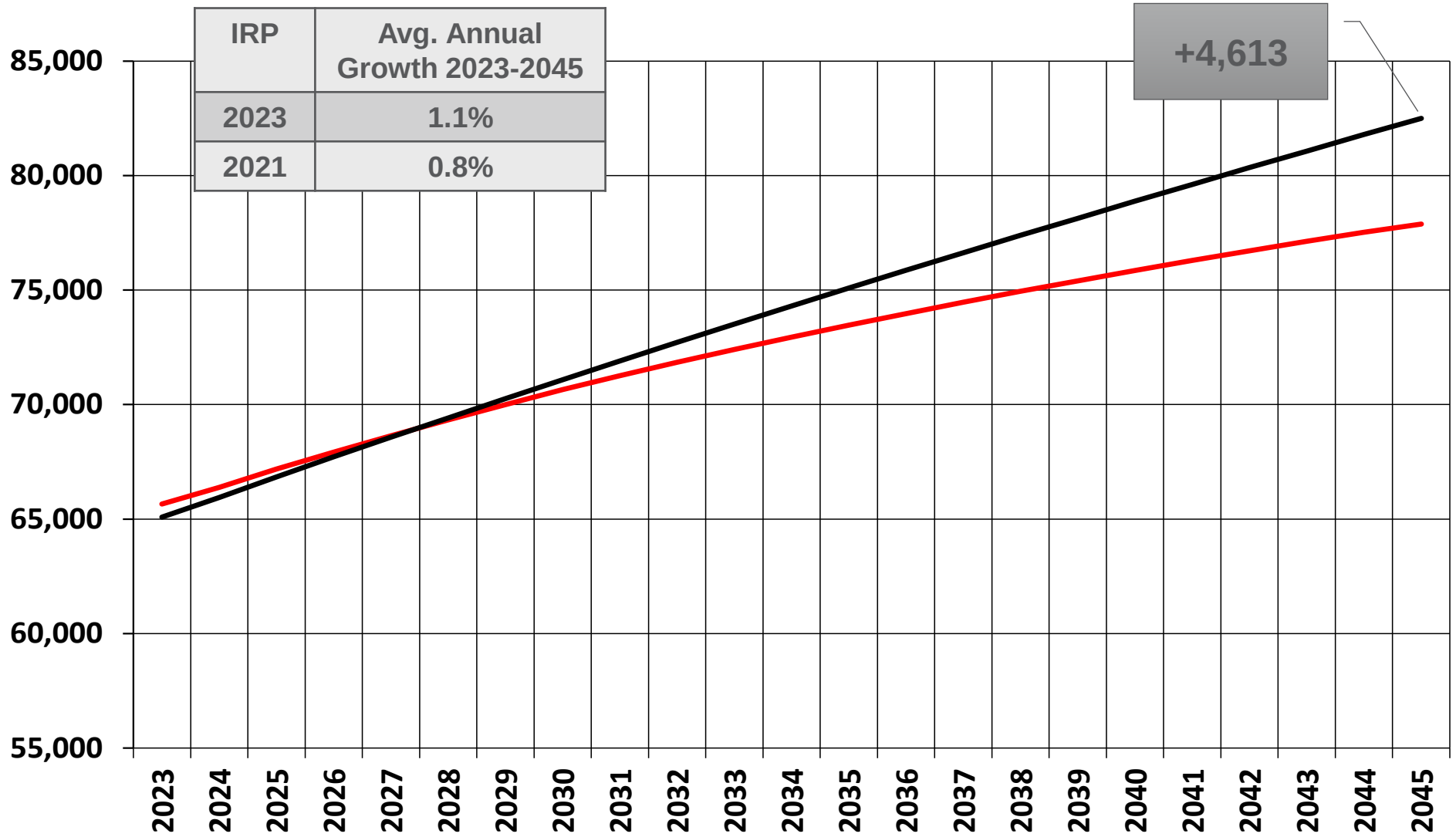
OR Region Firm Customers (2023-2045)

IRP	Avg. Annual Growth 2023-2045
2023	0.9%
2021	0.7%

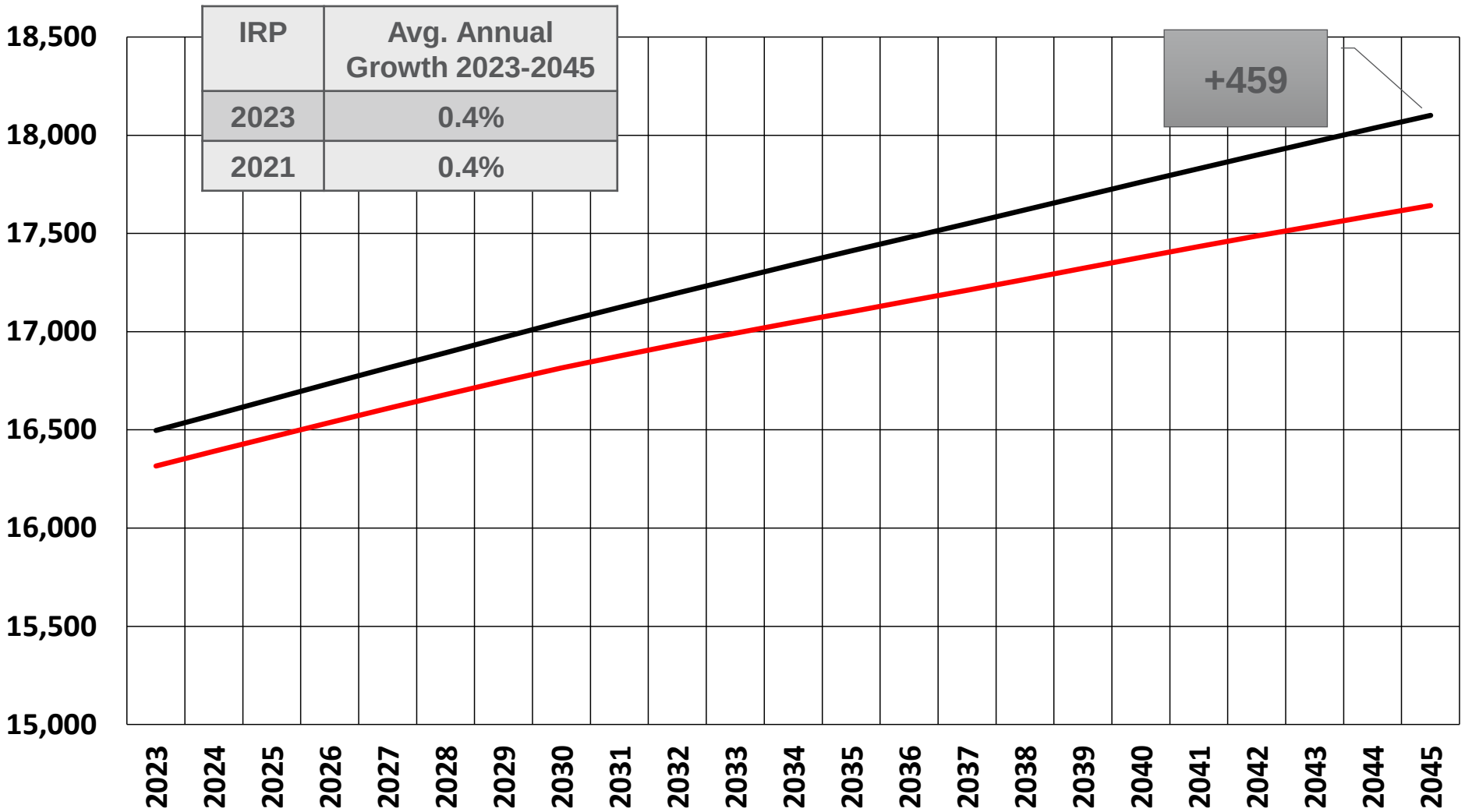


Medford, OR Region Firm Customers (2023-2045)

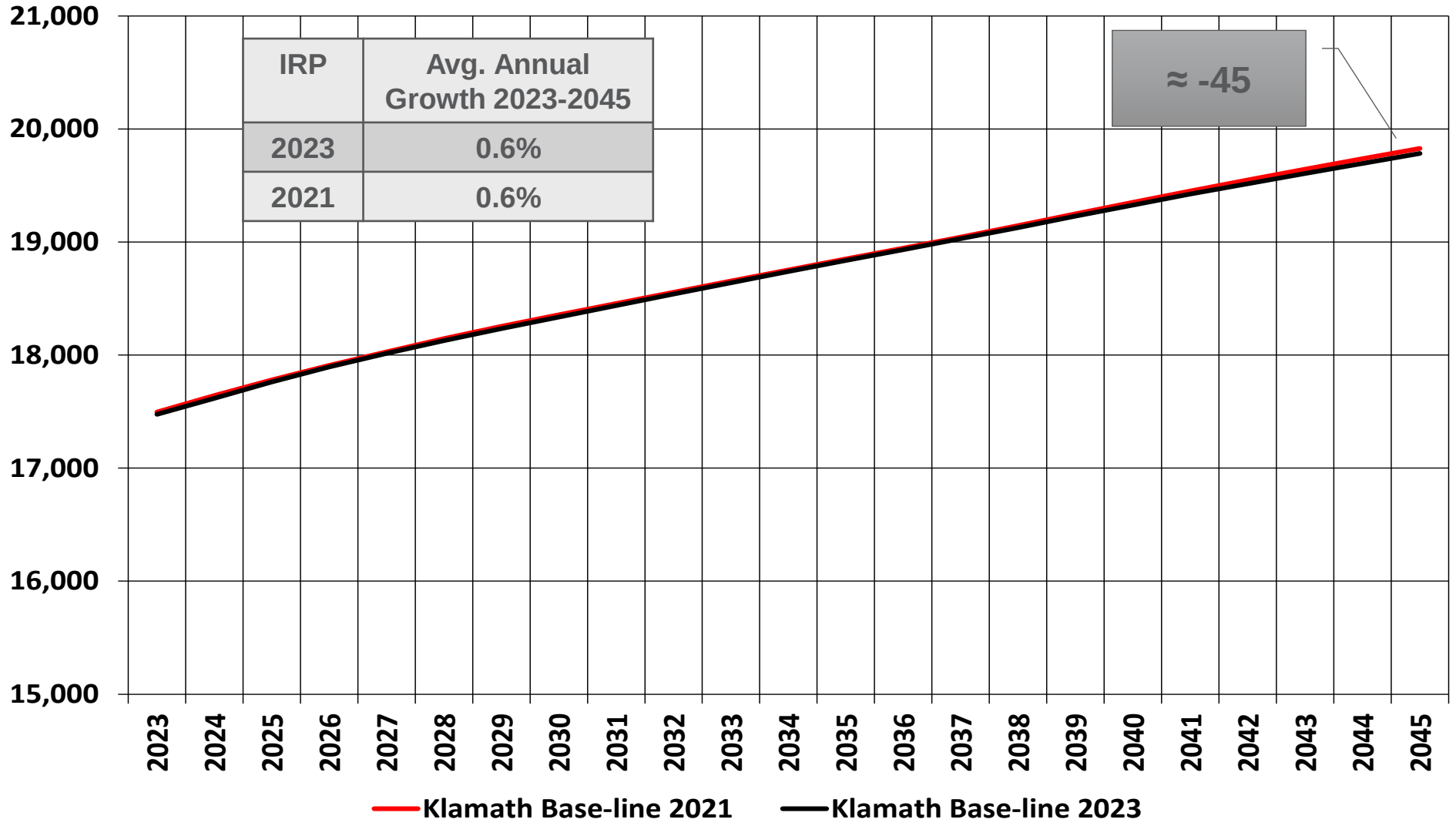
IRP	Avg. Annual Growth 2023-2045
2023	1.1%
2021	0.8%



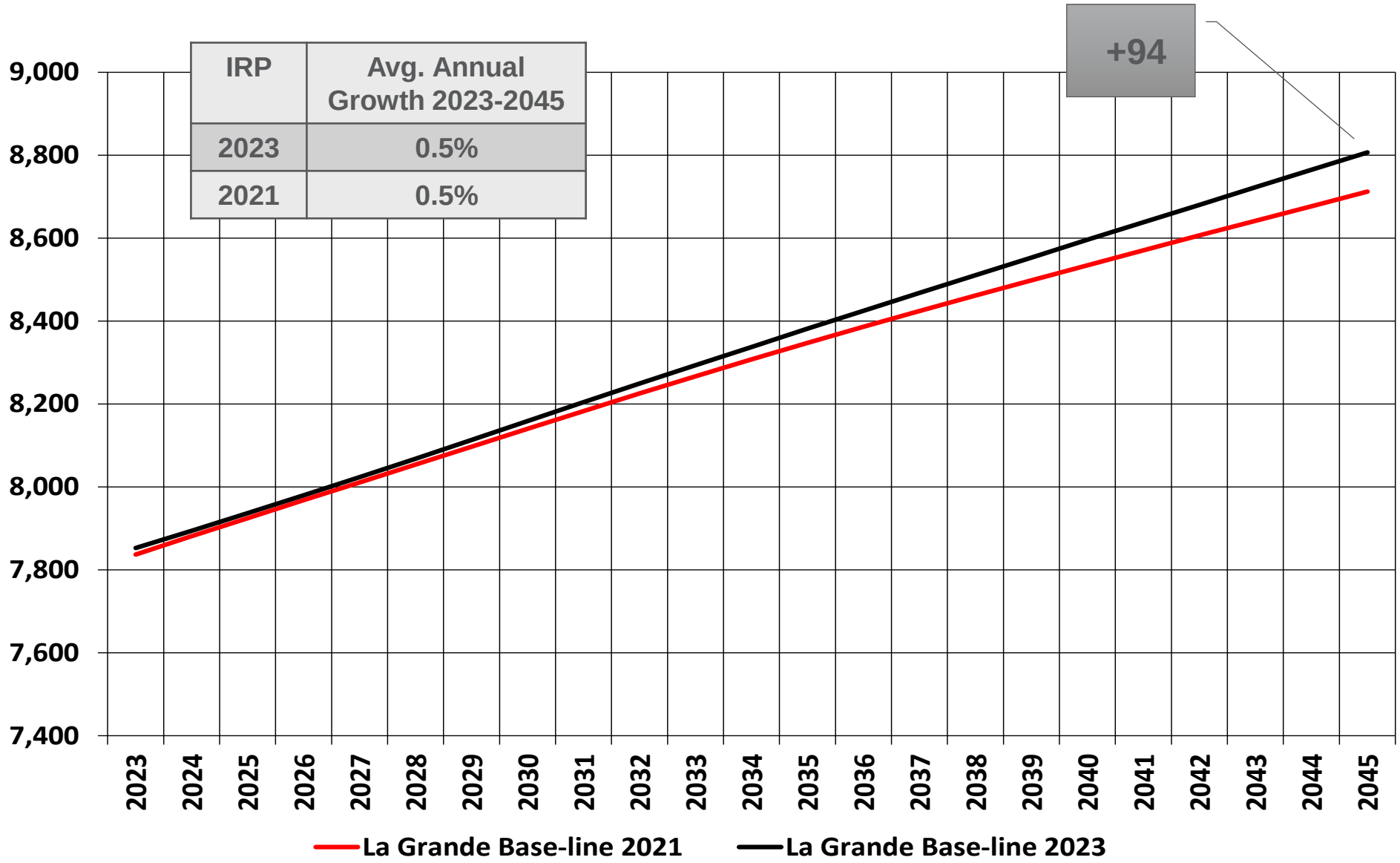
Roseburg, OR Region Firm Customers (2023-2045)



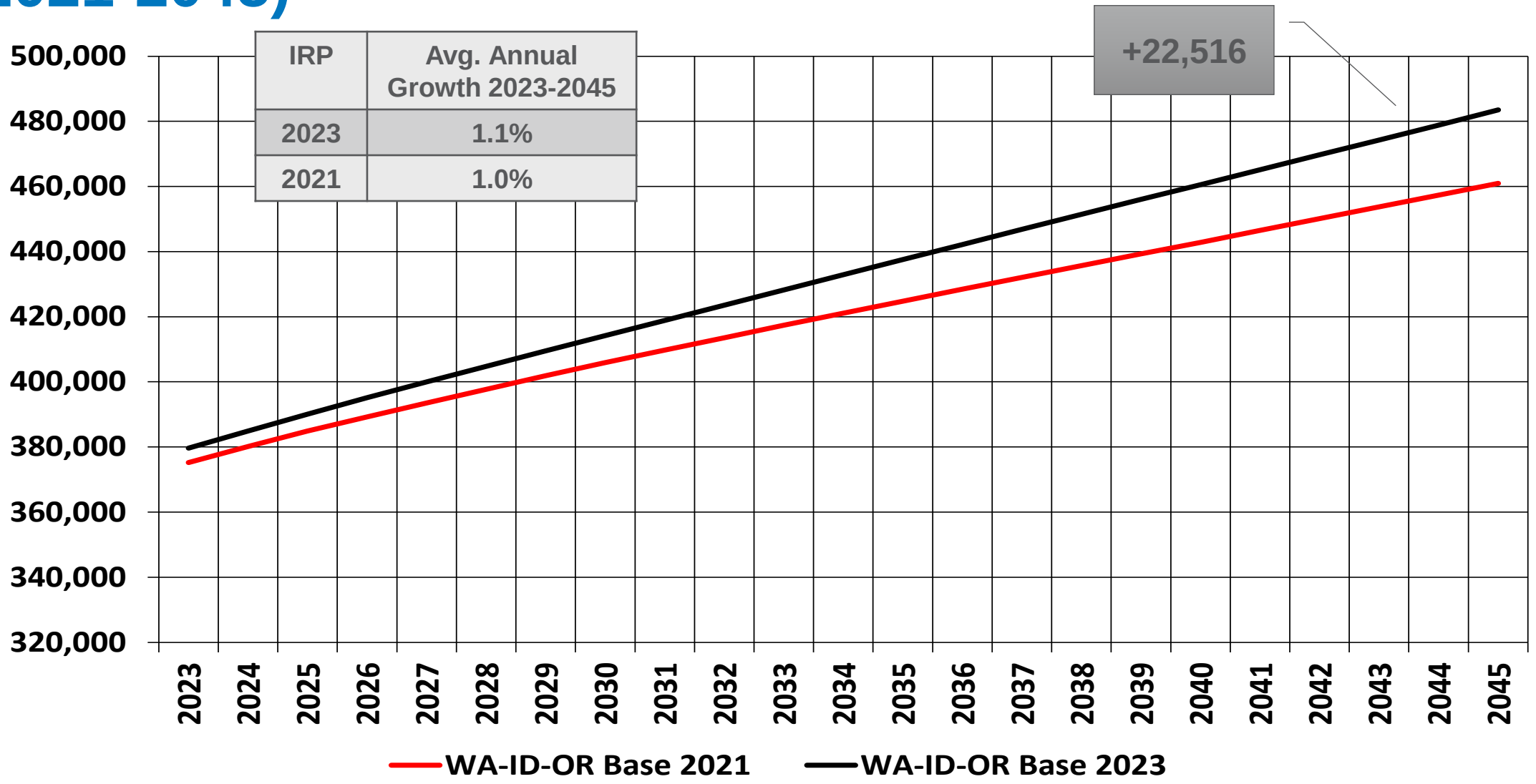
Klamath, OR Region Firm Customers (2023-2045)



La Grande, OR Region Firm Customers (2023-2045)

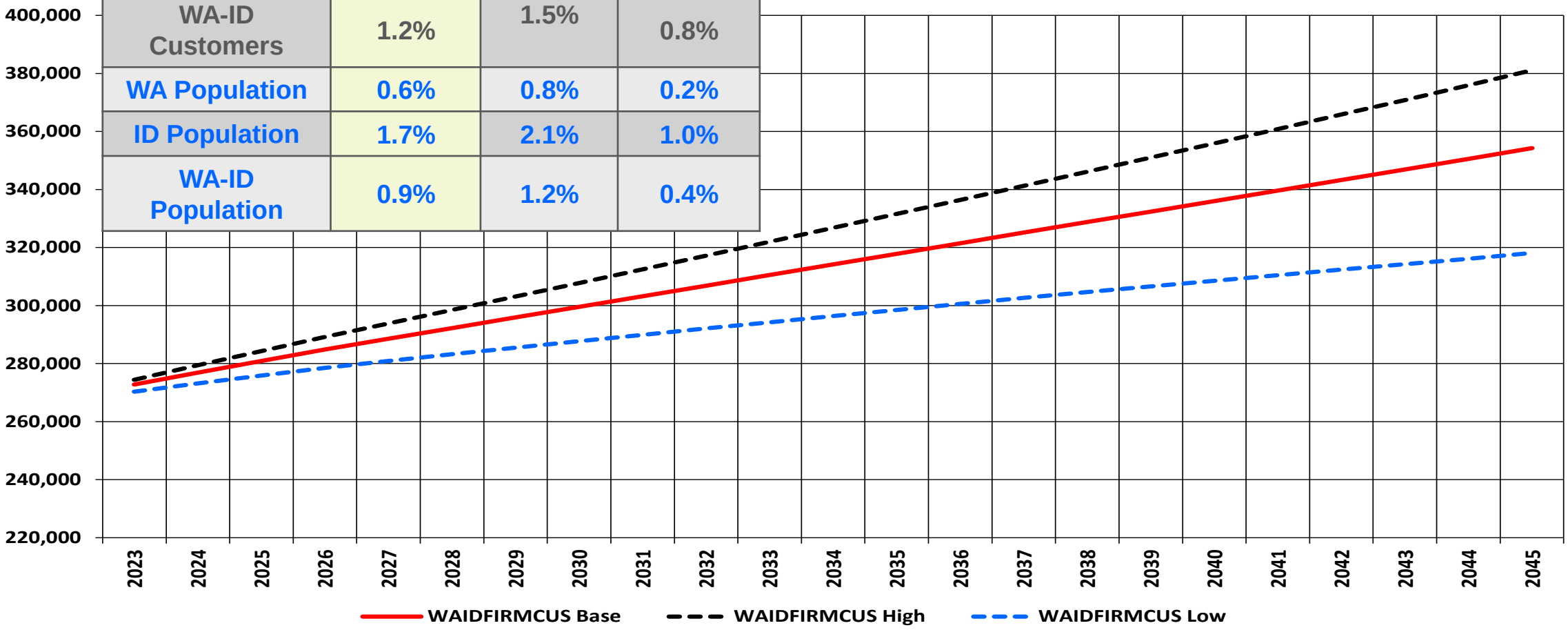


System Firm Customers (2021-2045)



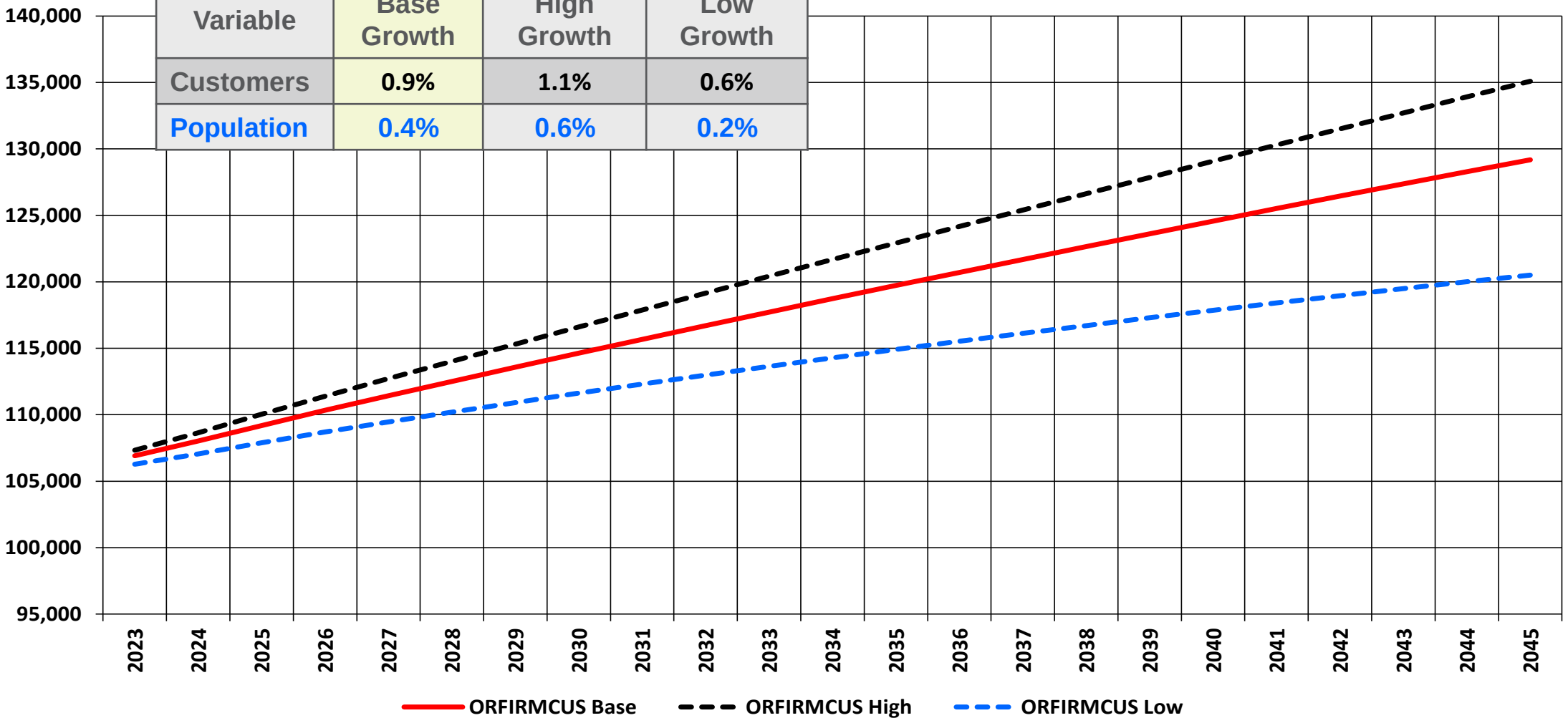
WA-ID Region Firm Customer Range (2023-2045)

Variable	Base Growth	High Growth	Low Growth
WA-ID Customers	1.2%	1.5%	0.8%
WA Population	0.6%	0.8%	0.2%
ID Population	1.7%	2.1%	1.0%
WA-ID Population	0.9%	1.2%	0.4%



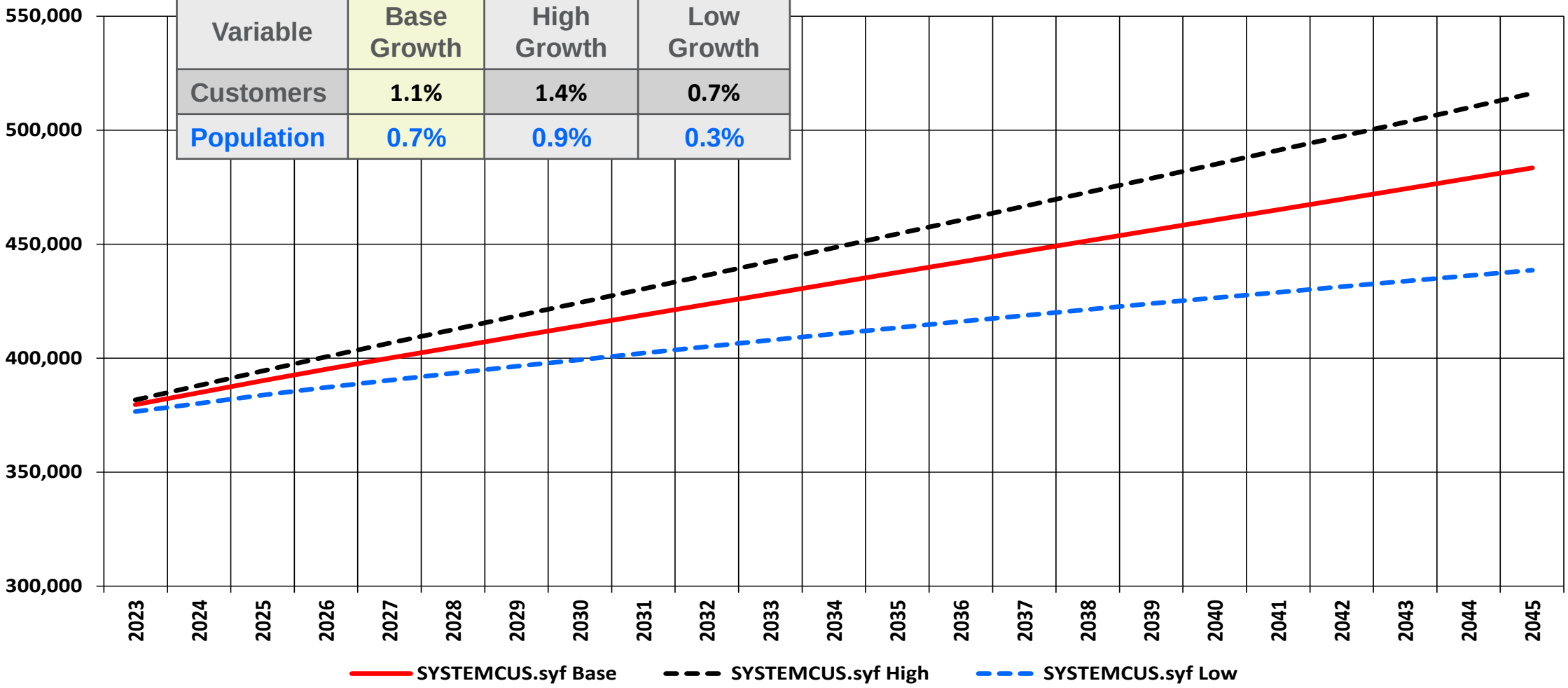
OR Region Firm Customer Range (2023-2045)

Variable	Base Growth	High Growth	Low Growth
Customers	0.9%	1.1%	0.6%
Population	0.4%	0.6%	0.2%



System Firm Customer Range (2023-2045)

Variable	Base Growth	High Growth	Low Growth
Customers	1.1%	1.4%	0.7%
Population	0.7%	0.9%	0.3%



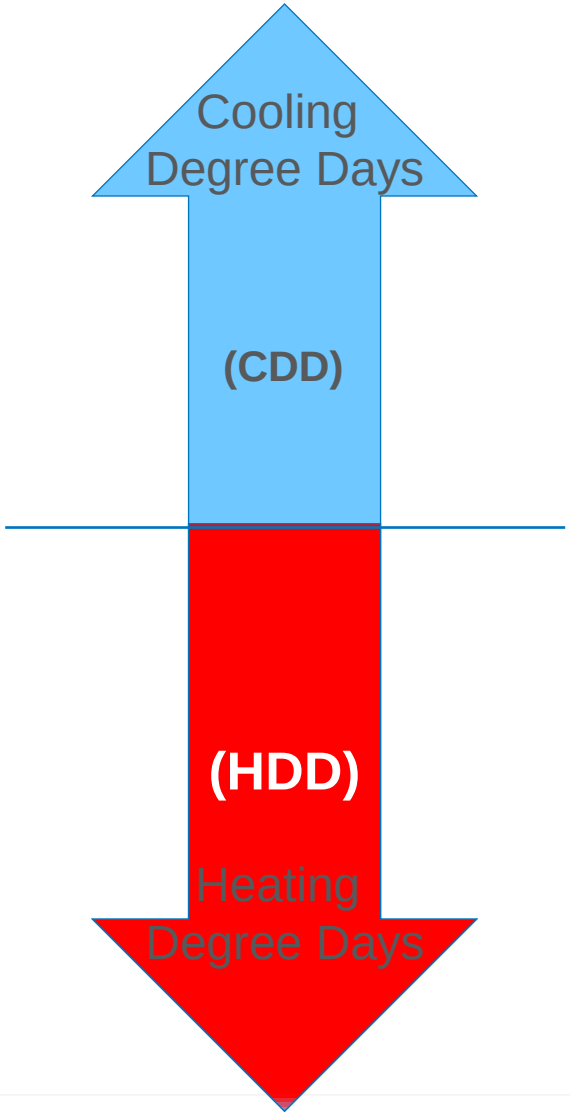
Summary of Growth Rates

System	Base-Case	High	Low
Residential	1.2%	1.5%	0.8%
Commercial	0.5%	0.8%	0.1%
Industrial	0.0%	2.1%	-16.9%
Total	1.1%	1.4%	0.7%
WA	Base-Case	High	Low
Residential	1.1%	1.3%	0.8%
Commercial	0.4%	0.7%	0.1%
Industrial	0.0%	1.8%	-22.6%
Total	1.1%	1.3%	0.7%
ID	Base-Case	High	Low
Residential	1.6%	2.0%	0.9%
Commercial	0.5%	1.0%	-0.1%
Industrial	0.0%	1.3%	-100.0%
Total	1.5%	1.9%	0.8%
OR	Base-Case	High	Low
Residential	0.9%	1.1%	0.6%
Commercial	0.6%	0.8%	0.3%
Industrial	0.0%	4.4%	-9.8%
Total	0.9%	1.1%	0.6%

-100% reflects zero customers by 2045

Use per Customer

Temperature & Degree Days



Temp (°F)		Degree Days
100	=	35
90	=	25
80	=	15
70	=	5
65	=	0
60	=	5
50	=	15
40	=	25
30	=	35
20	=	45
10	=	55
0	=	65
-10	=	75
-20	=	85

Base Coefficients

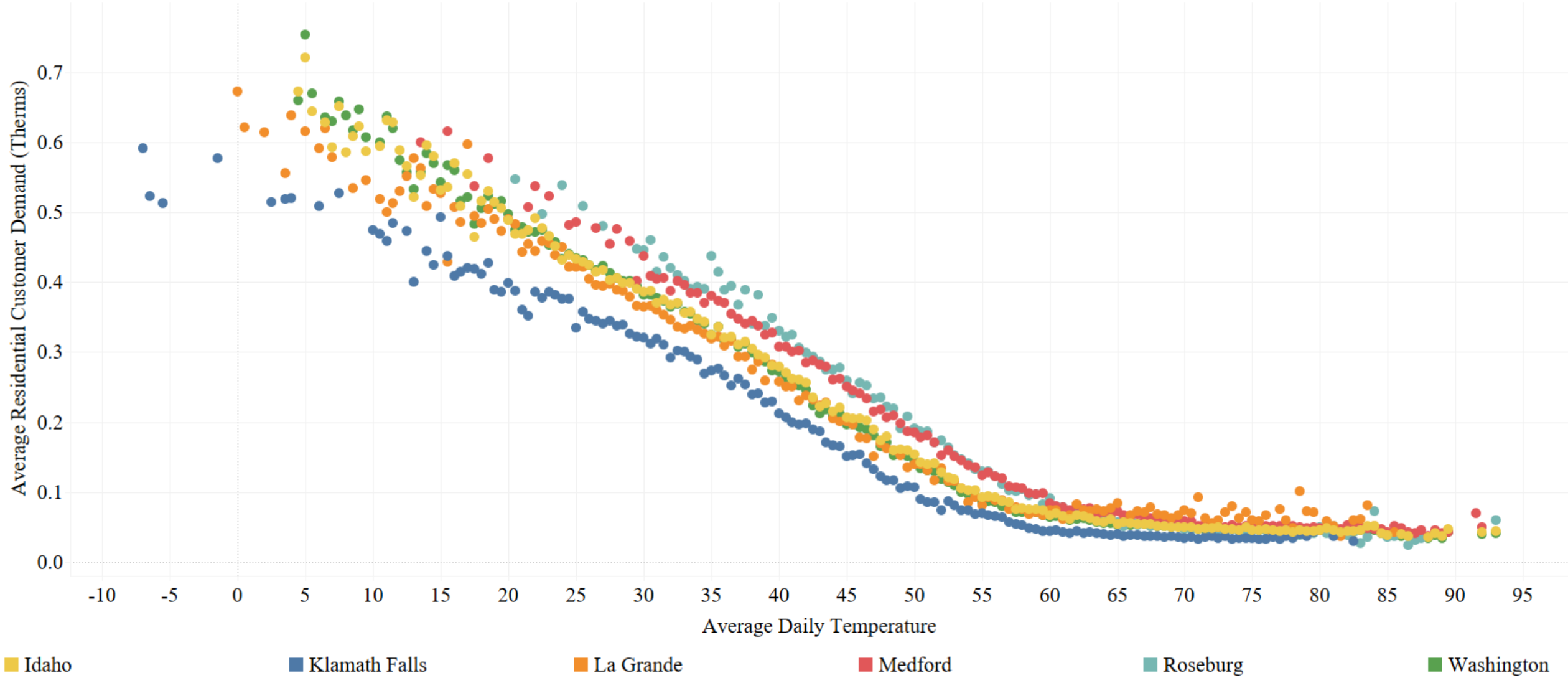
	Residential			Commercial			Industrial		
	2 Year	3 Year	5Year	2 Year	3 Year	5Year	2 Year	3 Year	5Year
Washington	0.04606	**0.04656**	0.04692	0.34753	**0.36691**	0.37156	3.38736	**3.30828**	3.27823
Idaho	0.05007	**0.04931**	0.04813	0.35555	**0.37307**	0.37783	4.44256	**4.85642**	5.05549
Klamath Falls	0.03769	0.03793	**0.03612**	0.23591	0.24248	**0.23301**	4.65297	4.37893	**4.15214**
La Grande	0.05968	0.06263	**0.06556**	0.28766	0.32194	**0.34687**	42.01296	47.95618	**49.61649**
Medford	0.05927	0.05567	**0.05291**	0.43019	0.41408	**0.39437**	4.73881	4.52838	**4.25709**
Roseburg	0.06747	0.06151	**0.05156**	0.47685	0.44512	**0.38135**	5.65826	5.60567	**4.07662**

Heat Coefficients

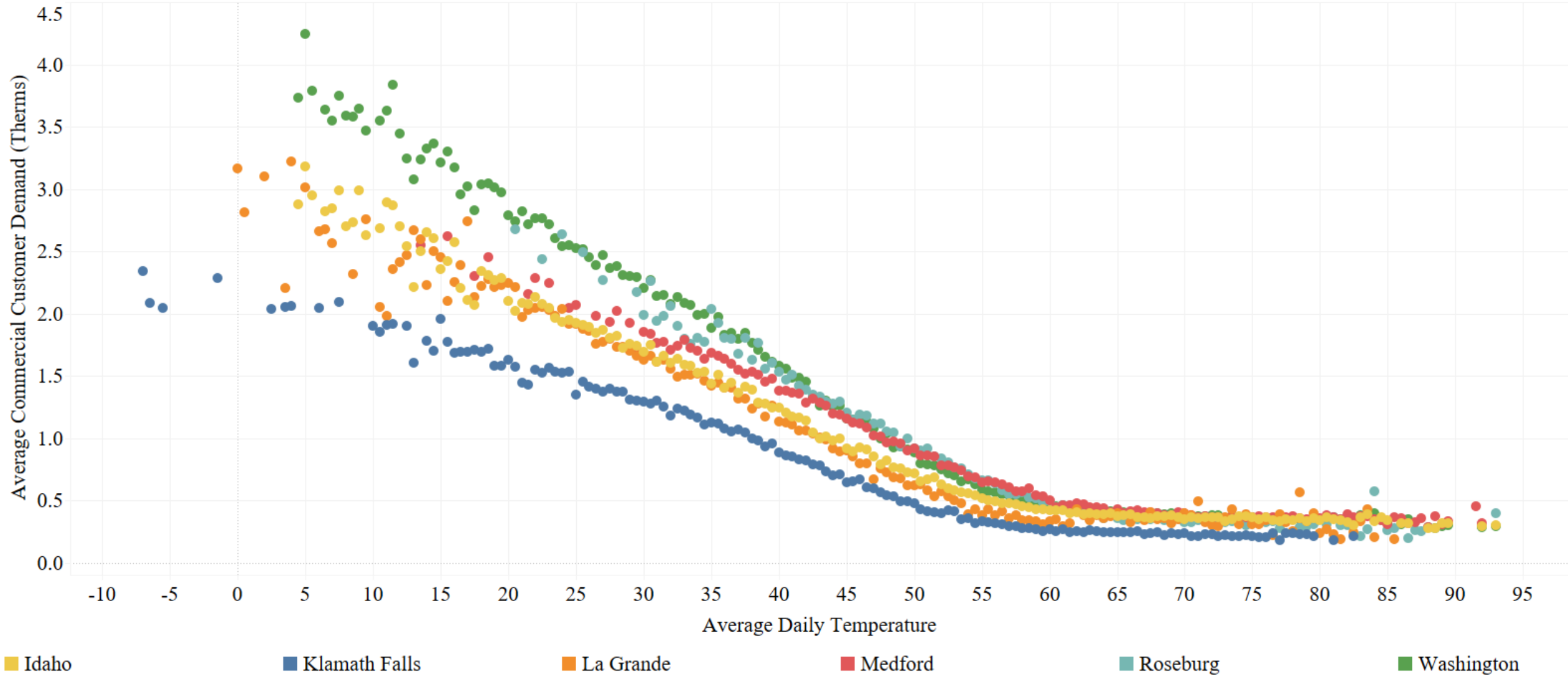
	Residential			Commercial			Industrial		
	2 Year	3 Year	5Year	2 Year	3 Year	5Year	2 Year	3 Year	5Year
Washington	0.00629	**0.00631**	0.00633	0.03554	**0.03714**	0.03687	0.20622	**0.18381**	0.16876
Idaho	0.00666	**0.00663**	0.00649	0.02769	**0.02806**	0.02842	0.23788	**0.23223**	0.22321
Klamath Falls	0.00514	0.00526	**0.00513**	0.01921	0.01995	**0.01946**	0.18185	0.17935	**0.14478**
La Grande	0.00542	0.00551	**0.00600**	0.02254	0.02395	**0.02688**	0.51825	0.88173	**1.58695**
Medford	0.00869	0.00789	**0.00723**	0.03860	0.03446	**0.03030**	0.22523	0.16844	**0.12185**
Roseburg	0.00855	0.00847	**0.00717**	0.03672	0.03783	**0.03086**	0.06607	0.05201	**0.03476**

*Values reflect 12-month average heat coefficient

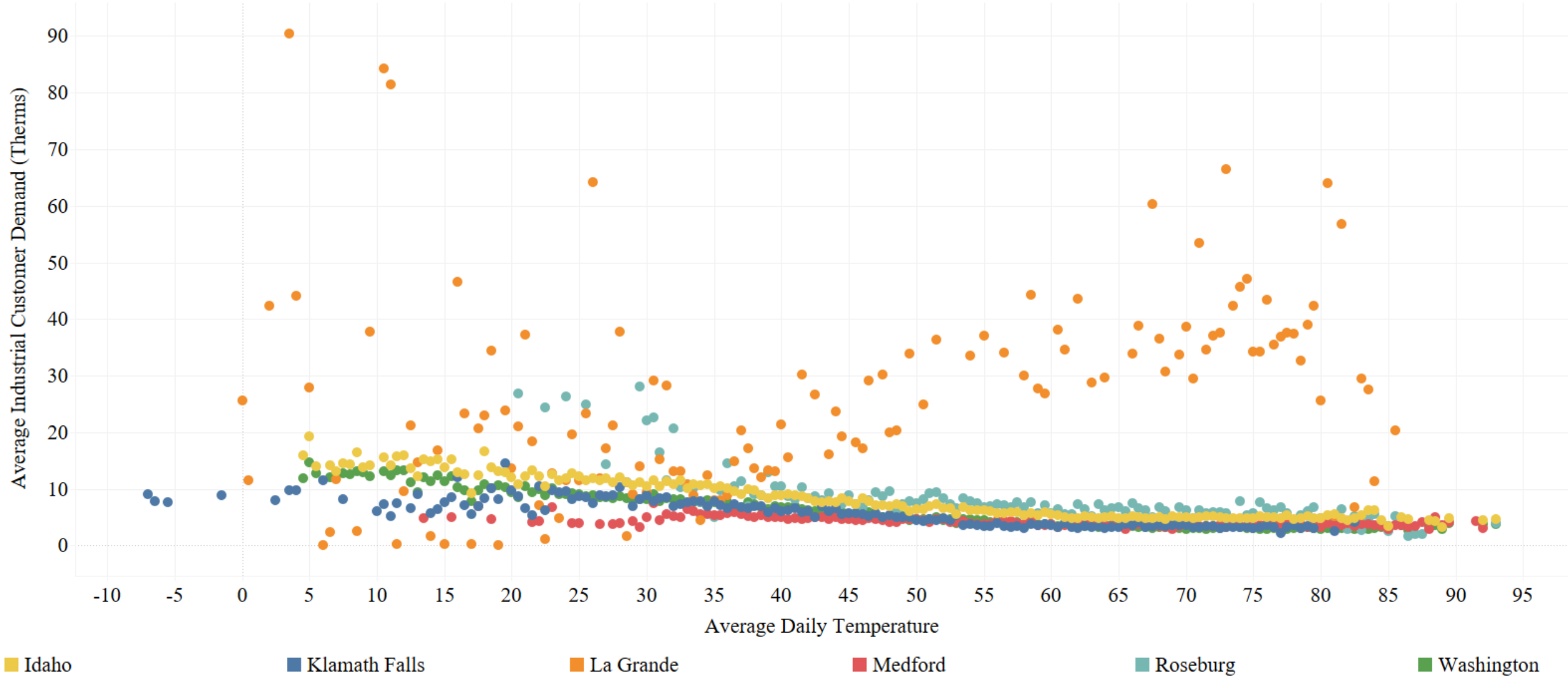
Residential (2012-2021)



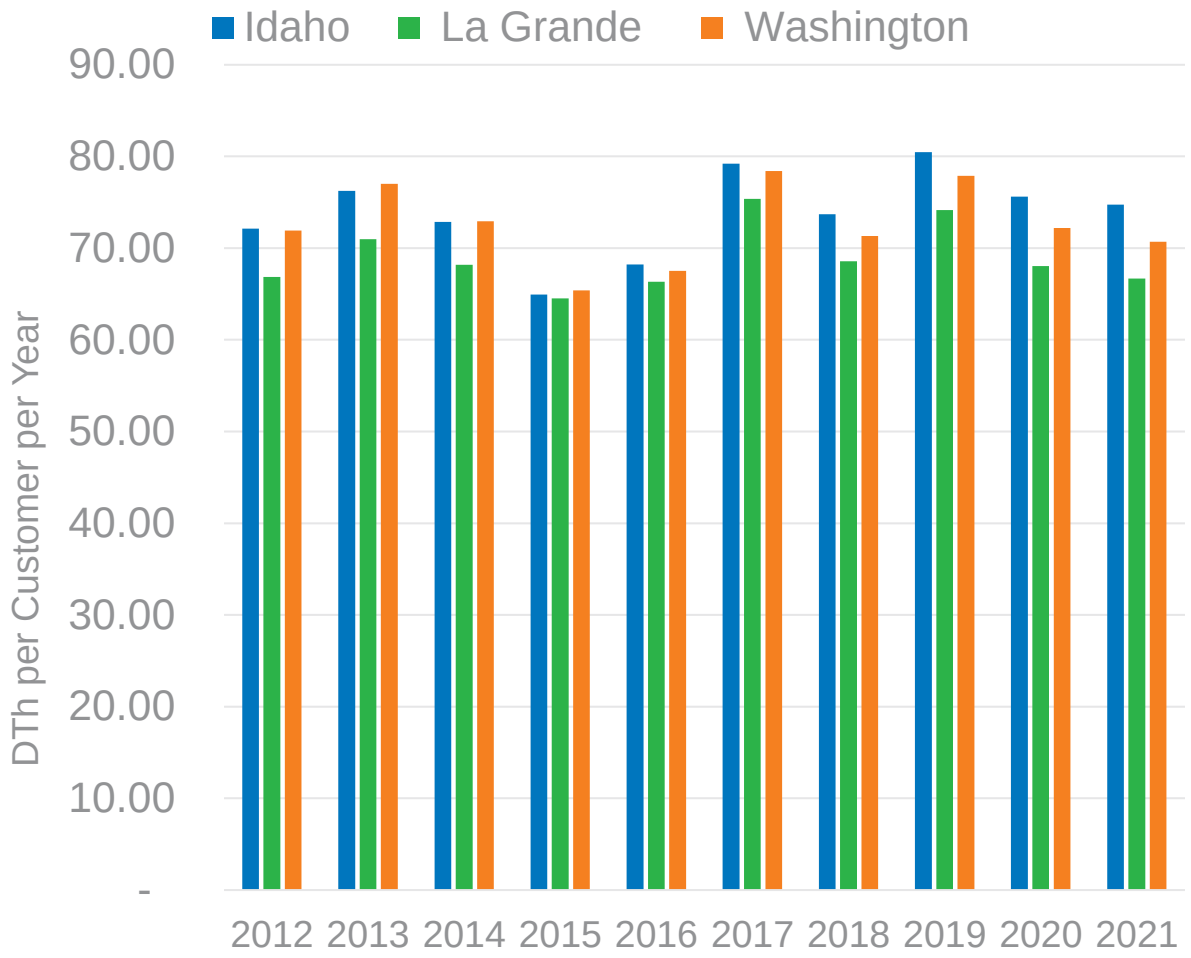
Commercial (2012-2021)

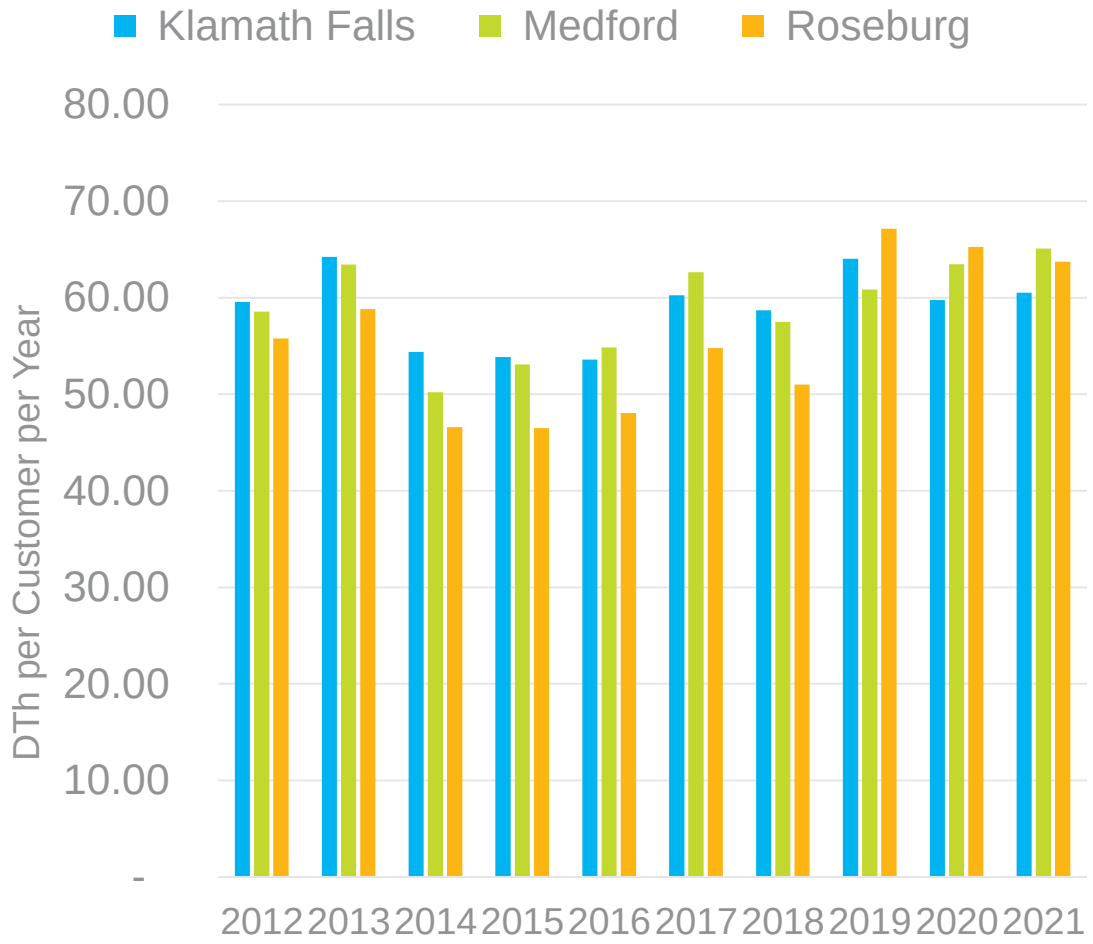


Industrial (2012-2021)

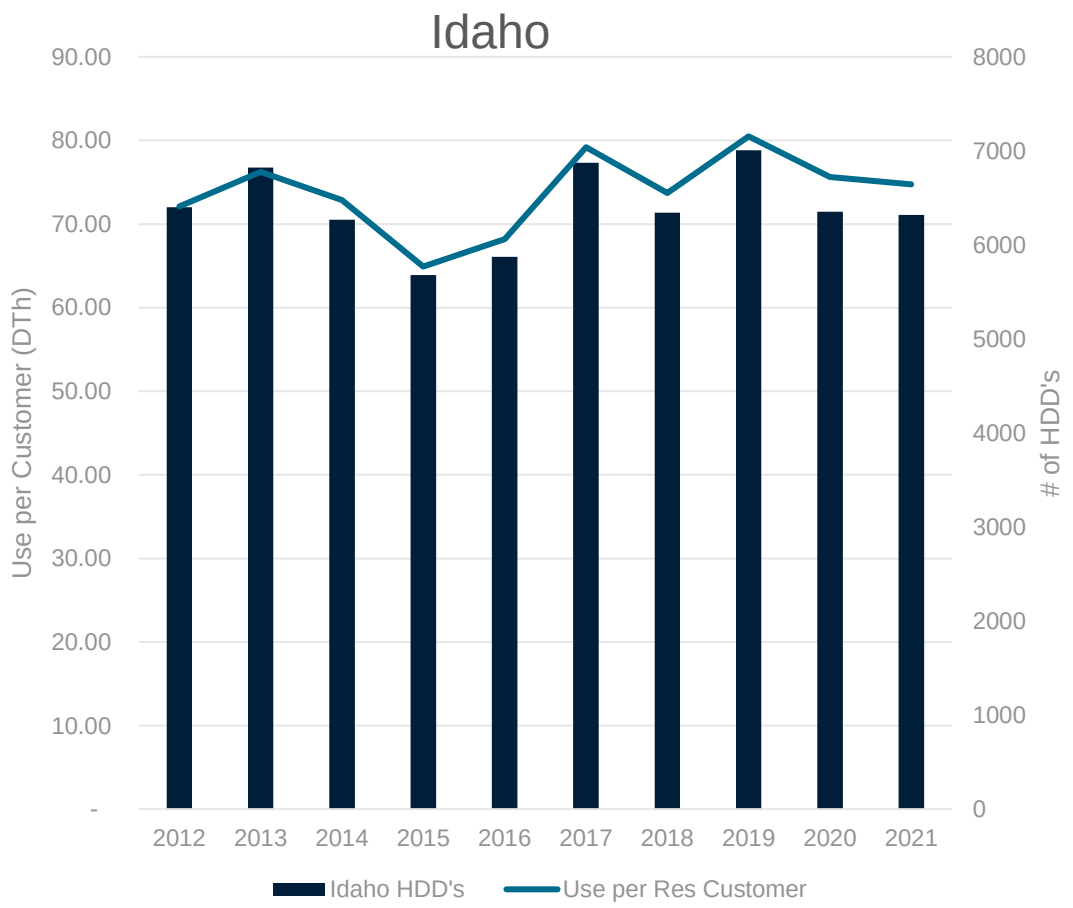


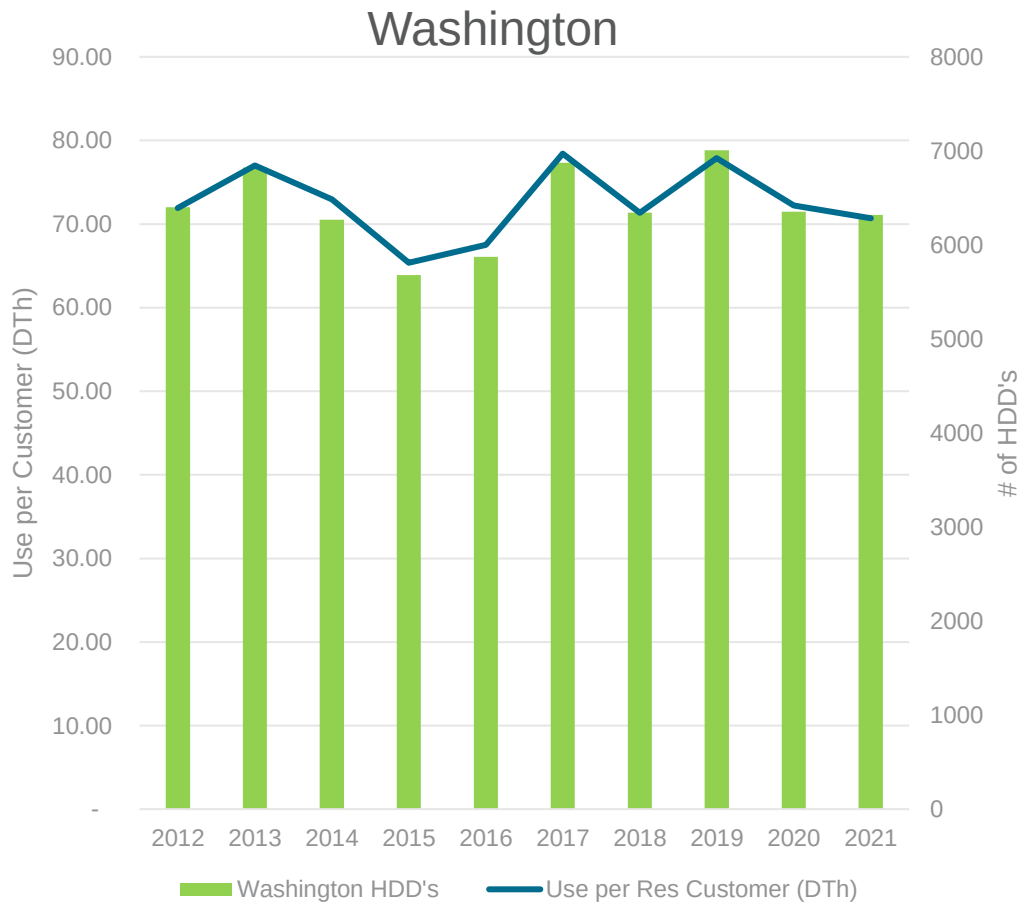
Use Per Customer



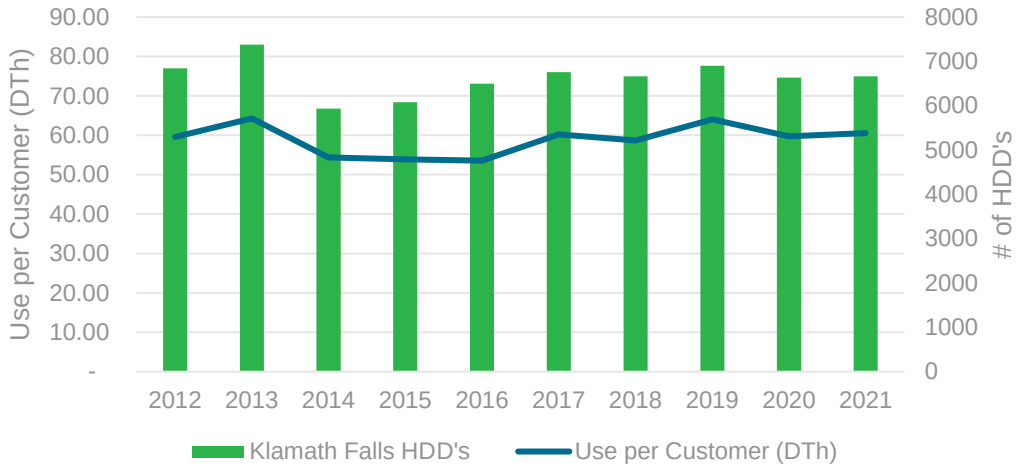


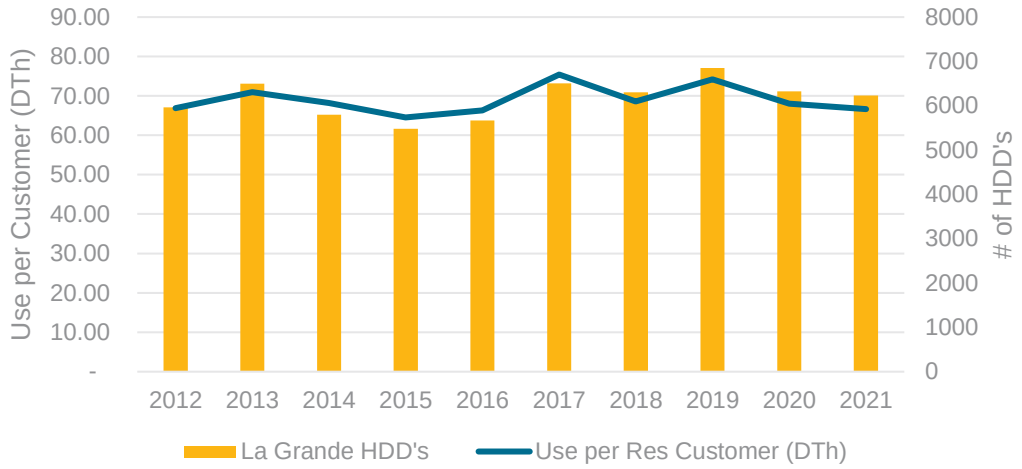
Residential Use per Customer (Idaho and Washington)

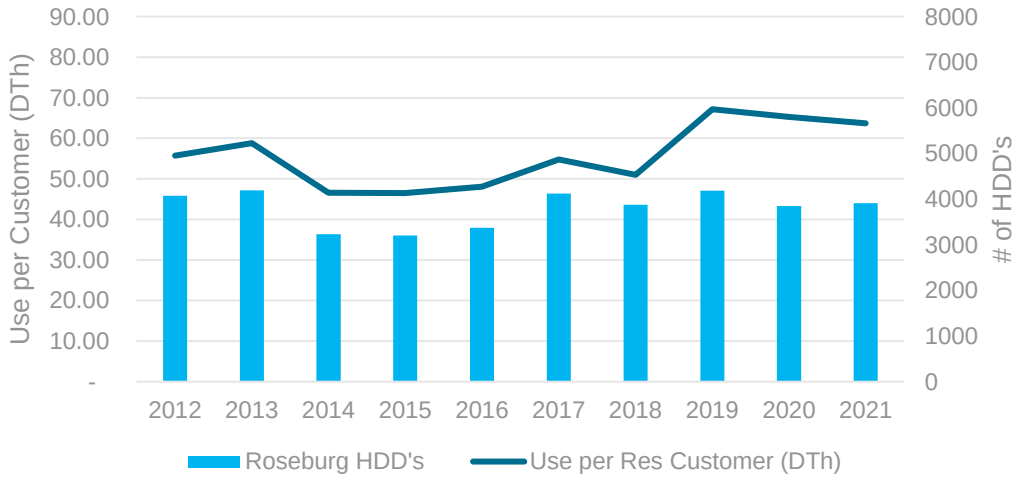


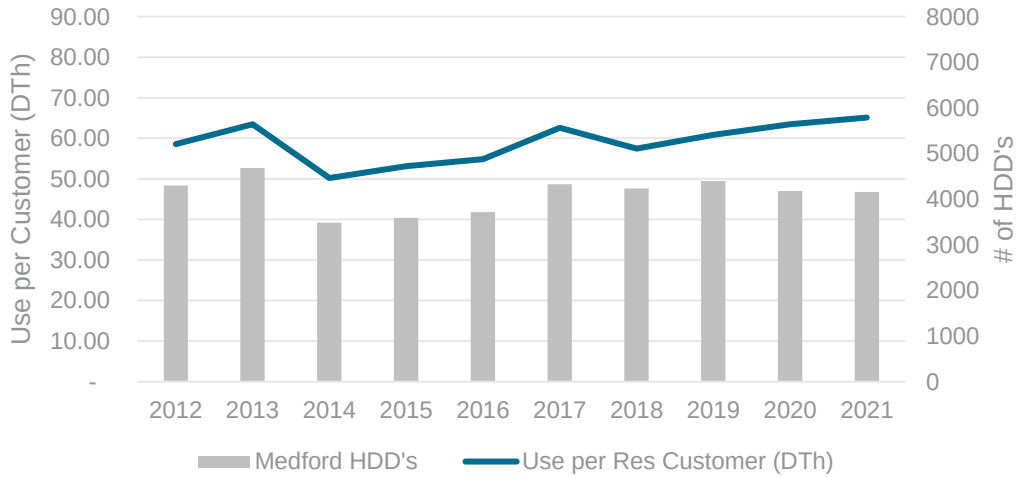


Residential Use per Customer (Oregon)

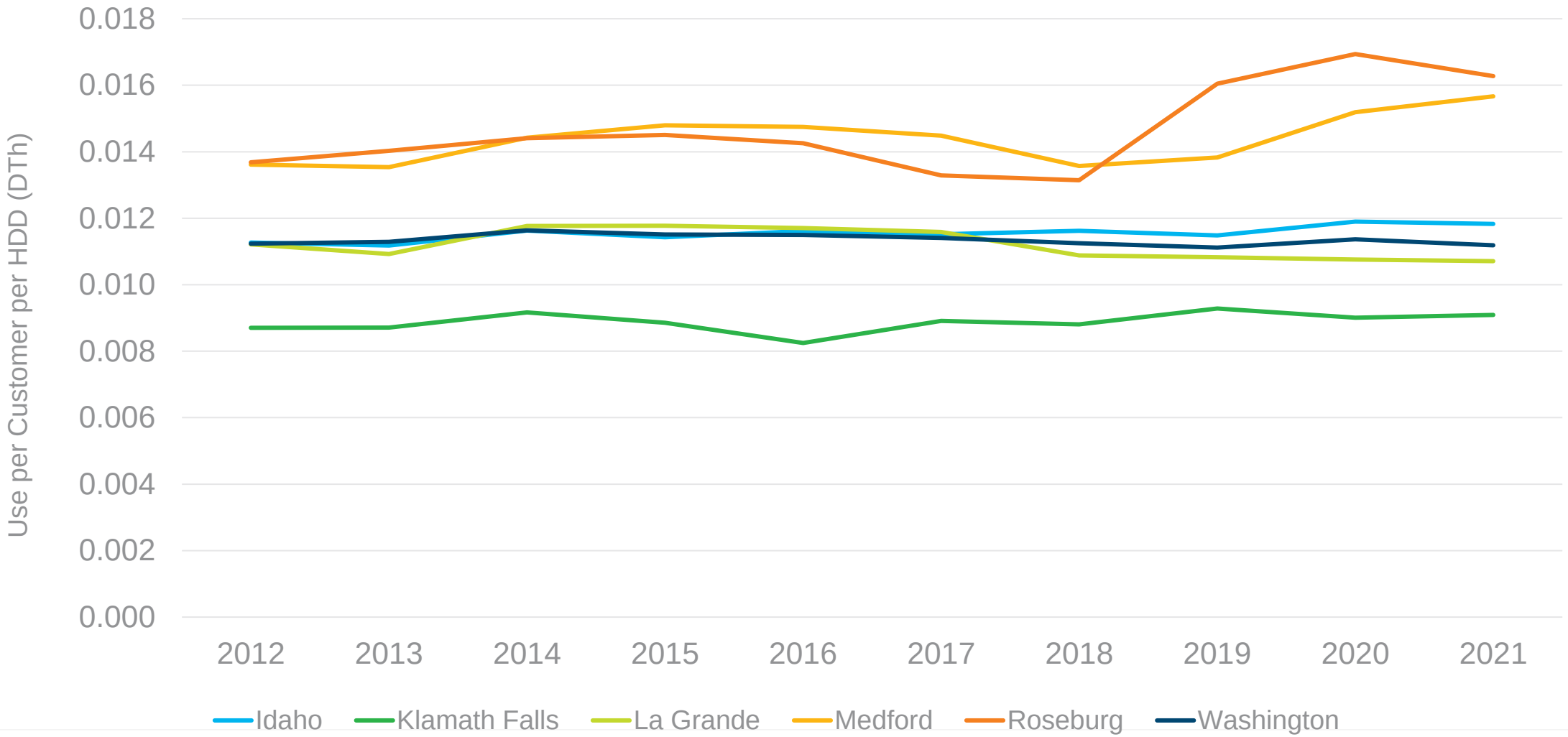




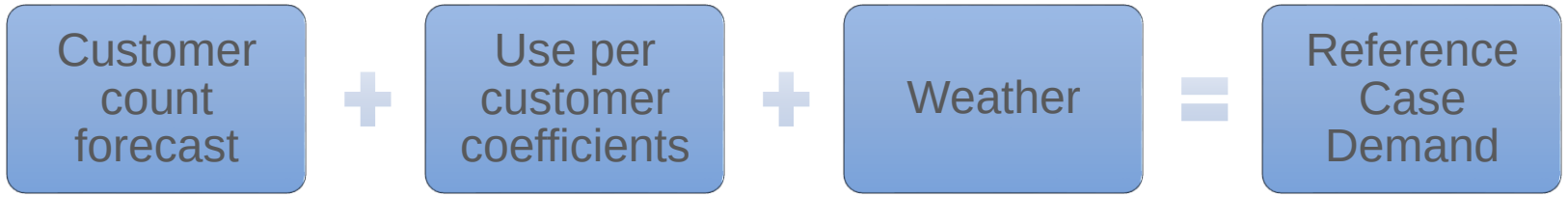




Residential Use per Customer per HDD



Developing a Reference Case



1. Expected customer count forecast by each of the 6 areas
2. Use per customer coefficients: 5-, 3-, or 2-year average use per HDD per customer
3. Current weather planning standard

Demand Modeling Equation – a closer look

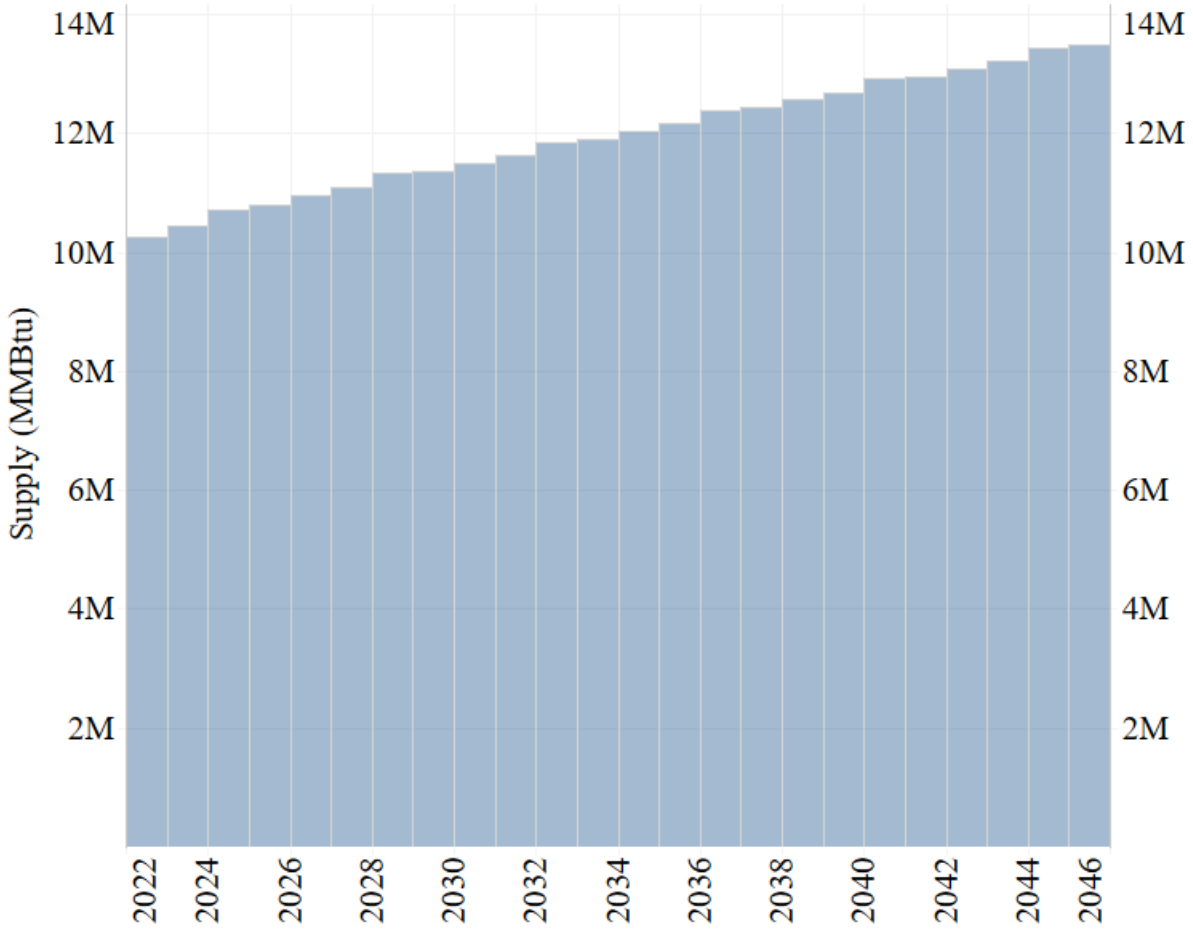
The **base** and **weather sensitive** usage (degree-day usage) factors are developed outside the model and capture a variety of demand usage assumptions.

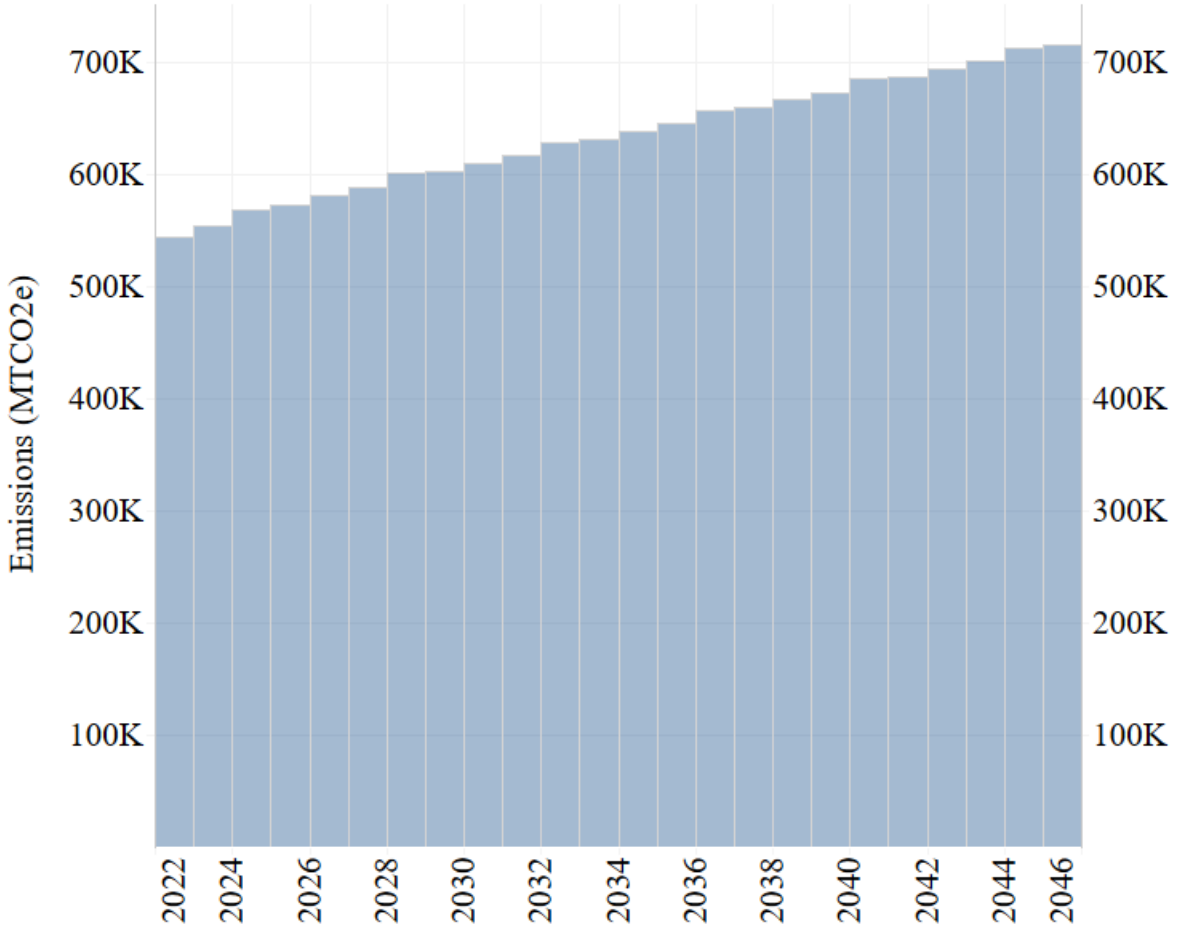
# of customers **x** Daily **base usage** / customer

Plus

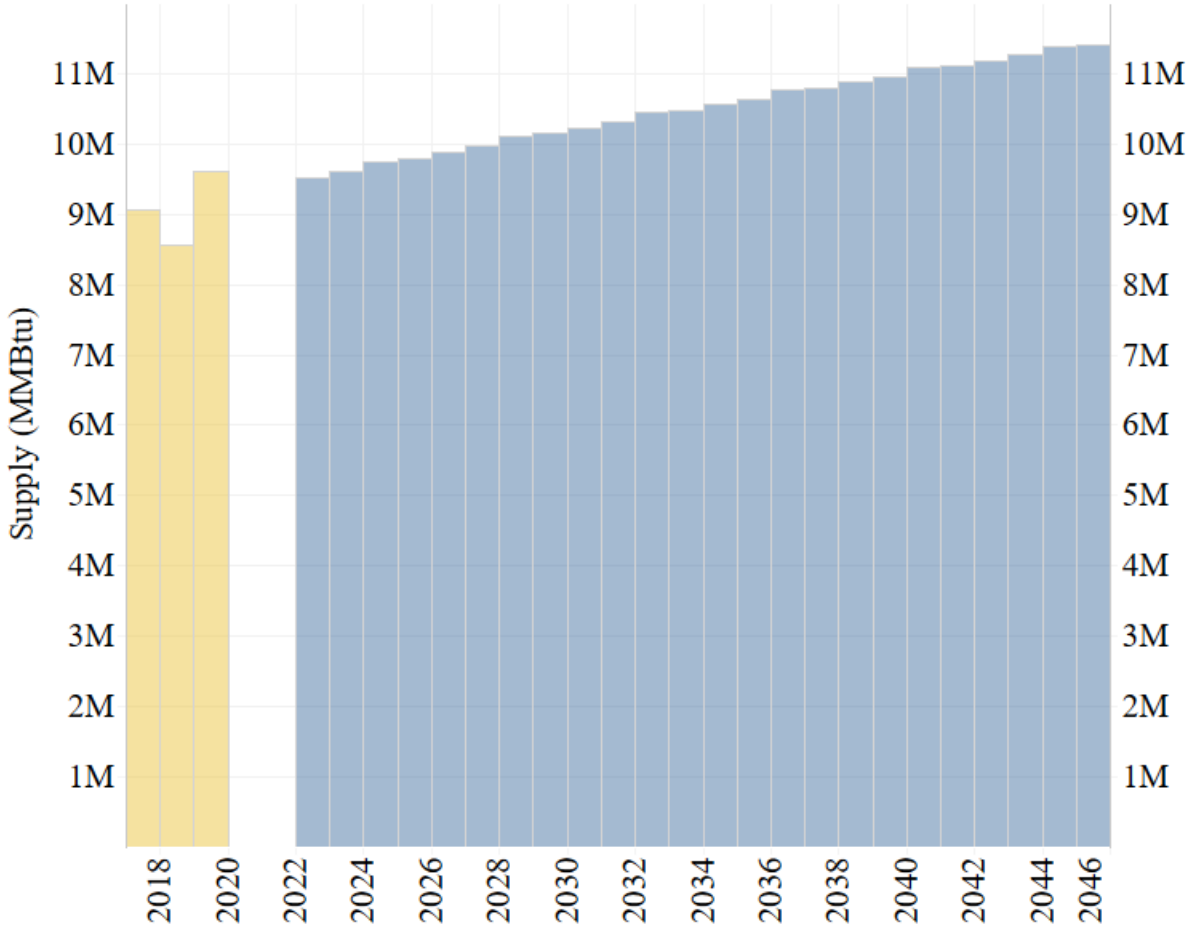
# of customers **x** Daily **weather sensitive** usage / customer

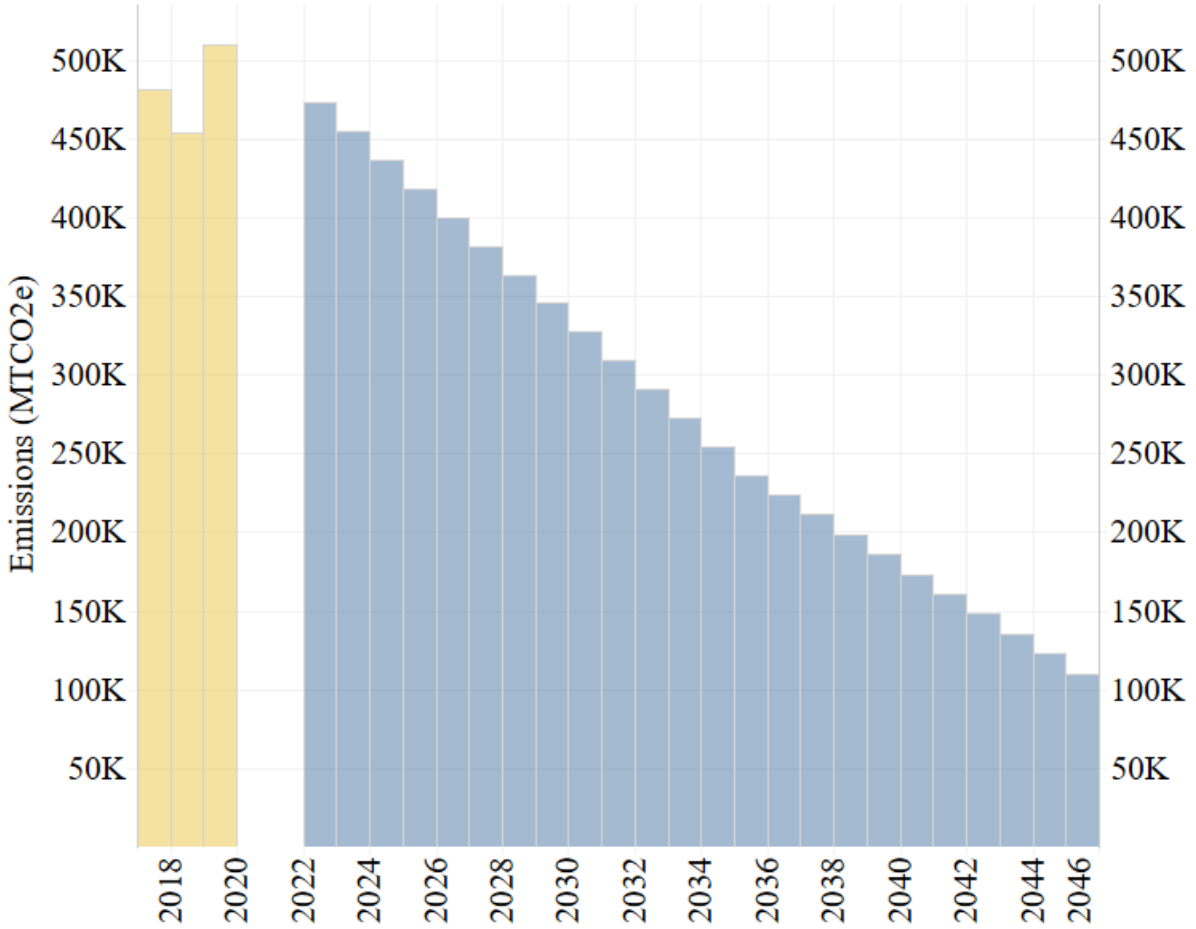
Idaho


Supply (MMBtu)
14M
12M
10M
8M
6M
4M
2M
2022
2024
2026
2028
2030
2032
2034
2036
2038
2040
2042
2044
2046

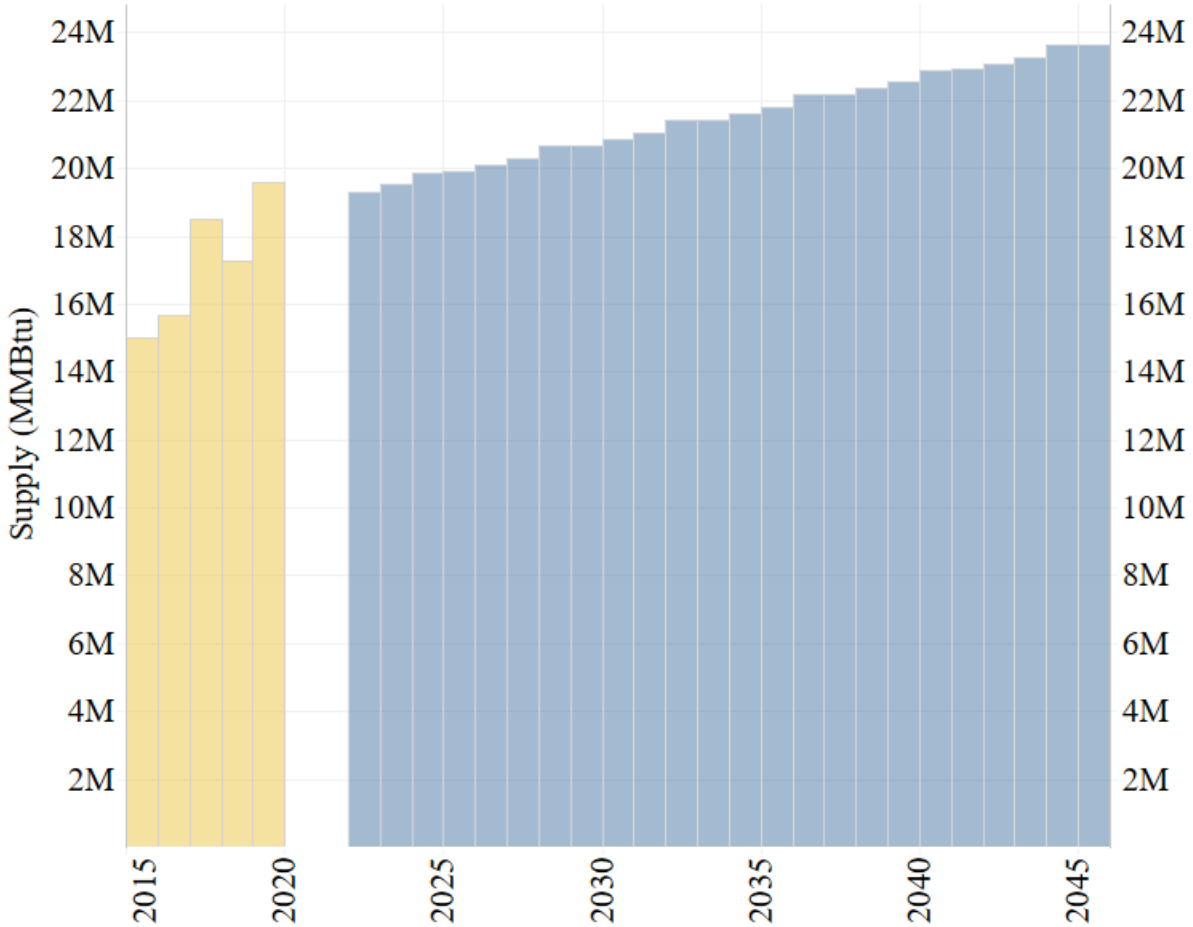

Emissions (MTCO2e)
700K
600K
500K
400K
300K
200K
100K
2022
2024
2026
2028
2030
2032
2034
2036
2038
2040
2042
2044
2046

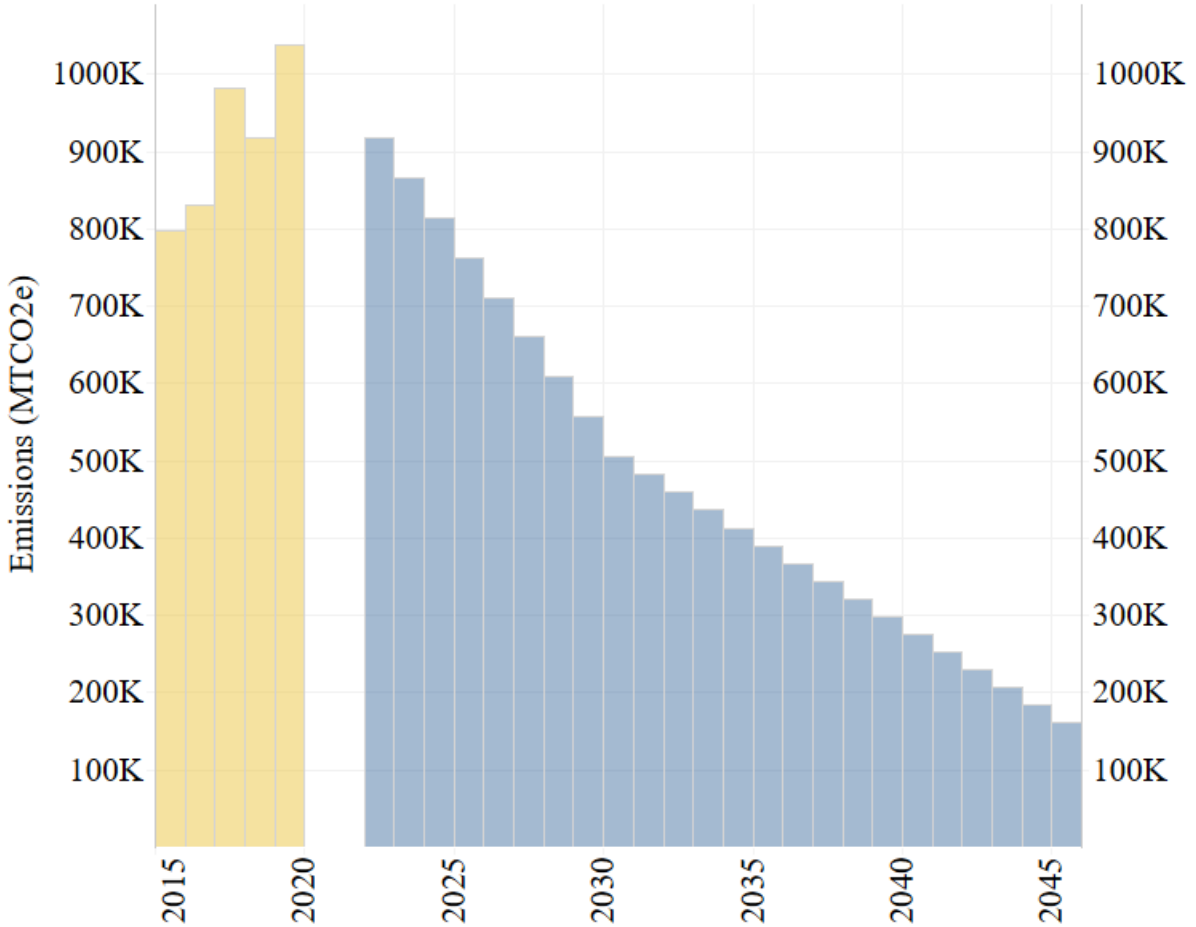
Oregon


Supply (MMBtu)
11M
10M
9M
8M
7M
6M
5M
4M
3M
2M
1M
2018
2020
2022
2024
2026
2028
2030
2032
2034
2036
2038
2040
2042
2044
2046


Emissions (MTCO2e)
500K
450K
400K
350K
300K
250K
200K
150K
100K
50K
2018
2020
2022
2024
2026
2028
2030
2032
2034
2036
2038
2040
2042
2044
2046

Washington


Supply (MMBtu)
24M
22M
20M
18M
16M
14M
12M
10M
8M
6M
4M
2M
2015
2020
2025
2030
2035
2040
2045


Emissions (MTCO2e)
1000K
900K
800K
700K
600K
500K
400K
300K
200K
100K
2015
2020
2025
2030
2035
2040
2045

Supply Side Resources

Justin Dorr

Manager of Natural Gas Resources

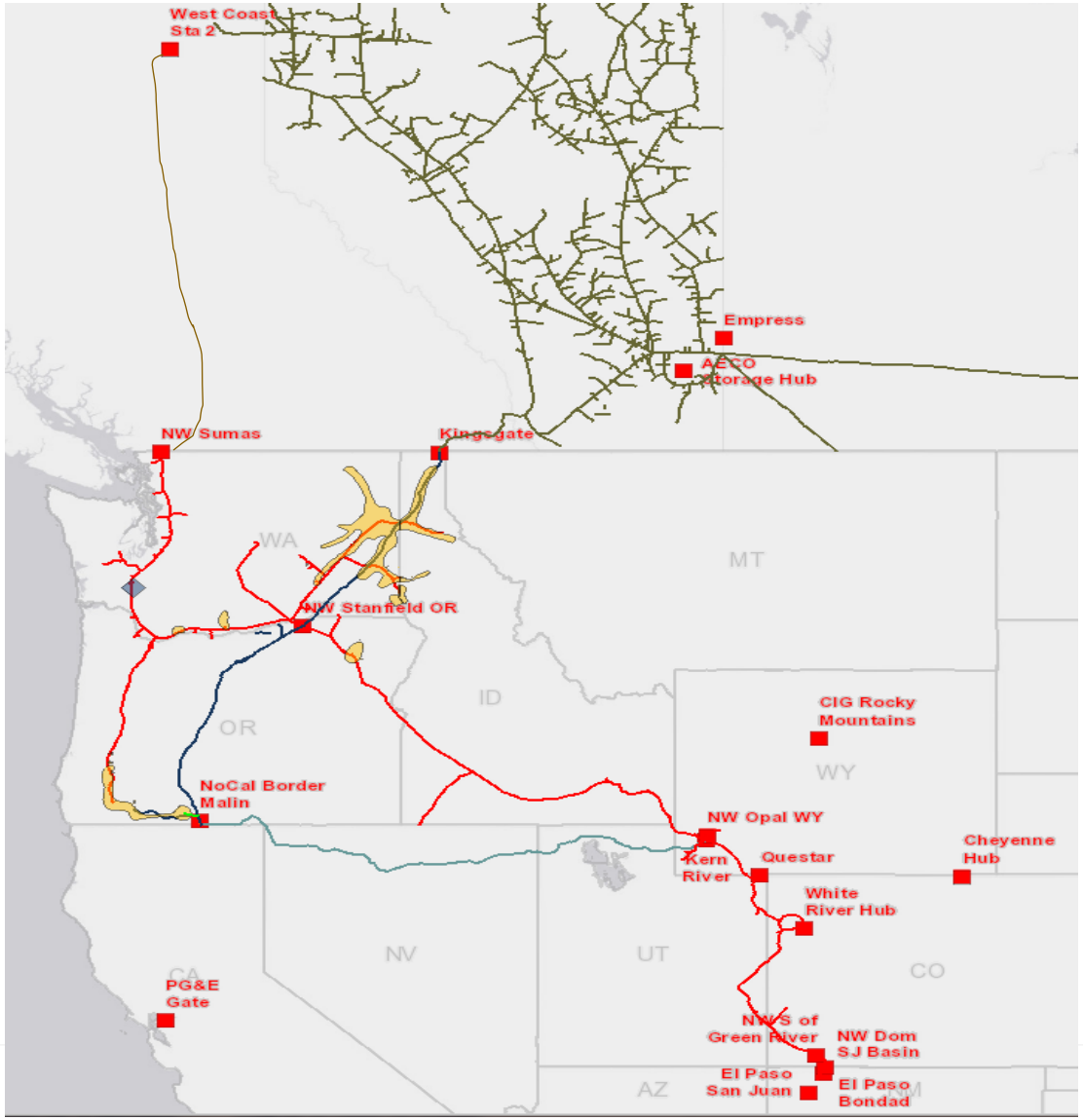
Interstate Pipeline Resources

- The Integrated Resource Plan (IRP) brings together the various components necessary to ensure proper resource planning for reliable service to utility customers.

- One of the key components for natural gas service is interstate pipeline transportation. Low prices, firm supply and storage resources are meaningless to a utility customer without the ability to transport the gas reliably during cold weather events.

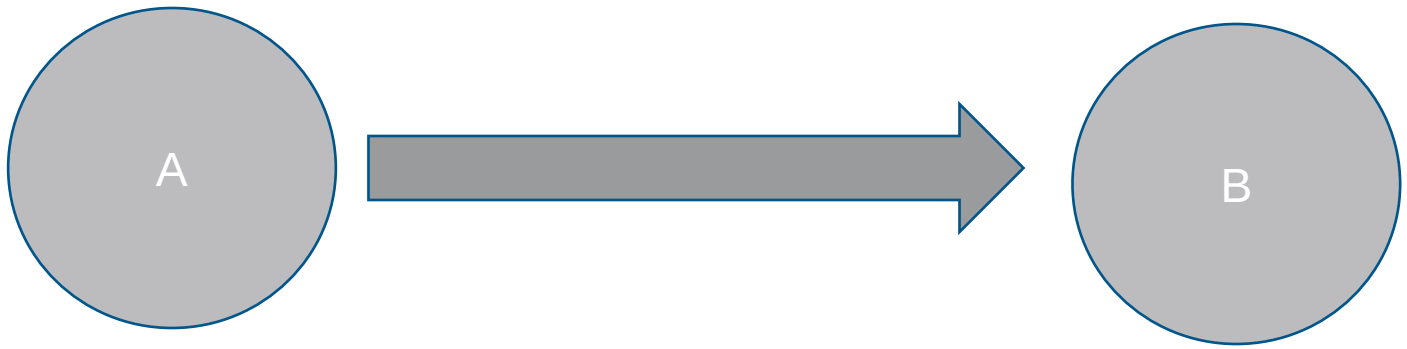
- Acquiring firm interstate pipeline transportation provides the most reliable delivery of supply.

Pipeline Overview



Pipeline Contracting

Simply stated: The right to move (transport) a specified amount of gas from Point A to Point B



Contract Types

- Firm transport
  - Point A to Point B
  - Kingsgate to Malin
- Alternate firm
  - Point C to Point D
  - Kingsgate to Stanfield
- Seasonal firm
  - Point A to Point B but only in winter
- Interruptible
  - Maybe it flows, maybe it doesn’t

Pipeline Rate Design

- Mileage Rate (GTN)
  - Distance between receipt and delivery determines price
  - Plus variable charges

- Postage Stamp (NWP)
  - 1 mile from receipt to deliver same price as 1000 miles
  - Plus variable charges

Avista's Transportation Contract Portfolio

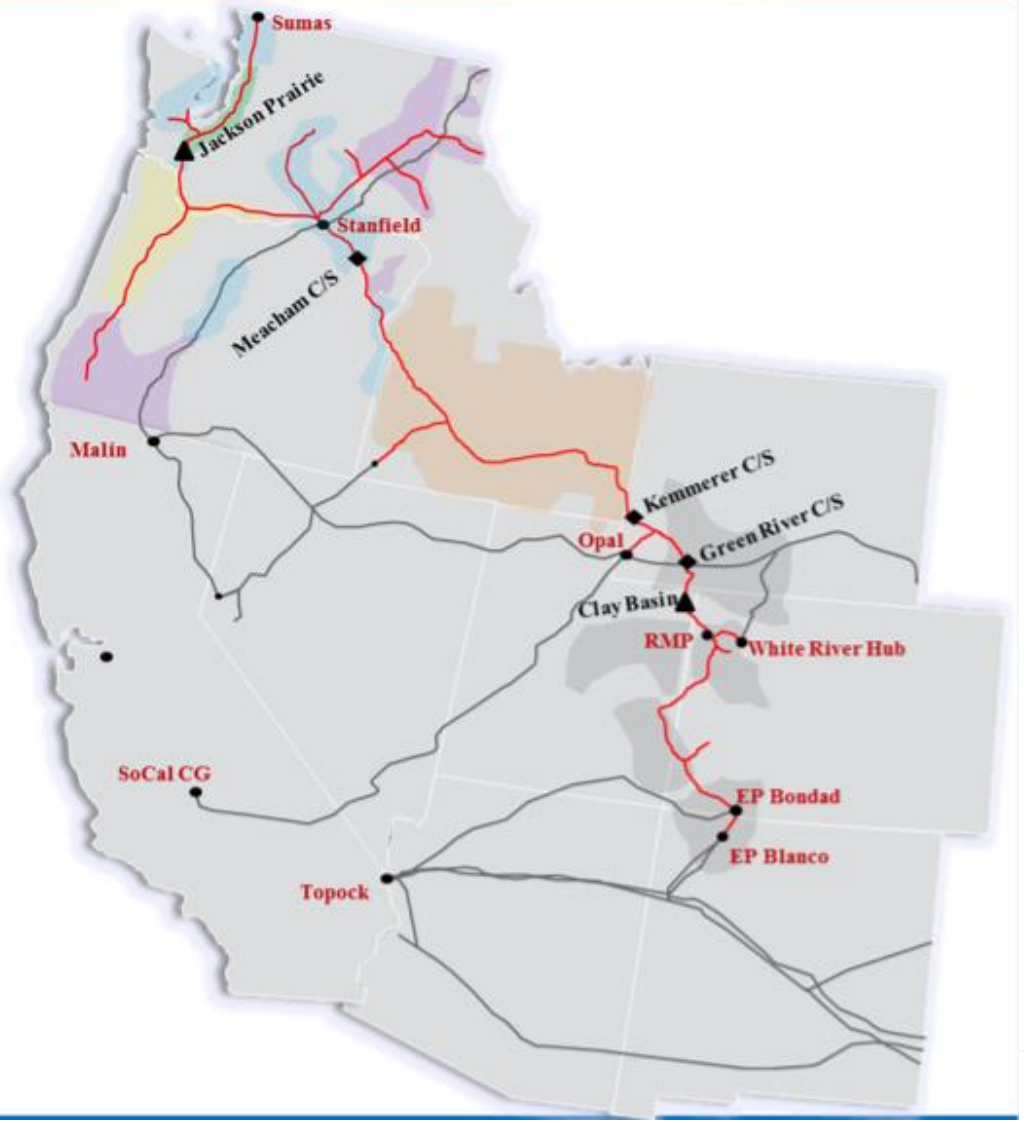
Avista holds firm transportation capacity on 6 interstate pipelines:

Pipeline	Expirations	Base Capacity Dth
Williams NWP	2025 – 2042 (2035)	285,000
Westcoast (Enbridge)	2026	10,000
TransCanada - NGTL	2024-2046	208,000
TransCanada - Foothills	2024-2046	204,000
TransCanada - GTN	2023-2028	210,000 164,000
TransCanada-Tuscarora	2023	200

1) Pipe reservations and modeling are only for LDC customers
2) Pipe reservations and model explicitly DO NOT CONSIDER electric side of business.

Northwest System – Strategically Located

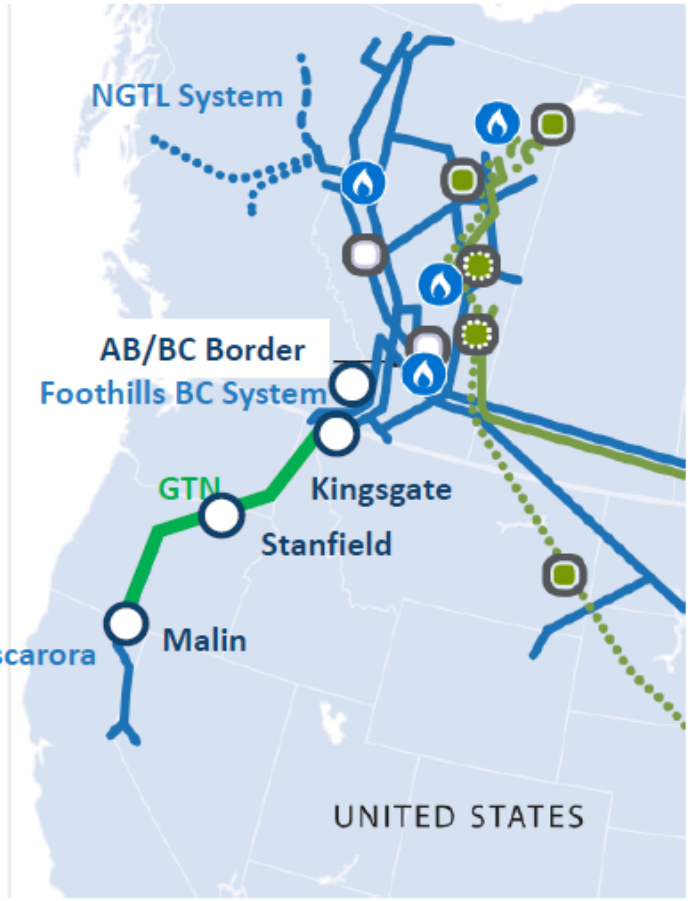
- **Low-cost, primary service provider in the Pacific Northwest**
  - 3,900-mile system with 3.8 Bcf/d peak design capacity
  - ~120 Bcf of access to storage along pipeline, with high injection and deliverability capability in market area
- **Bi-directional design**
  - Provides flexibility (Rockies to market and Sumas to market)
  - Cheapest supply drives flow patterns
  - Provides operational efficiencies through displacement
- **Supply and market flexibility**
  - 65 receipt points totaling 11.6 Bcf/d of supply from Rockies, Sumas, WCSB, San Juan, emerging shales
  - 366 delivery points totaling 9.7 Bcf/d of delivery capacity



Alternate slide for GTN

GTN Overview

- Transports WCSB and Rockies natural gas to Washington, Oregon and California
- Approximately 1,377 miles of pipeline
- Kingsgate best efforts receipt capability of approx. 2.87 Bcfd and throughput capacity of approx. 2 Bcfd through Station 14
- Deliveries of up to 1.5 Bcfd to non-California Markets
- Concurrent transport expansions from NIT to Malin:
  - Tranche 1
    - 110 TJ/d (NGTL and FHBC), 100 MDth/d (GTN)
    - November 1, 2022 - Targeted in-service
  - Tranche 2
    - 175 TJ/d (NGTL and FHBC), 150 MDth/d (GTN)
    - November 1, 2023 - Targeted in-service



TC Energy

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AVISTA

NGTL to Malin West Path expansion

Connecting WCSB supply to key North American markets

Valued transport path for both Supply and End Use Shippers

Concurrent transport expansions from NIT to Malin:

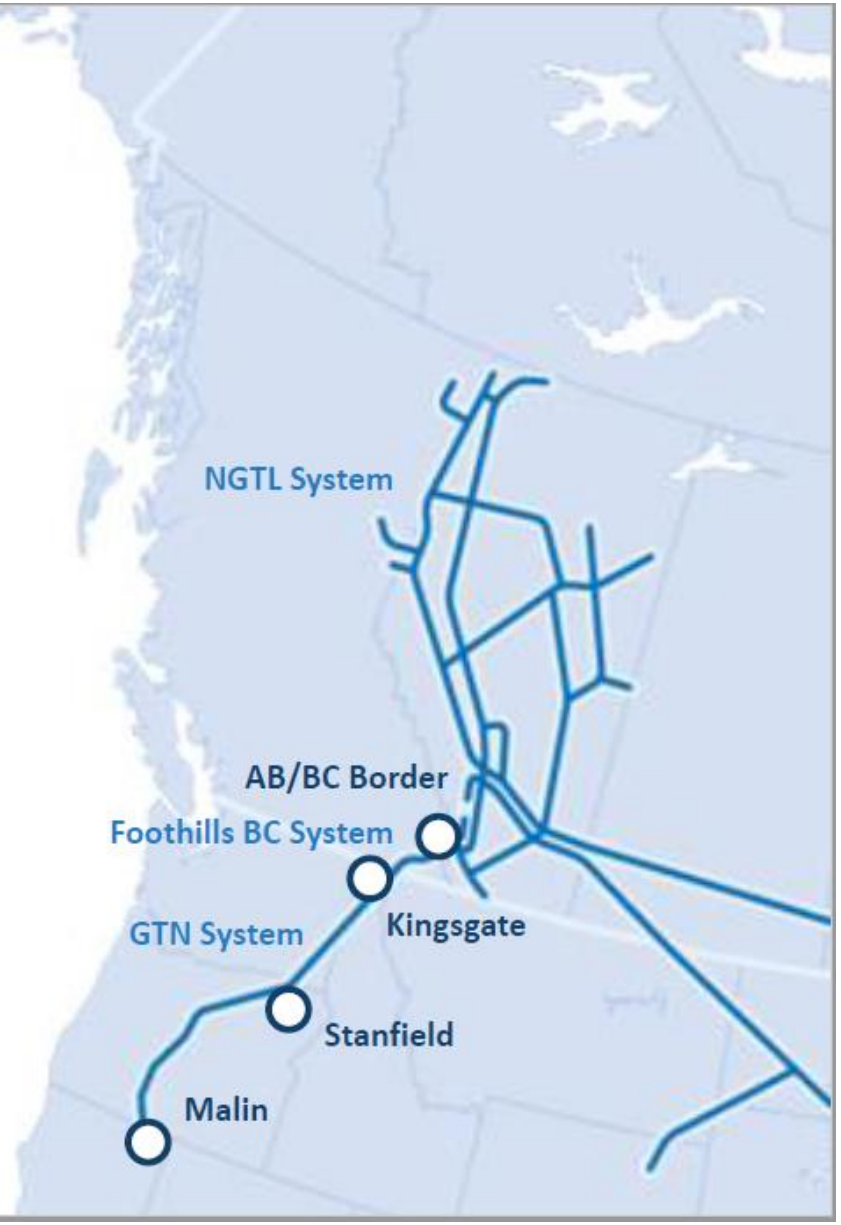
Tranche 1

- 110 TJ/d (NGTL and FHBC), 100 MDth/d (GTN)
- November 1, 2022 - Targeted in-service

Tranche 2

- 175 TJ/d (NGTL and FHBC), 150 MDth/d (GTN)
- November 1, 2023 - Targeted in-service

- Average term of awarded capacity:
- 31.3 years NGTL
- 31.4 years Foothills BC



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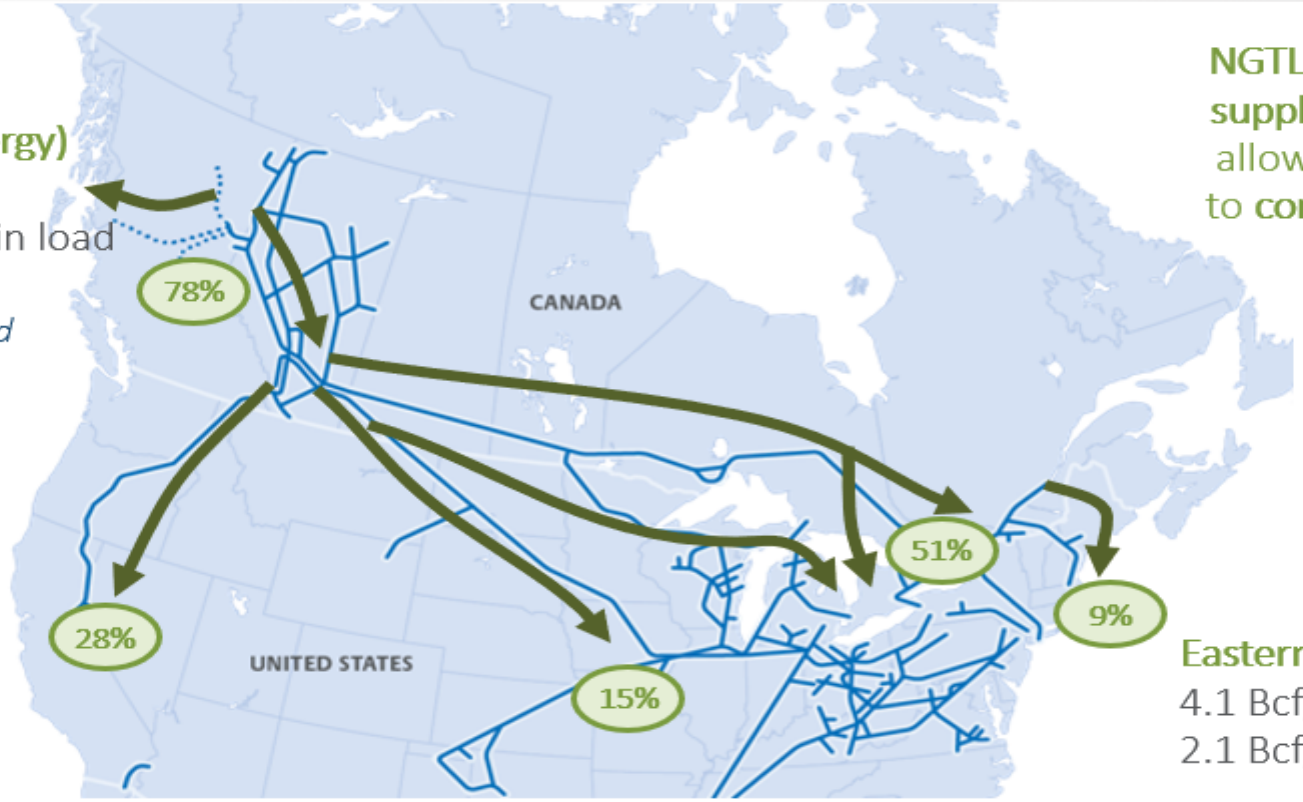
WCSB gas is competitive in key markets,
Safety, Toll Competitiveness & Reliability is Our Focus

WCSB (78% TC Energy)
16.1 Bcf/d supply
7.1 Bcf/d intra basin load
8.9 Bcf/d export
4 Bcf/d LNG projected



NGTL System provides access to **stable supply source** for WCSB **end users** and allows **unique** opportunity **producers** to **compete** in multiple export markets

U.S. Northeast
7.8 Bcf/d market
0.8 Bcf/d via TC

Pacific
8.2 Bcf/d market
2.3 Bcf/d via TC

Eastern Canada
4.1 Bcf/d market
2.1 Bcf/d from WCSB via TC

Chicago (Mid-West)
11.9 Bcf/d end use market
1.5 Bcf/d from WCSB via TC

Flow data based on 2021 Calendar year
Source: TC Energy, EIA and Downstream Pipeline Nominations

11

Storage – A Valuable Asset

- Peaking resource
- Improves reliability
- Enables capture of price spreads between time periods
- Enables efficient counter cyclical utilization of transportation (i.e. summer injections)
- May require transportation to service territory
- In-service territory storage offers most flexibility

Avista's Storage Resources

Washington and Idaho
Owned Jackson Prairie

- 7.7 Bcf of Capacity with approximately 346,000 Dth/d of deliverability

Oregon

Owned Jackson Prairie

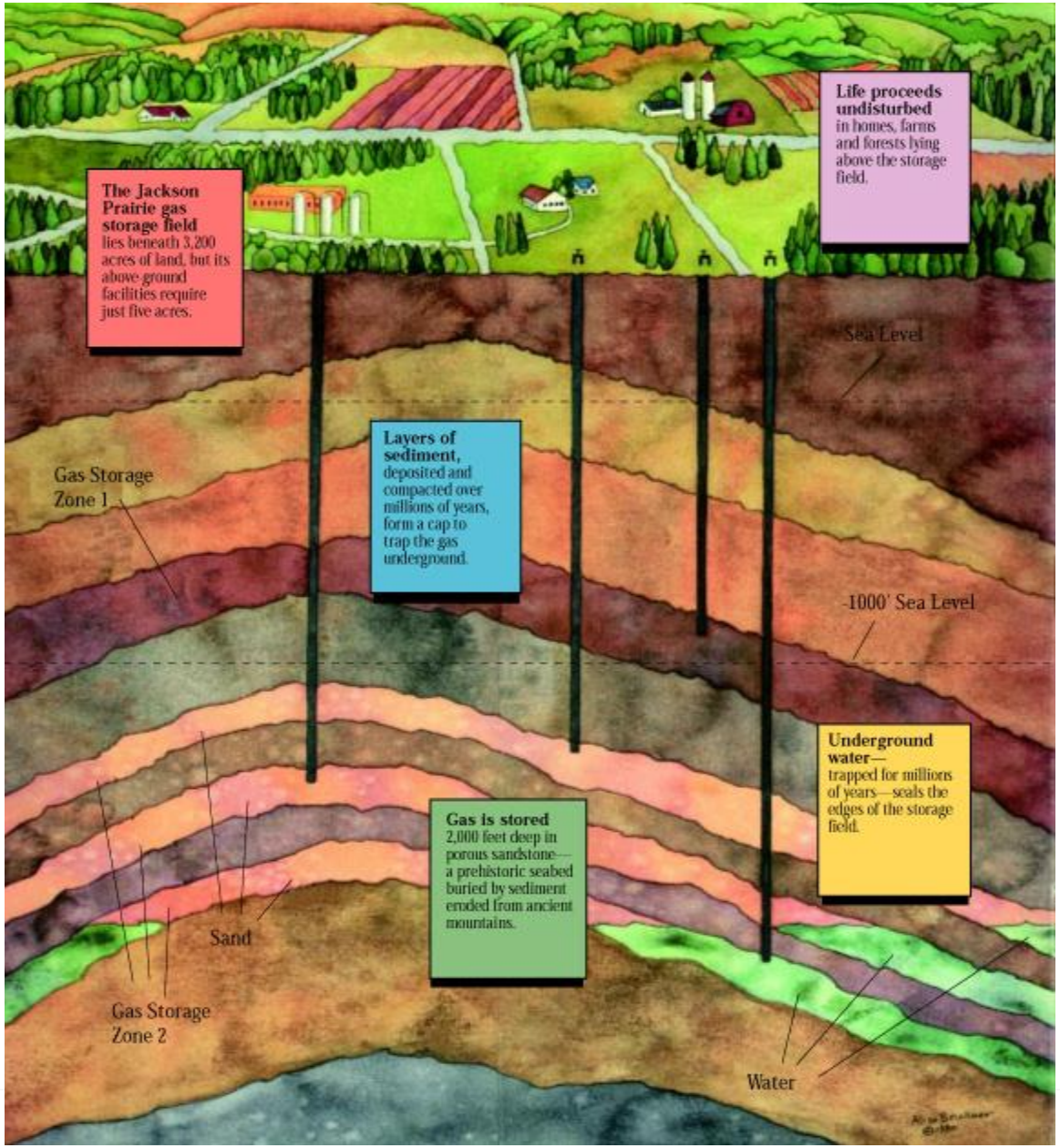
- 823,000 Dth of Capacity with approximately 52,000 Dth/d of deliverability

Leased Jackson Prairie

- 95,565 Dth of Capacity with approximately 2,654 Dth/d of deliverability

The Facility

- Jackson Prairie is a series of deep, underground reservoirs – basically thick, porous sandstone deposits.
- The sand layers lie approximately 1,000 to 3,000 feet below the ground surface.
- Large compressors and pipelines are employed to both inject and withdraw natural gas at 54 wells spread across the 3,200 acre facility.



Jackson Prairie Energy Comparisons

1.2 Bcf per day (energy equivalent)

- 10 coal trains with 100 - 50 ton cars each
- 29 - 500 MW gas-fired power plants
- 13 Hanford-sized nuclear power plants
- 2 Grand Coulee-sized hydro plants (biggest in US)

45 Bcf of stored gas

- 12” pipeline 11,000,000 miles long (226,000 miles to the moon)
- 1,400 Safeco Fields (Baseball Stadiums)
- Average flow of the Columbia River for 2 days
- Cube - 3,550 feet on a side

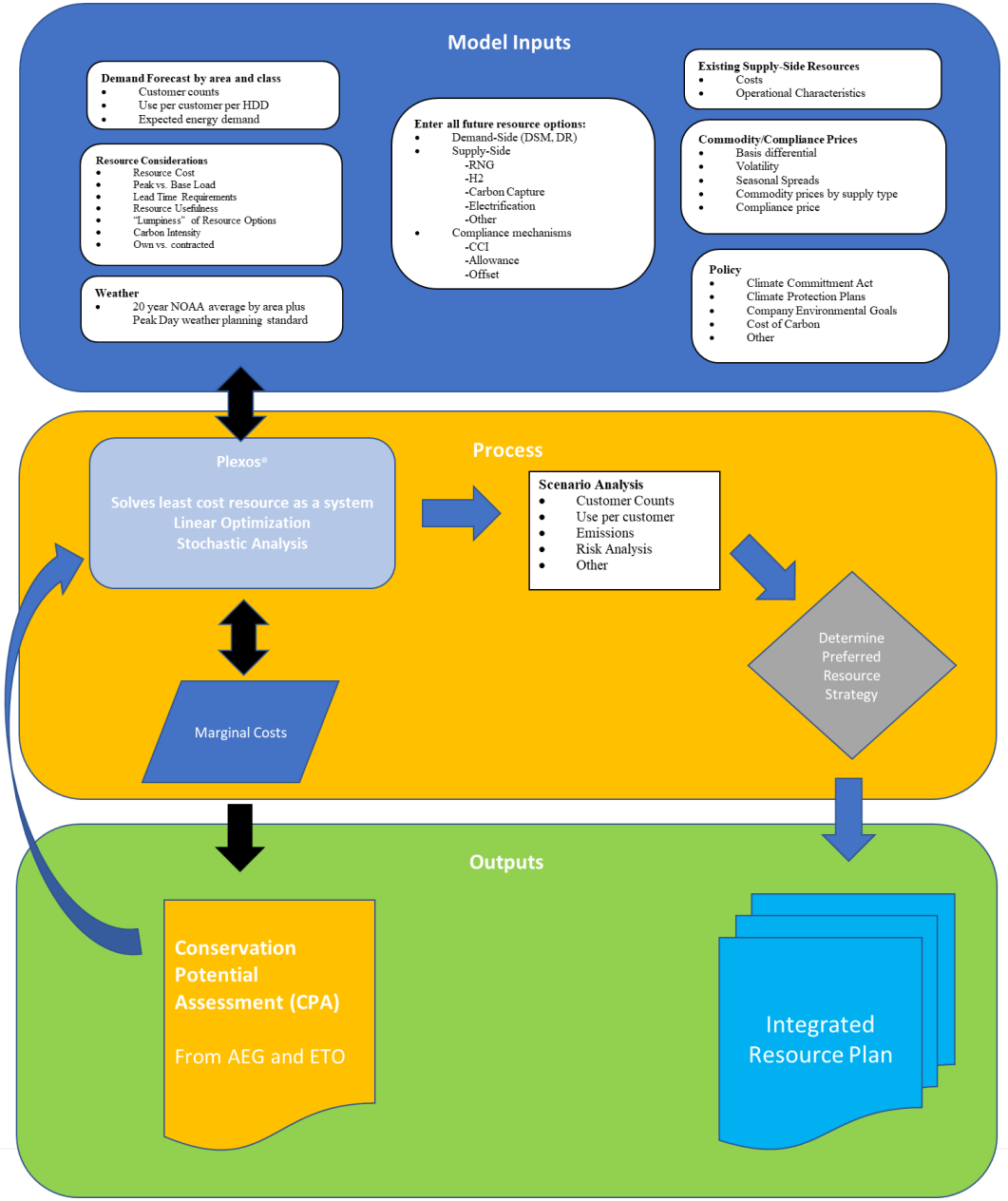
Plexos

New Optimization Model

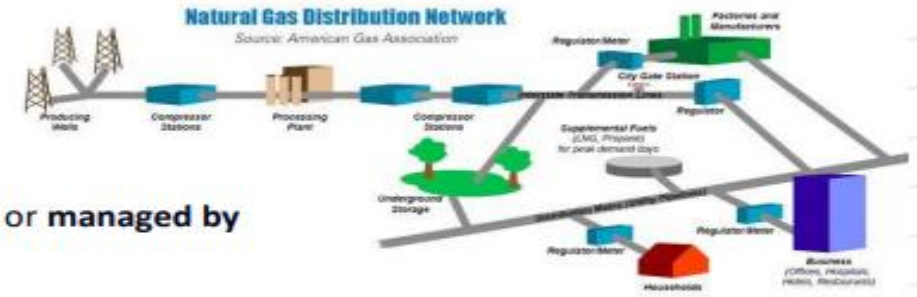
- Prior model, SENDOUT, had not been updated by the vendor since 2013

- Increasing complexity in planning for new rules, emissions constraints and fuel types was not easily handled within SENDOUT

Model Diagram



Gas Portfolio Optimization



Portfolio Optimization and Resource Planning

- Determine **optimal utilization of resources,** assets and contracts owned or **managed by the entity**.
- Supported by customer specific **asset and contract parameters & data**.

Components include

- PLEXOS Gas Module
- Customer Portfolio Data (Assets, Parameters, Assumptions)

Applications		
Cost of Gas (CGA / PGA)	**Gas Resource Planning and IRP** (Portfolio Design)	**Capacity & Contract Evaluation**
Reliability and Stress-testing (Resource Adequacy)	**Scenario Analysis and Portfolio Risk Assessment**	**Daily, Monthly, Seasonal Dispatch Plans and Schedules**
Policy and Regulation Impact Analysis Emissions, Carbon Caps / Penalties, RNG	**Capacity Release, Off-system Sales and Arbitrage Opportunities**	**Co-optimization and Portfolio Synergies**

Energy Exemplar

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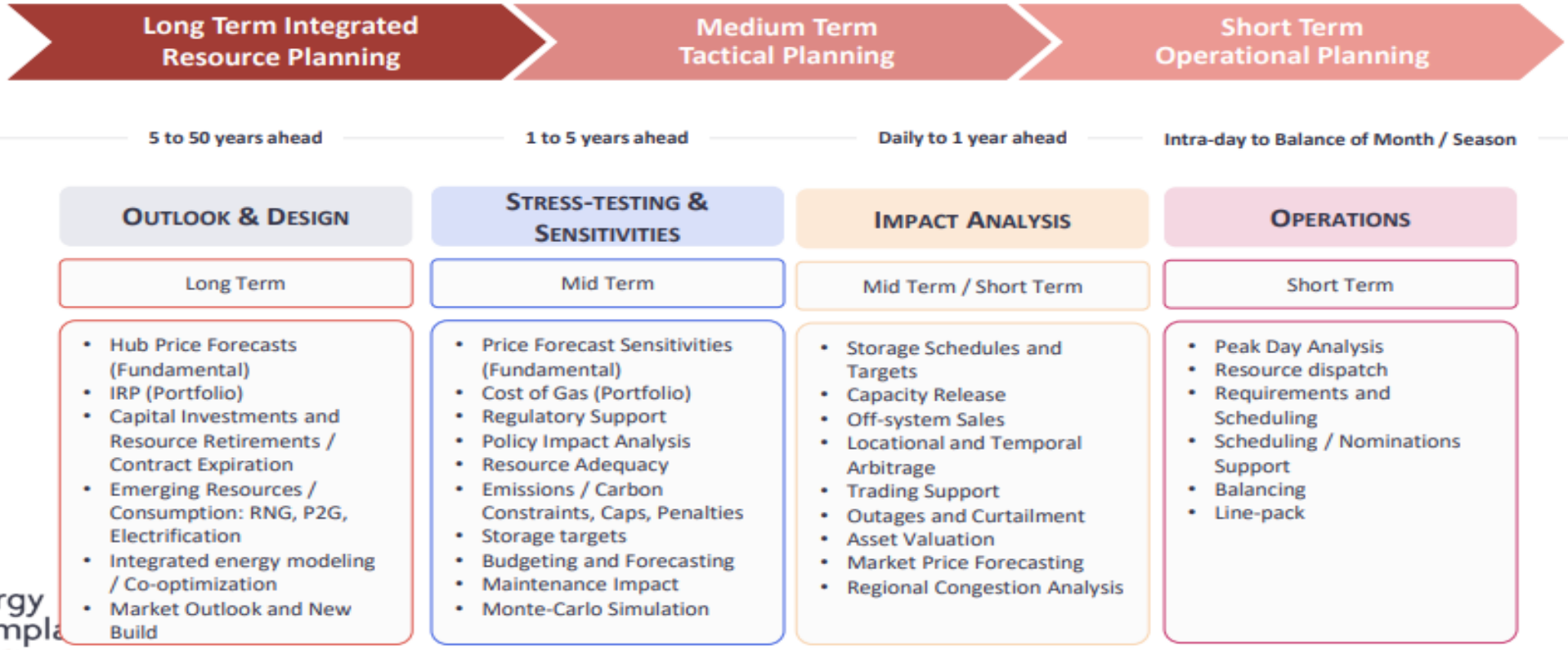
PLEXOS Gas: Chronological Modeling

Representative Study-types Across Optimization Horizons



Balancing Resources & Requirements

Objective Function: Satisfy Demand at Best Cost

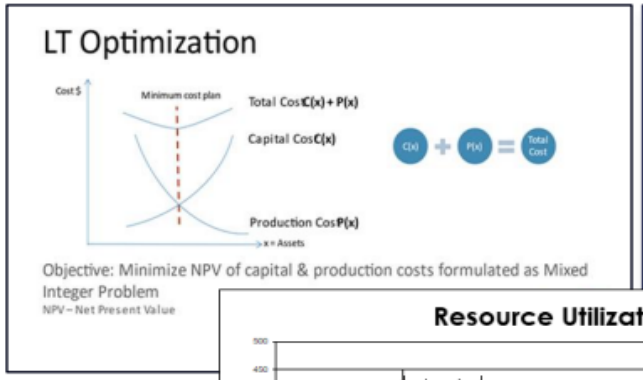
- Given available resources
- Bound by Constraints
- Considering economic assumptions and market opportunities
- Within criteria for reliability / priority to serve

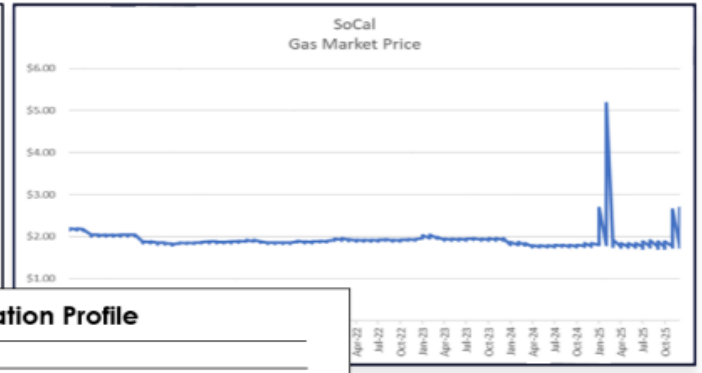
Supports Multiple Objective Functions

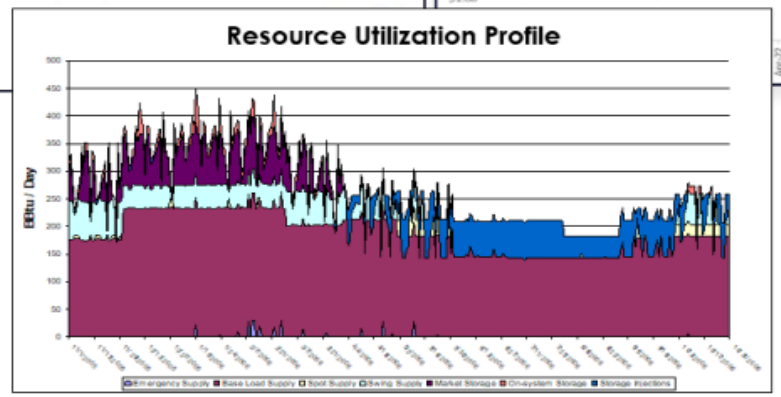
- Prioritized (Weighted)
- Example:
- Minimize Gas Costs
- Minimize System Costs (Gas + Generation)
- Minimize CO2
- Maximize Revenue (Net Cost)

Advances in Technology

- Modeling Detail
- Scalability
- Granularity
- Solvers & Methodologies
- Simulations
- Performance







Energy Exemplar

Deterministic Scenarios

Monte-Carlo Simulation

Stochastic Optimization

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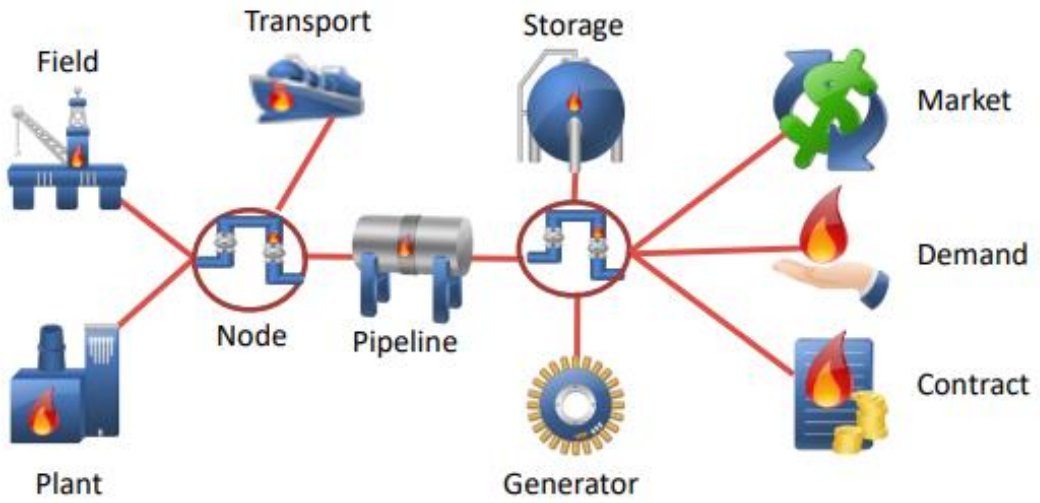
Comprehensive Gas Modelling and Operational Detail



Symbol	Class	Description
	Gas Field	Field from which gas is extracted
	Gas Basin	A summary class to contain a collection of Gas Fields
	Gas Storage	Storage where gas can be injected & extracted
	Gas Pipeline	Pipeline for transporting gas
	Gas Node	Connection point to gas network
	Gas Demand	Demand for gas covering one or more nodes
	Gas Zone	A collection of Gas Nodes

Energy Exemplar PLEXOS

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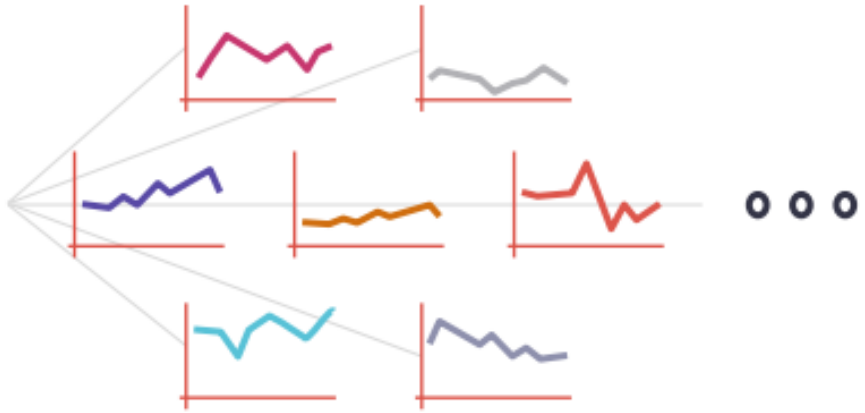
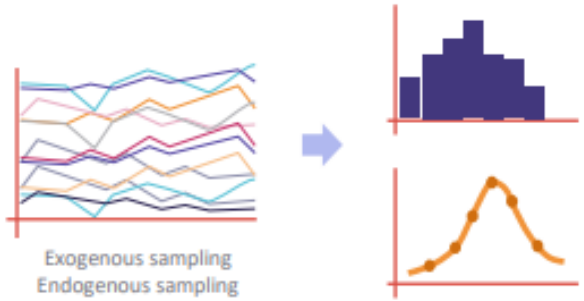
Uncertainty Modelling

Deterministic Scenarios



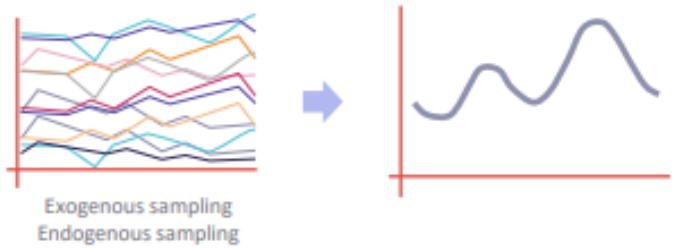
- One optimal solution for each deterministic scenario.
- Scenario comparison for decision support.

Monte-Carlo Simulations



- One optimal solution for each Monte-Carlo sample.
- Statistical analysis required for decision support.

Stochastic Optimization



- One optimal solution (Storage Schedules) for the entire stochastic sample set.
- Multi-stage stochastic optimization

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Energy Exemplar

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What Makes PLEXOS Unique

Delivering value ahead of the industry transformation curve

Unified Energy Model

- Global co-optimization
- Short-term through Long-term Horizons
- Emissions and Renewable Integration
- Flexible and Configurable

Modeling Detail & Custom Constraints

- Linear constraints
- Non-linear constraints
- User-defined Constraints

Uncertainty Modeling

- Deterministic scenarios
- Monte-Carlo simulations
- Stochastic optimization

Flexible Deployment & Infrastructure

- On-premise
- Cloud based SaaS

Performance & Scalability

- Grid & cloud computing
- Distributed Processing
- Burst cloud

Advanced Analytics

- Advanced visualization
- PLEXOS API
- Faster time to insights

Energy Exemplar

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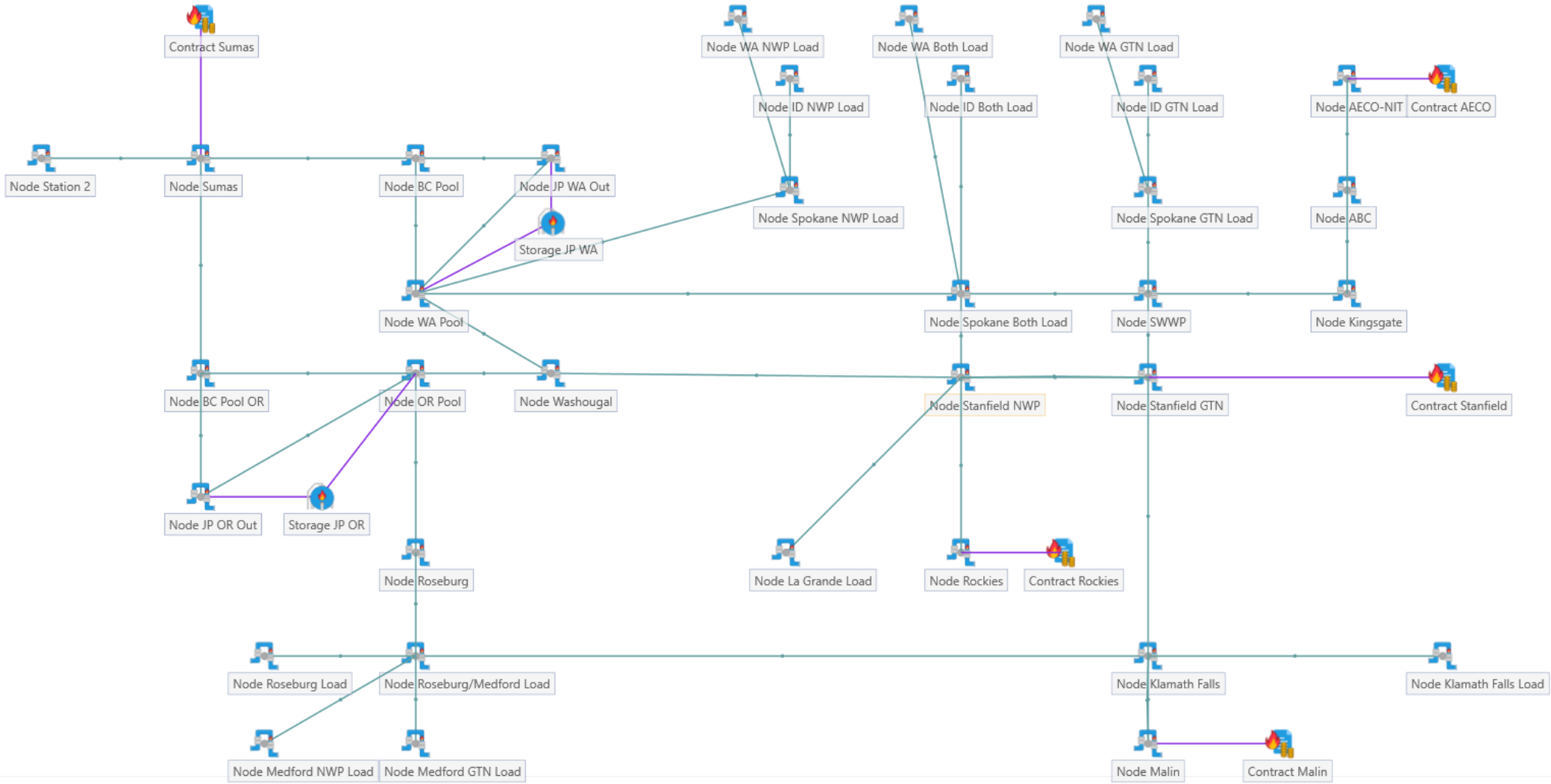
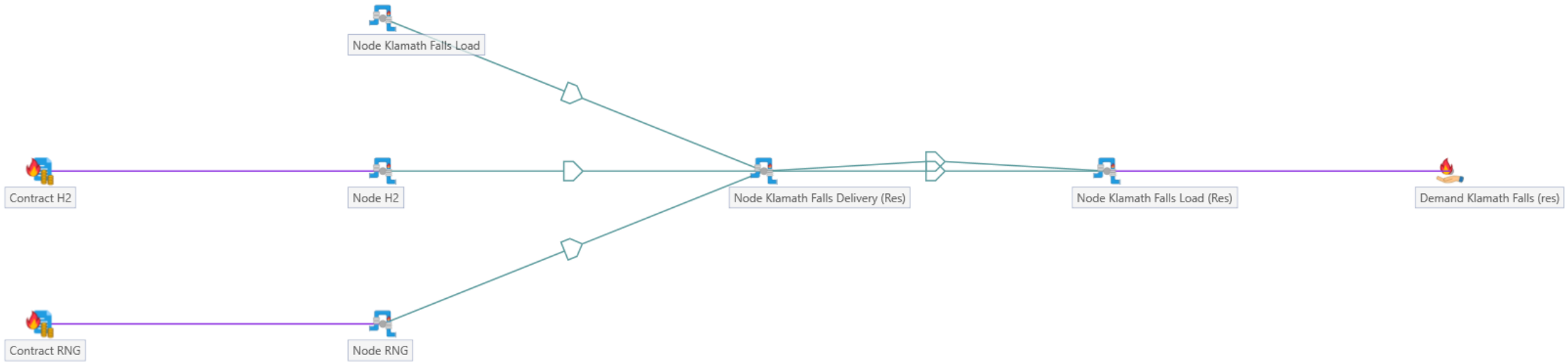
Plexos Model Visual – Pipeline Network



Plexos Model Visual – Emissions Constraint



Proposed Scenarios

Emission Reduction Paths

Proposed Scenarios

	Preferred Resource Case	Avista company goal Carbon Neutral by 2045	Electrification Push	High Customer Case	Limited RNG Availability	High Prices	Interrupted Supply
Customer Growth	Expected Customer Growth		No New Customers after 2023 in Oregon and Washington	High Customer growth	Expected Customer Growth		
Use Per Customer	Expected UPC						
Expected Price	Blend of 2 fundamental consultants, 1 fwd price						
Hydrogen (Green and Synthetic Methane)	20% blend by volume 6% by energy						
RNG - Dairy, Waste Water Treatment, Landfill, Food Waste, Carbon Capture and Recycle (CC&R)	125% of Population Weighted national supply curve from ICF	150% of Population Weighted national supply curve from ICF	125% of Population Weighted national supply curve from ICF		Low Resource Potential from ICF	125% of Population Weighted national supply curve from ICF	
OR - Community Climate Investments	Cost, limits and restrictions defined in CPP rule						
WA - Allowances and Offsets	TBD - Currently in Draft						
Energy Efficiency	ETO CPA in Oregon and AEG CPA in Idaho and Washington						
Weather	20 year rolling Average						
Peak Weather	99% Probability based on prior 30 year annual peak, by planning area						
Environmental Program	CCA (WA), CPP (OR)						
Demand Response	Expected						
Climate Protection Plan - OR	Per Rules						
Climate Commitment Act - WA	Per Rules						

Scenarios - Draft

- **Preferred Resource Case** – Our expected case based on assumptions and costs with a least risk and least cost resource selection
- **Avista company goal - Carbon Neutral by 2045** – Intended to move the 2050 state/federal goals up to the company goal of 2045
- **Electrification Push –** A low demand case to show the risk involved with energy delivered through the natural gas infrastructure moving to the electric system
- **High Customer Case** – A high case to measure risk of additional customer and meeting our emissions and energy obligations
- **Limited RNG Availability** – A scenario to show costs and supply options if RNG availability is smaller than expected
- **High Prices - Interrupted Supply** – A scenario to show the impacts and risks associated with large scale supply impacts and the ability for Avista to provide the needed energy to our customers
- **Other?**

Questions?

2023 – Avista Natural Gas IRP

Major Milestone	Date	Topics
TAC 1	Wednesday, February 16, 2022	RNG Discussion, Compliance To EO 20-04, Policy, Peak Day Weather Planning Standard
TAC 2	Tuesday, May 3, 2022	Use Per Customer, Planned Scenarios, Customer Forecast, Current Supply Side Resources, Plexos Model Overview, Baseline Demand Projections
TAC 3	Wednesday, June 22, 2022	Customer Survey Results,CCA Overview, Distribution
TAC 4	Tuesday, August 23, 2022	Future Supply Side Resource Options, CPA, Demand Response
TAC 5	Tuesday, October 25, 2022	Final Results / Stochastics, Scenario Results
Draft Feedback Due	Wednesday, February 1, 2023	
File	Friday, March 31, 2023