2025 Electric Integrated Resource Plan

Technical Advisory Committee Meeting No. 4 Agenda

Tuesday, April 9, 2024

Virtual Meeting – 8:30 am to 10:00 am PTZ

Topic	Staff
Introductions	John Lyons
Future Climate Analysis	Mike Hermanson
Economic Forecast & Five-Year Load Forecast	Grant Forsyth

2025 IRP TAC 4 Introductions

John Lyons, Ph.D.
Technical Advisory Committee Meeting No. 4
April 9, 2024

Today's Agenda

Introductions, John Lyons

Future Climate Analysis, Mike Hermanson

Economic Forecast & Five-Year Load Forecast, Grant Forsyth

Remaining 2025 Electric IRP TAC Schedule

- **TAC 5: April 23, 2024: 8:30 to 10:00 (PTZ)**
  - Long Run Load Forecast (AEG)
  - Review Planned Scenario Analysis

- **TAC 6: May 7, 2024: 8:30 to 10:00 (PTZ)**
  - Conservation Potential Assessment (AEG)
  - Demand Response Potential Assessment (AEG)

- **TAC 7: May 21, 2024: 8:30 to 10:00 (PTZ)**
  - Variable Energy Resource Study
  - Portfolio/Market Scenarios

- **TAC 8: June 4, 2024: 8:30 to 10:00 (PTZ)**
  - Load & Resource Balance and Methodology
  - Loss of Load Probability Study
  - New Resources Options Costs and Assumptions

- **TAC 9: June 18, 2024: 8:30 to 10:00 (PTZ)**
  - IRP Generation Option Transmission Planning Studies
  - Distribution System Planning within the IRP & DPAG update

Remaining 2025 Electric IRP TAC Schedule

- **Technical Modeling Workshop: June 25, 2024: 9:00 am to 12:00pm (PTZ)**
  - PRiSM Model Tour
  - ARAM Model Tour
  - New Resource Cost Model

- **TAC 10: July 16, 2024: 8:30 to 10:00 (PTZ)**
  - Preferred Resource Strategy Results
  - Washington Customer Benefit Indicator Impacts
  - Resiliency Metrics

- **TAC 11: July 30, 2024: 8:30 to 10:00 (PTZ)**
  - Preferred Resource Strategy Results
  - Portfolio Scenario Analysis
  - LOLP Study Results

- **TAC 12: August 13, 2024: 8:30 to 10:00 (PTZ)**
  - Preferred Resource Strategy Results (continued)
  - Portfolio Scenario Analysis (continued)
  - LOLP Study Results (continued)
  - QF Avoided Cost

Remaining 2025 Electric IRP TAC Schedule

- **September 2, 2024- Draft IRP Released to TAC.**

- **Virtual Public Meeting- Natural Gas & Electric IRP (September 2024)**
  - Recorded presentation
  - Daytime comment and question session (12pm to 1pm- PST)
  - Evening comment and question session (6pm to 7pm- PST)

IRP Climate Change Analysis

Forecasted streamflow and temperature changes for 2025 IRP Analysis

Mike Hermanson, Senior Power Supply Analyst

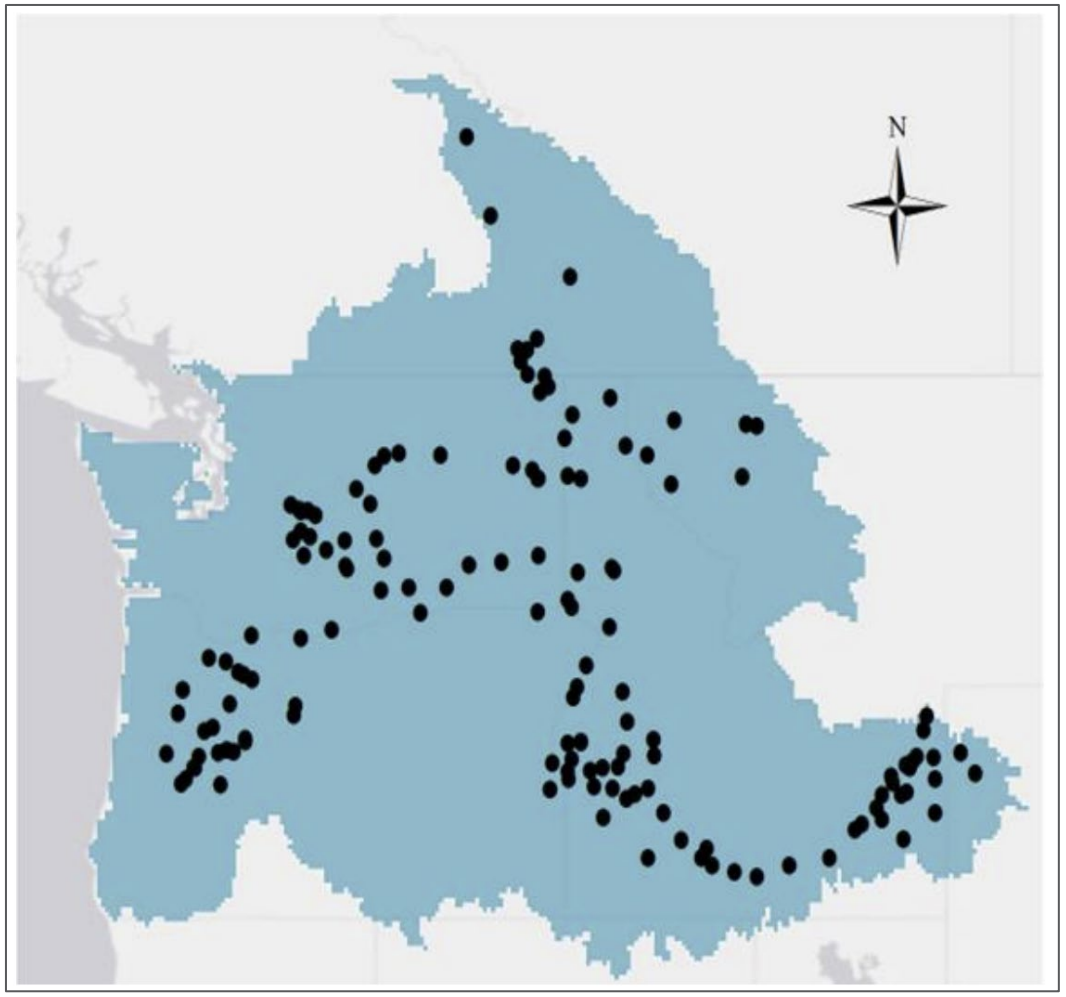
April 9, 2024

Overview

- Data sources and methodology
- Hydrogeneration
- Temperatures for load forecast
- Temperatures for peak load forecast

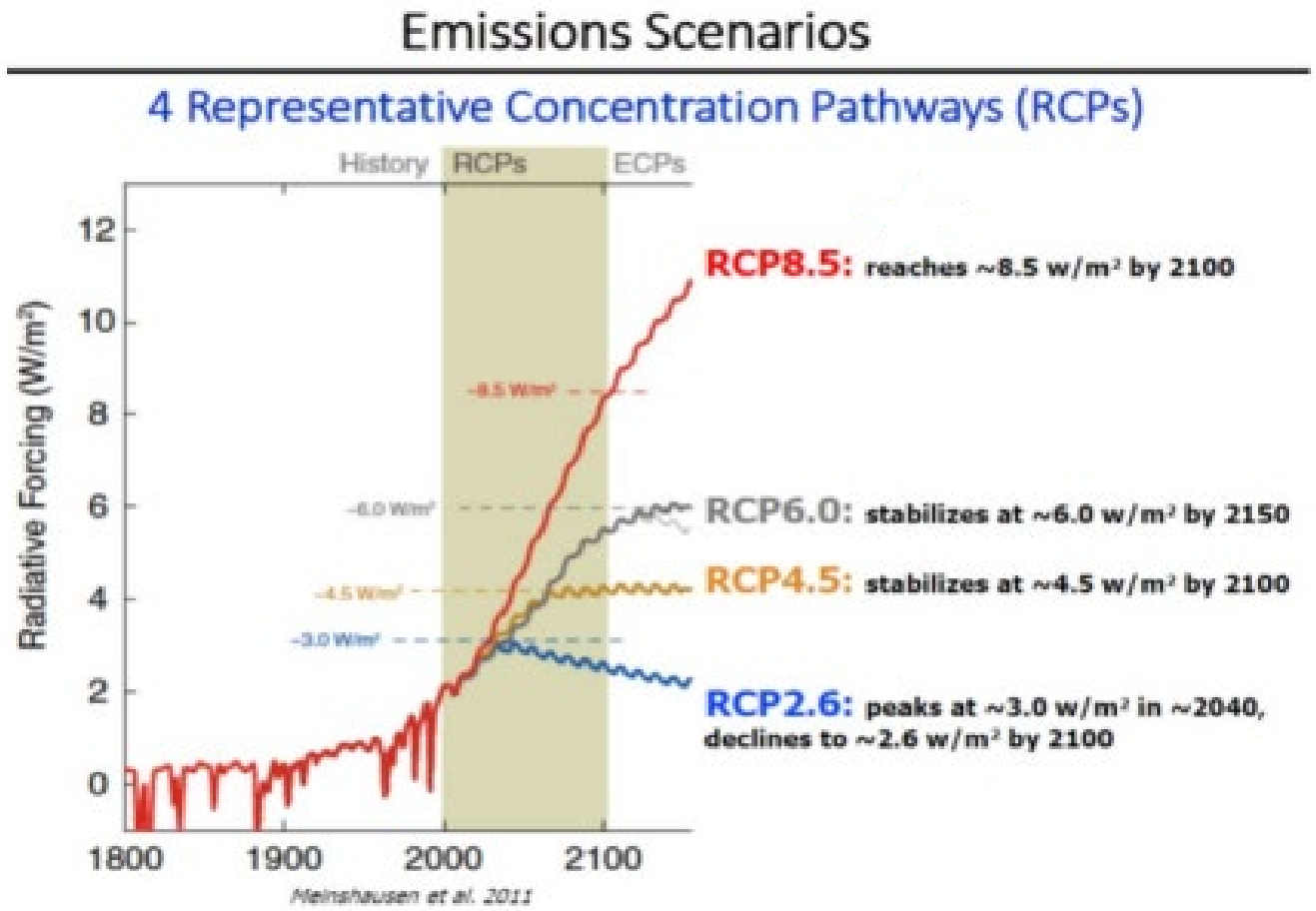
Data Sources

- Climate and Hydrology Datasets for RMJOC Long-Term Planning Studies: Second Edition
  - River Management Joint Operating Committee (RMJOC)
    - BPA, US Army Corps of Engineers, US Bureau of Reclamation
  - Research Team
    - University of Washington, Oregon State University
- Part I – Unregulated stream flows
- Part II – Reservoir Regulation and Operations
- Wind data – University of California-Merced
  - Data from 20 climate models downscaled using the MACA (Multivariate Adaptive Constructed Analogs).



Global Climate Models

- Global Climate Models (GCMs)
  - Coarse resolution ranging from 75 to 300 km grid size
  - Provides projections of temperature and precipitation, and other meteorological variables (wind)
  - Multiple Representative Concentration Pathways (RCP 4.5 & RCP 8.5)
  - 10 GCM models used in study
    - CanESM2 (Canada)
    - CCSM4 (US)
    - CNRM-CM5 (France)
    - CSIRO-Mk3-6-0 (Australia)
    - GFDL-ESM2M (US)
    - HadGEM2-CC (UK)
    - HadGEM2-ES (UK)
    - inmcm4 (Russia)
    - IPSL-CM5-MR (France)
    - MIROC5 (Japan)



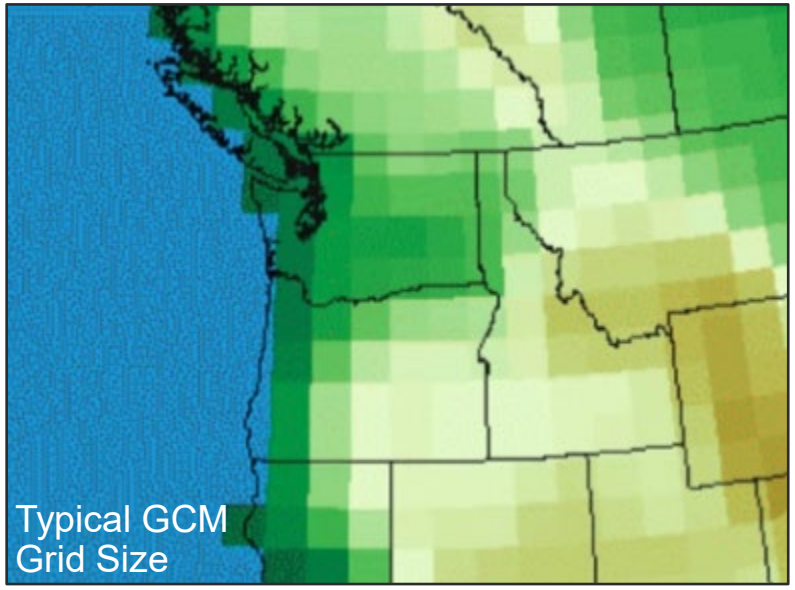
Representative Concentration Pathways

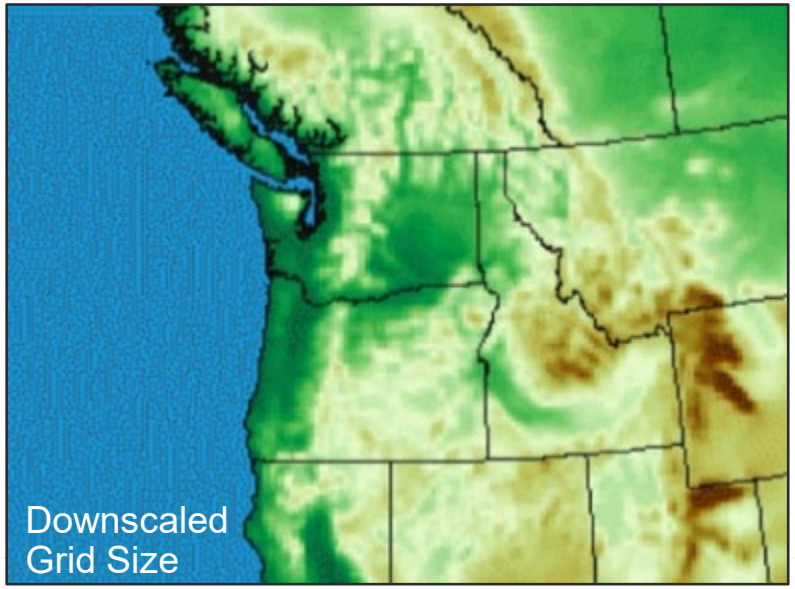
- Description by Intergovernmental Panel on Climate Change (IPCC)
  - RCP2.6 – stringent mitigation scenario
  - RCP4.5 & RCP6.0 – intermediate scenarios
  - RCP8.5 – very high GHG emissions
- RMJOCII Study evaluated RCP4.5 and RCP8.5
- RCP4.5 and RCP6.0 similar likely range by the end the IRP planning horizon

	Scenario	2046-2065		2081-2100	
		Mean	Likely range	Mean	Likely range
Global Mean Surface Temperature Change (C°)	RCP2.6	1.0	0.4 to 1.6	1.0	0.3 to 1.7
	RCP4.5	**1.4**	**0.9 to 2.0**	**1.8**	**1.1 to 2.6**
	RCP6.0	**1.3**	**0.8 to 1.8**	**2.2**	**1.4 to 3.1**
	RCP8.5	2.0	1.4 to 2.6	3.7	2.6 to 4.8

Downscaling Techniques

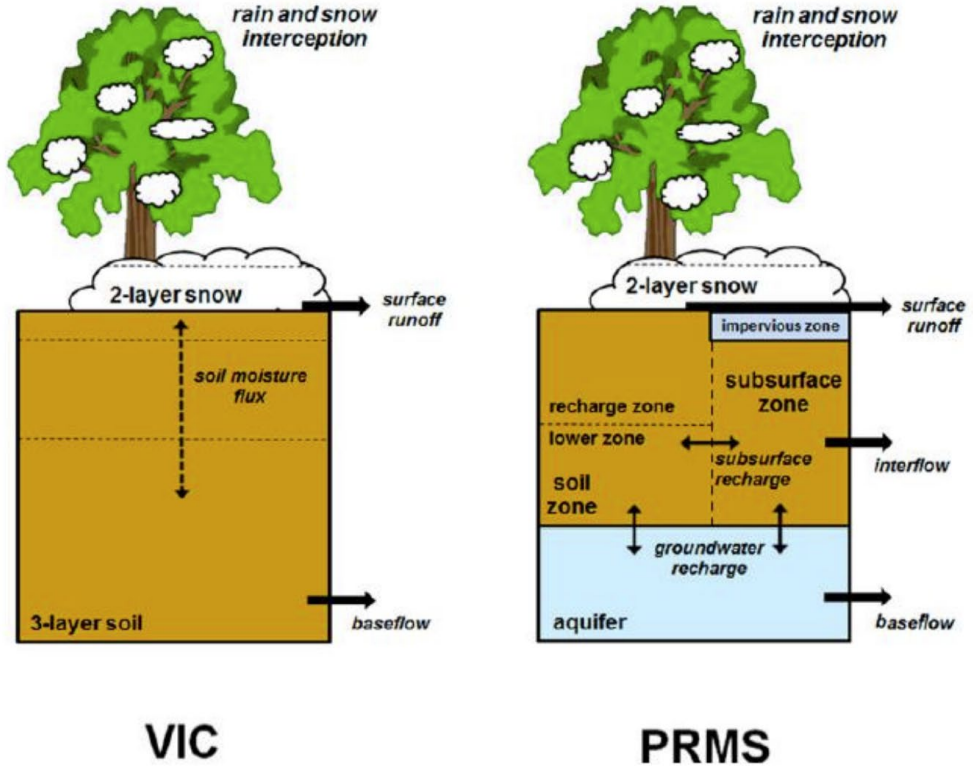
- Downscale GCM data to finer resolution necessary to model hydrology
  - Statistical methods to represent variation within large grid size
  - Two methods used (BCSD, MACA)
    - Bias Corrected Spatial Disaggregation
    - Multivariate Adaptive Constructed Analog



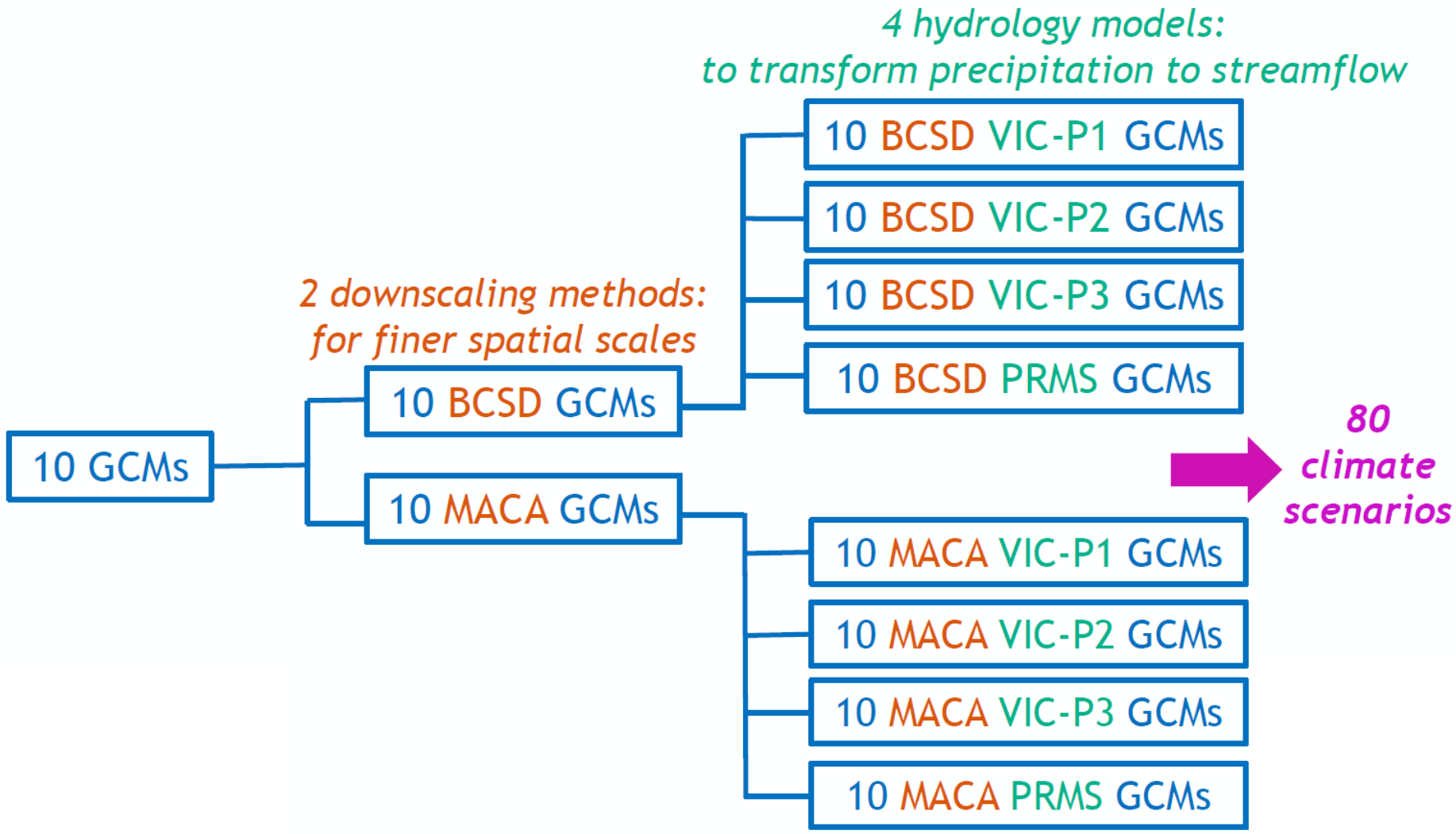


Modeling Climate Change Impacts on Hydrogeneration

- Hydrologic models
  - Downscaled temperature and precipitation is input to hydrologic models.
  - Hydrologic models use soil, geology, slope, vegetation, aspect, snow cover, etc. to model how precipitation translates into runoff and streamflow.
  - 2 different hydrology models used.
    - 1 version of PRMS model
    - 3 versions of VIC model
- Hydro regulation models
  - Unregulated streamflow is input to reservoir models of Columbia River system to generate regulated flows.



Modeling Climate Change Impacts on Hydrogeneration



2025 IRP Hydrogeneration

- BPA selected 19 of the 80 scenarios that encompass a sufficient range of uncertainty.
- Three regulated river flow data sets utilized:
  - BPA 1929-2018. Most recent data available from BPA for each Avista project.
  - 2019 utilized actual flow.
  - 2020-2045 used climate change data set.
- Median of 19 BPA selected scenarios was used in the flow data set.
- All flows were combined into one data set (1929-2045) and ran in Plexos to estimate generation for Noxon, Cabinet, Long Lake, & Little Falls
- Run-of-river projects were estimated utilizing regression analysis based on historical relationship of river flow and generation.

Results

Comparison of Annual (aMW) of Avista Hydro Projects

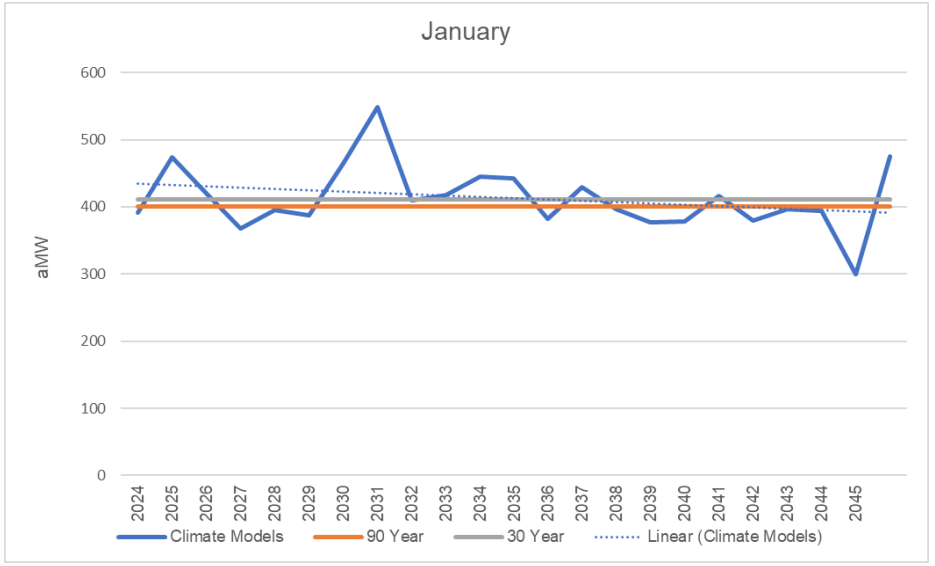
	90-Year Hydro (1929-2018)	Recent 30-Year (1994-2024)	Climate Change (2019-2049)
Mean	446	459	472
Median	363	390	408
Standard Deviation	224	204	211
10th Percentile	227	276	262

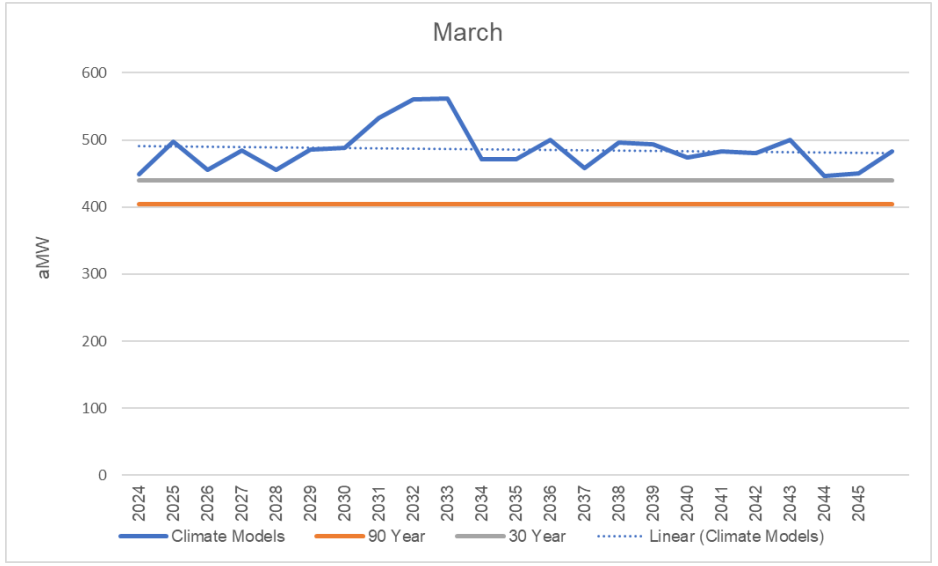
Note: Does not include Mid-C due to contractual changes during planning horizon that impact generation quantities

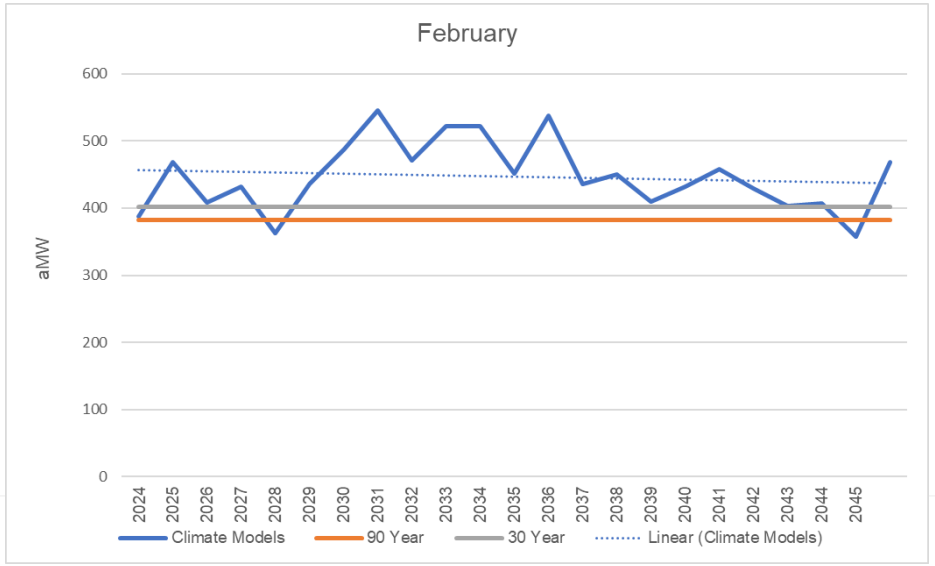
- Recent 30-year shows slight increase in annual energy
- Climate change scenarios show an increase in annual energy consistent with the projection of overall increase in precipitation in the Northwest

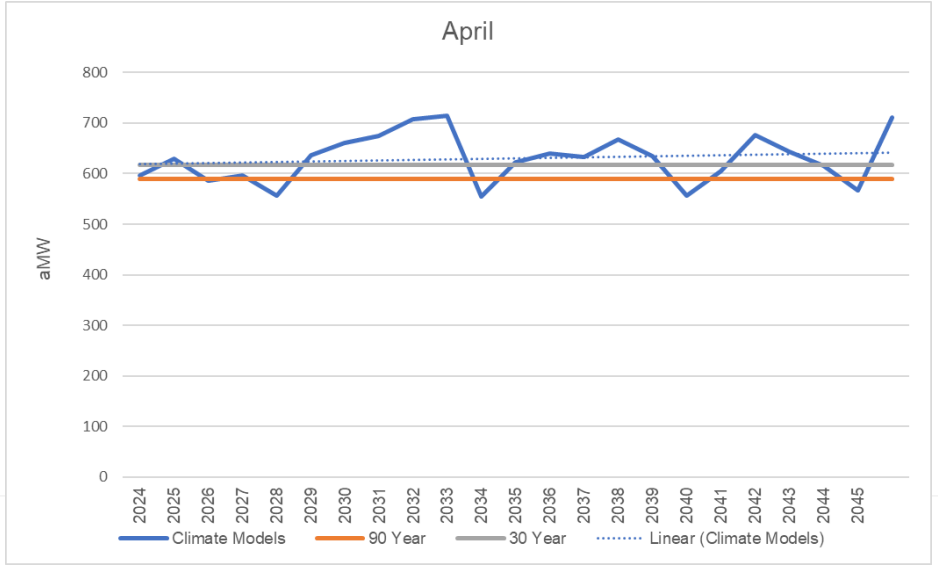
Results

2024-2045 Trend



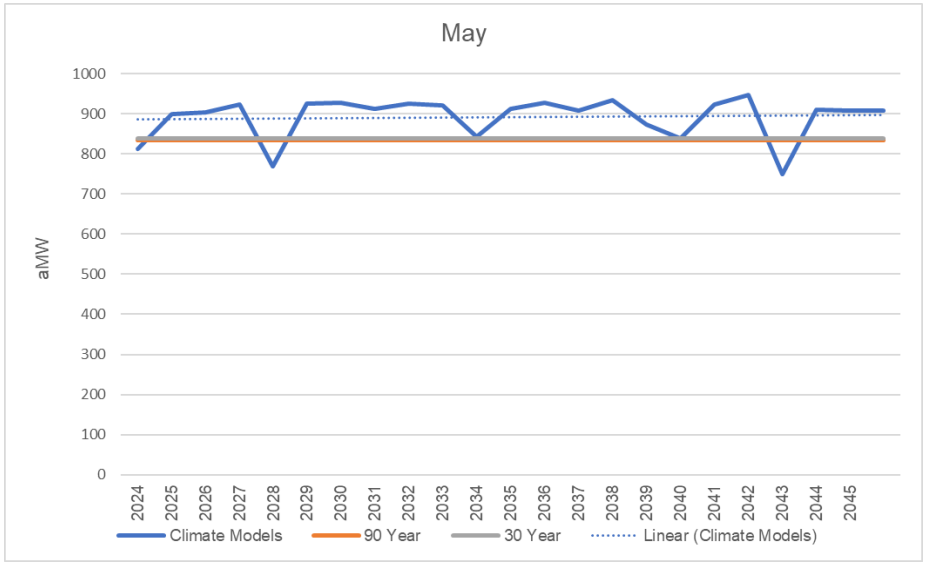


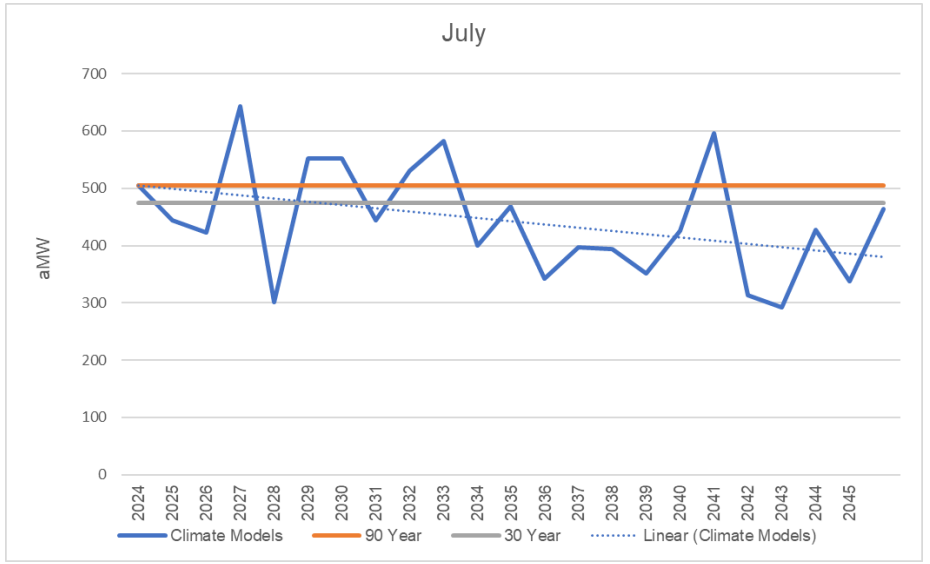


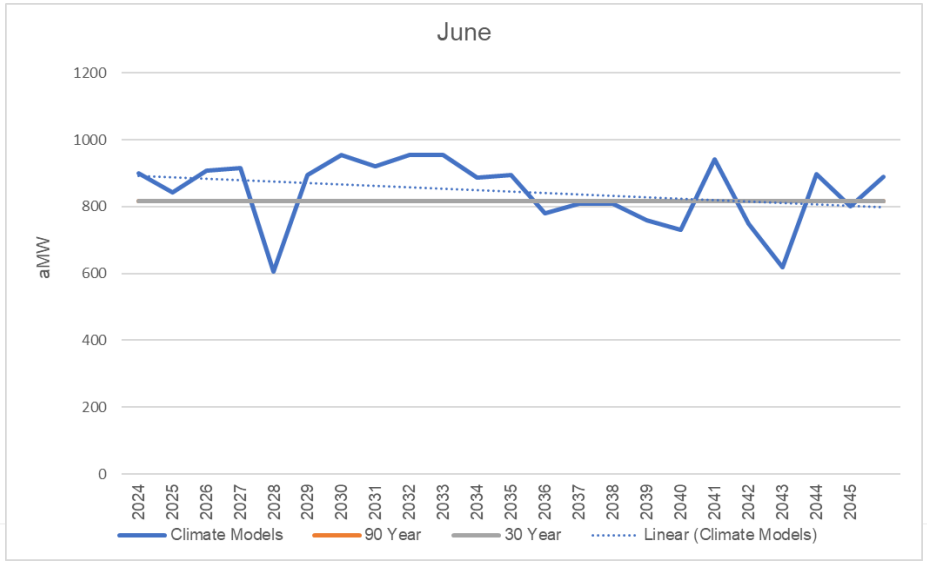


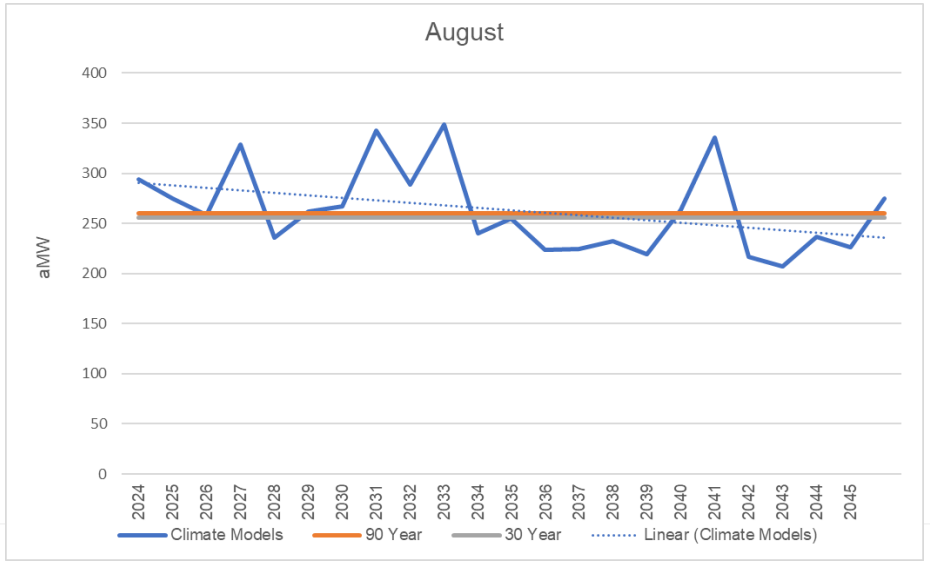
Results

2024-2045 Trend



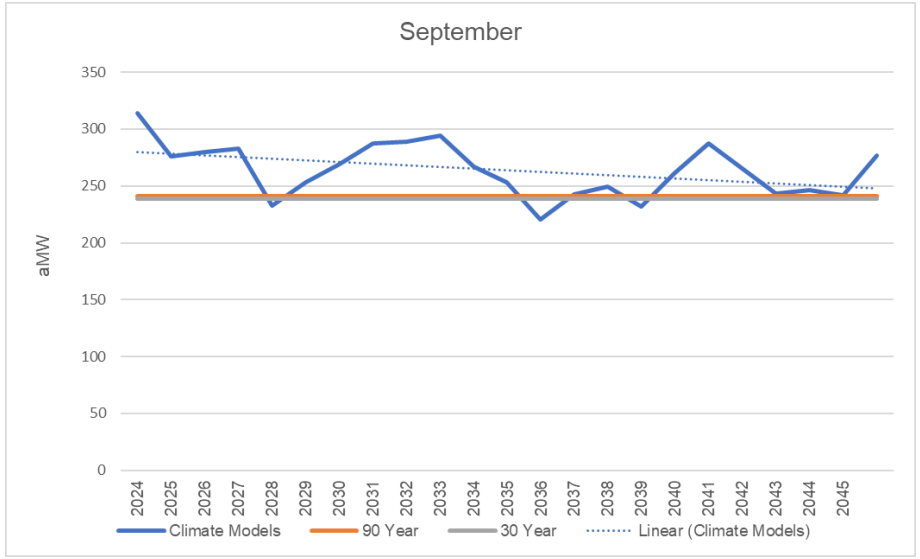


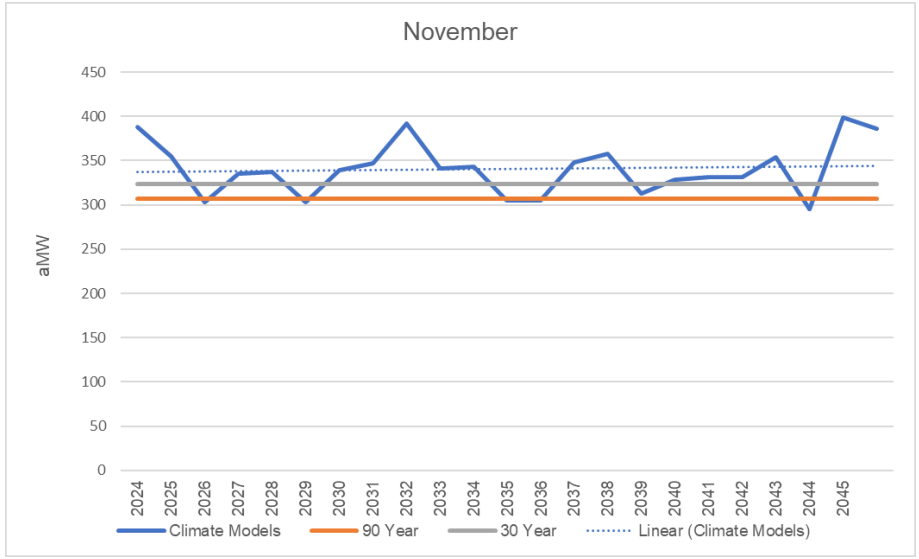


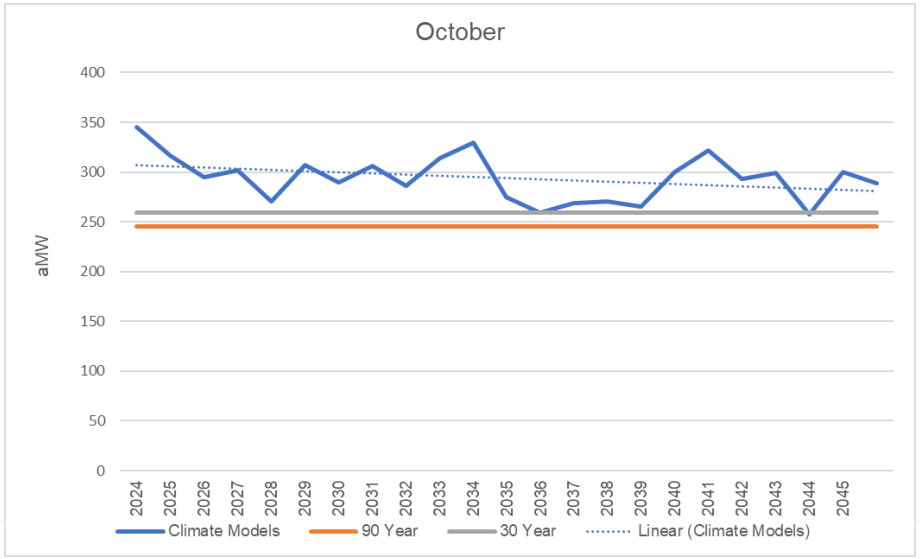


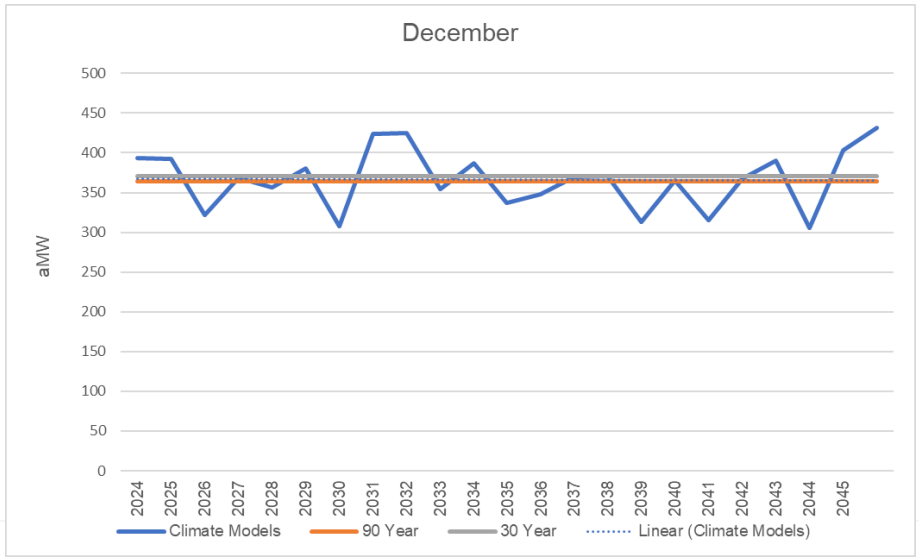
Results

2024-2045 Trend





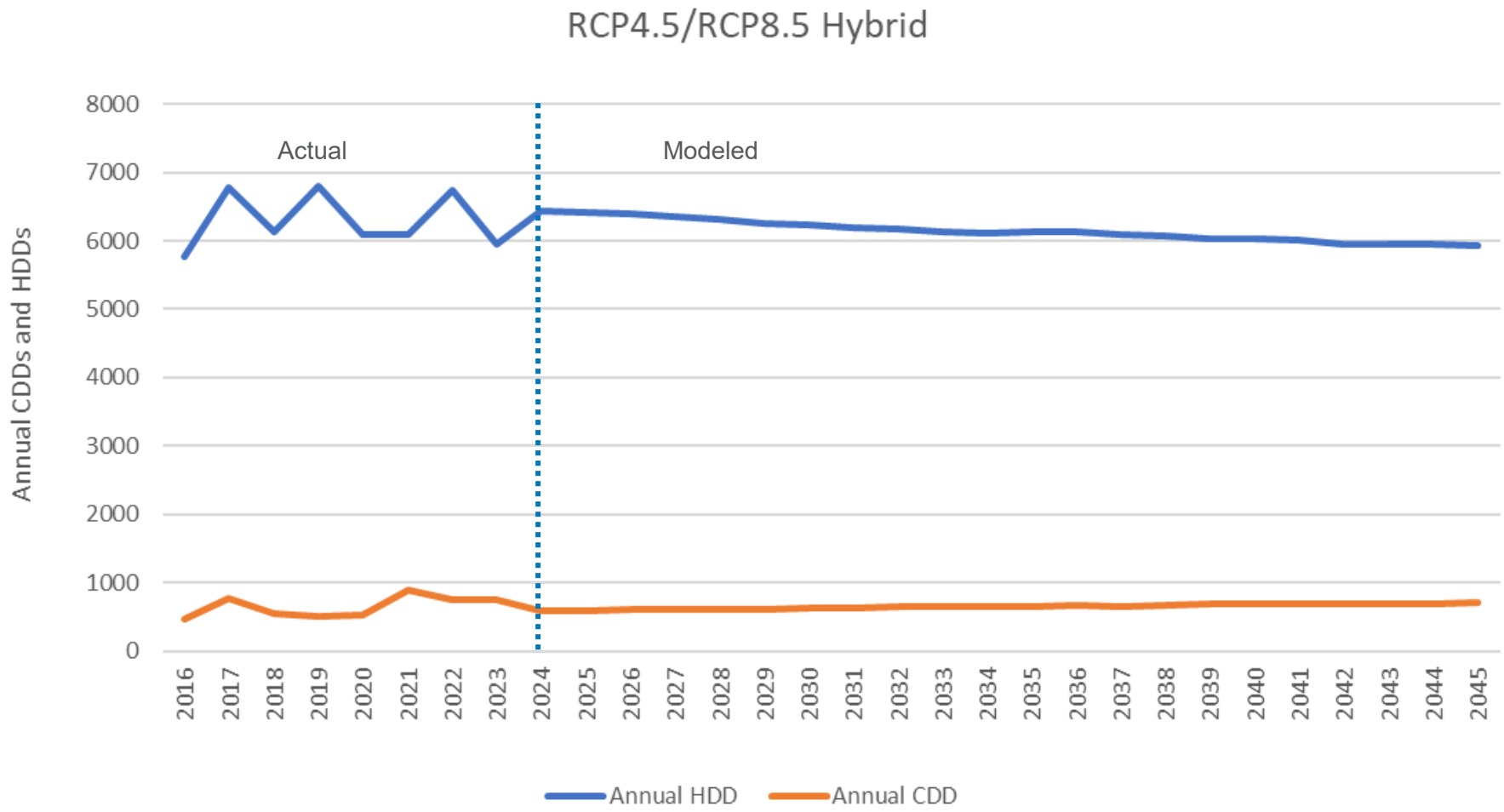




Climate Change Temperatures for Load Forecast

- Data:
  - Daily max and min temperature for Spokane airport through 2045 that correspond to the 19 BPA scenarios.
  - Data for both RCP4.5 and RCP8.5
- Temperatures for load forecast will use RCP4.5 for January – May and October – December, and RCP8.5 for June – September.
- Approach will allow representation of increasing temperatures over the IRP period without losing cold events that are important to plan for.

Climate Change Temperatures for Load Forecast

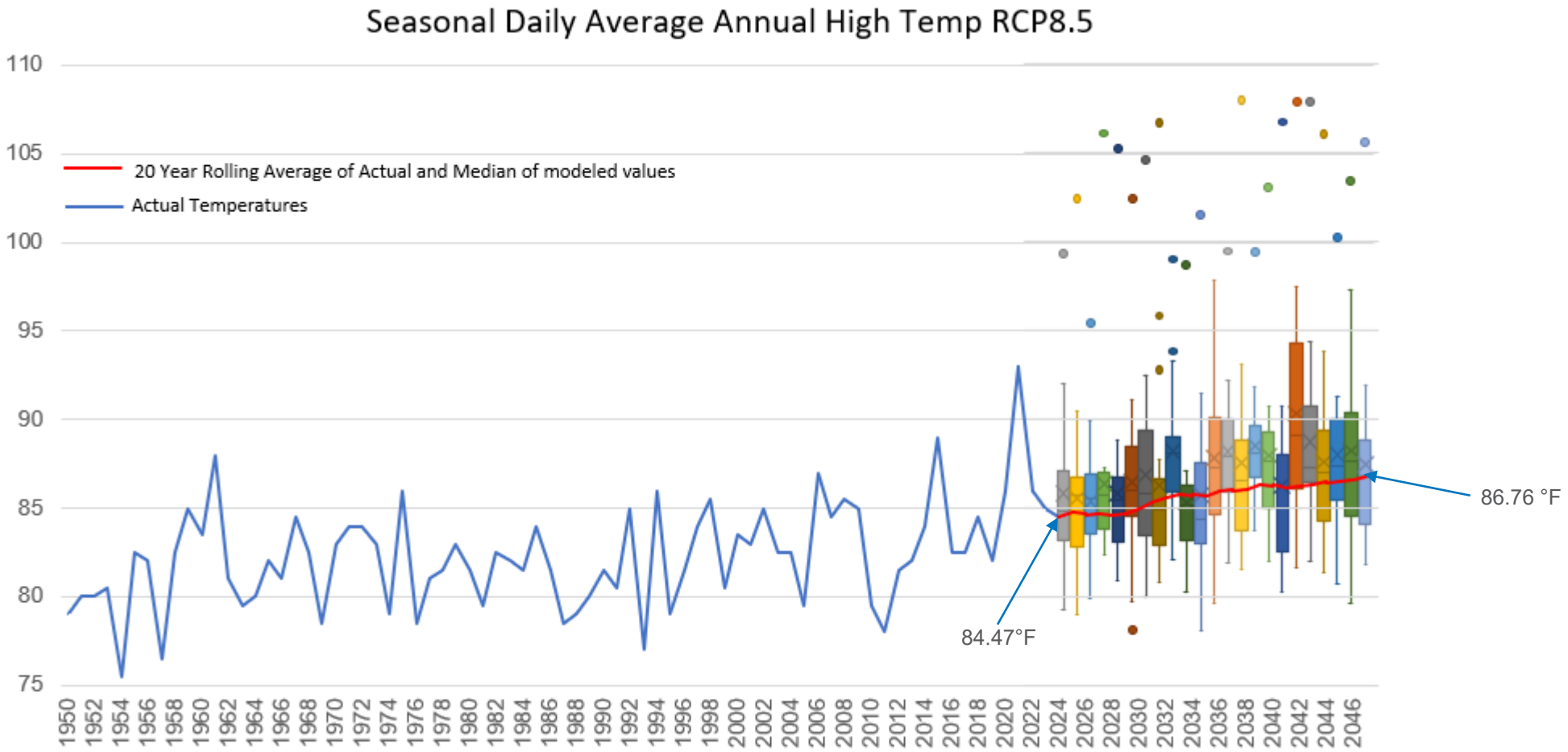


Climate Change Impacts to Peak Load

- Peak load model utilizes minimum/maximum daily average temperature for each season.
  - Winter – January through May, and October through December
  - Summer – June through September
- Winter uses RCP 4.5 and Summer uses RCP 8.5
- Median of minimum/maximum average daily temperature for each season of all models.
- Winter peak is based on a 76-year* moving average, summer peak is based on a 20-year moving average.

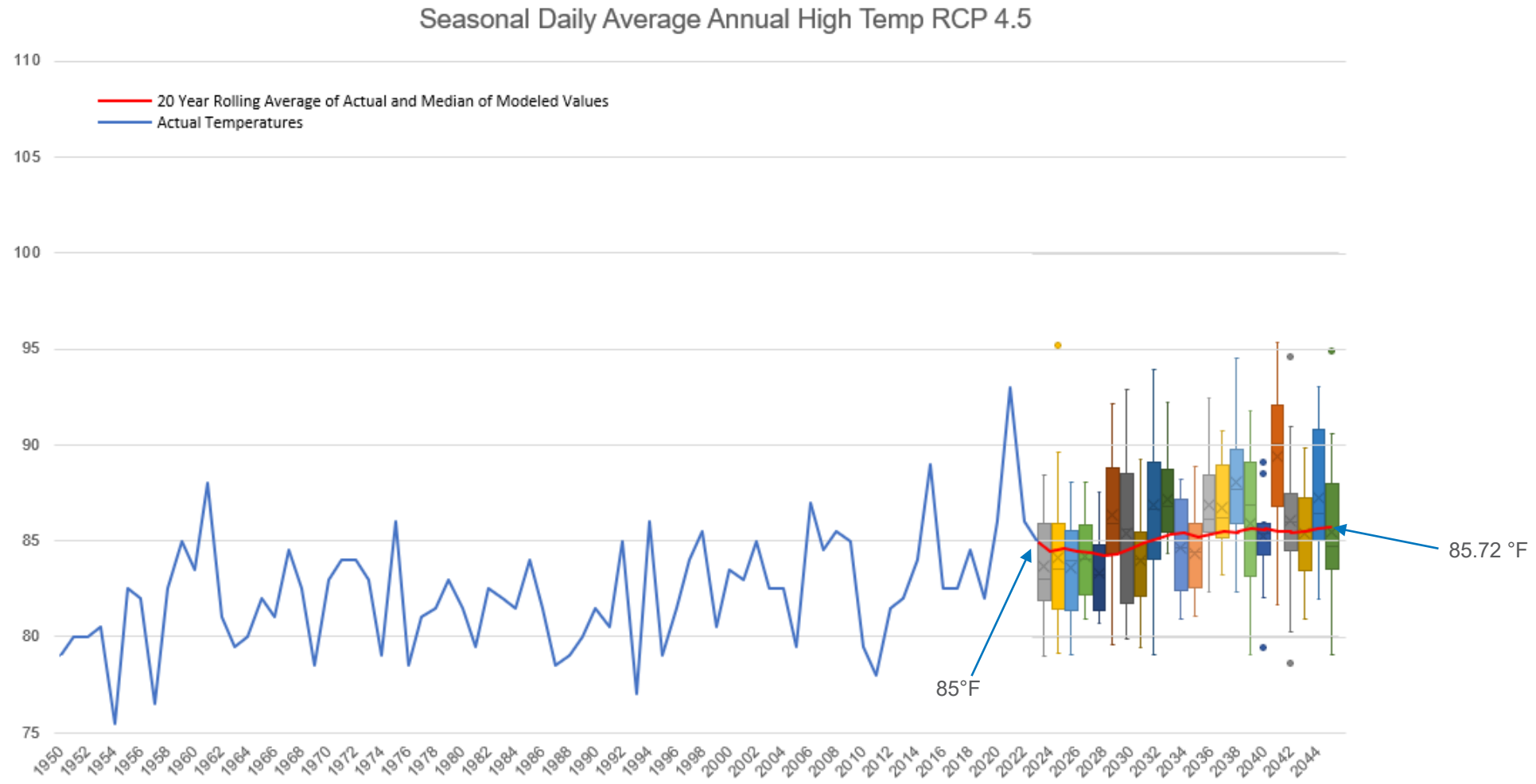
* Location for Spokane temperature data changed in 1947.

Climate Change Impacts to Peak Load



- Peak load estimate is a 1-2 event

Climate Change Impacts to Peak Load



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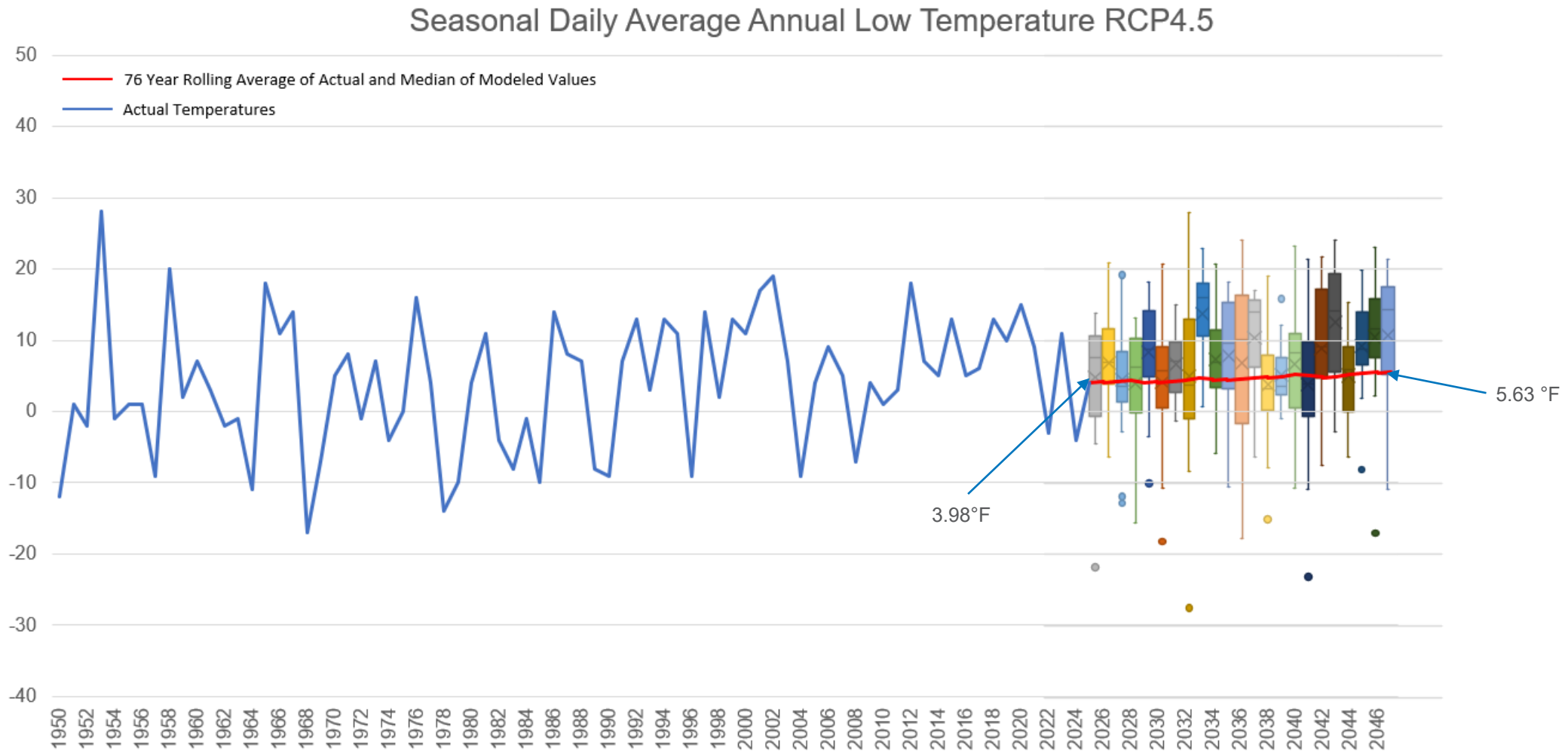
Climate Change Impacts to Peak Load



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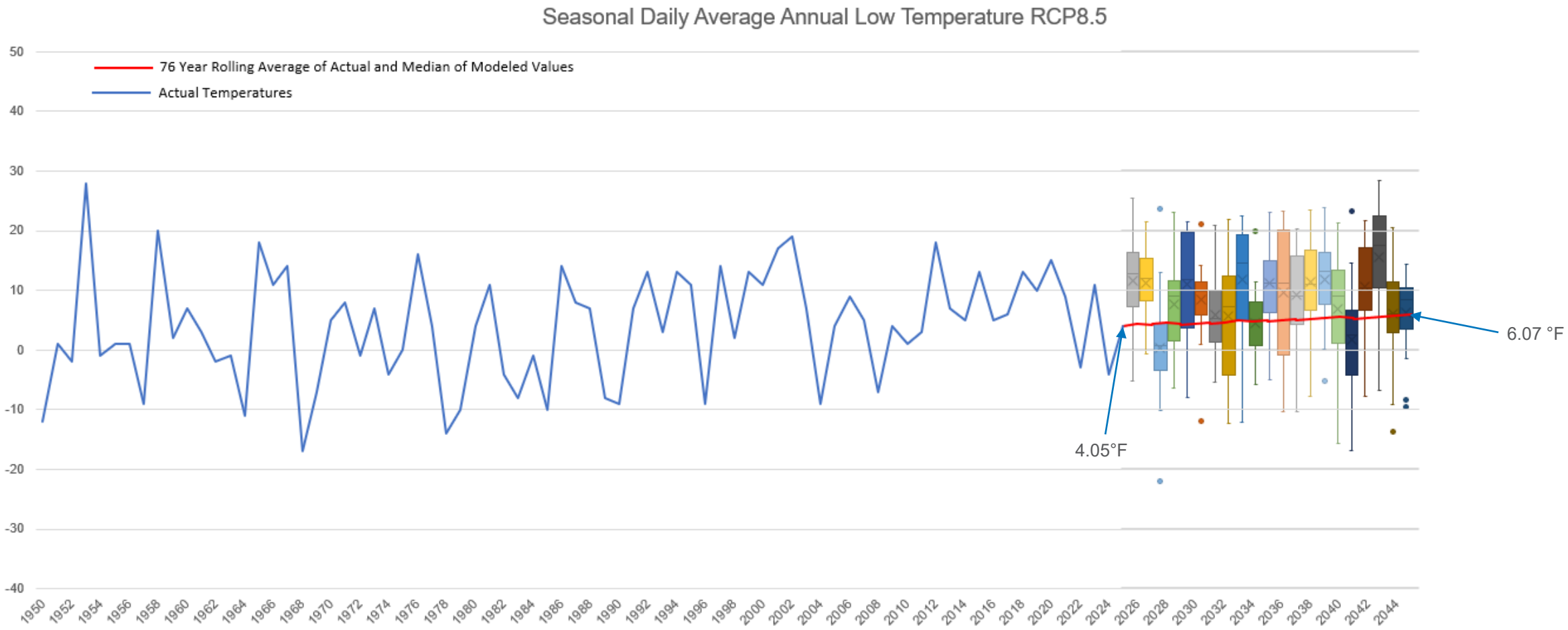
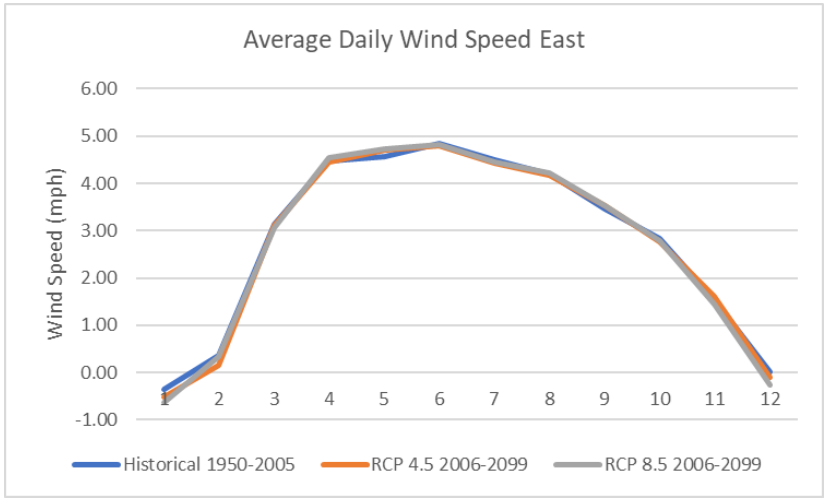
Climate Change Impacts to Peak Load

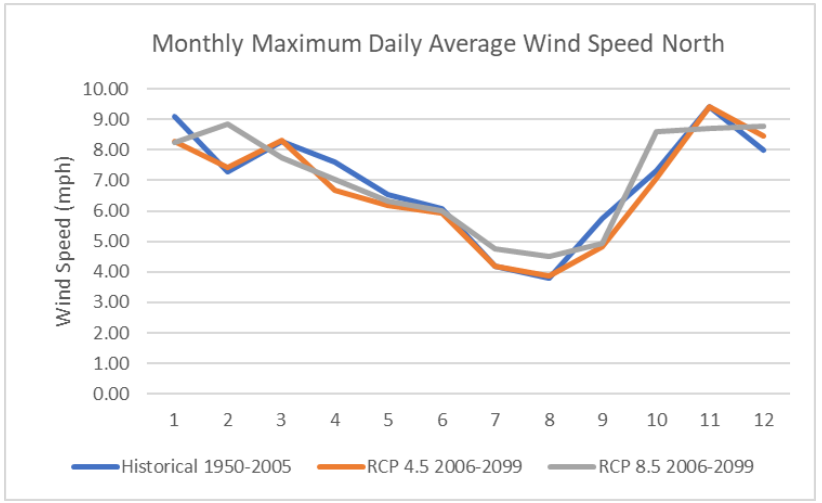


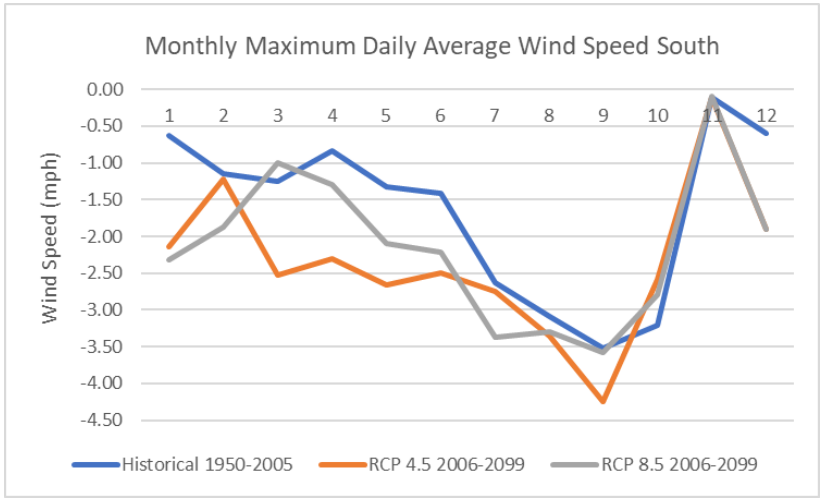
- Peak load estimate is a 1-2 event

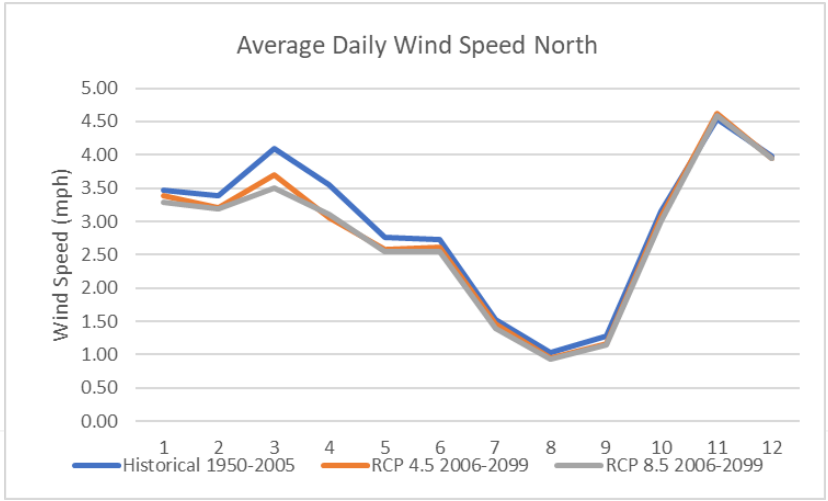
Climate Change Impacts to Wind Generation

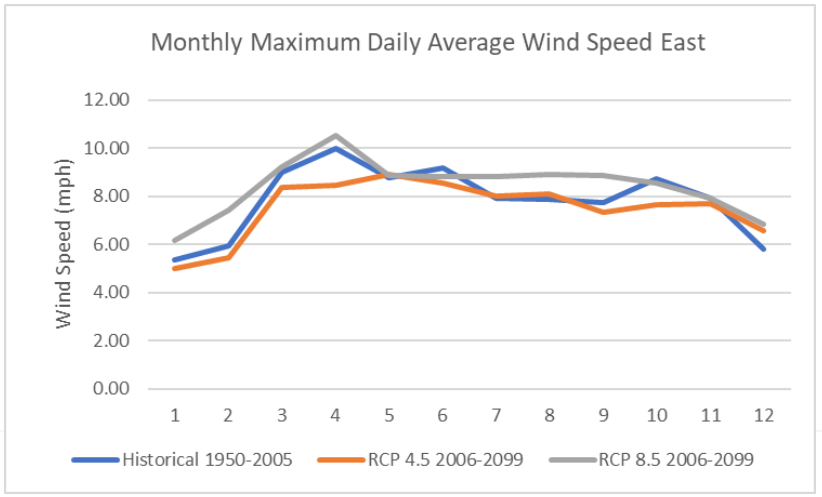
- Evaluated modeled wind speed in the north/south and east/west direction for a historical time period (1950-2005) and climate futures using the RCP4.5 and RCP8.5 (2006-2099) for the location of our Palouse Wind Project.

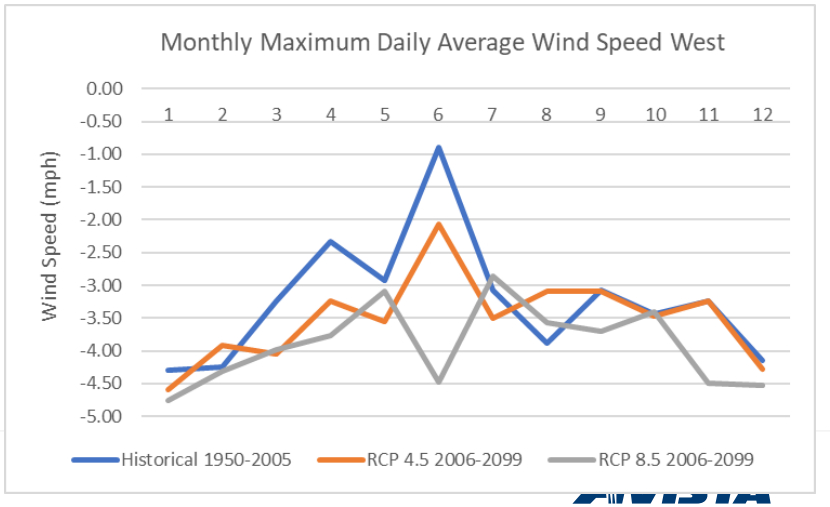












IRP Climate Change Approach Summary

- Proposed approach utilizes both RCP 4.5 (winter) and RCP 8.5 (summer)
  - Description by Intergovernmental Panel on Climate Change (IPCC)
    - RCP2.6 – stringent mitigation scenario
    - RCP4.5 & RCP6.0 – intermediate scenarios
    - RCP8.5 – very high GHG emissions
  - RCP4.5 & RCP6.0 are similar in IRP planning horizon
- Hydrogeneration – Proposing to utilize latest BPA regulated flows (1929-2018), one year of actuals and median of BPA selected climate models. Monthly flows were used in Plexos to develop generation.
- Peak Load Forecast – Proposing to use moving average of previous 20 years (summer peak) and 76 years (winter peak).
  - Used seasonal peak temperature (low and high)

TAC Meeting

April 9, 2024

2025 IRP: Economic Conditions and Preliminary Medium-Term Forecasts

Grant Forsyth, Ph.D.
Chief Economist
Grant.Forsyth@avistacorp.com

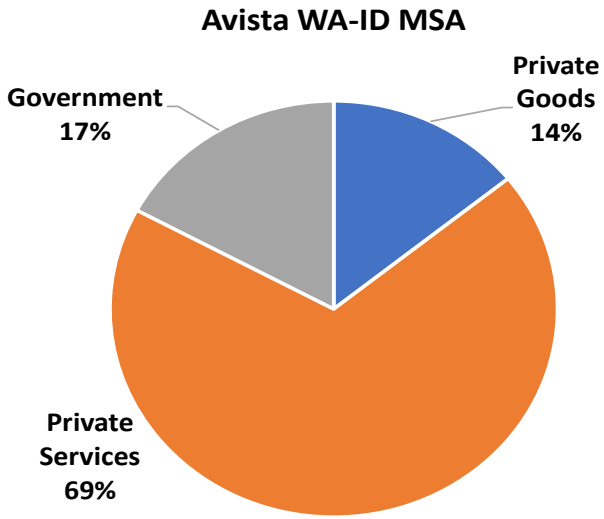
Outline

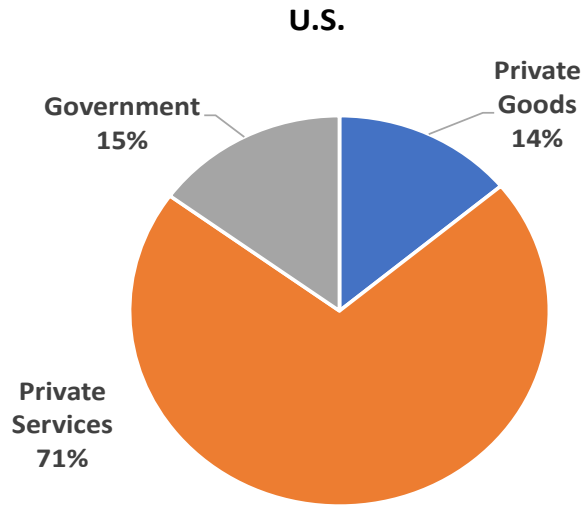
- **Service Area Economy**
- **Medium-Term Energy Forecast (Spring 2024)**

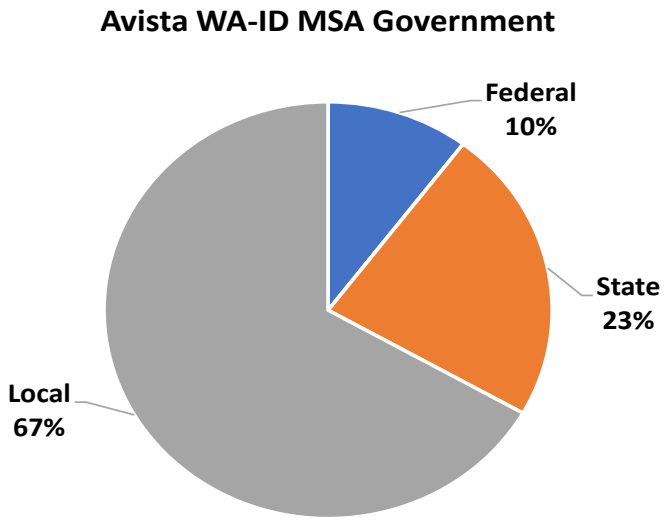
"This presentation is 40 minutes of a finite life you will never get back."

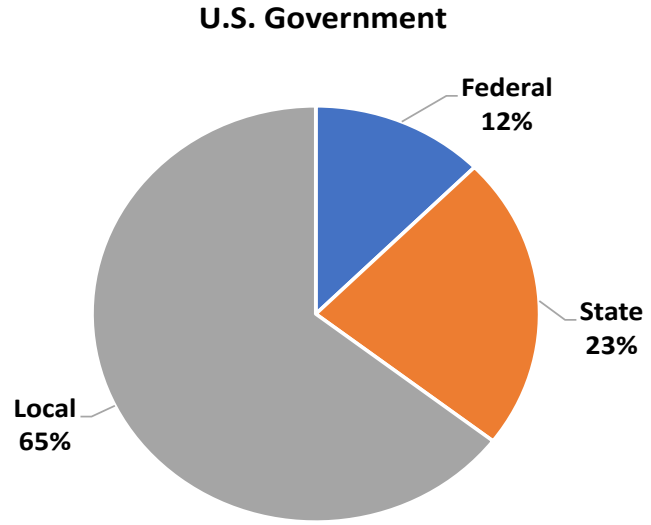
-Grant Forsyth, April 9, 2024.

Service Area Economy: Non-Farm Employment Structure







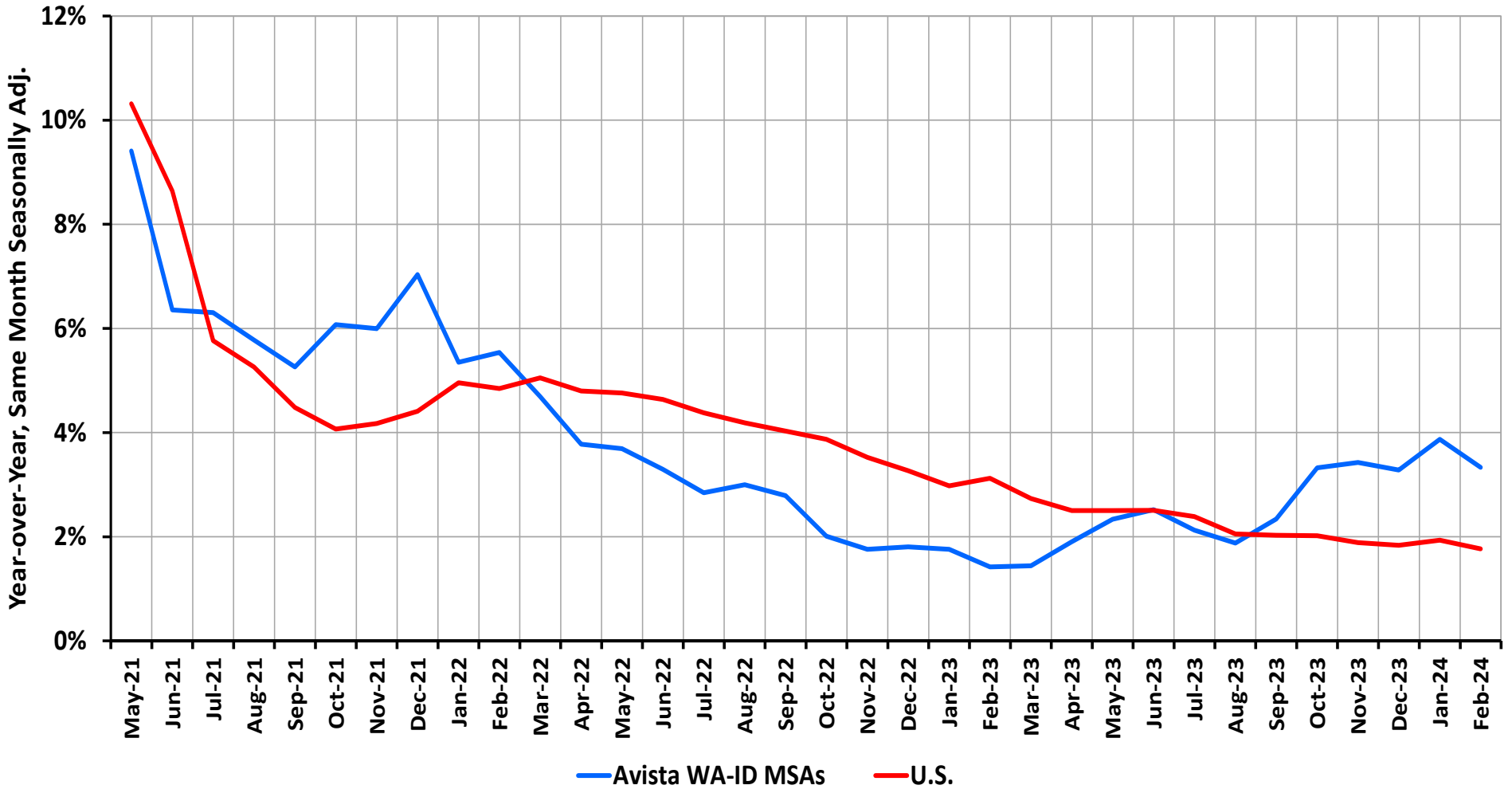


Comments

- **Employment structure very similar to the U.S.**
- **Employment dominated by private services. Without service sector growth, very little employment growth will be generated.**
- **Majority of public sector employment is local and related to education.**
- **If agriculture is considered, it would account for about 1% to 1.5% of employment.**

Source: BLS and author's calculations.

Service Area Economy: Non-Farm Employment

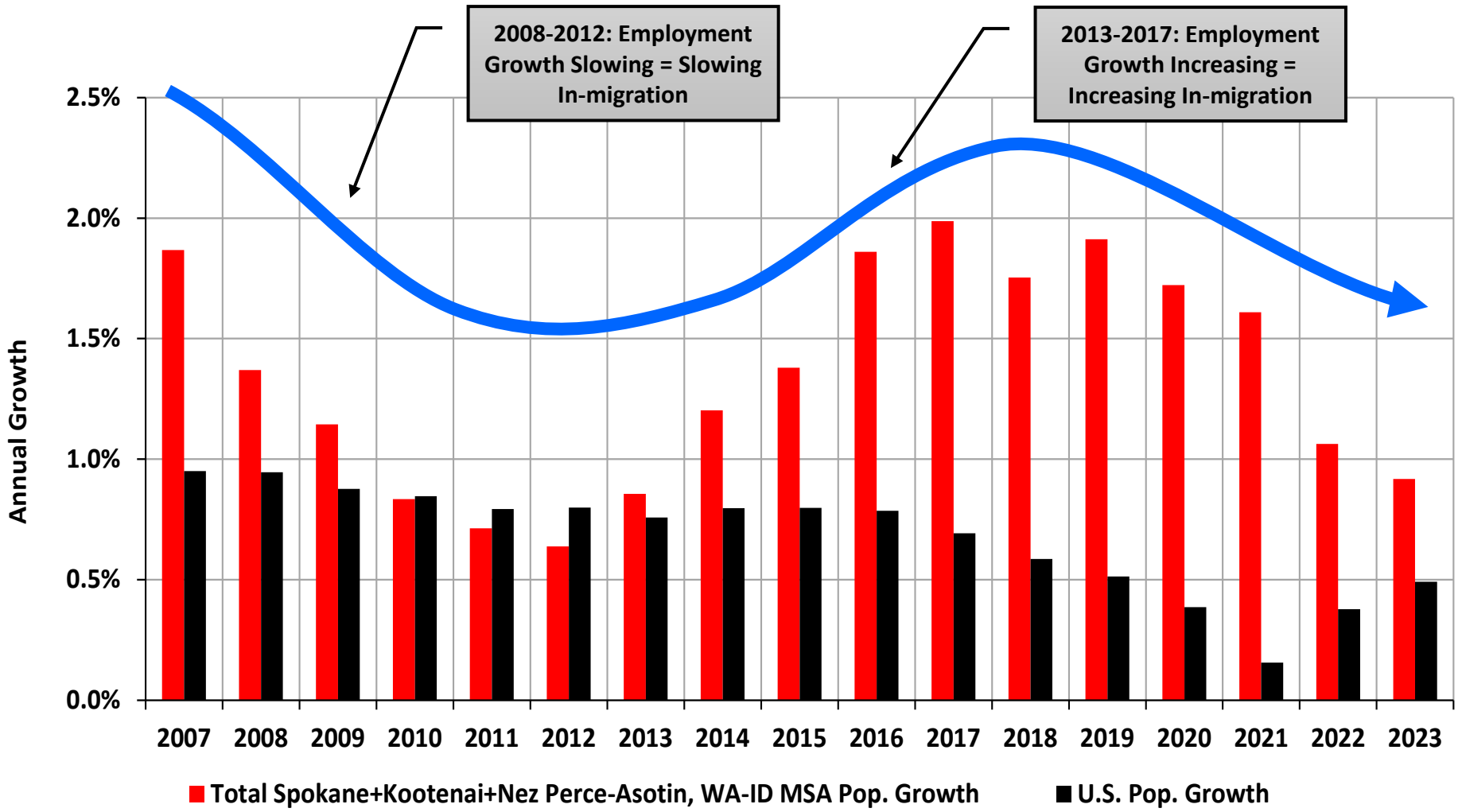


Comments

- **Region has recovered from the pandemic faster than the U.S.**
- **Growth has been strongest on the ID side.**
- **WA-ID employment growth has remained relatively strong, even with the rapid rise in interest rates.**

Source: BLS, WA ESD, and author's calculations.

Service Area Economy: WA-ID Metro Population Growth

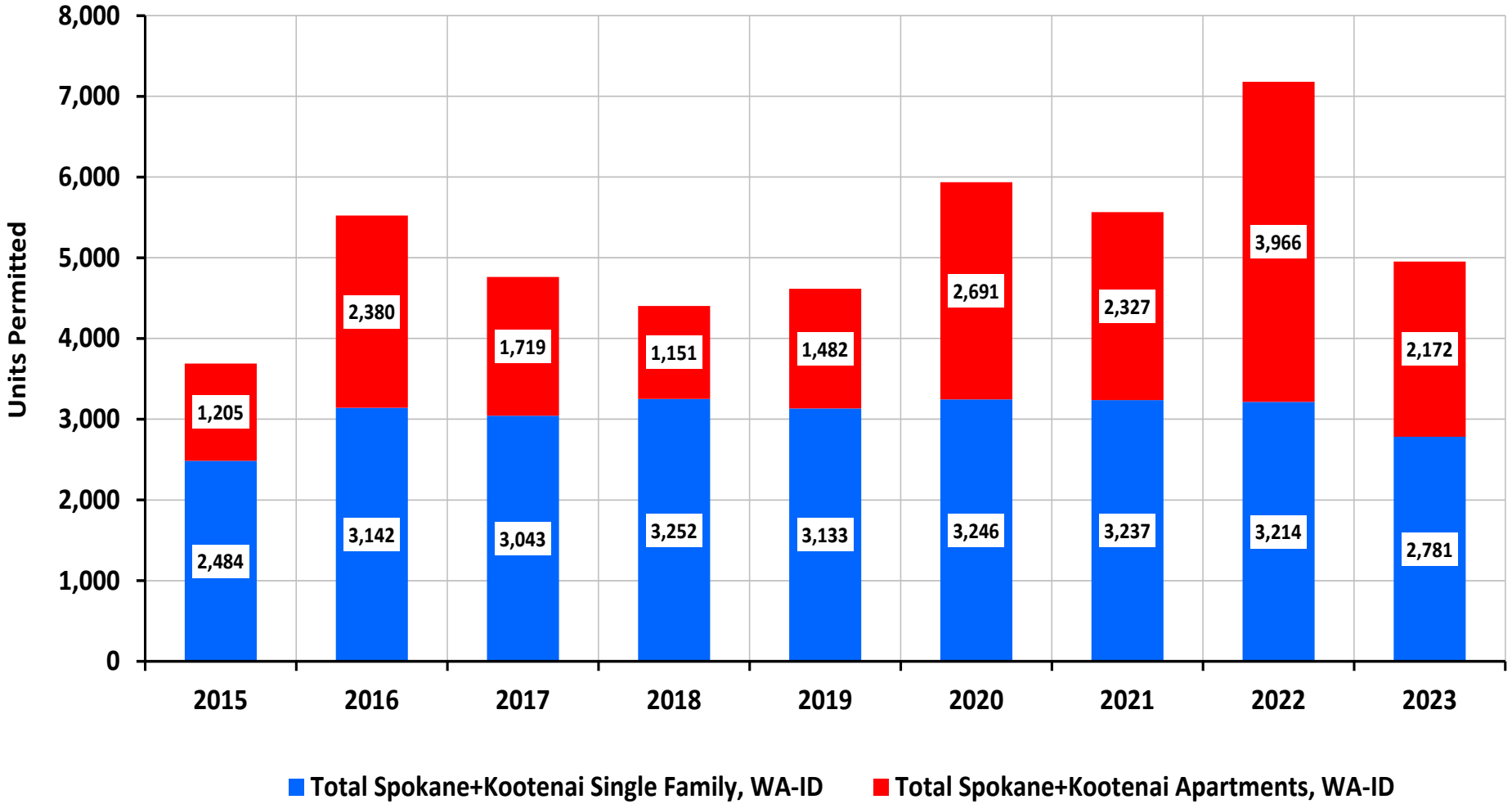


Comments

- Population growth drives most of our customer growth.
- Significantly higher than U.S. growth because of in-migration. Without in-migration, growth would look like U.S. or be lower.
- Growth is highest on the ID side.
- Strong employment growth is correlated with strong population growth…but
- Historical relationships may be changing due to high housing prices, but it's not clear at this point.

Source: BEA, U.S. Census, and author's calculations.

Service Area Economy: Spokane+Kootenai Residential Units Permitted

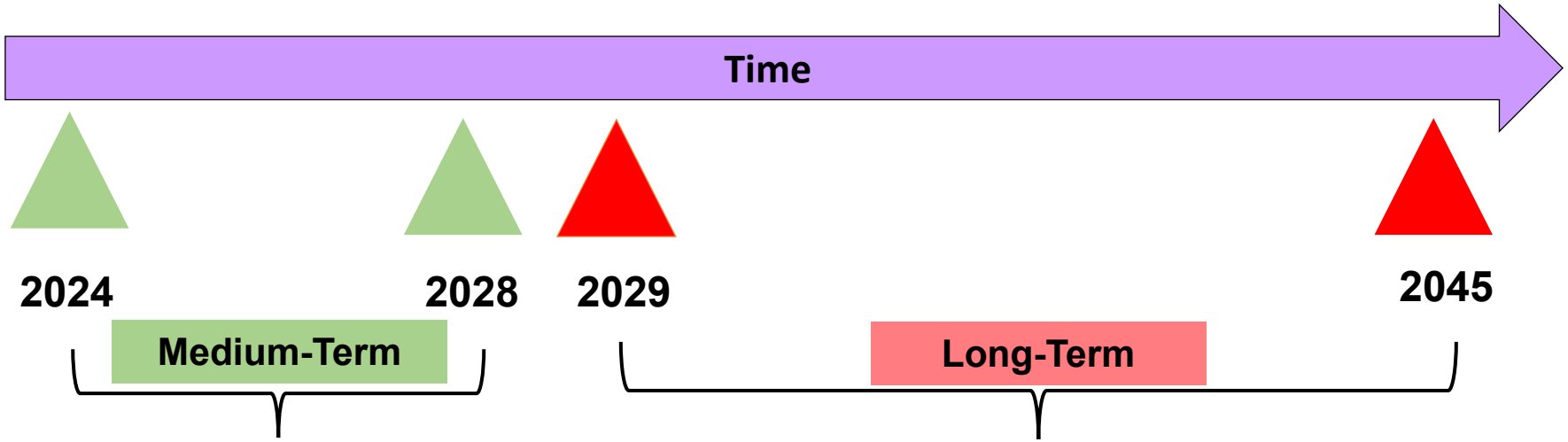


Comments

- Strongly connected to population growth.
- Held up surprisingly well given increase in interest rates.
- Prices of single-family housing have not declined significantly. The supply side remains constrained.
- Apartments and duplexes are still and important source of new housing in both WA and ID. Duplexes are counted as "single family" in the graph.
- Starting this year, ADUs are now covered by Construction Monitor.

Source: Construction Monitor and author's calculations.

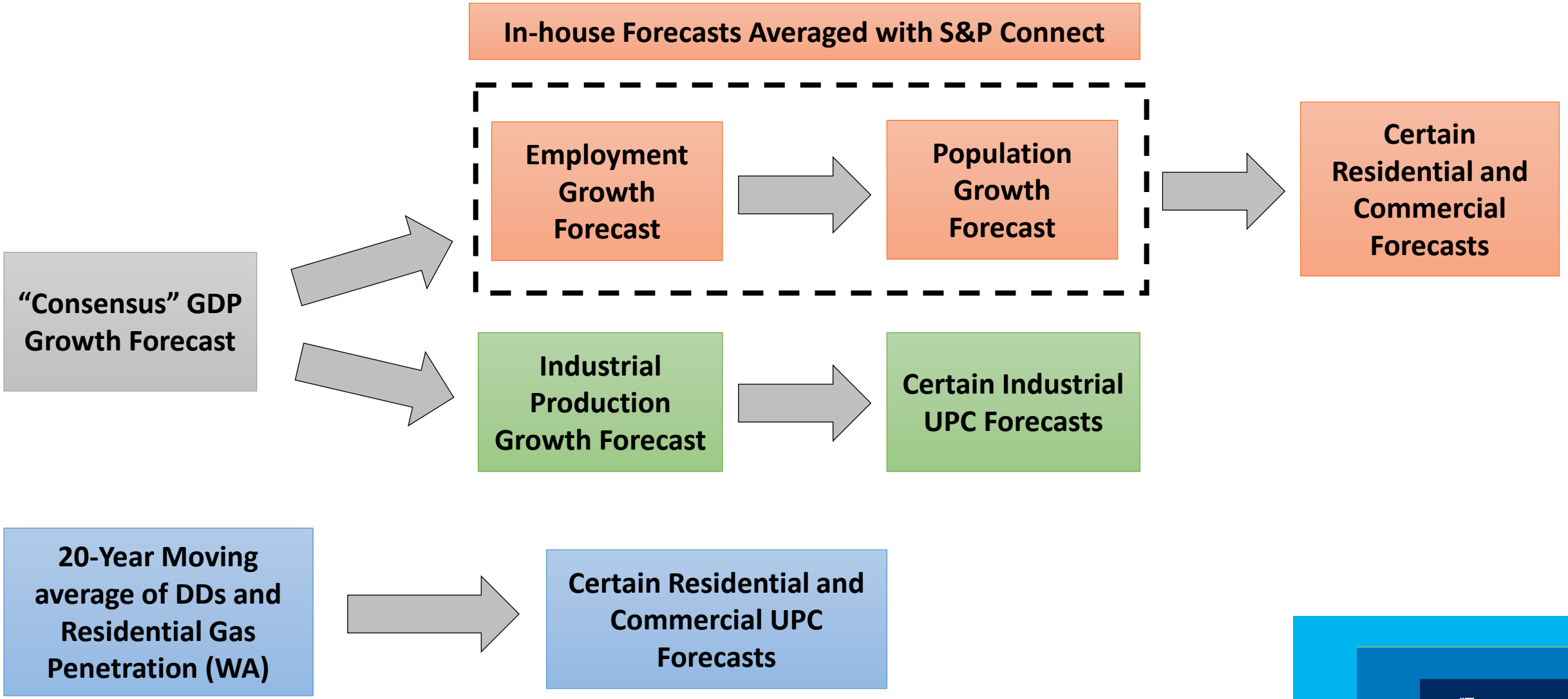
The Energy Forecast: Basic Approach



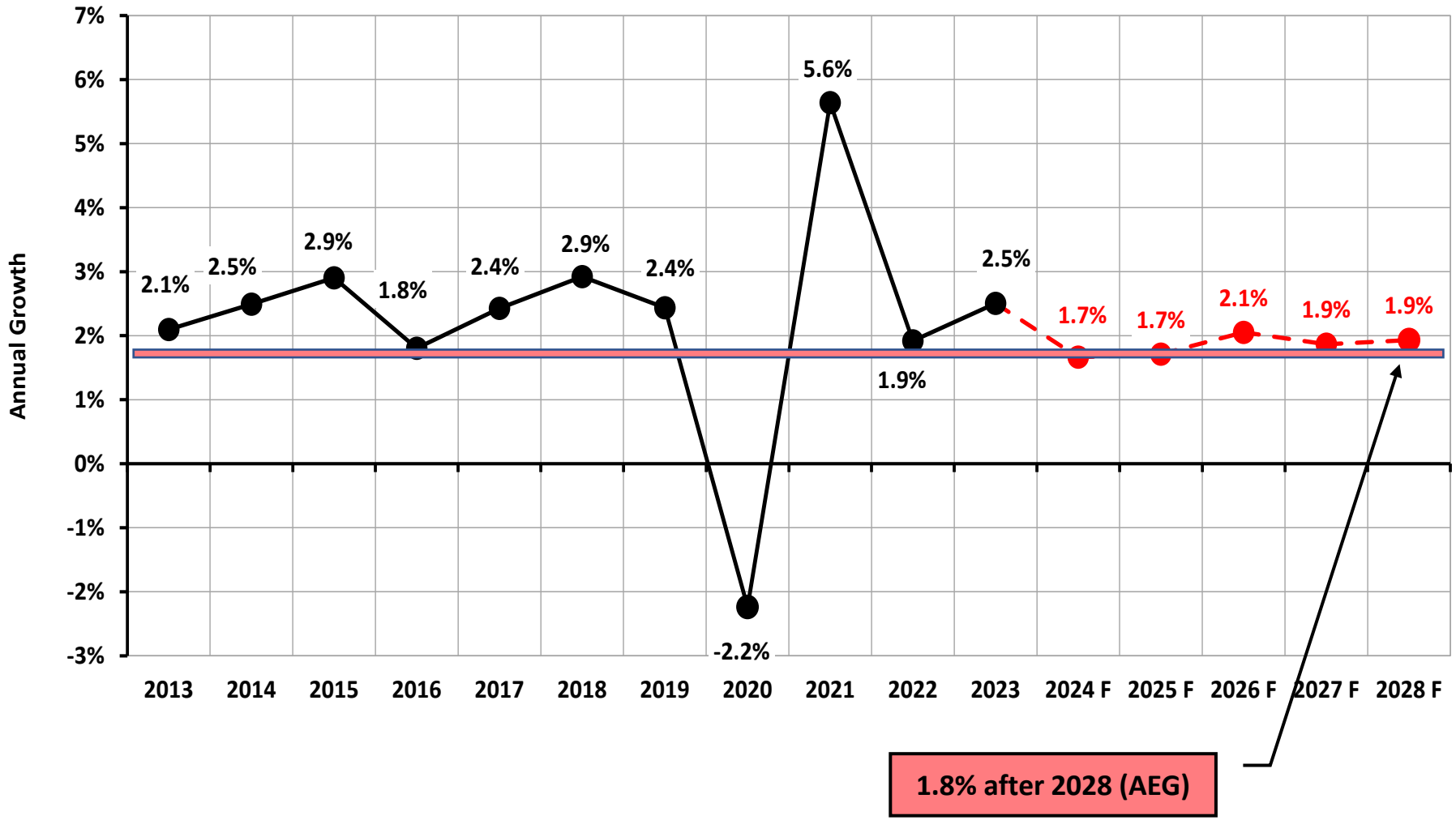
1) Monthly econometric model by schedule for each customer class.
2) Customer and UPC forecasts.
3) 20-year moving average for "normal weather."
4) Economic drivers: GDP, industrial production, employment growth, population, natural gas penetration.
5) Native load (energy) forecast derived from retail load forecast.
6) Current 2025 IRP forecast is the Spring 2024 Forecast (completed in March).

1) Shifting to end-use modeling.
2) Being handled by AEG with a few assumptions from Avista.

Medium-Term Forecast: Basic Approach



Economic Assumptions: U.S. GDP Growth Assumptions

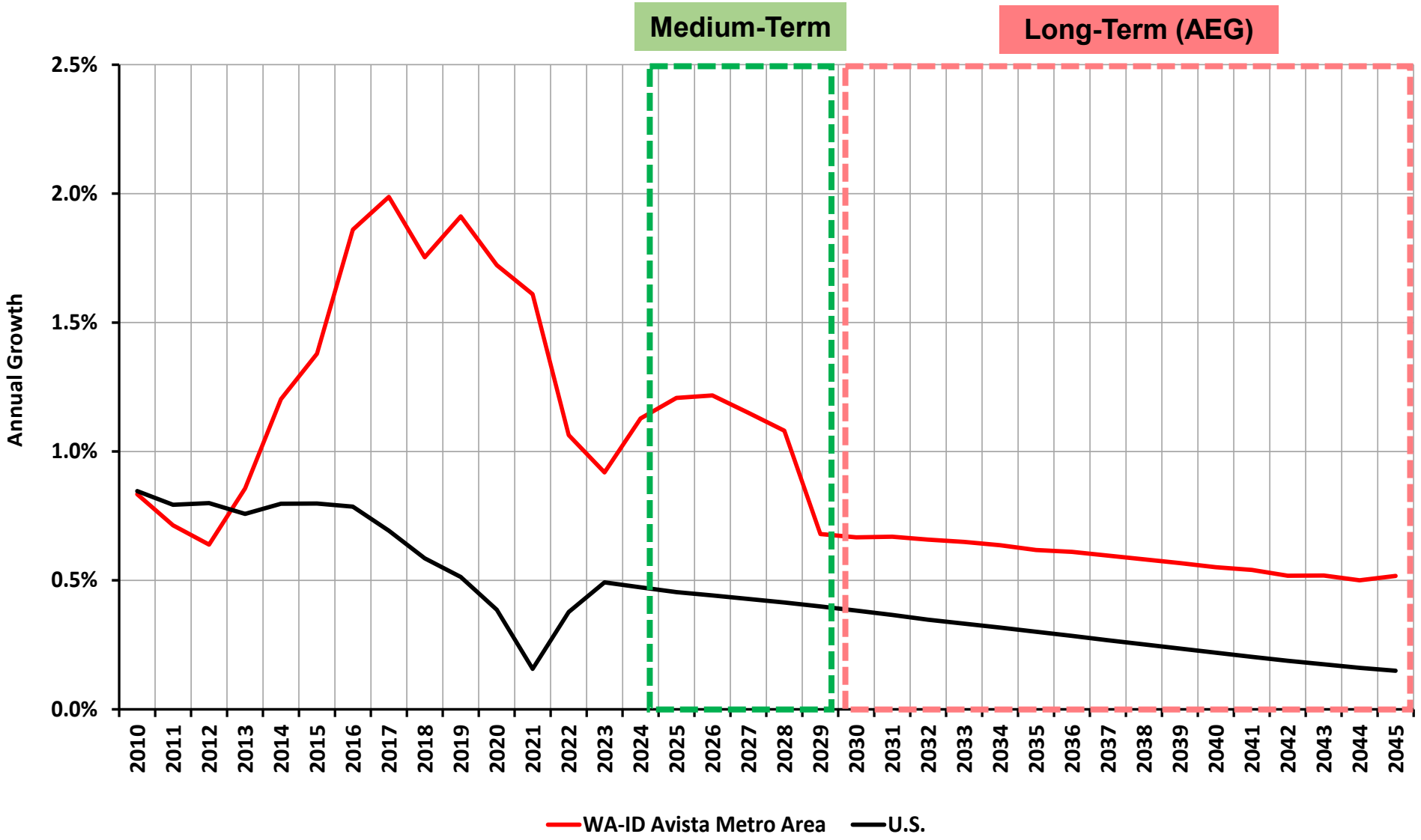


Comments

- **Long-run growth is the sum of population growth and labor productivity growth.**
- **U.S. continues to have weak productivity growth and weak population growth.**
- **The Fed's long-run expectation for GDP growth has fallen from 2% to 1.8% (red line). This is the growth rate assumed from 2029 to 2045.**
- **Long-run GDP growth must exceed 1.6% for industrial load to grow.**

Source: Various and author's calculations.

Economic Assumptions: Population Growth



IRP	Avg. Annual Growth, 2024-2028	Avg. Annual Growth, 2029-2045
2023 IRP*	1.1%	0.8%
2025 IRP	1.2%	0.6%
2025 WA	0.9%	0.3%
2025 ID	2.0%	1.4%

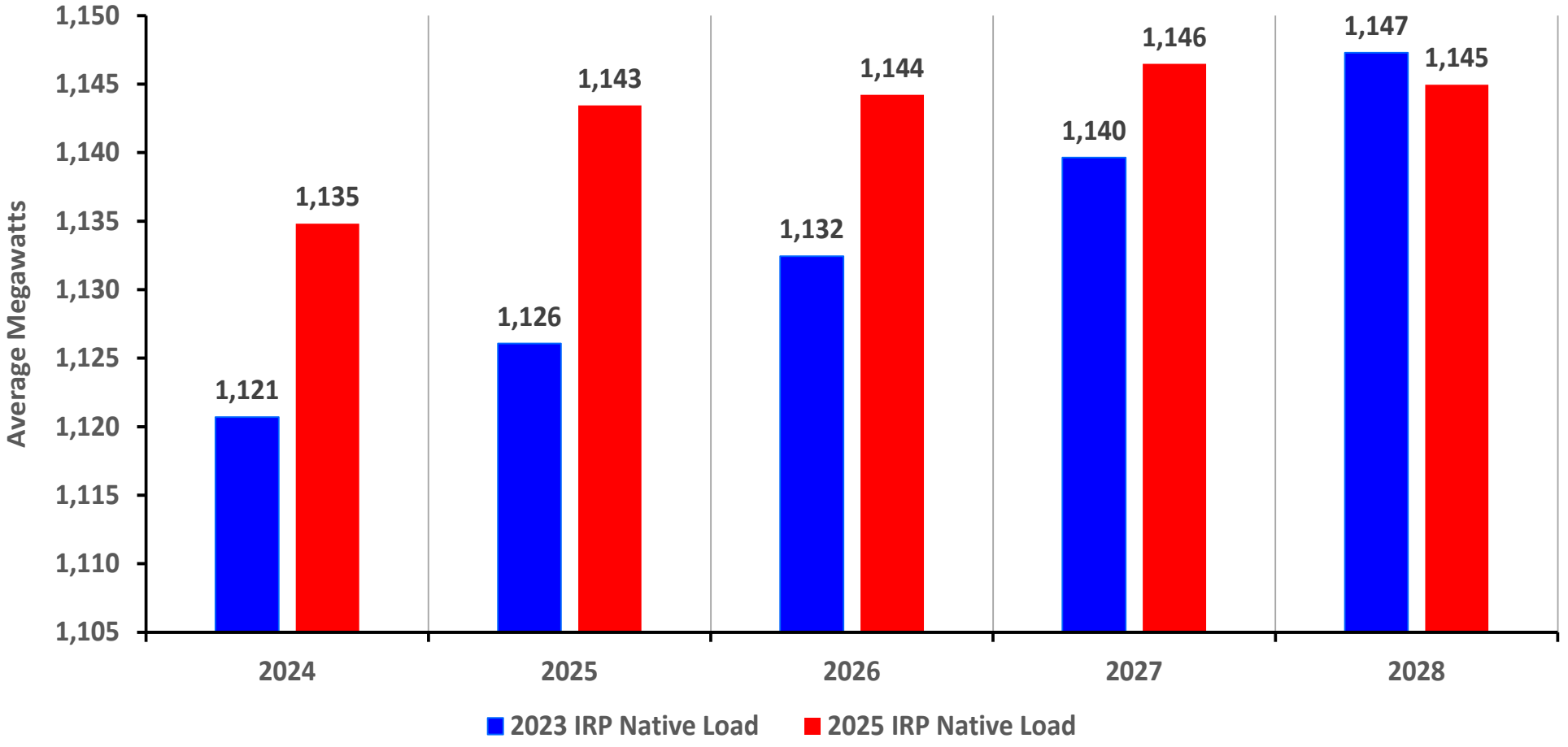
* Spring 2022 forecast in 2023 IRP

Comments

- From 2029 on, the time-path reflects S&P 500 Connect population forecasts.
- Average population growth is a proxy for customer growth.

Source: BEA, U.S. Census, S&P 500 Connect, and author's calculations.

Medium-Term Energy Forecast: Native Load



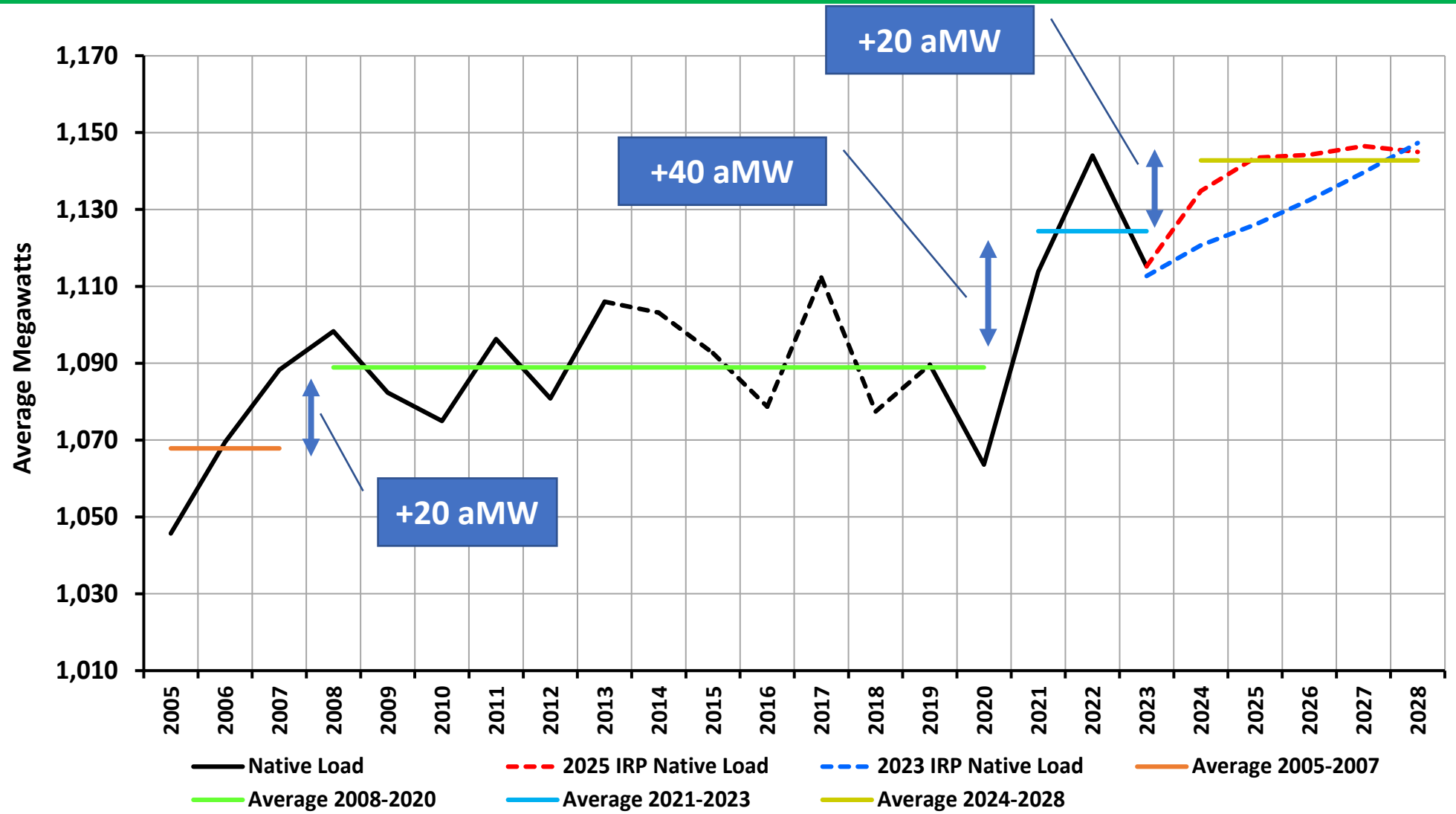
IRP	Avg. Annual Growth, 2024-2028*
2023 IRP	0.59%
2025 IRP	0.22%

* Spring 2022 forecast in 2023 IRP

Comments

- The difference reflects a step up in residential UPC starting in 2022, forecasted declining gas penetration in WA, and higher forecasted industrial loads.
- No significant difference by 2028.

Medium-Term Energy Forecast: Native Load since 2005

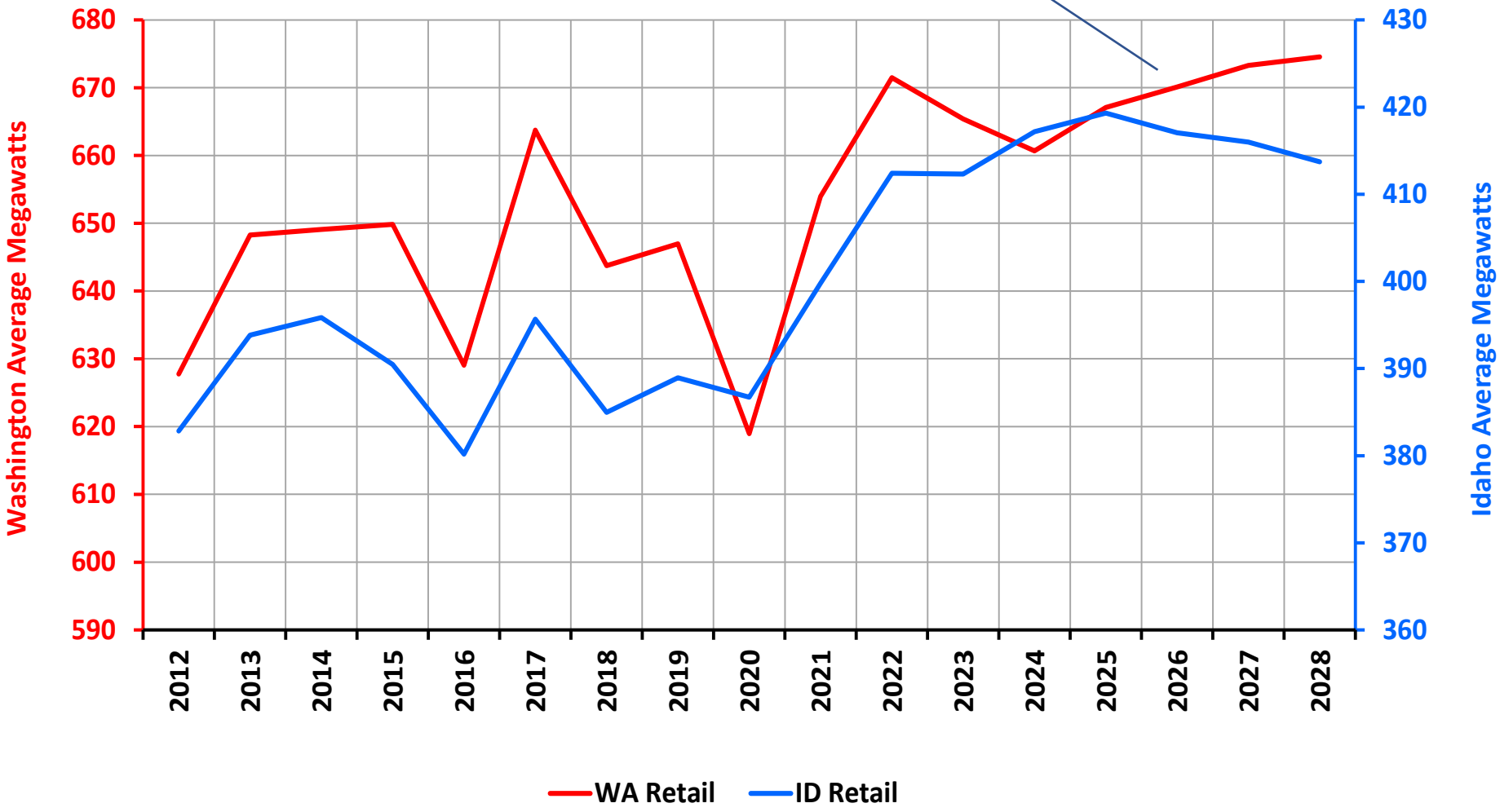


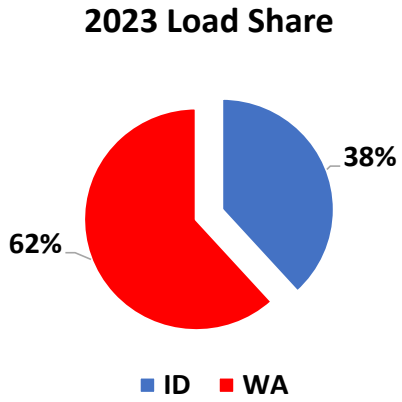
Comments

- Prior to 2021/2022, the housing bubble period was the last significant step up in native load.
- The hybrid work environment will have some permanence, but commercial buildings still need to be heated and cooled.
- Dashed black line reflects an adjustment for a specialized contract with a large customer with self-generation.

Medium-Term Retail Forecast: Washington vs. Idaho

WA forecast explicitly assumes residential gas penetration continues to fall. This generates a slightly different time-path in the forecast compared to ID





Questions?