Integrated Resource Planning

ROUNDTABLE 21-5

JULY 2021





MEETING LOGISTICS

Electronic version of presentation:

https://www.portlandgeneral.com/our-company/energy-strategy/resource-planning/integrated-resource-planning/irp-public-meetings

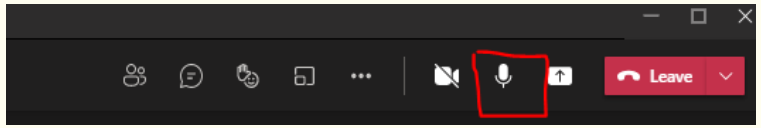
Teams Meeting

Please click the meeting link sent to your email or here:

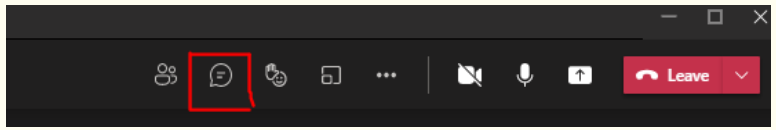
Join Microsoft Teams Meeting
+1 971-277-2317 (dial this number into your phone for best results)
PW: 515 538 239#
*Please use Microsoft Edge or Google Chrome with Teams as it will give you the best experience

PARTICIPATION

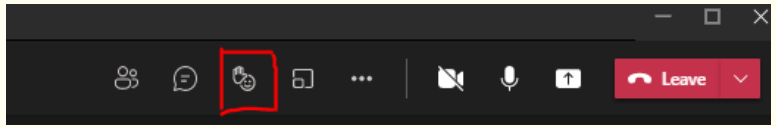
- Mute your mic while others are speaking; to unmute via phone press *6



- We will ask for comments and questions along the way
- Participate using the chat box or ask questions verbally



- Use the “raise hand” feature to signal you’d like to ask your question verbally



- Wait to be called on
- Please be polite and respect all participants on the webinar
- Please stay on topic; we may interrupt or shorten questions to meet the time commitment of the meeting

AGENDA

Welcome and introductions	15 minutes
Safety moment	5 minutes
Load Forecast	50 minutes
Portfolio requests from participants	5 minutes

SAFETY MOMENT

Firework safety

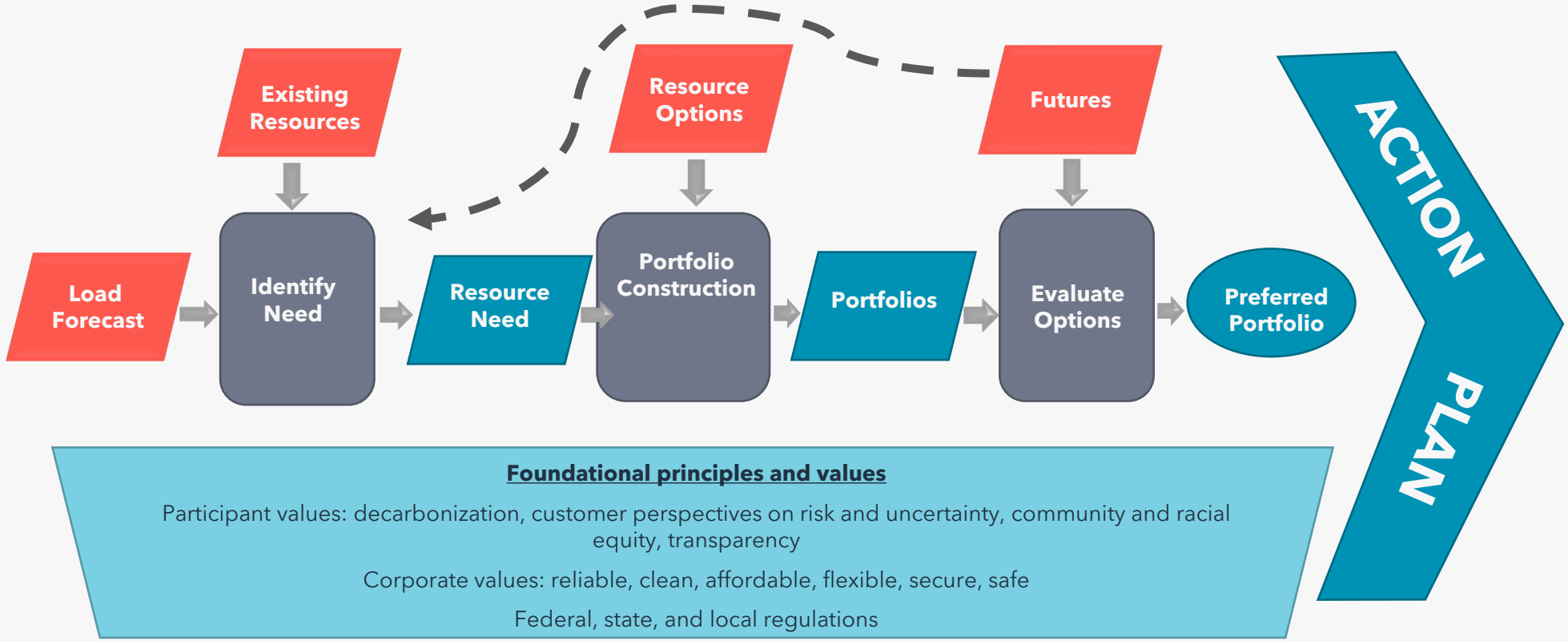
In July fireworks cause thousands of injuries that require medical treatment. 50% of injuries are to children and young adults.

Additionally, fireworks start an average of 18,500 fires each year

If you choose to use legal fireworks follow these tips:

- Never allow young children to use fireworks
- Older children should be closely supervised
- Never use fireworks while under the influence of alcohol or drugs
- Use protective eyewear
- Never point of throw fireworks at another person
- Only use fireworks outdoors
- Never use illegal fireworks
- Keep a bucket of water close by to soak used fireworks before discarding

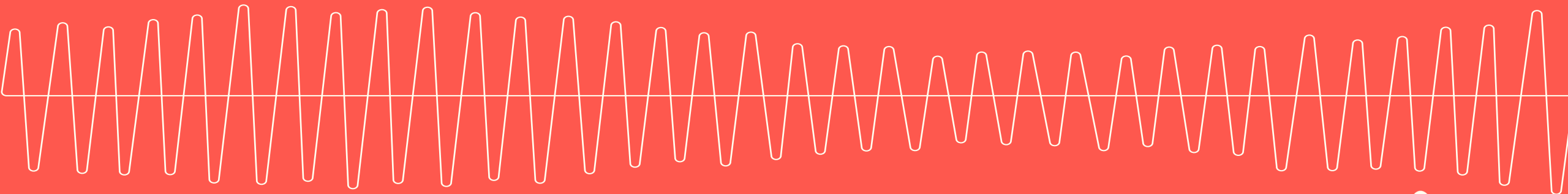
IRP ANALYSIS PROCESS



LOAD FORECAST

Amber Riter and Shannon Greene

ROUNDTABLE 21-5



LOAD FORECAST AGENDA

Introductions and Overview

Peak Modeling

Long Term Modeling

Uncertainty and Scenarios

LOAD FORECAST UPDATE

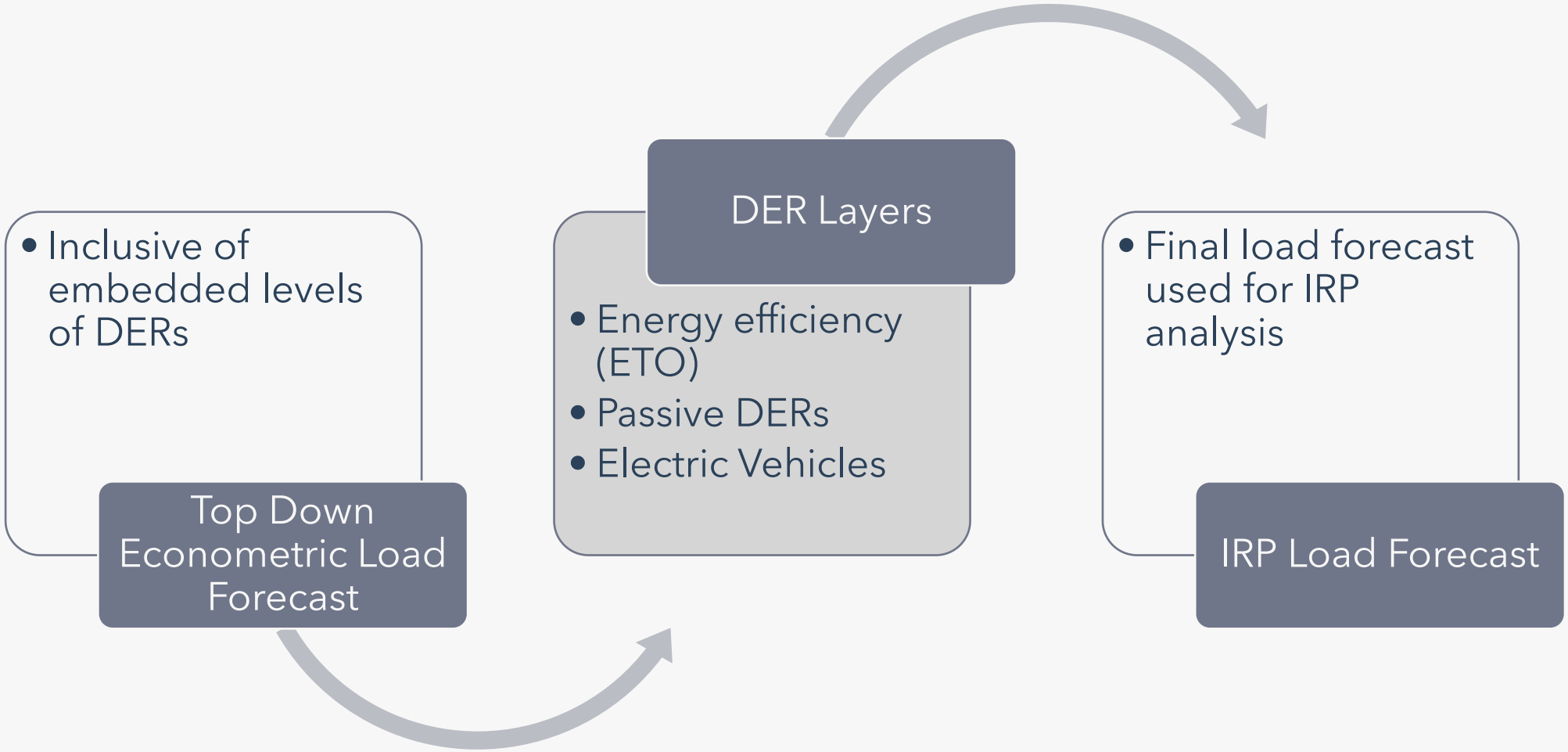
In October 2020, we provided an update on how COVID-19 was impacting energy deliveries and adjustments to the short-term load forecast models

Today, we provide:

- Preliminary long-term and peak demand models
- Analysis of alternative industrial drivers for the long-term models
- Benchmarking of peer utility drivers

Next update, we will provide the load forecast to be used in the 2022 IRP

PGE'S LOAD FORECAST MODEL



TOP-DOWN ECONOMETRIC LOAD FORECAST

Near Term (1-5 Years)

25 regression-based monthly energy deliveries models

Business cycle influences energy deliveries

Individual forecasts ~25 large customers

Explicitly removes incremental energy efficiency

Updated as frequently as every quarter

Long Term (5+ Years)

Convergence to long term growth rates, agnostic to business cycle and specific customer growth

Three aggregated customer class models

Assumes energy efficiency is embedded in growth rates

Growth rates are appended to near term model output

Updated annually, to support IRP

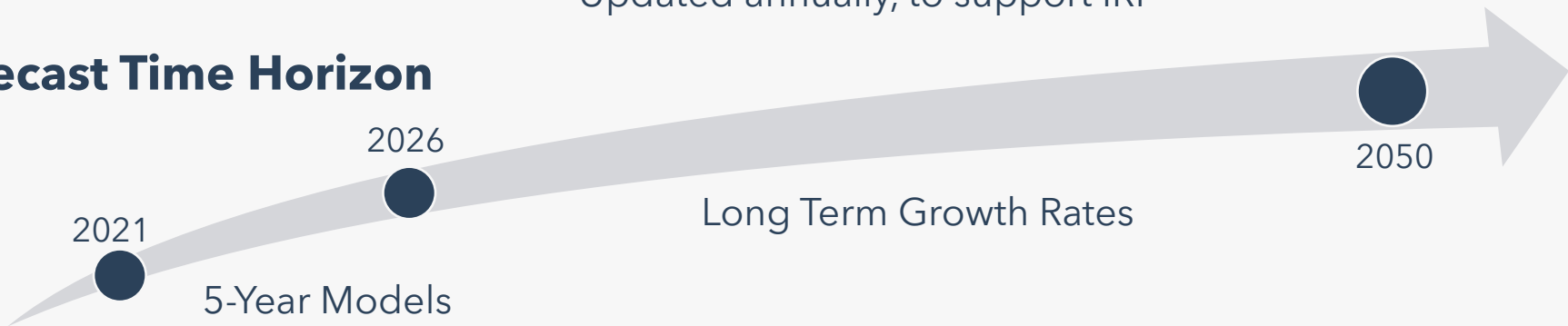
Peak Demand

Model spans full time horizon, near term and long term

Average energy is a model input

Updated annually

Forecast Time Horizon



ACCOUNTING FOR COVID-19

Primarily considered in the Near-Term model

- Include a set of binary variables reflecting shut down phases in the sector level models

Long-Term and Peak model

- Intended to be agnostic to business cycle
- Longer estimation periods used
- Similar binary control measures used where appropriate
- Outcome is long term growth rate

Long-term COVID-19 impacts

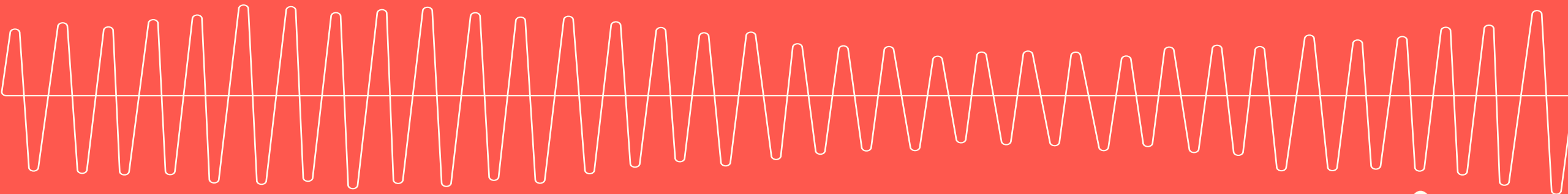
- Increase in UPC reflecting 1/3 work from home
- Based on employment recovery

ADDRESSING UNCERTAINTY

The load forecast centers around a **base case point estimate**. However, the IRP process captures uncertainty associated with load in several ways

- Near term forecast is updated more frequently
- Visuals in this presentation present model uncertainty based upon statistical confidence intervals
- Load forecast scenarios are developed based on varying economic inputs
  - We will gather feedback on these cases today
- Weather uncertainty is also considered in the IRP and is presented as a part of Sequoia analysis, not within the load forecast

PEAK DEMAND MODEL



HOW IS WEATHER CONSIDERED IN THE IRP?

Econometric Load Forecast

Input assumptions reflect 'normal' (or average) conditions

- For peak demand, our input assumption is based upon average conditions over 15 years
- For average monthly energy, our input assumption includes gradual warming

LOAD SIM

Simulation of how the base case load forecast changes due to different weather conditions using 30-years of historical, hourly, weather conditions

Planning to use for assessment of resource adequacy

Other

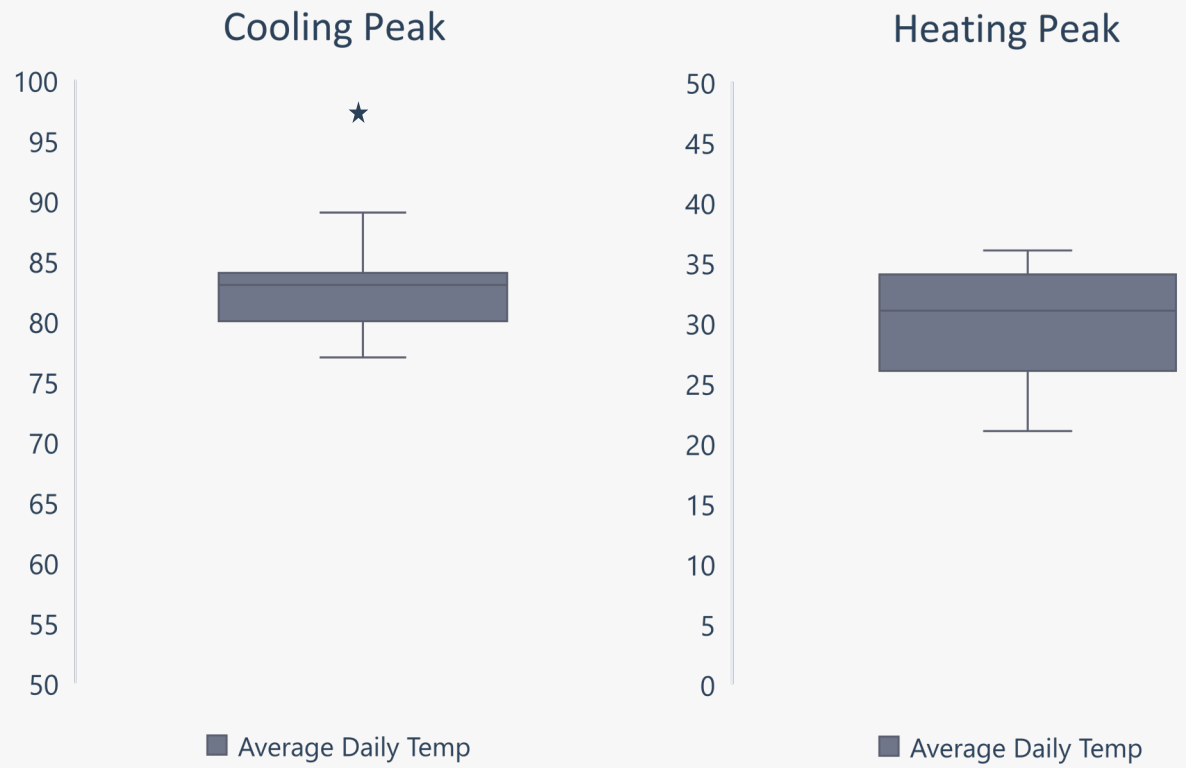
Resource Impacts

PEAK TEMPERATURE CONDITIONS

For the econometric forecast, the input assumption is based upon average conditions over 15 years

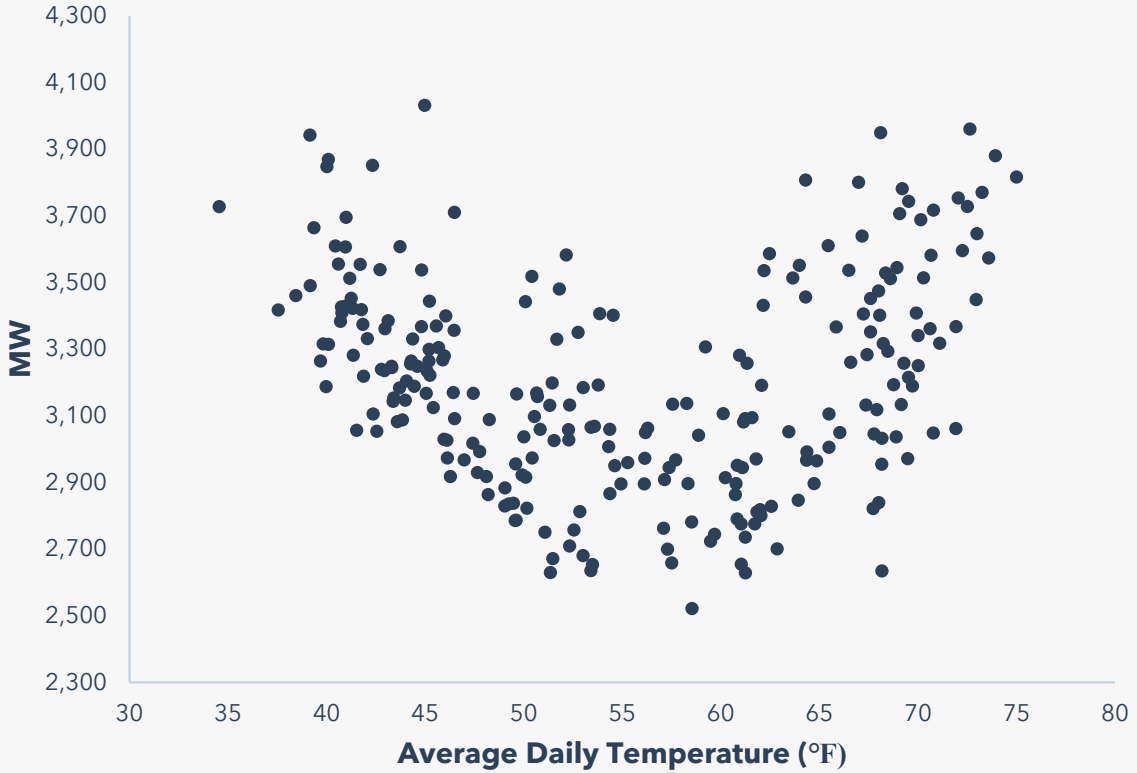
- Cooling peak daily average temp of 82 degrees
- Heating peak daily average temp of 29 degrees
- Most (statistically) likely to occur in August and December

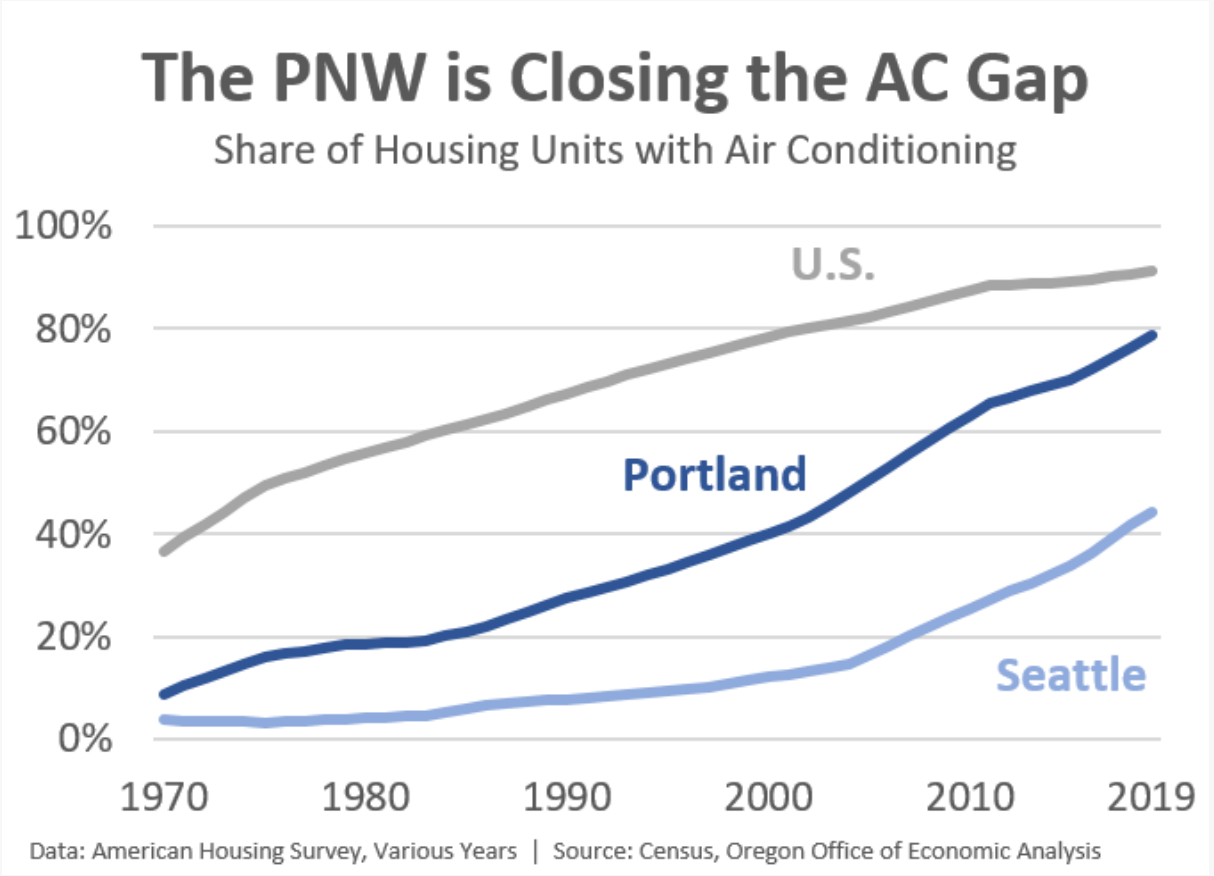
★ June 2021 extreme weather event shown with star, daily average temp of 96 degrees



DRIVERS OF PEAK DEMAND

Relationship between Peak Demand and Average Daily Temperature





*Oregon Office of Economic Analysis (OEA)

PRELIMINARY MODEL STRUCTURE

Estimation period: January 2000 – March 2021

Data frequency: Monthly Peak

Seasonal Models

- $Cooling\ Peak = fn(Peak\ Day\ CDD, Previous\ Day\ CDD, AC\ Saturation, Average\ Energy\ Usage, Monthly\ CDD, Monthly\ Trends)$
  - Back-cast Mean Average Percentage Error (MAPE): 1.99%
- $Heating\ Peak = fn(Peak\ Day\ HDD, Previous\ Day\ HDD, Peak\ Day\ Wind, Average\ Energy\ Usage, Monthly\ HDD, Monthly\ Trends)$
  - Back-cast MAPE: 1.94%

Stationarity – No difference needed

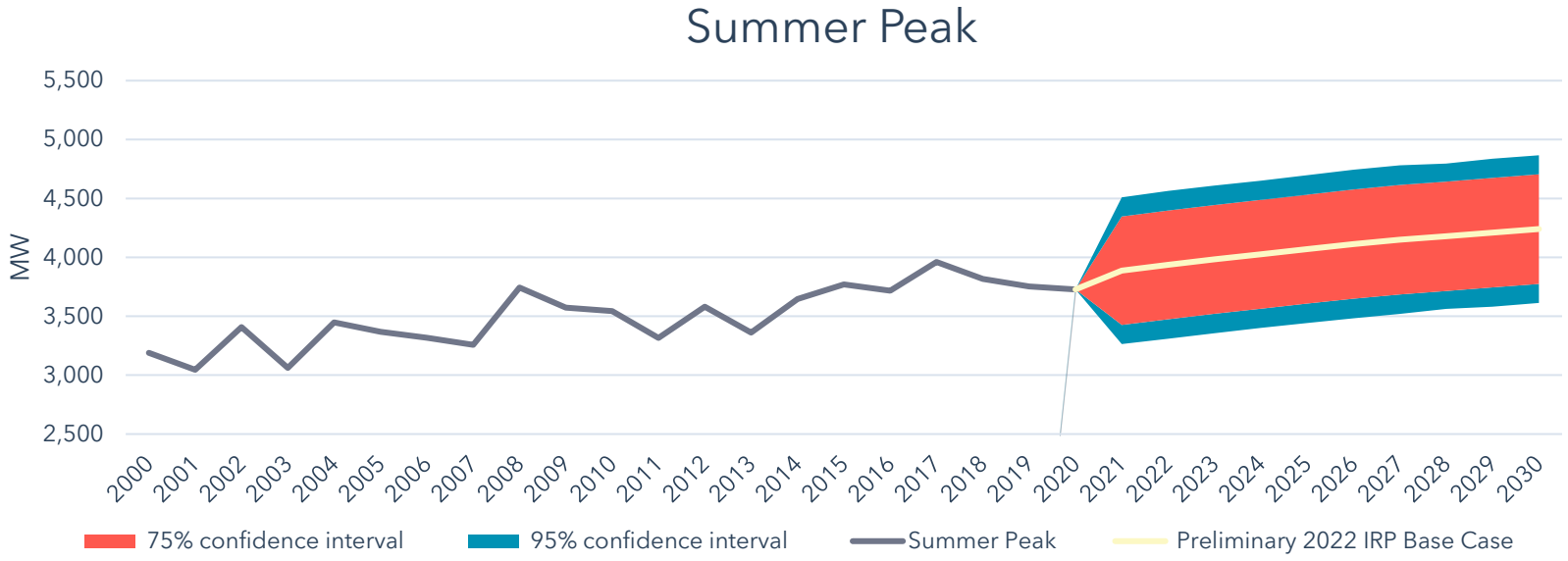
PRELIMINARY SEASONAL PEAK DEMAND MODEL

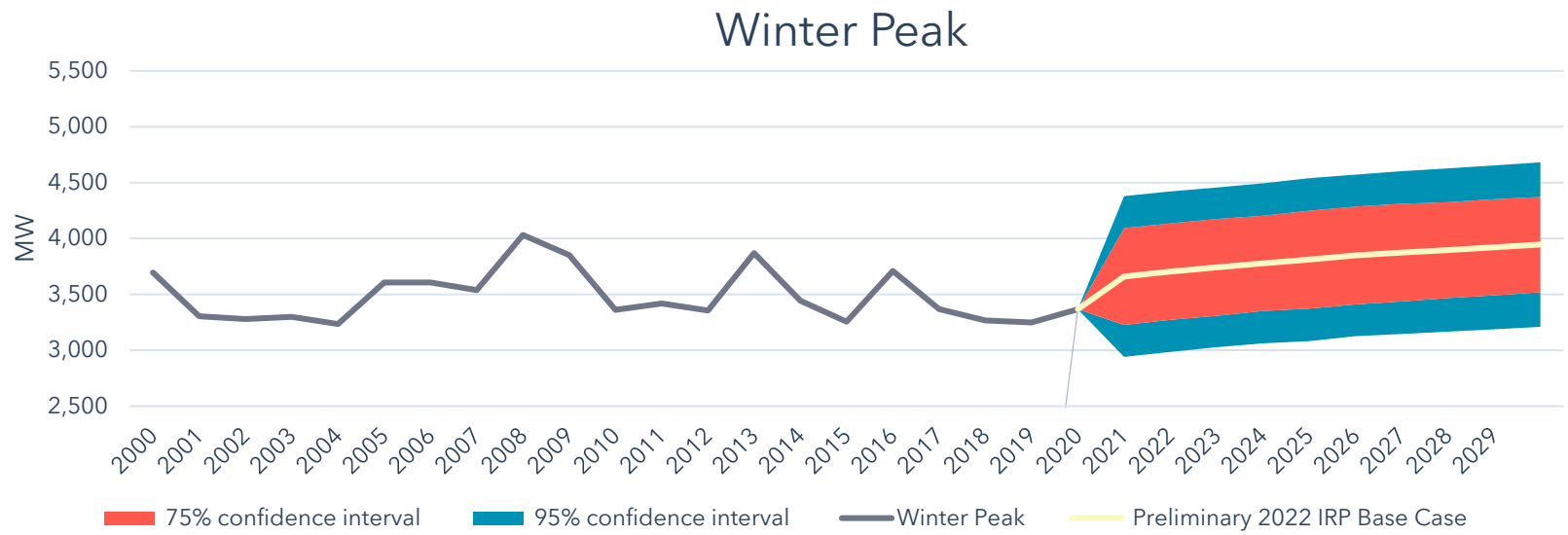
Est period: 2000 – 2021

Data frequency: Monthly

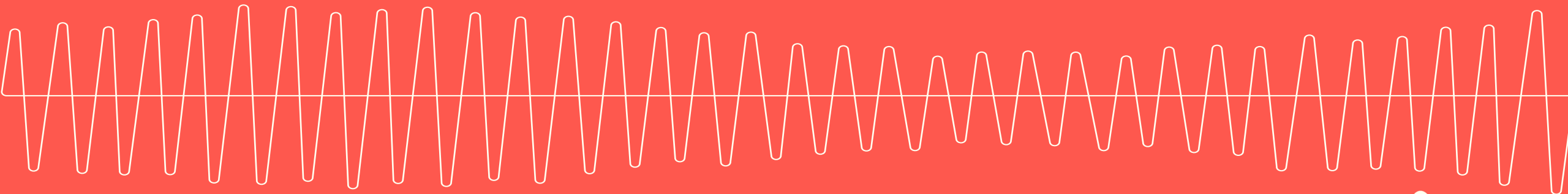
Average Growth Rate:

- Summer: 1.0%
- Winter: 0.8%





LONG TERM ENERGY MODEL



MODEL DEVELOPMENT

RESIDENTIAL

RESIDENTIAL CUSTOMER COUNTS

COMMERCIAL

INDUSTRIAL

Univariate Analysis

- Stationarity testing
  - If non-stationary, first differencing was implemented
    - Residential customer counts
    - Industrial usage

Drivers

- Drivers tested using correlation matrix and model fit

COVID-19

- Indicator variables were used to control for the impact of COVID-19 on energy usage

Statistical Parameters

- Review of model residuals and statistics to isolate top models (including Adj R^2, AIC, and DW)
- Back-casting to review performance

ECONOMIC DRIVERS BENCHMARKING

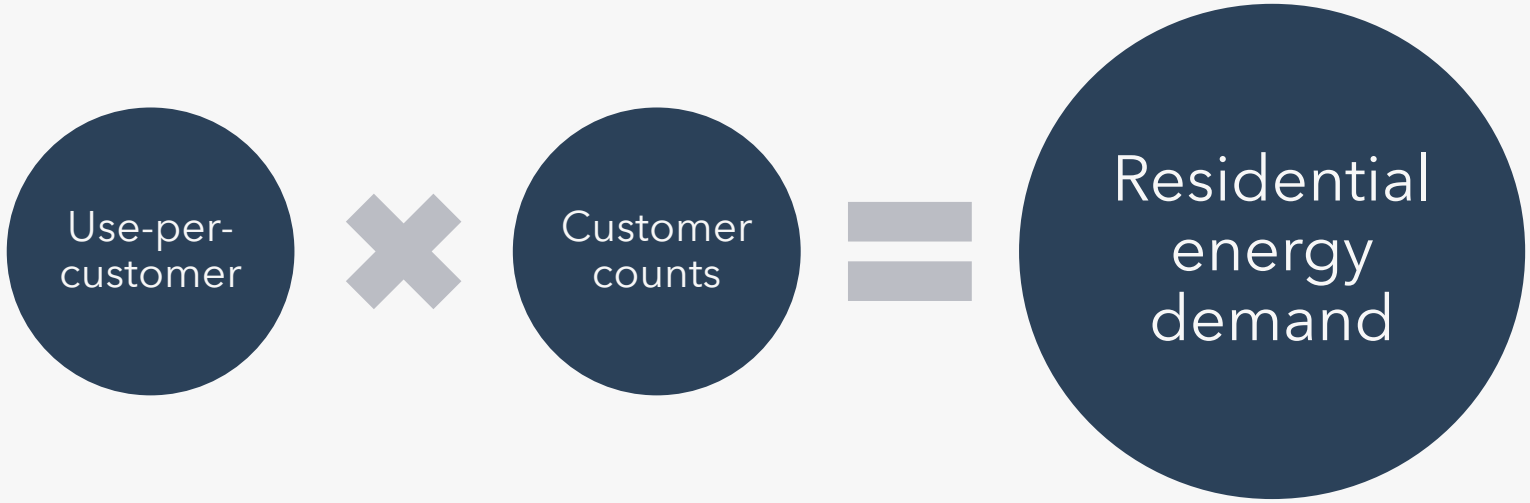
PGE conducted a survey of peer utilities asking what economic drivers were utilized in their long-term models, we received 8 responses, 4 of which have service areas in Oregon, Washington, or Idaho

Gathered a diverse set of drivers for PGE's testing

Economic Drivers	Residential	Non-Residential
Inflation or retail rates	X	X
Personal or HH Income	X	
Wage Earnings		X
Unemployment	X	X
Employment	X	X
Manufacturing Employment		X
Population	X	
Households	X	X
GDP (US)		X
Sector GDP (US)		X

RESIDENTIAL FORECAST STRUCTURE

The separation of use-per-customer and customer counts allows us to isolate competing trends: decreasing average usage and an increasing customer base



PRELIMINARY RESIDENTIAL MODEL

Use Per Customer

Estimation period: 2000 – 2020

Data frequency: Monthly

Stationarity – No difference needed

$UPC = fn(\text{HDD60}, \text{CDD65}, COVID\ Cycle, Monthly\ Controls, Monthly\ Trends)$

Back-cast MAPE: 1.8%

Residential Customer Count Model

Estimation period: 1980 – 2020

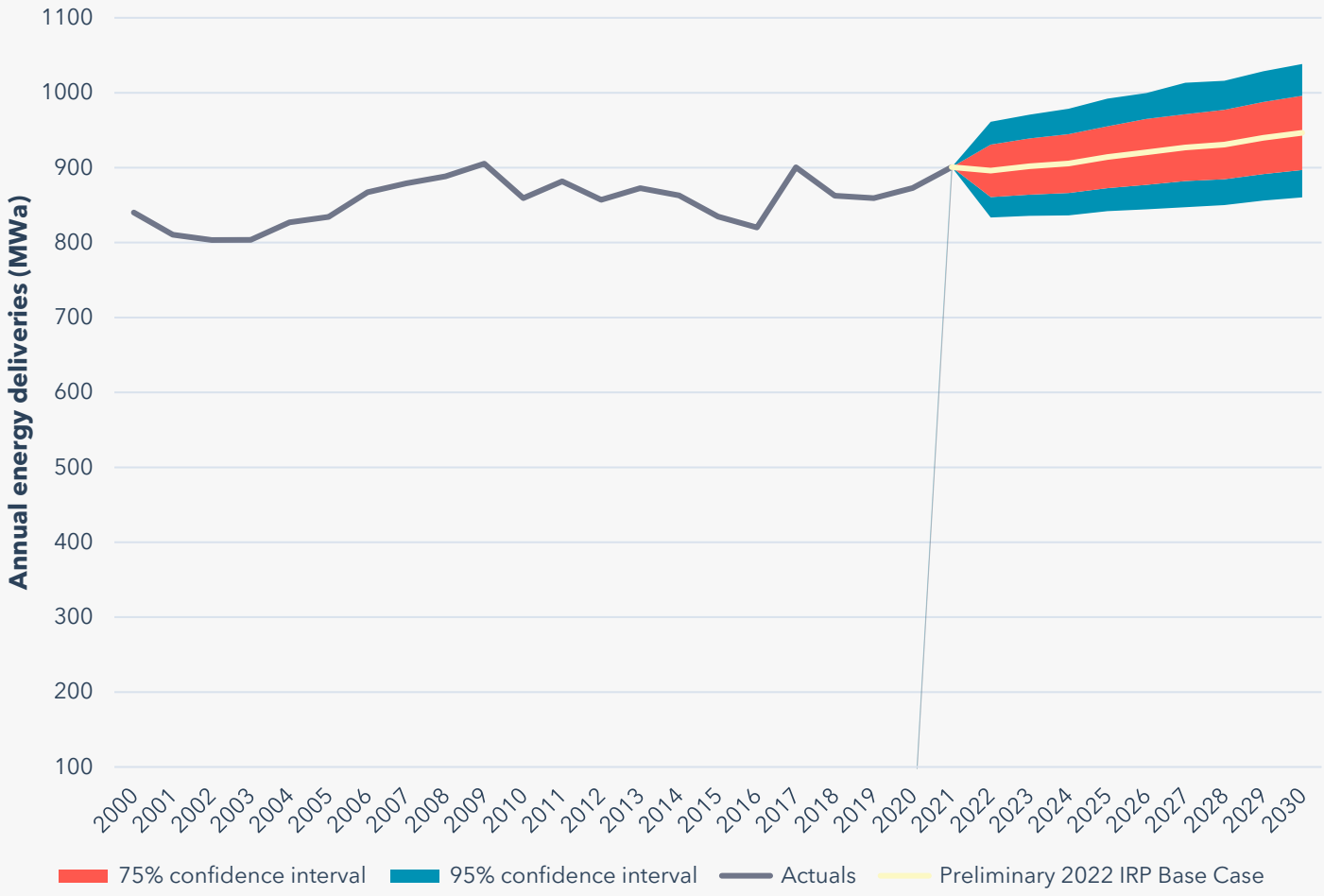
Data frequency: Annual

Non-Stationarity – First difference needed

$Customer_{t-1} = fn(Oregon\ Population_{t-1}))$

Back-cast MAPE: 2.0%

Average annual growth rate, 2023 – 2050 = 0.8%



PRELIMINARY COMMERCIAL MODEL

Estimation period: 2000 – 2020

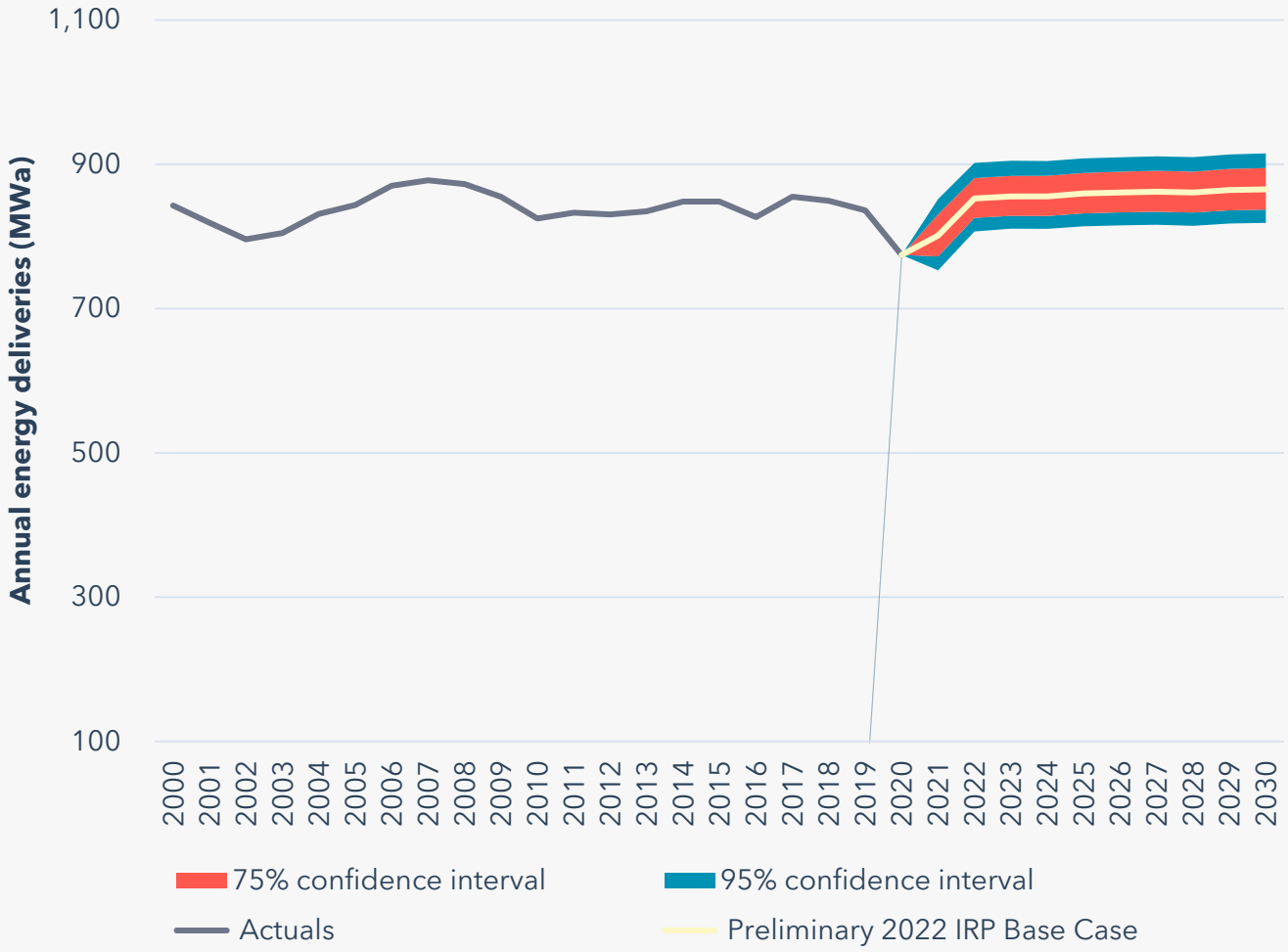
Data frequency: Monthly

Stationarity: Trend stationary, no difference needed

$ERC3 = fn(OR\ Employment, HDD50, CDD60, Covid\ Phase\ 1, Covid\ Phase\ 2, Month)$

Back-cast MAPE: 2.2%

Average annual growth rate, 2023 – 2050 = 0.2%



INDUSTRIAL DRIVER SELECTION

In previous years, PGE has included GDP in the long-term industrial model

- "How fast the economy grows, as measured by growth in gross domestic product (GDP), is a key determinant of growth in energy demand. "[1]

Stakeholders have recommended use of a local economic driver

For the 2022 IRP, PGE tested multiple economic variables from a new source, Woods and Poole (W&P) results are shown in the table

Selected Total Oregon Personal Income as a driver

Economic Driver	Coefficient	p-value	AIC	Adjusted R^2	Time Period
Total Oregon Income (W&P)	14.4	0.0000	24.742	0.3900	1980-2018
Oregon Mean Income (W&P)	20.0	0.0002	24.874	0.3037	1980-2018
US GDP (OEA)**	149.3	0.0068	25.062	0.1599	1980-2018
Non-Farm Oregon Employment (W&P)	699.6	0.0171	25.106	0.1210	1980-2018
Oregon GDP (W&P)	5.4	0.1272	25.310	0.0717	1980-2018
PGE GDP (W&P)***	11.2	0.0800	25.661	0.1279	1980-2018

* All models include a first difference, and no ARMA terms for testing
** Oregon Office of Economic Analysis (OEA)
*** Compiled from W&P county level forecast

[1]2018 AEO Assumptions

PRELIMINARY INDUSTRIAL MODEL

Estimation period: 1980 – 2018*

Data frequency: Annual

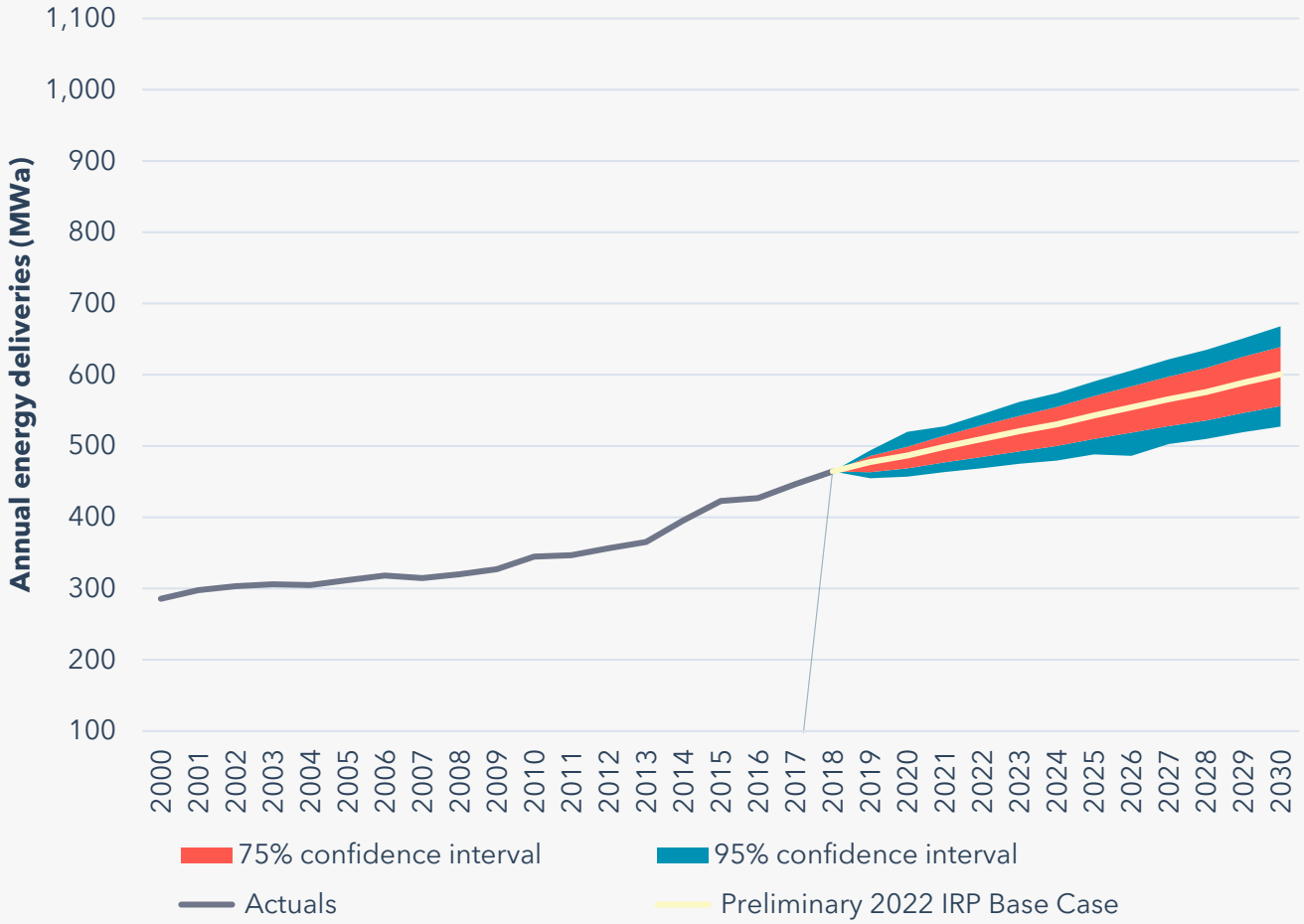
Non-Stationarity – First difference needed

$$ERC5_{t-1} = fn(\text{Oregon Total Income}_{t-1})$$

Back-cast MAPE: 8.6%

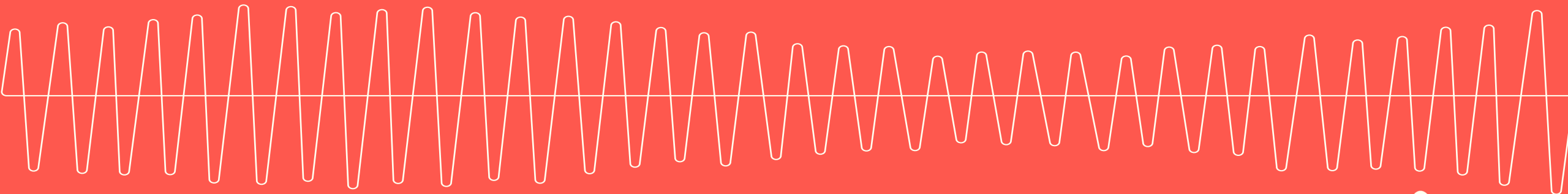
Average annual growth rate, 2023 – 2050 = 1.9%

* Through 2018 due to data constraints



Note: For the long-term model, Industrial is defined as Primary Voltage customers (Revenue Class 5) and does not include Sub-Transmission Voltage customers (Revenue Class 4) for which PGE assumes no long-term growth.

SCENARIOS



LOAD FORECAST SCENARIOS

Economic (Top-Down Load Forecast)

- Many economic forecast sensitivities are based on *near term outlook* and converge to a long-term equilibrium
- For the purpose of creating scenarios for load planning, we want to consider differences in the *long-term growth rates* for PGE's service area

Forecast 'Layers'

- DER scenarios are also used for creating varied resource need futures
    - Flexible Load
    - Rooftop PV & Battery
    - Electric Vehicles

2019 IRP

TABLE 3-1: Need Future variables

	Low Need Future	Reference Need	High Need Future
Top-down Load Forecast	Low Growth	Reference	High Growth
Energy Efficiency	High EE	Reference	Reference
Distributed PV	High Adoption	Reference	Low Adoption
EV + DLC_{EV}	Low Adoption	Reference	High Adoption
Demand Response	High Participation	Reference	Low Participation
Customer Battery Storage	High Adoption	Reference	Low Adoption
Market Capacity	High Availability	Reference	Low Availability

TABLE 4-1: Top-down load forecast scenarios

	Low Load	Reference Case	High Load
Economic Driver	Average annual growth rates (2020-2050)		
Population	0.4%	0.9%	1.4%
Employment*	0.0%	0.5%	1.2%
US GDP	1.6%	1.9%	2.5%
Model Uncertainty†	-1 SD	None	+1 SD

*Oregon total non-farm employment.

†Standard deviation (SD) including regression error and coefficient uncertainty.

2022 IRP DRAFT ECONOMIC INPUTS

Economic Inputs			
	Oregon Population Growth	**Oregon Non-Farm Employment Growth**	**Oregon Personal Income Growth**
Historical Annual Growth Rates (1990-2018)			
Annual Average	1.4%	1.5%	3.2%
Range	0.5% to 2.5%	-6.2% to 4.2%	-1.2% to 8.6%
Standard Deviation	0.5%	2.2%	2.6%
Forecast Average Annual Growth Rates (2023-2050)			
Forecast Source	OEA	OEA	W&P
Base case	0.8%	1.5%	1.4%
High growth	*1.8%*	*2.5%*	*2.4%*
Low growth	*-0.2%*	*0.5%*	*0.4%*

Looking for stakeholder conversation on selected scenarios

GENERATION PROVIDER

All load forecast modeling is at the net system level, regardless of direct access program participation

For the IRP:

- One-year opt outs are considered Cost-of-Service (COS) after the first year, reflecting their ability to return to COS rates with no notice
- Current long-term elections are assumed to remain on Direct Access schedules, reflecting the lead time needed to return to COS

Up to 300 MWa may opt out of PGE's cost-of-service rates to be served by an Electric Service Supplier (ESS) under the LTDA program. Additionally, 119 MWa may be served under the NLDA program

The 2022 IRP will also examine assumptions of direct access growth per Order 20-152

NEXT TIME…

Present Final 2022 IRP Peak and Long-Term Forecast

Questions? Feedback?

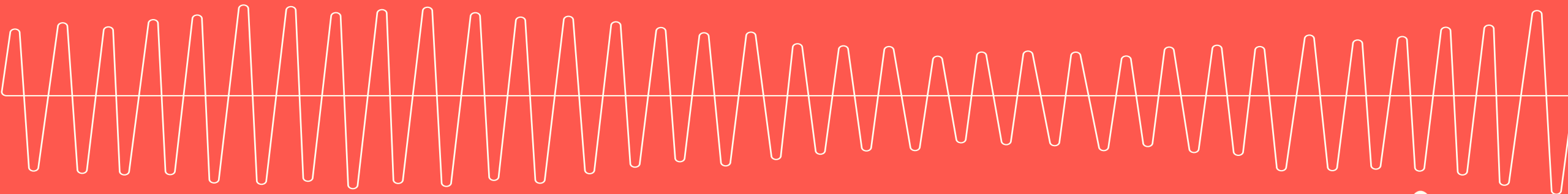
Email: IRP@pgn.com and direct your comment to load forecasting

QUESTIONS/DISCUSSION?

PORTFOLIO REQUESTS FROM PARTICIPANTS

SETH WIGGINS

ROUNDTABLE 21-3



PORTFOLIO REQUESTS

- Our portfolio optimization model ROSE-E has flexibility to evaluate any specific resource/size/year combination
  - ⓾ For example, we could estimate the portfolio effects of adding 235 MW of SE Washington wind in 2036 and/or 150 MW of 6-hr batteries in 2026
  - ⓾ In the 2019 IRP, we used this capability to evaluate the size and timing of 16 different renewable additions MW/year combinations

- We are open to any suggestions for portfolio questions to be evaluated
  - Please contact us (email: IRP@PGN.com)

QUESTIONS/DISCUSSION?

NEXT STEPS

Submit feedback by August 6

A recording from today's webinar will be available next week

THANK YOU

CONTACT US AT:
IRP@PGN.COM

ATTACHMENT A: ACRONYMS

Adj R2, AIC, DW: statistical parameters used to perform analysis

COS: cost of service

DER: distributed energy resources

ESS: electric service provider

ETO: Energy Trust of Oregon

GDP: gross domestic product

IRP: integrated resource plan

LTDA: long term direct access

LUCAS, ROM, PGE-zone, Sequoia, ROSE-E, and AURORA: models PGE uses for IRP analysis (see Appendix I: 2019 IRP Modeling Details from the 2019 IRP)

MWa: megawatt average

NLDA: new load direct access program

OEA: Oregon Office of Economic Analysis

SIM: simulation shorthand

UPC: use per customer

W&P: Woods and Poole