PGE CEP & IRP Roundtable 24-3

July 11th 2024

July 11th, 2024 – Agenda

9:00 – 9:05	Welcome | Meeting Logistics
9:05 – 9:30	Transmission Options
9:30 – 10:30	Load Forecast
10:30 – 10:50	Resource Economics Update
10:50 – 11:05	Small Scale Renewables
11:05 – 11:25	ROSE-E Changes
11:25 – 11:30	Closing Remarks | Next Steps

Meeting Details

1

Electronic version of presentation

https://portlandgeneral.com/about/who-we-are/resource-planning/combined-cep-and-irp/combined-cep-irp-public-meetings

2

Zoom meeting details

- Join Zoom Meeting https://us06web.zoom.us/j/84391255924?pwd=RDQ2VFpUZERVSEcraU5CZWw3VDhQZz09
- Meeting ID: 843 9125 5924
  Passcode: 108198

3

Participation

- Use the raise hand feature to let us know you have a question
- Unmute with microphone icon or *6 on phones

Meeting Logistics

Focus on Learning & Understanding

- There will be no chat feature during the meeting to streamline taking feedback
- Team members will take clarifying questions during the presentation, substantive questions will be saved for the end (time permitting)
- Attendees are encouraged to 'raise' their hand to ask questions

Follow Up

If we don't have time to cover all questions, we will rely on the CEP/IRP feedback form

Transmission Options

Laura Green, PGE

Seth Wiggins, PGE

2023 CEP/IRP Transmission Limitations

Previous PGE IRPs only incorporated zonal transfers and wheeling costs in price forecasting and portfolio analysis, respectively

The 2023 CEP/IRP's portfolio analysis was limited by the contractual transmission system

Resources from the PNW (CV solar, Gorge wind, etc.) were only available to be added if there were available transmission through BPA's system (more on this shortly)

The capacity expansion model was also able to select additional resources beyond the PNW with added costs and benefits associated with transmission expansion

E.g. NV solar, WY wind

2023 CEP/IRP Transmission Limitations

PGE's geography necessitated an analysis requiring three components:

1. A characterization of the existing transmission system

How much transmission capacity is available to PGE today?

2. A characterization of the future transmission system

How much transmission capacity will be available to PGE when expected upgrades are made?

3. A description of actions PGE can take in increase transmission capacity

What can PGE do to bring more transmission capacity?

2023 CEP/IRP Transmission Limitations

PGE's geography necessitated an analysis requiring three components:

1. A characterization of the existing transmission system [Discussed today]

How much transmission capacity is available to PGE today?

2. A characterization of the future transmission system [Future roundtable]

How much transmission capacity will be available to PGE when expected upgrades are made?

3. A description of actions PGE can take in increase transmission capacity [Future roundtable]

What can PGE do to bring more transmission capacity?

2023 CEP/IRP Transmission Limitations

PGE's geography necessitated an analysis requiring three components:

A characterization of the existing transmission system [Discussed today]

How much transmission capacity is available to PGE today?

In the 2023 CEP/IRP, PGE extrapolated from Transmission Service Requests (TSRs) in BPA's previous four TSR study and expansion process (TSEPs) to estimate this transmission capacity in each resource zone

We are following that method and presenting updated results here

Table 129. Transmission ATC by Resource Zone

Resource Zone	LTF	CF	Total
Christmas Valley	490	510	1000
Gorge	190	388	578
McMinnville	10	0	10
Montana	0	0	0
Offshore	0	80	80
SE Washington	0	150	150
Total	690	1128	1818

ATC Available transfer capability
LTF Long-term firm
CF Conditional firm

Assumptions

Data pulled as of 6.20.2024

Queried Transmission Services Requests (TSR) with a status of Received, Study and Confirmed.

Request type: Originals and Redirects

Start date: 8.20.2022 which was the close of the 2023 Cluster Study through 8.15.2024, the close of the 2025 Cluster Study.

Those Long-Term Point to Point (PTP) TSRs in a study status and requesting NewPoint, you cannot see their sink, however their Point of Delivery (POD) is BPAT.PGE

Through BPA's Evolving Grid projects, BPAT's system is likely to expand; however, it is hard to predict how many requests will follow through to energization.

2024 IRP OASIS pull of TSRs with a POD of BPAT.PGE

PGE

IRP Zone	Long Term Firm	Conditional Firm	Total
Christmas Valley	3	*	
Gorge	875	*	
McMinnville	80	*	
Montana	280	*	
Offshore	80	*	
Southeast Washington	0	*	
Wasco	76	*	
Total	**1394**	**1,360**	**2,754**

*NewPoint TSRs are under study and masked. Therefore, IRP Zones are not available

OASIS - Open Access Same Time Information System
POD – Point of Delivery
TSR – Transmission Services Request

2024 Summary

An overall increase from the last IRP by 936 MWs

LTF increased by 704

CF increased by 232

Load Forecast

Amber Riter and Shannon Greene, PGE

Load Forecast Update

In last summer's CEP/IRP Addendum, we presented an updated load forecast based on the June 2023 load forecast

Rapid evolution in industrial demand created a large change in the forecast and brought to light the need for long-term load forecast methodology to better capture large projects

Today we will present an updated load forecast which aligns the reference case with the latest load trends

- Recent load growth trends
- Methodological updates
- Results
- High and low load futures

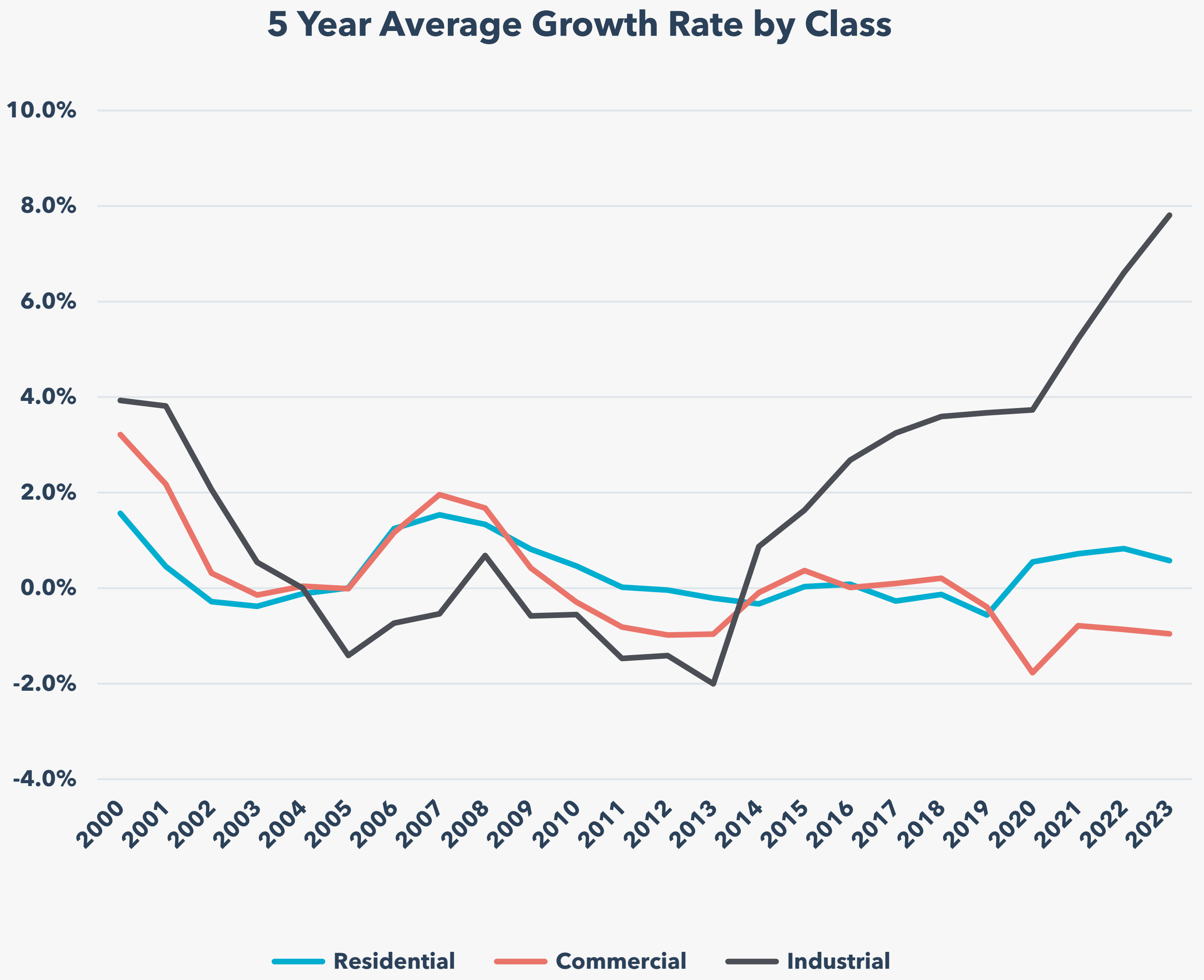
Recent Trends – Energy Deliveries

During peak work from home years, energy usage moved from the workplace to the home

This trend has largely normalized

An acceleration of industrial growth has occurred in recent years

This is expected to continue as Oregon's semiconductor industry grows and data center demand from cloud and AI uses expands

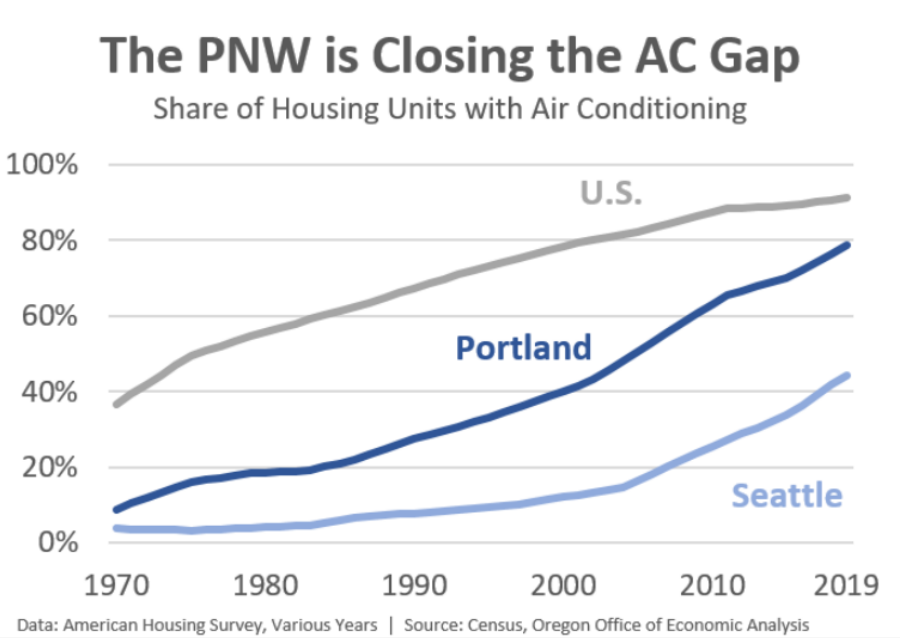


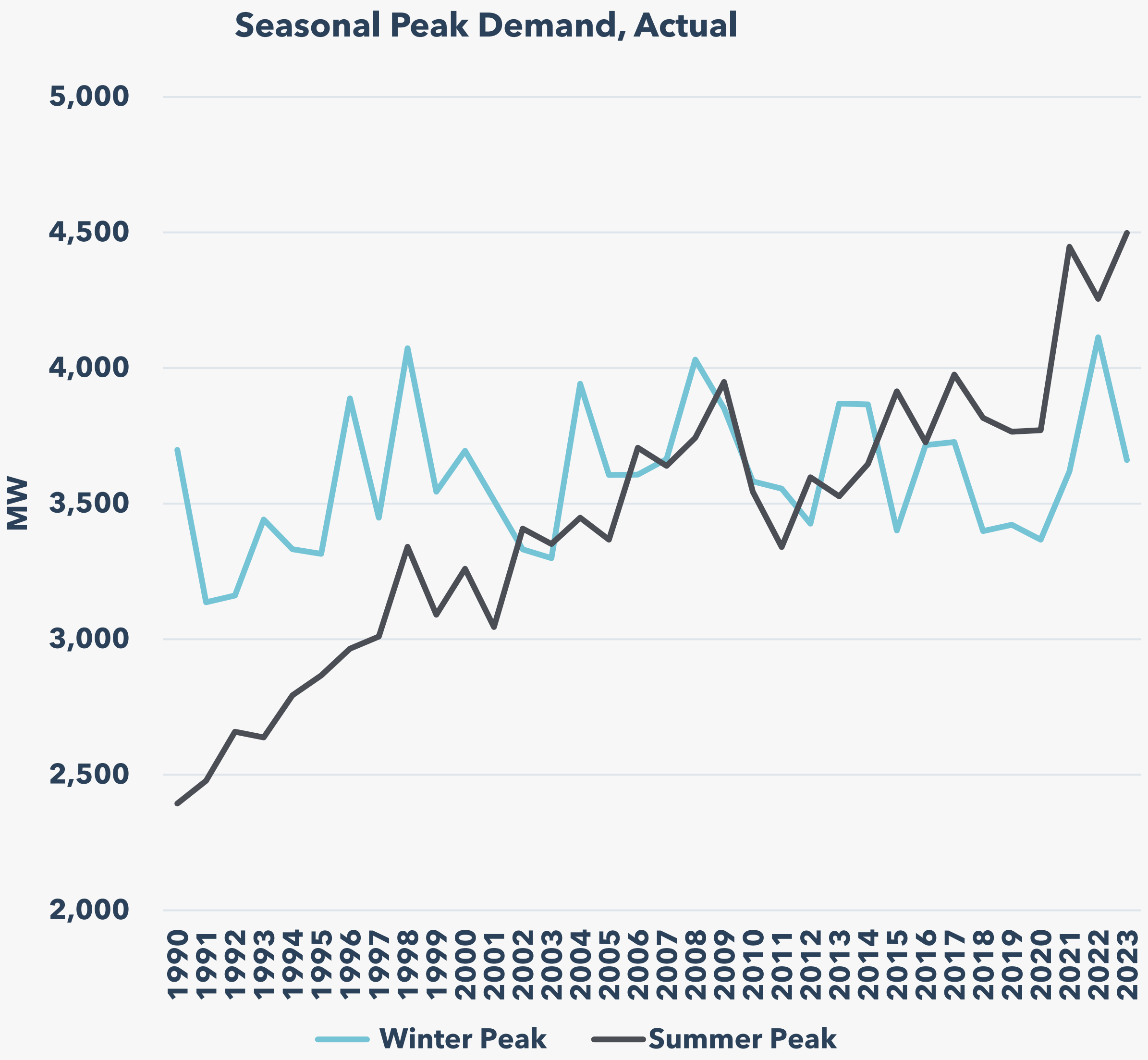
Recent Trends - Peak Demand

PGE's system has been experiencing increasing summer cooling for several decades

This trend has accelerated over the last few years with increased AC saturation and utilization

- Increase in work from home
- Wildfire smoke events in 2020
- Extreme heat events, including the 2021 heat dome





PGE's Load Forecast Model

Today's focus

Forecast is based on historical data, inclusive of historical trends, energy efficiency and embedded levels of DER's

Top-Down Econometric Load Forecast

DER Layers

AdopDER Model

Account for incremental (or new) loads associated with market driven DER adoption (including electrification and rooftop solar)

More detail from future roundtable

Final load forecast used for IRP analysis

Load Forecast

DER – Distributed Energy Resource

Energy Deliveries Model
Overview

Based on historical, monthly billing data

- Updated 2-4 times per year
- 3 sets of residential equations based on average usage and customer count
- 6 regression equations based on monthly energy deliveries by rate schedule
- Individual forecasts for large customers

Changes in Method

5-year model has been extended to the full forecast horizon

+ consistency across model	+ ability to capture more information about large load additions

Energy Deliveries Model
Residential Models

Estimation Period: UPC 2011-2024, Count 2000-2024,
Building Permits 2010-2024

Data Frequency and source: Monthly, billing data

Grouping: Dwelling type

Model Type: ARIMA

Input Assumptions: Normal weather, including warming trend

UPC =	fn (HDD, CDD, wind, energy efficiency, monthly indicators, COVID indicator)
Count =	fn (Building Permits, monthly indicators, control indicators)
Building Permits =	fn (Housing starts, construction employment, monthly indicators, control indicators)

Heating and cooling degree days

Housing Starts

Energy Efficiency Forecast

Indicator Variables (Covid, monthly)

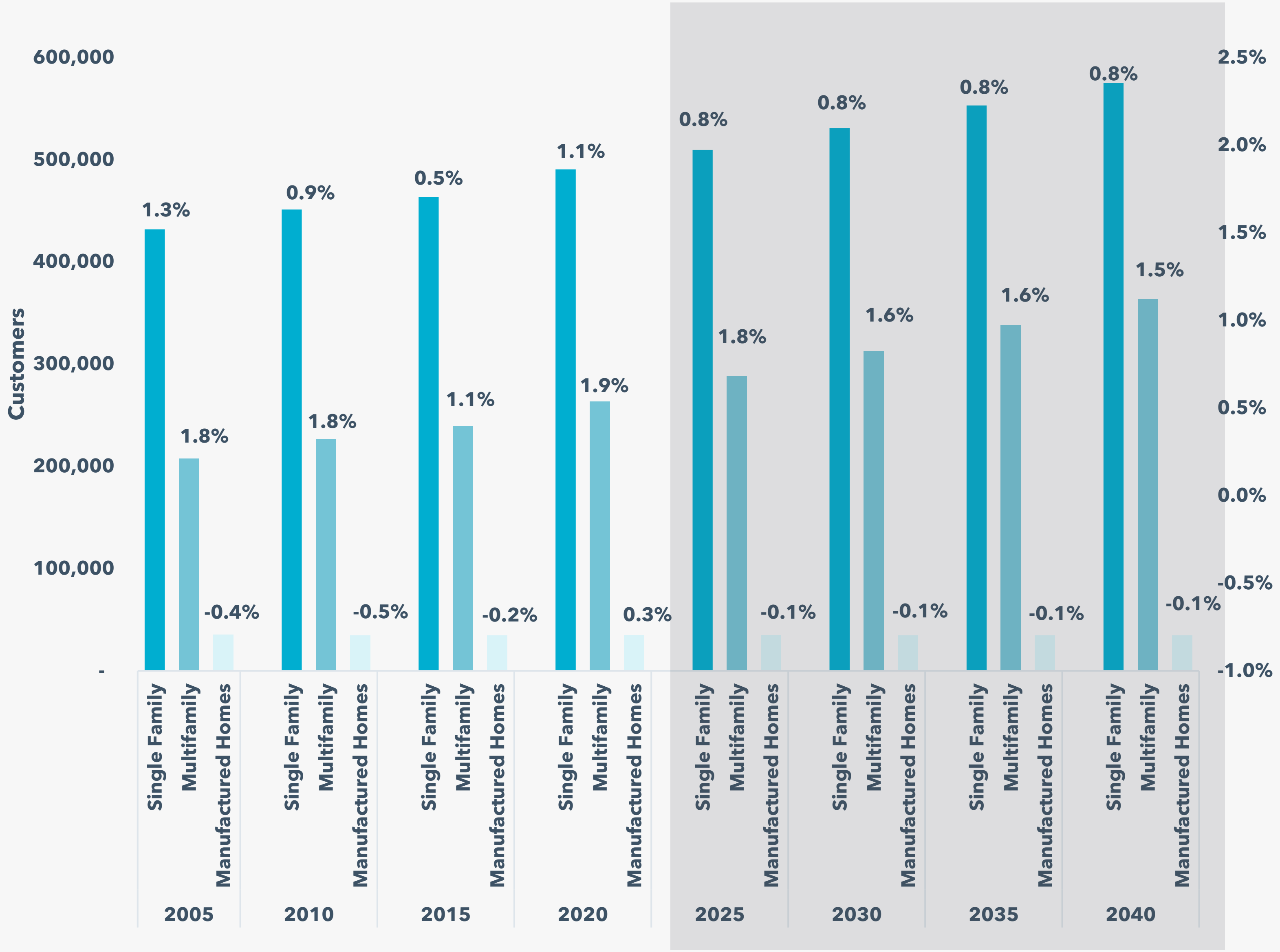
ARIMA: autoregressive integrated moving average
CCD: Cooling Degree Day
HDD: Heating Degree Day
UPC: Usage Per Customer

Residential Customer Forecast

PGE

Historically, the majority of PGE's residential customer have been single family (currently ~60%)

- The multifamily sector has been growing rapidly over the last two decades
- This trend is expected to continue in the forecast period



Energy Deliveries Model
Non-Residential Rate Schedule Models

Estimation Period: 2011-2024

Data Frequency and source: Monthly, billing data

Grouping: Rate Schedule

Model Type: ARIMA

Input Assumptions: Normal weather, including warming trend

- Heating and cooling degree days
- Oregon Employment
- Energy Efficiency Forecast
- Indicator Variables (Covid, monthly)

Usage = fn (HDD, CDD, energy efficiency, employment, monthly indicators, control indicators)

ARIMA: Autoregressive Integrated Moving Average
CCD: Cooling Degree Day
HDD: Heating Degree Day

Energy Deliveries Model
Non-Residential Large Load

Individual customer forecasts for approximately 30 large customers, 24% of 2023 system deliveries

- Focus on large sites with high energy intensity
- Usage is less tied to regional economic indicators
- Can experience stepwise changes in operations

Customer requests

Historic load ramp and comparison to like customer

Segment level industry reports

Company credit review

Acceleration of Semiconductor and Data Center Segments

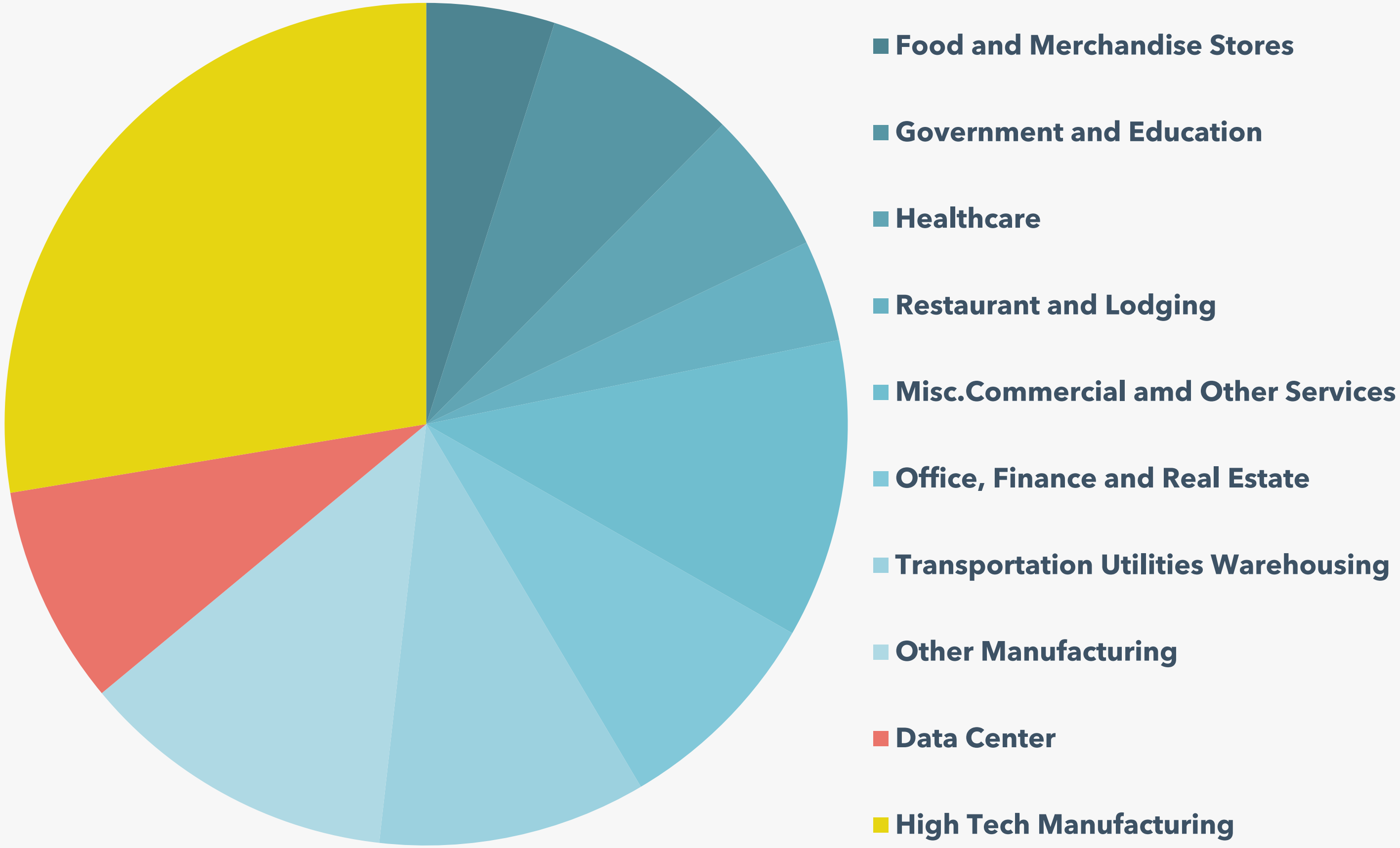
The Oregon CHIPS Program allocates up to $240M to Oregon semiconductor manufacturers applying for federal CHIPS Act dollars

In March, Intel announced its plans to spend $36B to modernize and expand in Oregon

Hillsboro continues to be a desirable location for data center developers

CBRE* reports 262.4 MW Inventory and 280.8 MW Under Construction in 2023

Share of 2023 C&I Energy Deliveries



*https://www.cbre.com/insights/reports/north-america-data-center-trends-h2-2023

Energy Deliveries Model
Resulting Forecast

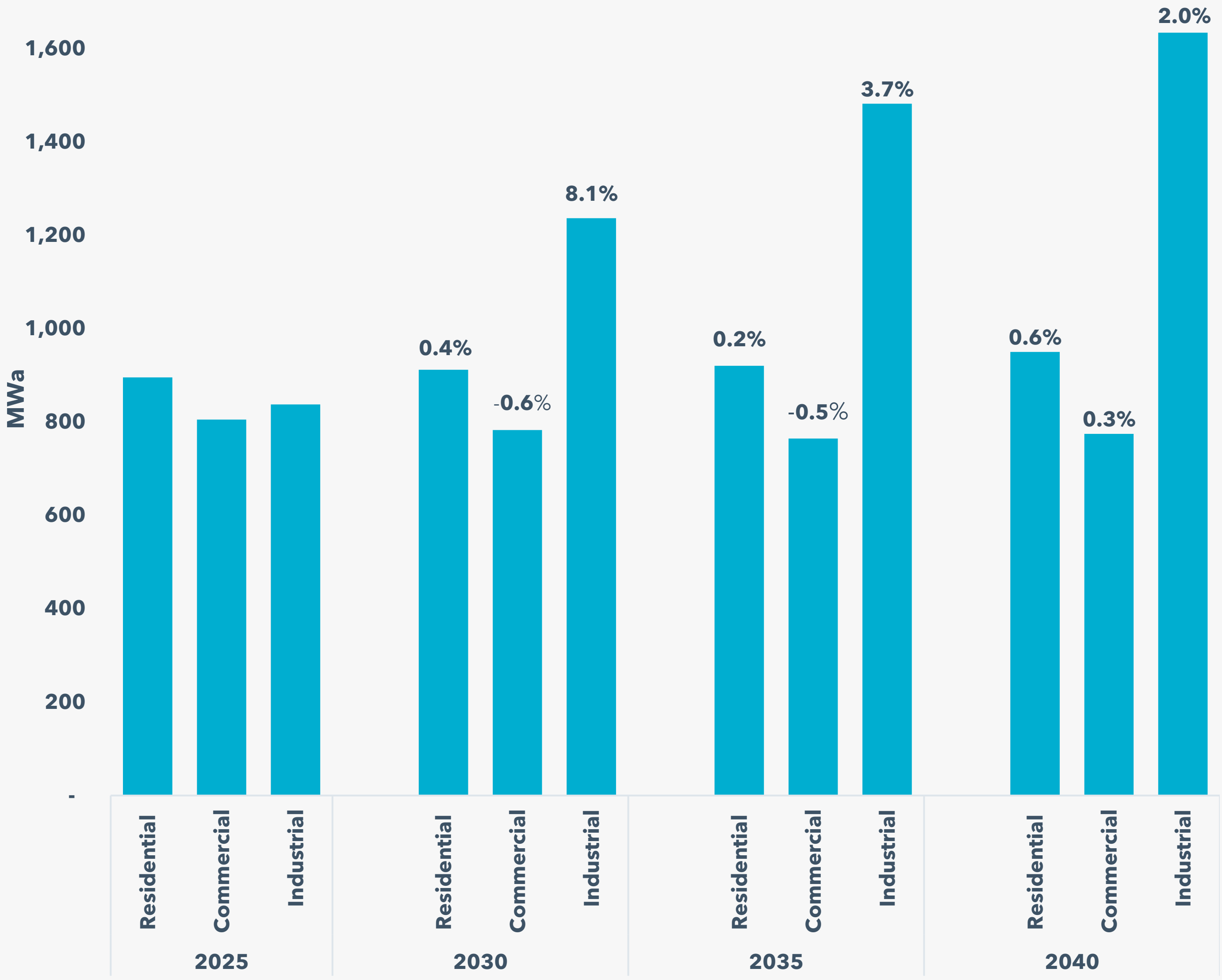
Average 20 Year Growth Rate: 1.9%

Excluding the impact of Rooftop Solar, Transportation and Building Electrification

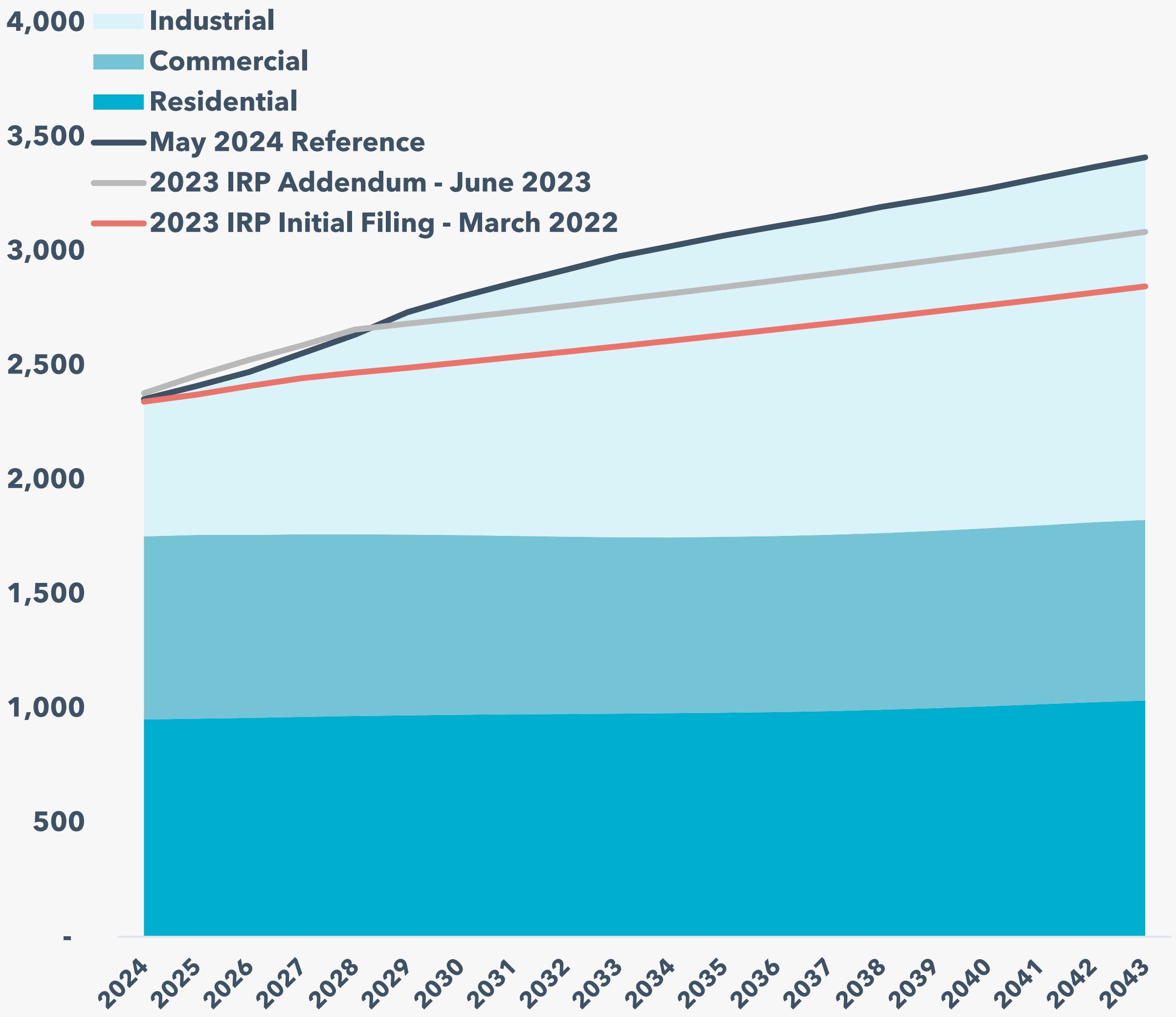
The residential and commercial sectors are expected to remain relatively flat, with energy efficiency offsetting customer growth

The **industrial** sector is expected to continue to **grow rapidly**, driven primarily by data centers and semiconductor manufacturing

The industrial segment **quickly outsizes** residential and commercial segments



Comparison to 2023 CEP/IRP - Energy



20 Year Average Annual Growth Rates			
	2023 CEP/IRP (March 2022)	2023 CEP/IRP Addendum (June 23)	May 2024 Reference
Total Energy	1.2%	1.6%	1.9%
Residential	0.5%	0.6%	0.4%
Commercial	0.0%	0.0%	-0.1%
Industrial	3.5%	3.9%	5.1%

Peak Demand Model
Specification

Estimation Period: 2019-2023

Data Frequency and source: hourly, load research

Grouping: Customer Class

Model Type: Fixed Effect

Input Assumptions: Scale to energy forecast

Hourly Usage = fn (CDD, CDD build up, HDD, HDD build up, wind, solar capacity, trend, indicator variables)

- Heating and cooling degree days, and other weather
- Solar capacity
- Trend
- Indicator Variables (Covid, monthly, DOW, extreme events)

CCD: Cooling Degree Day
HDD: Heating Degree Day

Peak Demand Model
Simulation Approach

Simulation approach to create a peak demand forecast

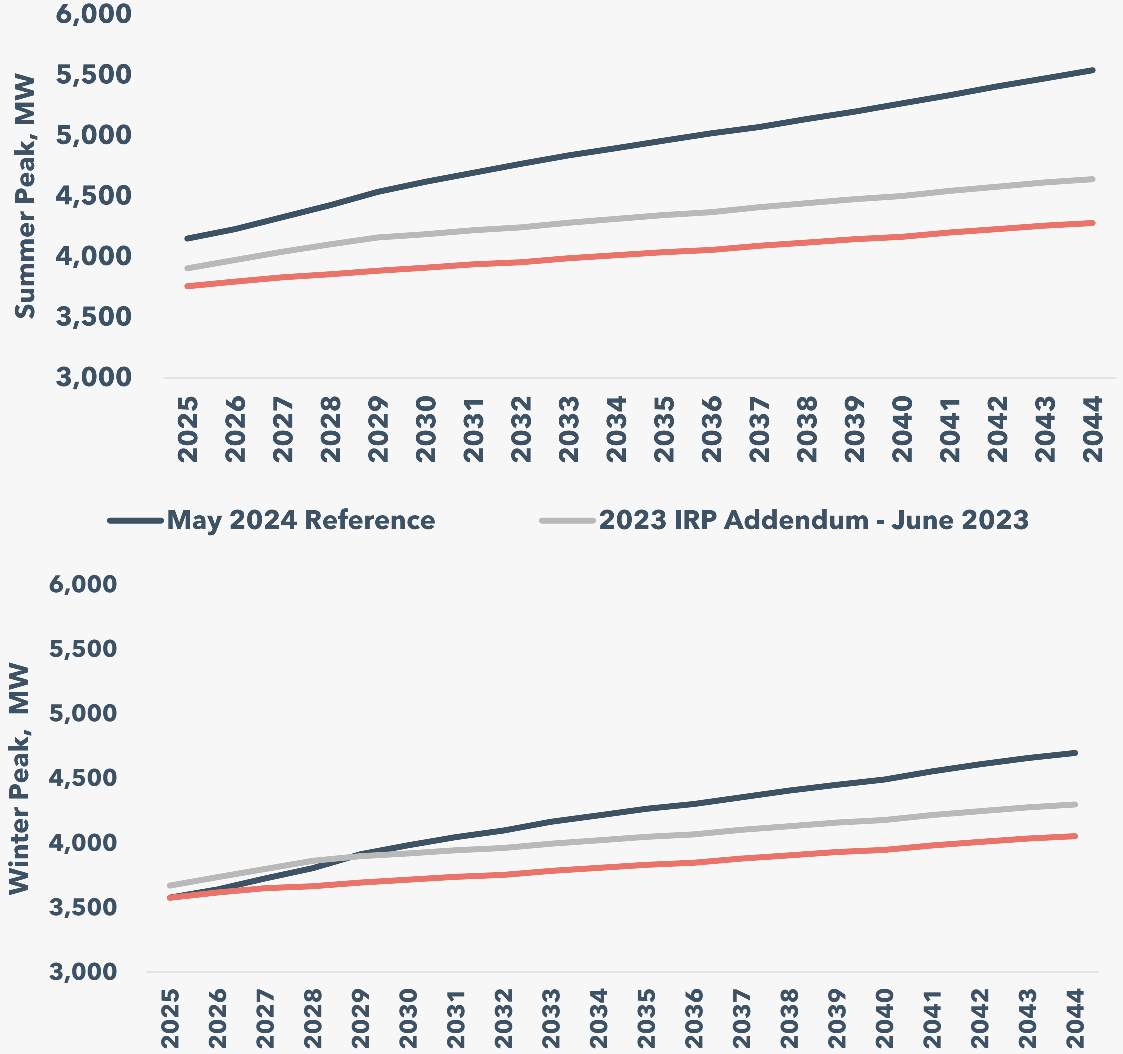
1. Simulates load over historical weather year draws used directly in Sequoia (hourly resource adequacy model)
2. Scaled to match monthly energy forecast
3. Average monthly and seasonal peaks used to describe 'expected' peak
4. Probabilistic output created based on standard deviation of simulated peak estimates

Changes in Method

Hourly simulation-based method vs monthly regression

+ shorter history with many more observations	+ class allows for changes in load shape

Comparison to 2023 CEP/IRP
Peak



20 Year Average Annual Growth Rates

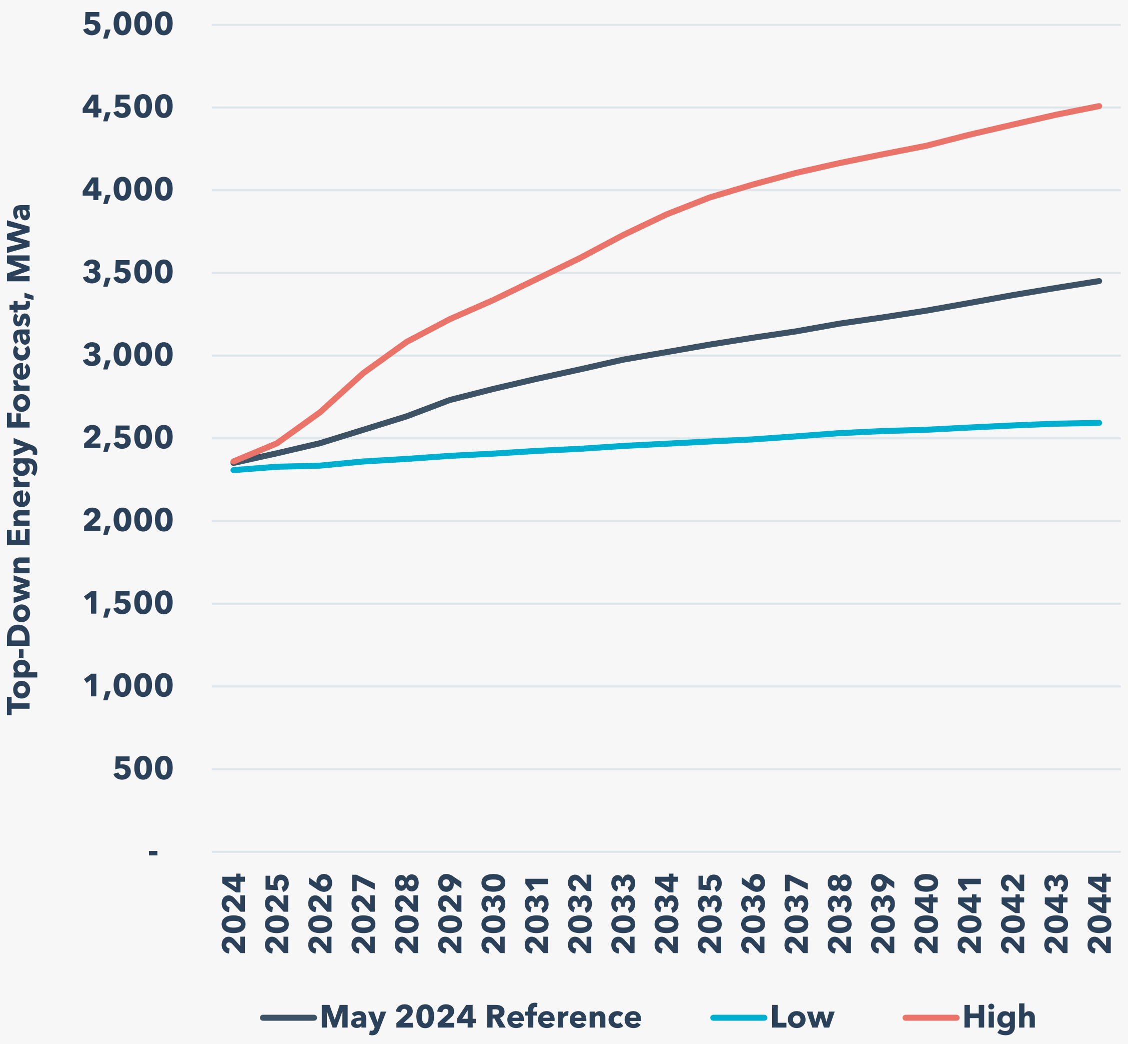
	2023 CEP/IRP (March 2022)	2023 CEP/IRP Addendum (June 23)	May 2024 Reference
Summer Peak	0.8%	1.1%	1.4%
Winter Peak	0.7%	0.9%	1.3%

Addressing Uncertainty

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

- Frequent forecast updates to account for new information
- High and Low load forecasts are developed based on varying economic inputs
- Weather uncertainty is considered within the resource adequacy model Sequoia

Resulting Base Load Forecast – High and Low



Driver	Low Load	Reference	High Load
Population	-0.1%	0.6%	1.5%
Employment	-0.1%	0.7%	1.5%

*Reference case from Oregon Office of Economic Analysis May 2024

	Low Load	Reference	High Load
Total Energy	0.6%	1.9%	3.3%
Residential	-0.2%	0.4%	1.0%
Commercial	-0.8%	-0.1%	0.5%
Industrial	2.9%	5.1%	7.5%

*20-year average annual growth rates for 2024-2043, before DER's

Appendix – Rate Model Specification

Model	UPC & Count	Weather	First Six Months of COVID-19 Pandemic	Monthly Dummies	Energy Trust of Oregon Energy Efficiency	Oregon Employment	Oregon Housing Starts
Single Family	X	X	X	X	X		X
Multifamily	X	X	X	X	X		X
Mobile home	X	X	X	X	X		X
Other Residential		X					
Rate Schedule 32		X		X	X	X	
Rate Schedule 38		X	X	X			
Rate Schedule 83		X		X	X	X	
Rate Schedule 85		X		X	X	X	
Rate Schedule 89				X		X	
Irrigation		X		X			

Resource Economics Update

Robert Brown, PGE

Supply-side Resource Options Overview

What's included

- Overnight capital
- 2023 IRP resource selections
- Updates to EIA (Energy Information Agency) and NREL (National Energy Laboratory Data)

What's not included here

- Tax credits
- Transmission or interconnection costs
- Operating costs
- Financing costs

IRPs use estimates – actual resource costs and parameters will differ

Utility-scale Resource Options

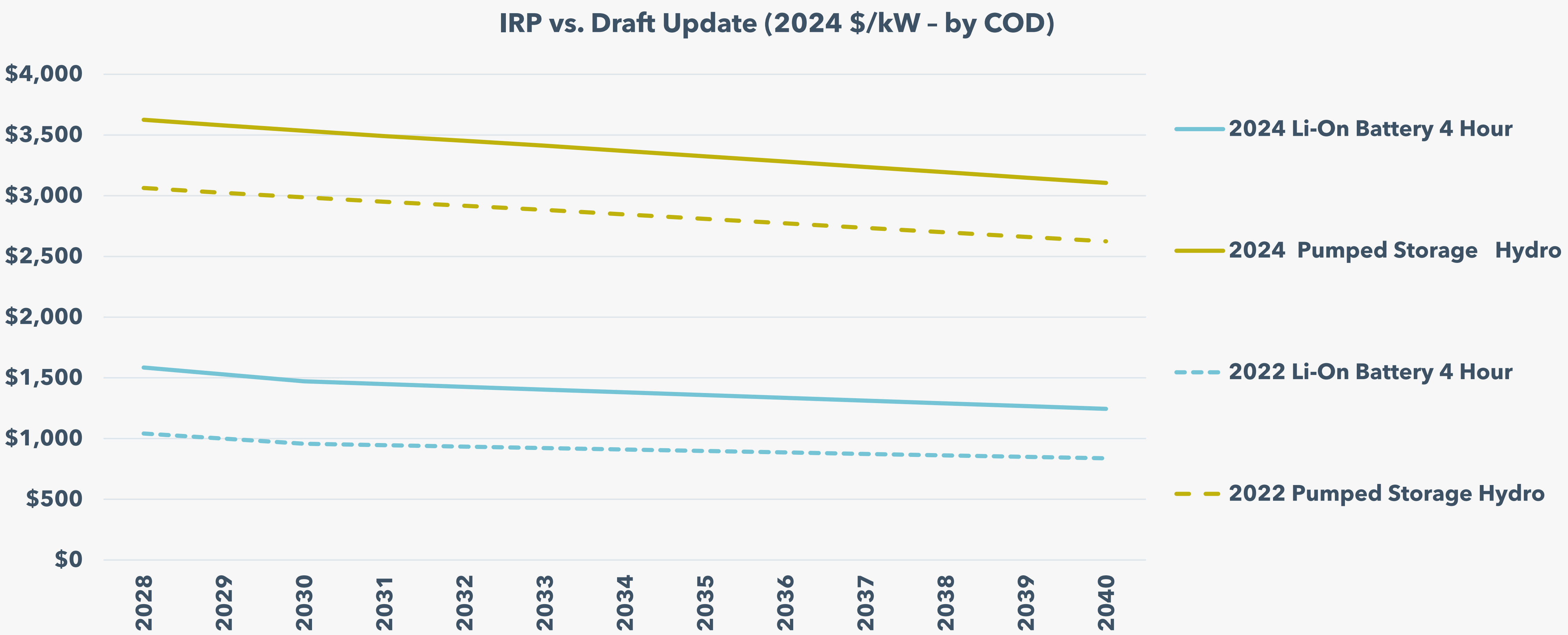
Energy Storage
- Battery Energy Storage Systems (BESS – multiple durations)
- Pumped-Storage Hydro (PSH)

Wind
- Onshore Wind (multiple locations)
- Offshore Wind

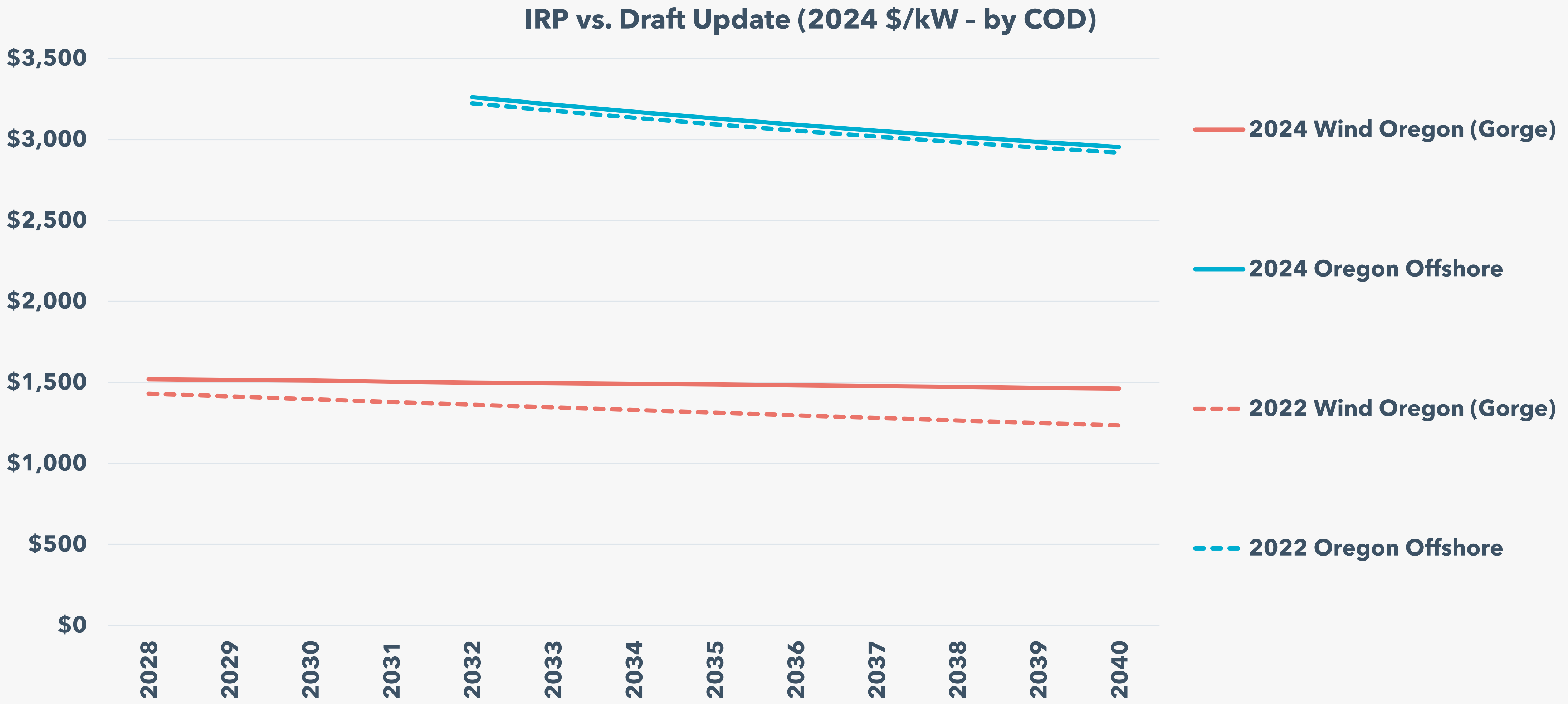
Solar PV
- Stand alone (multiple locations)
- Co-located w/ BESS

Thermal
- Nuclear SMR
- CCCT w/ H_2
- CCCT w/ CCS
- Geothermal

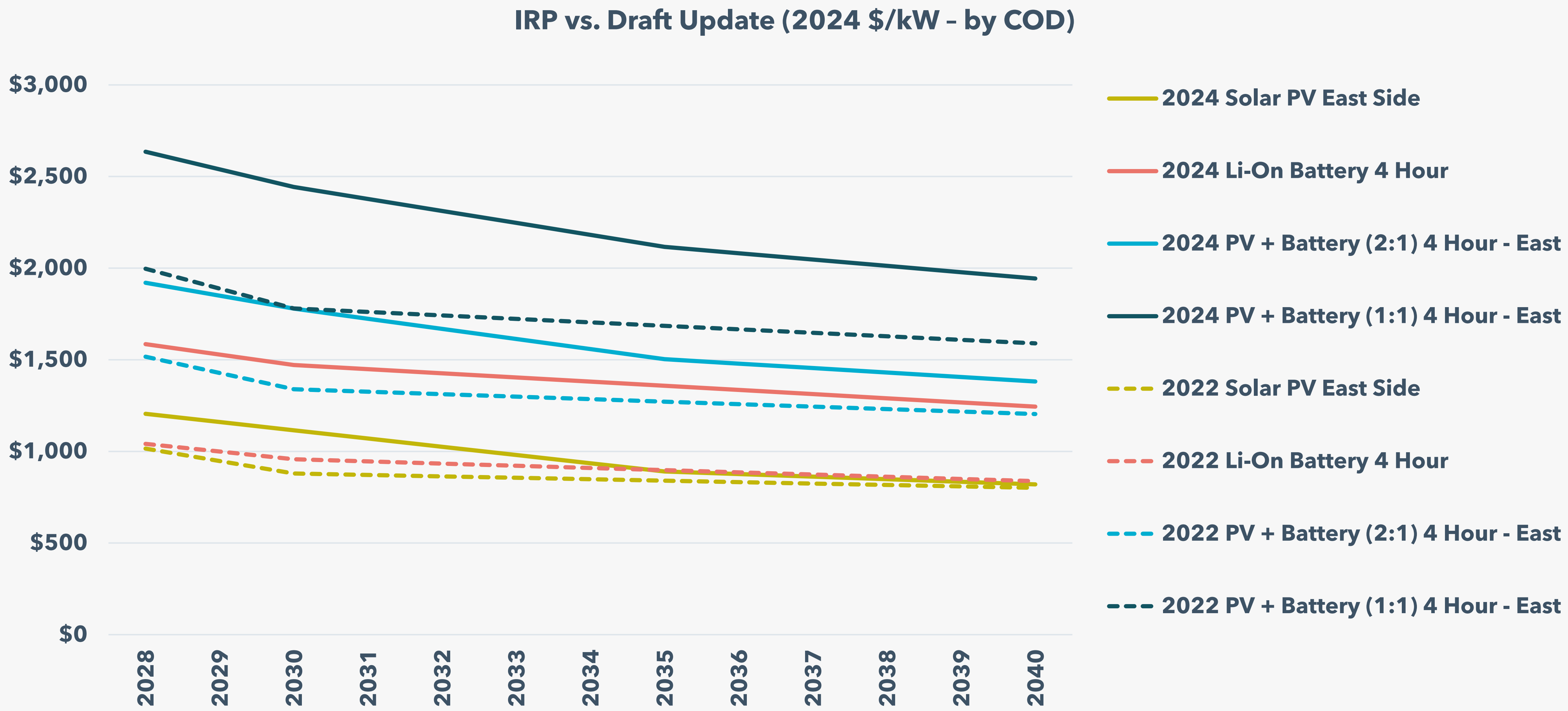
Overnight Capital Updates



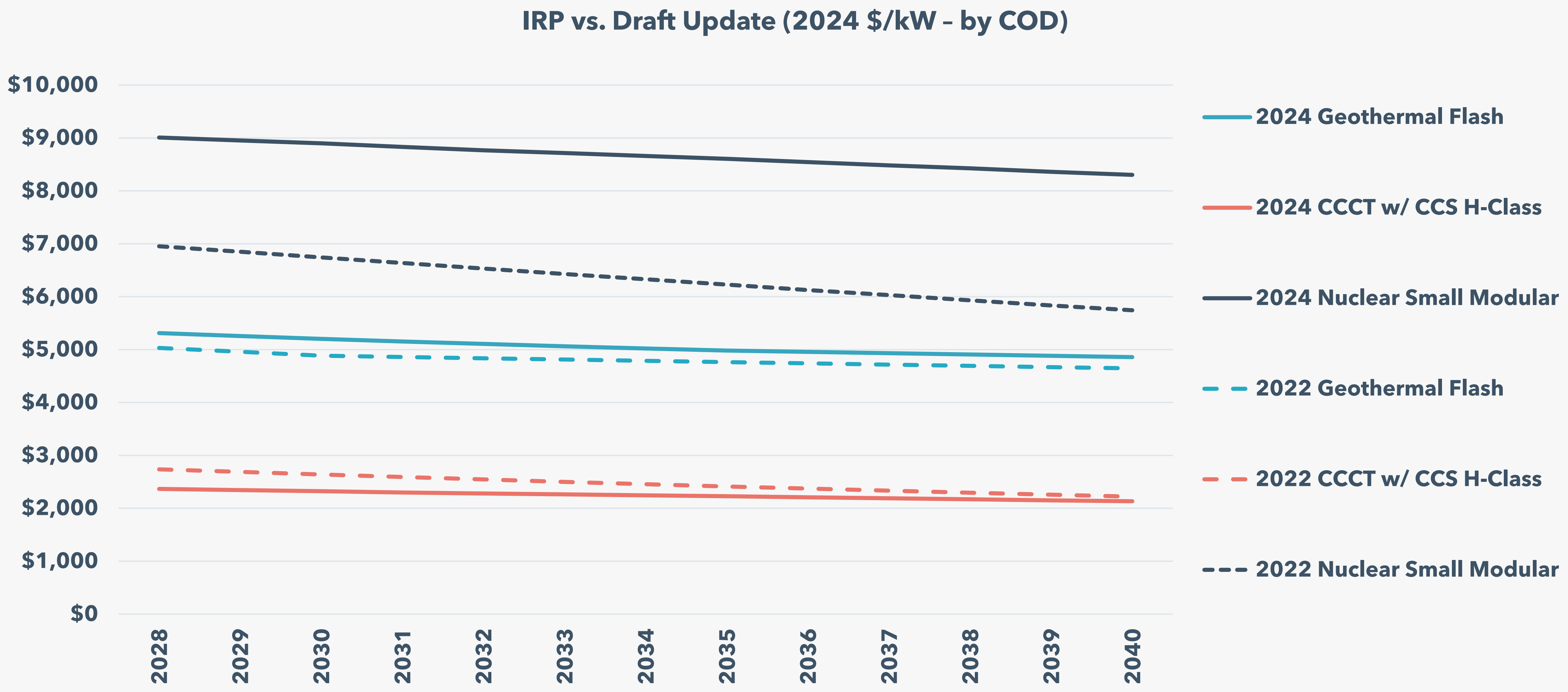
Overnight Capital Updates



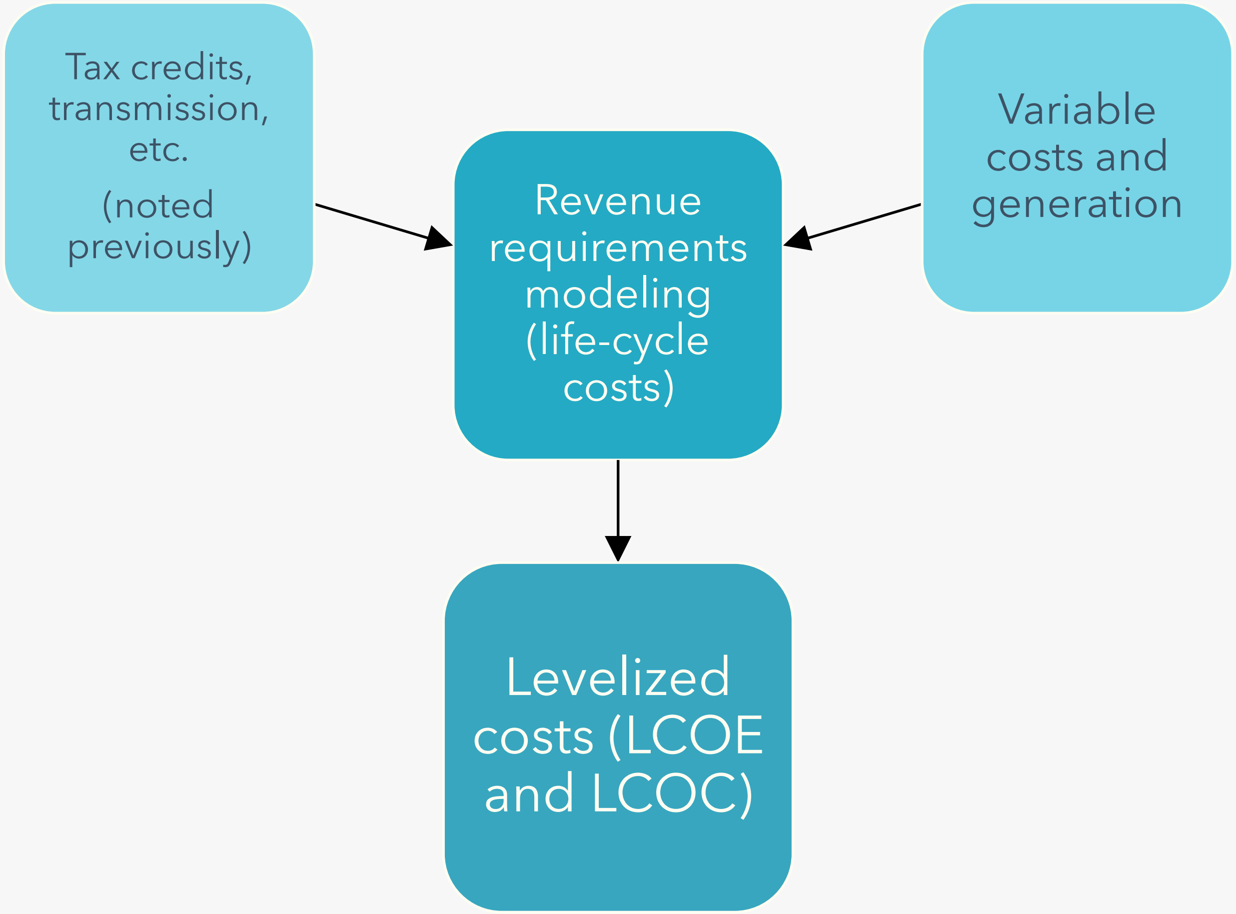
Overnight Capital Updates



Overnight Capital Updates



Still to come…



Small Scale Renewables

Rob Campbell, PGE

Oregon Small-Scale Renewables (SSR) Requirement

PGE is required to meet 10 percent of aggregate electrical capacity with renewable energy facilities less than 20 MW in size* by 2030[1]

Starting in 2029, PGE is required to file a report each year demonstrating compliance with the SSR requirement[2]

** eligible facilities also include biomass that generates thermal energy for a secondary purpose*

1 ORS 469A.210
2 OAR 860-091-0040

SSR Compliance Analysis

The Commission has directed PGE to include a small-scale renewable compliance analysis in the IRP Update*

The analysis will

- Demonstrate PGE's projected SSR compliance position
- Outline actions PGE plans to take to address any identified potential shortfall

** Staff Recommendation 5, adopted by the Commission in LC 80 Order 24-096*

Small Scale Renewables (SSRs) in the 2023 CEP/IRP Update

SSRs will be addressed in two ways in the CEP/IRP Update

1. SSR 2030 Compliance Analysis

2. SSR proxy resource in Portfolio Analysis

Previous Analysis

PGE conducted an SSR analysis in response to Staff Round 1 Comments*

Results of the analysis showed a wide range of potential outcomes for projected quantity of SSRs:

Table 9. Small-Scale Renewables Forecast

Resource Type	Current Capacity per 2023 CEP/IRP	2030 Forecast as updated in CEP/IRP Addendum
Community Solar Program	27 MW	93 MW
PURPA QF < 20 MW	271 MW	281 MW
CBRE	0 MW	155 MW
Customer DERs (AdopDER forecast)	183 MW (not SSR-eligible per Order 21-464)	739 MW of solar 121 MW of storage[193]
TOTAL SSR ELIGIBLE CAPACITY	**298 MW**	**529 - 1,268 MW**

Whether or not net-metered resources will count as SSR is a key unknown in calculation, driving uncertainty in outcomes**

*https://edocs.puc.state.or.us/efdocs/HAC/lc80hac131341.pdf
** Net-metered resources are not currently eligible to count toward SSR compliance

Planned Compliance Analysis for the IRP Update

1. Conduct SSR compliance analysis using updated modeling inputs and assumptions that impact resource additions in the Preferred Portfolio (i.e., load and resource forecasts; updated modeling methods) and current compliance rules.

2. Identify any projected shortfalls in SSR quantities

3. Evaluate the impact of alternative assumptions regarding eligibility of customer-sited resources

4. Describe PGE's planned approach for solutions to meeting any shortfalls identified

SSR Proxy Resource in Portfolio Analysis

The IRP Update will include a SSR proxy resource available for selection in portfolio analysis

While SSR resources can be a variety of renewable resources, in portfolio analysis a single SSR proxy resource will be used

SSR proxy resource will be based on an existing IRP proxy resource for utility-scale solar resource, with modified cost assumptions

Because the SSR proxy will be based on the characteristics of utility-scale solar it will be representative of SSRs on the larger end of the spectrum (closer to 20MW)

SSR Compliance Portfolio

Add SSR compliance constraint in ROSE-E

Constrain the model to comply with SSR requirements in every year starting in 2030:

- ROSE-E must meet the conditions of the constraint similar to capacity need, RPS obligation, etc.
- Any remaining SSR obligation after accounting for existing and forecast SSRs on PGE's system must be met with CBRE's and SSR proxy resource

Results from SSR portfolio will provide insights on:

1. Quantity of SSR additions needed for compliance
2. Cost premium associated with SSR compliance
3. Inform SSR acquisition actions

ROSE-E Changes

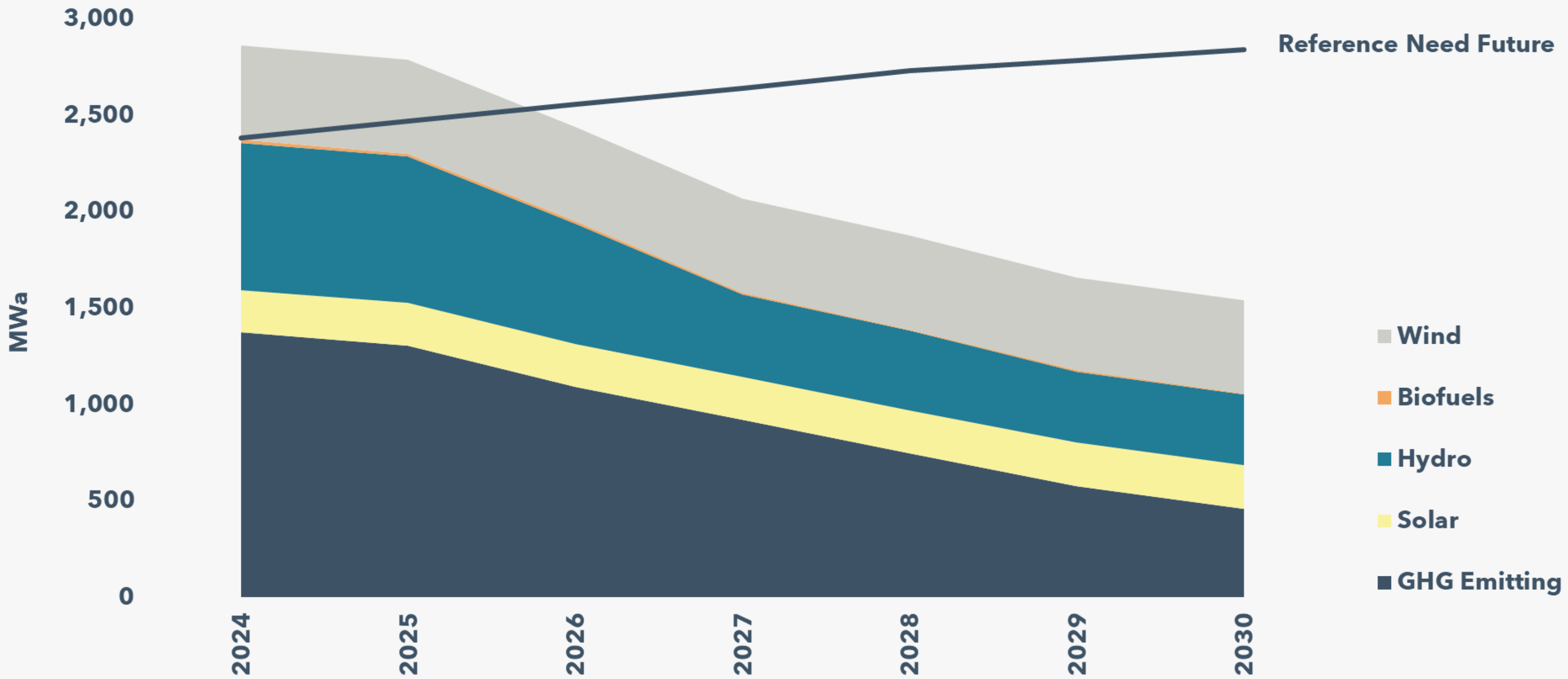
Rob Campbell, PGE

Temporal Granularity Energy Accounting

In the 2023 CEP/IRP, energy need in portfolio analysis was determined based on annual energy load-resource balance

Annual energy need = Annual average load – Annual average resource generation

Example of annual energy load-resource balance for the Reference Case*

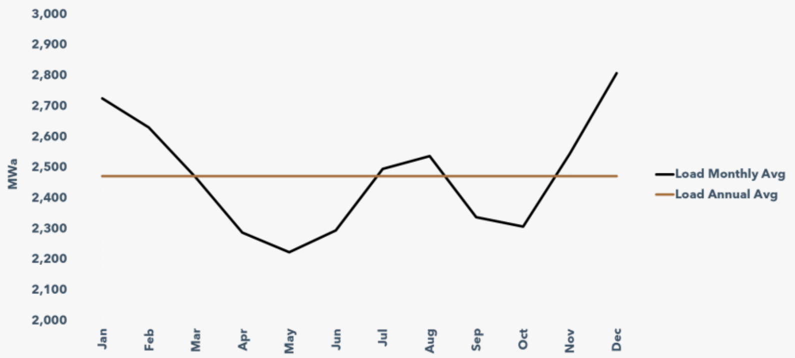


*Reference load, Linear GHG glidepath, RRRR (reference case price future)

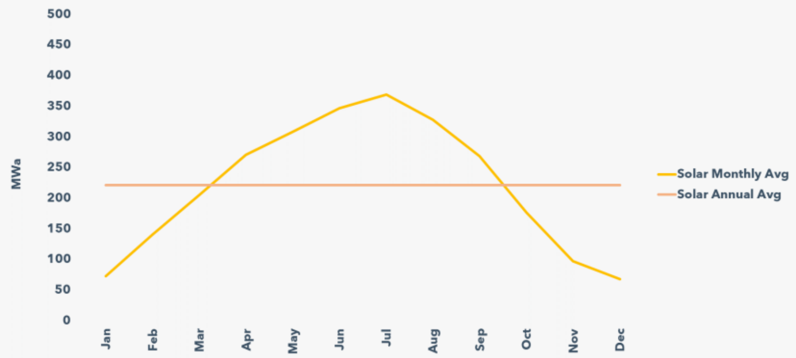
Limitations of Using Annual Energy Accounting

When energy need is calculated at annual level, load and generation are implicitly assumed to have a flat shape throughout each year, failing to capture seasonal variation.

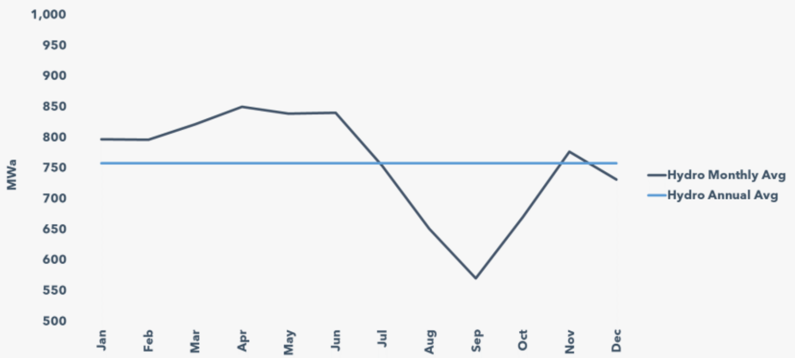
Load



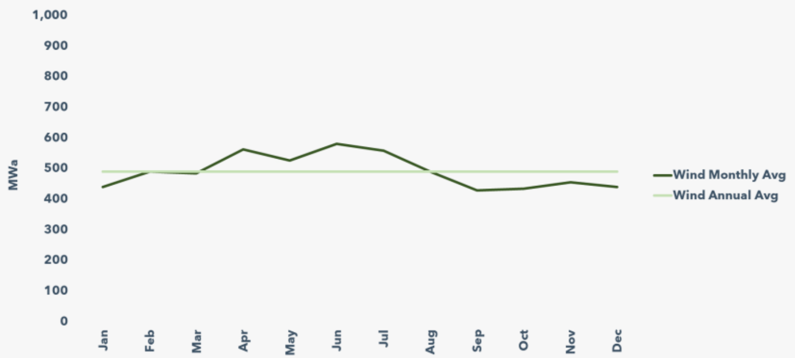
Solar Generation



Hydro Generation



Wind Generation



Note: Figures show 2025 values but are for illustrative purposes only and do not reflect updated values to be used in the 2023 IRP Update

Improvements to Portfolio Analysis

Capture seasonal variation in energy need

- Increase granularity of capacity factors for existing non-dispatchable resources from annual average to monthly average
- Increase granularity of load forecast from annual to monthly

Incorporate seasonality of energy need in optimized resource selection in ROSE-E*

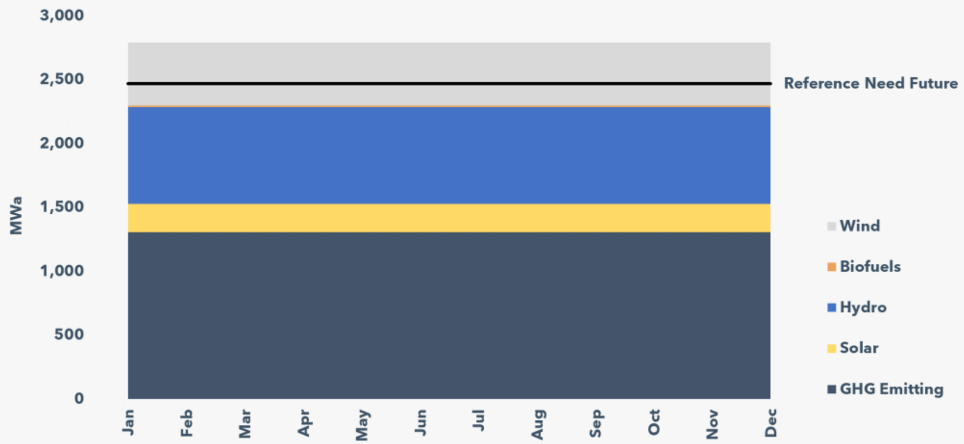
- Add monthly energy constraint
- Increase granularity of energy need input from annual average to monthly average
- Increase granularity of capacity factors for proxy renewable resources from annual average to monthly average
- Allow ROSE-E to co-optimized monthly allocation of GHG-energy

*ROSE-E is PGE's capacity expansion model

Impact on 2025 Energy Need

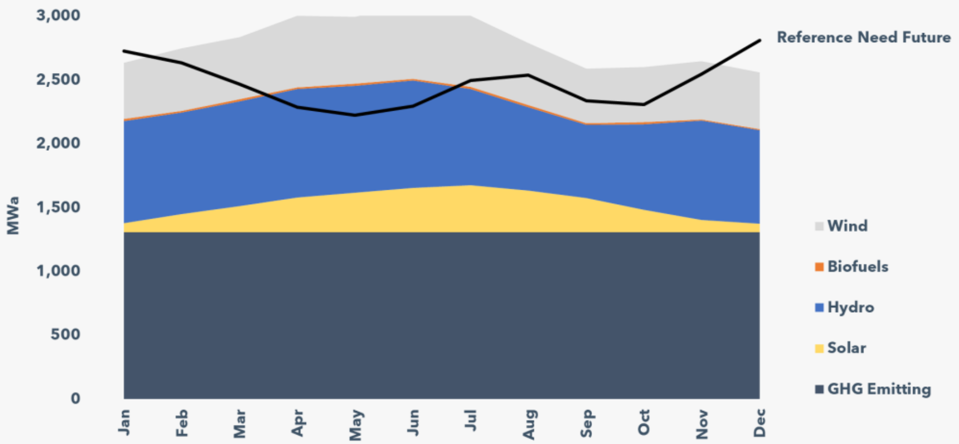
Annual

Long by approximately 300 MWa across the year



Monthly

Long in most months but short approximately 100 MWa in January and 250 MWa in December*



*Before monthly reallocation of GHG-emitting energy.

Note: Values do not reflect updated values to be used in the 2023 IRP Update and are for illustrative purposes only

Allocation of Thermal Generation in ROSE-E

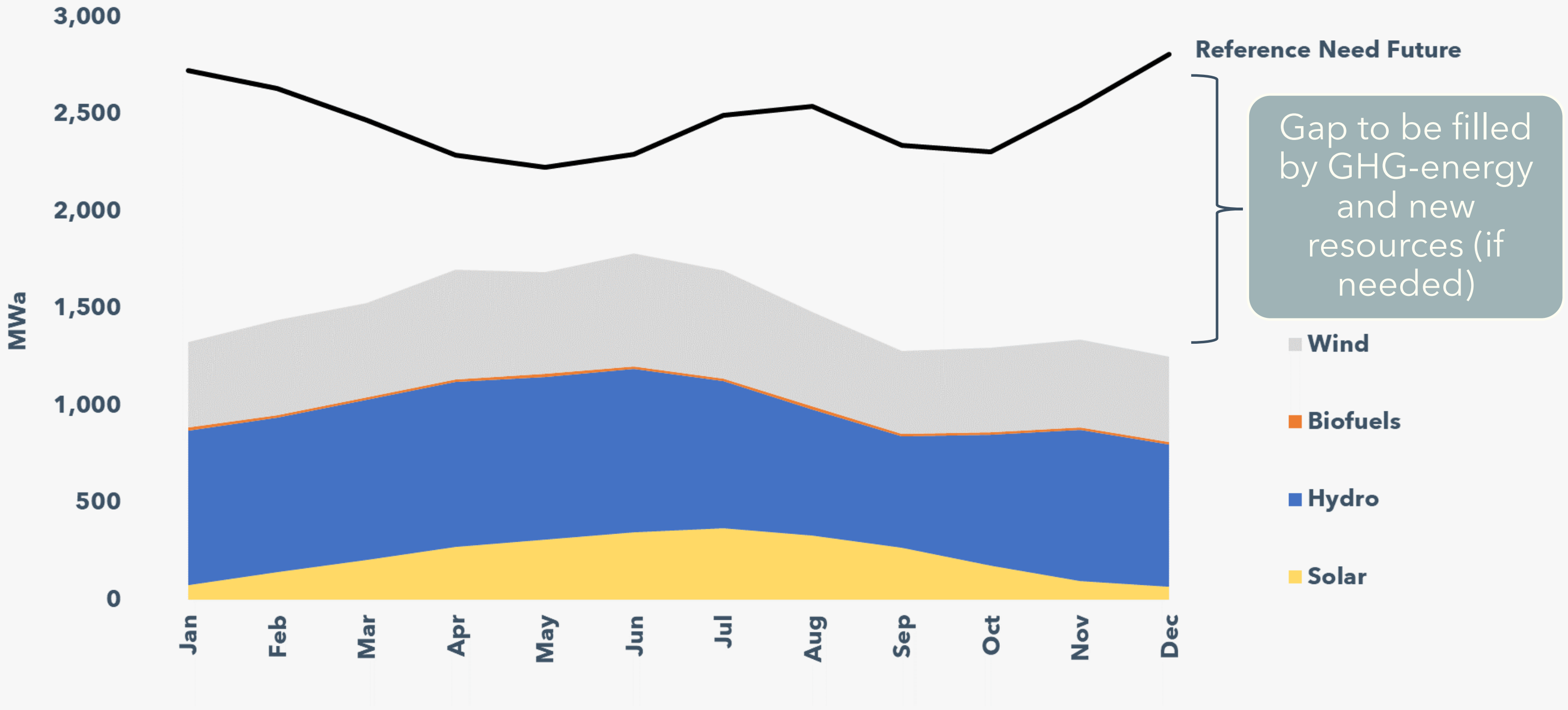
Energy from dispatchable sources cannot be allocated using static average capacity factors like non-dispatchable resources because the timing of their generation is determined by economic and operational decision making.

Remove GHG-emitting energy from calculation of energy need input

Provide ROSE-E with annual quantity of GHG-emitting energy available to serve retail load under HB 2021 targets as determined in PGE's Intermediary GHG model

Allow ROSE-E to determine optimal monthly allocation by meeting monthly energy through co-optimized determination of GHG-energy allocation and new resource additions to meet monthly energy need while minimizing costs

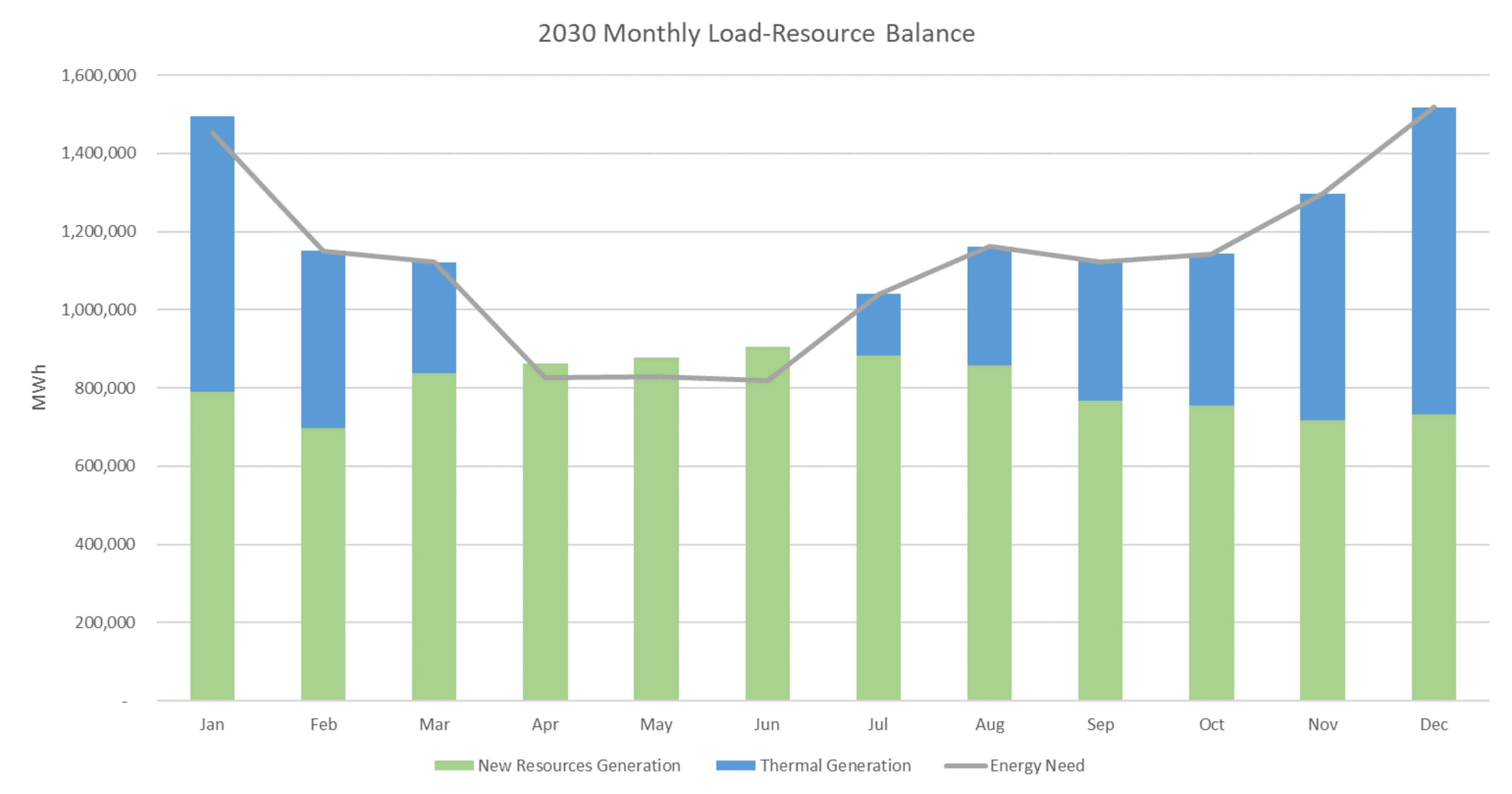
2025 Energy Position Without GHG-emitting Energy



Note: All numbers are for illustrative purposes only

Co-optimization of GHG-energy and Resource Additions

Example of ROSE-E meeting energy need with combination of existing GHG-energy and new resource additions in 2030

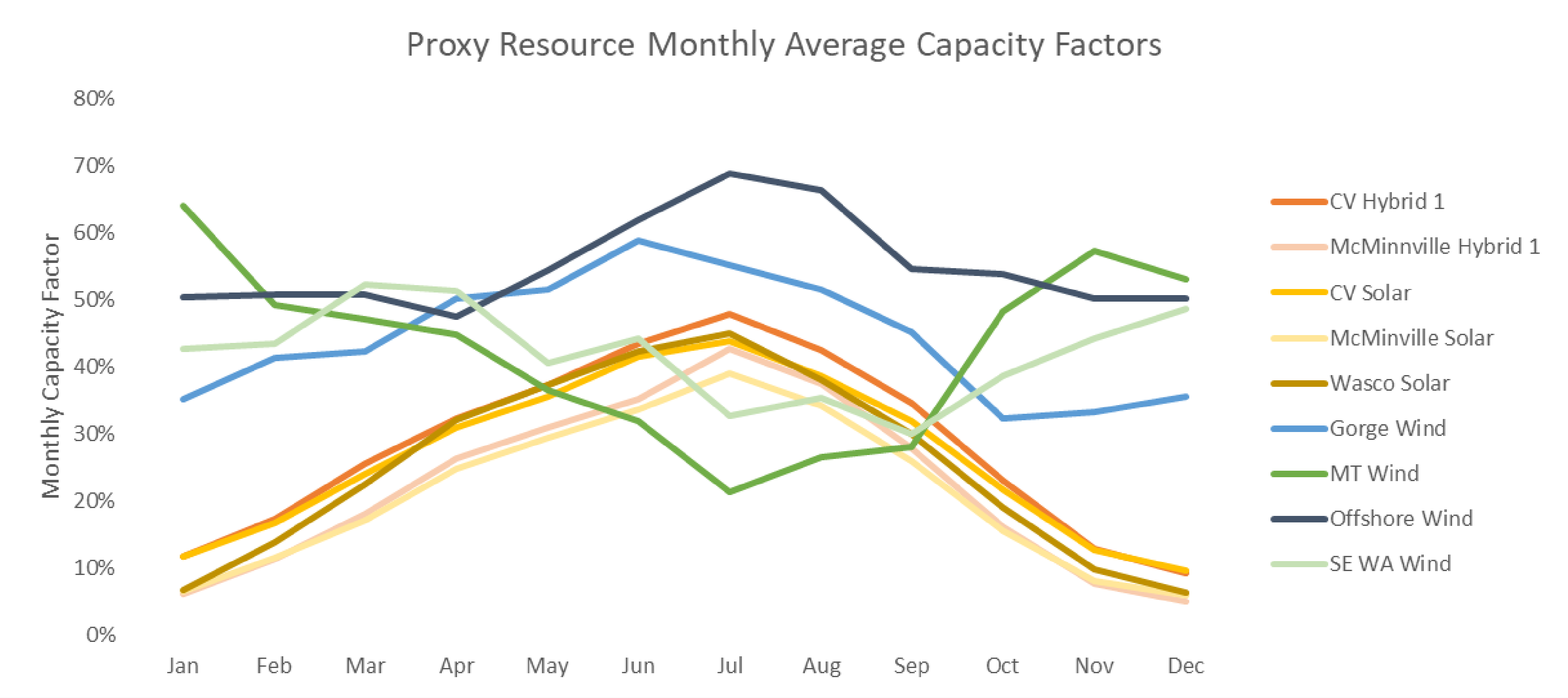


Note: All numbers are for illustrative purposes only

Seasonality of Proxy Resource Generation

Seasonal generation shapes of proxy resources will influence how effective they are at meeting monthly energy need

For example, if energy need is concentrated in the winter, adding MT wind with relatively high winter capacity factor will provide more value for meeting energy need than adding Gorge wind*



*Other factors like capacity benefit, cost, and transmission availability also influence resource selection

Balancing the Benefits and Costs of Increasing Temporal Granularity

Monthly granularity offers substantial improvement over annual with ability to capture seasonality of energy need and resource characteristics

Costs of increasing temporal granularity to monthly

- Increased dimensionality of input data (12x number of observations)
- Increased model runtimes

Increasing granularity further would come with significant computing and data handling challenges

- Hourly would increase observations of input data 8760x
- Hourly component is being considered through link with PGE Hourly Analysis*

* Presented in June 2024 Roundtable

Questions

NEXT STEPS

A recording from today's webinar will be available on our website in one week

Upcoming Roundtable: August 7th
Distribution System Workshop: July 25th

Thank you

Contact us at
IRP.CEP@PGN.COM

An

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kind of energy

ACRONYMS

ARIMA: autoregressive integrated moving average
ART: annual revenue-requirement tool
ATC available transfer capability
BPA: Bonneville Power Administration
C&I: commercial and industrial
CBI: community benefit indicators
CBIAG: community benefits and impacts advisory group
CBRE: community based renewable energy
CDD: colling degree day
CEC: California energy commission
CEP: clean energy plan
CF   conditional firm
DC: direct current
DER: distributed energy resource
DR: demand response
DSP: distribution system plan
EE: energy efficiency
ELCC: effective load carrying capacity
EJ: environmental justice
ETO: energy trust of Oregon
EUI: energy use intensity
GHG: greenhouse gas
HB2021: House Bill 2021
HDD: heating degree day
IE: independent evaluator
IOU: investor-owned utilities
ITE: information technology equipment
ITC: investment tax credit
kW: kilowatt
LOLH: loss of load hours
LT/ST: long term/ short term
LTF long-term firm
MW: megawatt
MWa: mega watt average
NAICS: North American industry classification system
NCE: non-cost effective
NG: natural gas
NPVRR: net present value revenue requirement
OASIS Open Access Same Time Information System
ODOE: Oregon department of energy
PPA: power purchase agreement
PSH: pumped storage hydro
PUC: public utility commission
PURPA: Public Utility Regulatory Policies Act
PV: photovoltaic
REC: renewable energy credit
RLRR: low carbon price future
ROSE-E: resource option strategy engine
RPS: renewable portfolio standard
RRRR: reference case price future
RTO: regional transmission organization
SoA: South of Allston
T&D: transmission and distribution
TSR: transmission service request
TSEP: TSR study and expansion process
Tx: transmission
UPC: usage per customer
UPS: uninterruptible power supply
VER: variable energy resources
VPP: virtual power plant
WECC: western electricity coordinating council