



**Mid-Columbia Market Report  
Release 5.1**

# About Ascend Analytics

- Founded in 2002 with ~140 employees in Boulder, Oakland, and Bozeman
- Six integrated service lines for asset operations, portfolio analytics, and planning
- Custom analytical solutions and consulting

## The Ascend Product Suite

DAILY OPS 5 minutes to 5 days	VALUATION/SITING 1 month to 30 years	HEDGING & PLANNING 1 month up to 30+ years	MARKET FORECAST Next month to 30 years	MERCHANT FINANCE 5 to 10 years	TRANSACTIONS Development Cycle
 <p><b>SmartBidder™</b></p> <p>Bid Optimization &amp; Scheduling Services</p>	 <p><b>BatterySIMM™</b></p> <p>Energy Storage &amp; Renewables Valuation</p>	 <p><b>PowerSIMM™</b></p> <p>Portfolio Risk Management &amp; Resource Planning</p>	 <p><b>AscendMI™</b> Market Intelligence</p> <p>Price &amp; Market Forecasts for the Energy Transition</p>	 <p><b>Ensurance™</b> Merchant Storage Financing</p> <p>Finance Merchant Storage</p>	 <p><b>AEX</b> Ascend Energy Exchange</p> <p>Clean Asset Marketplace</p>
<p>Forecasts Future Grid States</p> 	<p>Capture Nodal Volatility</p> 	<p>Evaluate Risk &amp; Return</p> 	<p>Market Forwards &amp; Forecasts</p> 	<p>Toll Secures Fixed Income</p> 	<p>Project Sales</p> 



# Market Forecasts at Ascend Analytics Supporting Project Financing

- Independent valuations for the developer-side and finance-side of stand-alone and renewable-paired storage projects
- Live bidding of storage projects in wholesale energy markets

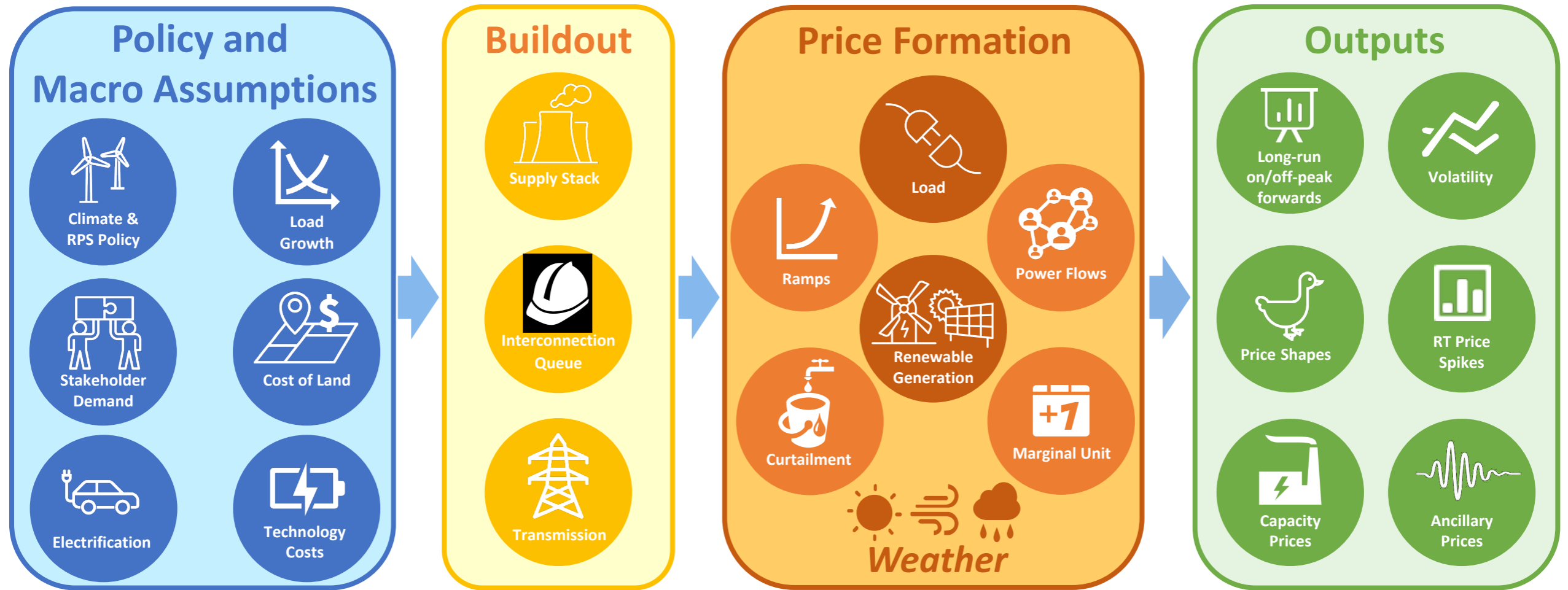
### Facts-at-a-Glance 2019-Present

- 8GW** Non-recourse finance supported since founding
- 40GW** Merchant finance supported
- \$6.2Bn** Value of current independent economic assessments
- 22** Operating Sites in three ISOs with more coming online in 2022

### Seller-side References

### Finance-side References

# Ascend Analytics Fundamental Forecasting Framework



# Non-Economic Driving Forces Will Have a Growing Influence on Energy Supply

- **ESG Driving Forces:**

- What percentage of major companies will be pursuing 100% clean energy by 2030 due to ESG goals, shareholder pressure, and/or efforts to attract young workers?
- Will companies with ESG goals power their data centers with carbon-emitting energy if they can't contract sufficient clean energy?
- What percentage of utilities and munis will be pursuing 100% clean energy over the next decade due to ESG goals or stakeholder pressure?

- **Policy Driving Forces:**

- Will any states loosen or fail to meet their clean energy targets?
  - Will interconnection challenges lead to missed targets?
  - Are utilities rethinking their clean energy strategies?
- How many states are likely to tighten their clean energy mandates?
- How many states are likely to adopt 100% clean energy mandates?
- How will financiers and state regulatory commissions view stranded asset risks for thermal generation?



*A forecast should be based on the **FUTURE** of policy and clean energy demand, rather than the status quo.*

# Key Developments & Updates

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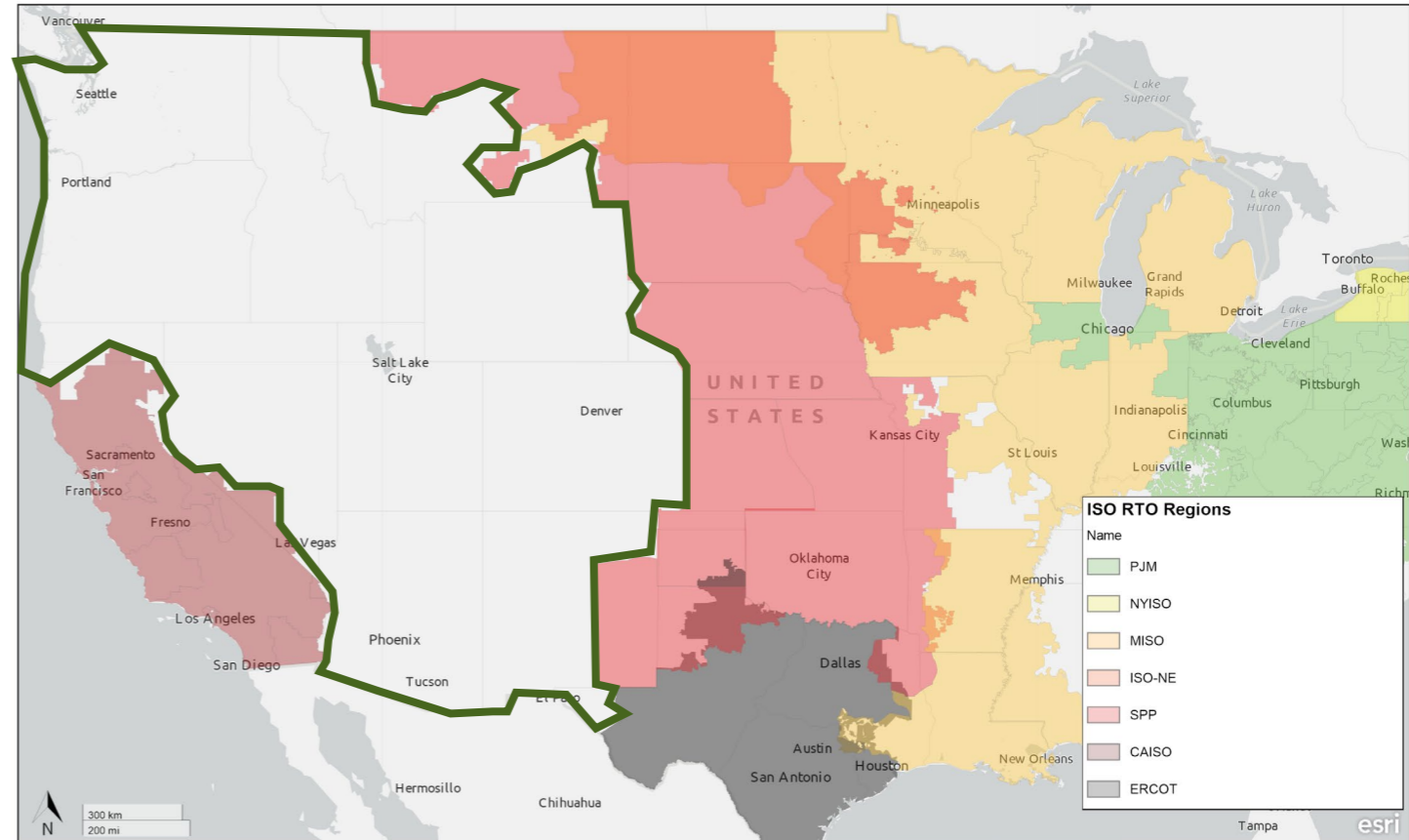
- **Planned capacity and transmission developments face delays** due to interconnection queue congestion, particularly with Bonneville Power Administration (BPA). Faced with significant load growth, notably including data centers, these delays will manifest in energy shortage conditions, particularly in the transmission-constrained Pacific coastal stretch between Portland and Seattle.
- Despite natural gas forwards falling in recent years, **market heat rates remain high in MidC** due to current and expected shortage of energy supply. This supply shortage and associated price impacts are expected to persist until new capacity and transmission can alleviate supply pressure.
- **The Washington Cap-and-Invest carbon allowance market is maturing**, with recent auctions settling around 20%, or \$5, above the floor price. These clearing prices around \$30 per allowance indicate that there is already real demand for allowances.
- Many utilities released updated IRPs in 2023, which for many utilities was the first IRP update since the signing of the Inflation Reduction Act. Most IRPs had notable increases in load growth as well as increased solar and storage in portfolio plans along with accelerated thermal retirements. **PacifiCorp revised their IRP in April 2024, lowering their clean energy goals.**
- **The Western Resource Adequacy Program (WRAP) began non-binding operations in 2023.** This program will facilitate broader reliability planning between WECC states, currently representing around 70% of WECC load excluding California, Mexico, and Alberta. Binding operations are scheduled to phase in between Summer 2025 and Winter 2027-28.
- **SPP and CAISO have both proposed independent system operations in the WECC, with Markets+ for SPP and EDAM for CAISO.** Both are still in early planning stages, with a variety of utilities exploring one or both markets.
- **Ascend has updated technology cost forecasts**, which reflect significant inflation and supply chain competition for renewables and storage in both near-term and long-term. Supply chain disruption has also resulted in delayed buildout.



# Market Development in the Greater WECC

# Levels of Market Coordination

- Level 1: Resource Adequacy Pooling & Coordination
- Level 2: Imbalance Markets (real-time only)
- Level 3: Day-ahead and Real-time market coordination, usually run by a Regional Transmission Organization (RTO)
  - The majority of the Eastern Interconnect is covered by an RTO, but the majority of the Western Interconnect is not
  - Momentum and pressure growing for utilities in the west to take advantage of more opportunities for resource pooling, cooperation and coordination

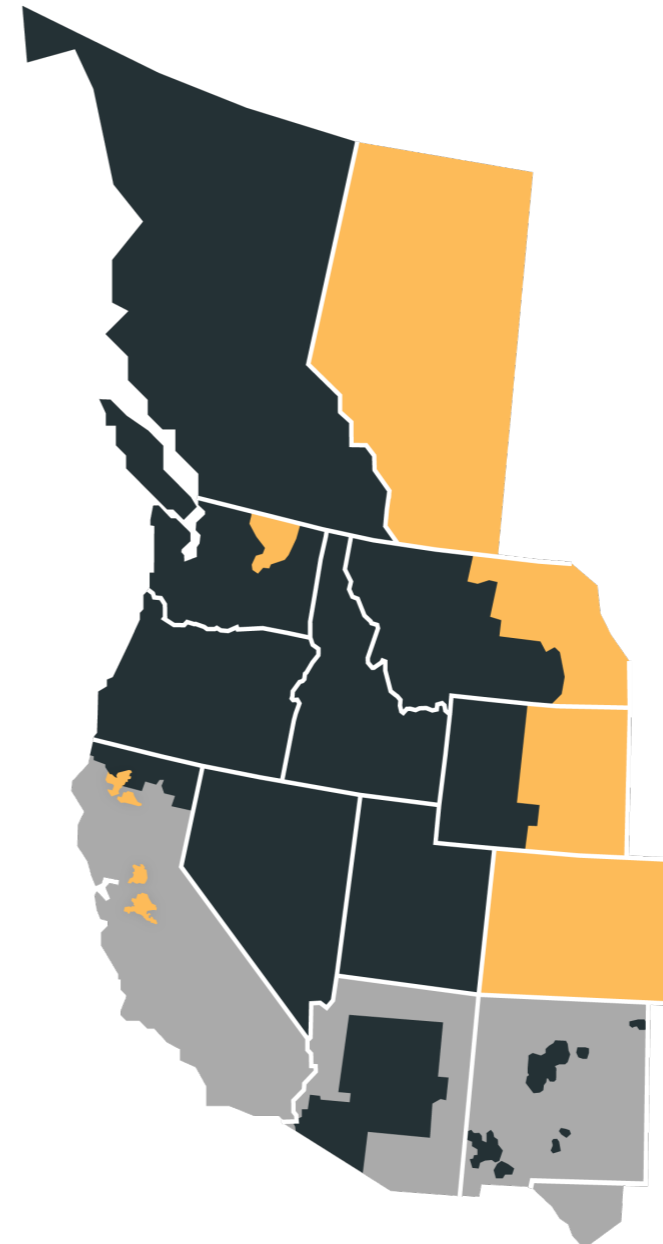


Source: S&P Global



# Western Resource Adequacy Program (WRAP)

- FERC approved WRAP tariff in February 2023
- WRAP facilitates reliability planning between western US states and Canada, with some participation from all WECC states except Colorado.
- 22 utilities currently participate in WRAP. These participating utilities represent around 70% of WECC load, excluding California, Mexico, and Alberta.
- Non-binding operations in the market begin 10/31/2023 and continue through 2025. Binding operations are slated to start in 2026, with the transition completing in 2028.
- Each participating utility is required to maintain resource adequacy in alignment with WRAP calculations
- Each participant is required to share resources as necessary with other participating members



## CURRENT PARTICIPANTS

- Arizona Public Service
- Avista
- Bonneville Power Administration
- Calpine
- Chelan County PUD
- Clatskanie PUD
- Eugene Water & Electric Board
- Grant PUD
- Idaho Power
- Northwestern Energy
- NV Energy
- PacifiCorp
- Portland General Electric
- Powerex
- Public Service Company of New Mexico
- Puget Sound Energy
- Salt River Project
- Seattle City Light
- Shell Energy
- Snohomish PUD
- Tacoma Power
- The Energy Authority

- ADDITIONAL WPP FOOTPRINT
- NON-WPP FOOTPRINT
- CURRENT WRAP FOOTPRINT

# Current California Energy Imbalance Market Covers Much of WECC

- The Energy Imbalance Market (EIM) is generally seen as a success
  - Most utilities in the WECC Participate
  - Started in 2014, expanding in each year
  - Only a sub-hourly market
  - Claims \$3.4 billion in gross benefits since November 2014 and \$1.5 billion in 2022
- There is no day-ahead component in the EIM
  - There is lots of discussion about how a day-ahead market would benefit utilities within WECC
  - Nevada and Colorado are required by their PUCs to join a wholesale market by 2030
    - One study estimated that CO would save 1% by joining EIM, 5% by joining RTO
- Two possible options have emerged:
  - California Extended Day-Ahead Market
  - SPP Markets+



# West Coast vs. Inland: Competing Proposals for Day-Ahead Markets

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- **California Extended Day Ahead Market (EDAM)**

- Tariff filed with FERC in end of 2023
- Planning to begin operations in 2026
- Current governance is exclusive to California as CAISO board members are appointed by the governor
  - The West-Wide Governance Pathways Initiative, introduced in May 2024, would broaden governance to better represent the greater West
- EDAM would build on the day-ahead market that is already run by CAISO (California-only currently) as well as the EIM

- **SPP Markets+**

- Tariff filed with FERC in early 2024
- Planning to begin operations Q1 or Q2 of 2027
- Governance is very open and inclusive of all participating members
- SPP Markets+ would build on its own sub-hourly imbalance market – called the Western Energy Imbalance System (WEIS)

# General Trends and Considerations for Market Expansion

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- Footprint is key
  - Many utilities could be isolated and so early movers can impact the markets other utilities join
  - Bonneville's decision could influence nearby utilities in the PNW
- Governance matters
  - Current governance for CA EDAM does not include voices from outside of CA. This could change but currently is a non-starter for most AZ utilities and probably others.
  - SPP has made it a point to include all possible participating utilities from the beginning
- Other considerations
  - Timing: who will be leaders and who will be followers?
  - Legislation: who will be mandated to join an RTO or market?
  - Pre-existing participation in EIM, WEIS, and WRAP: how will this affect decisions?

*Governance and footprint are top considerations for which day ahead market to participate in for many utilities, with some utilities making their decisions based on what the first movers do.*

# Individual Utilities and Major Questions for Market Participation

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- Individual Utilities
  - PacifiCorp and PGE are formally committed to EDAM. Idaho Power is leaning toward EDAM.
  - NorthWestern has not committed to either effort
    - “intends to delay a decision on joining until sufficient information on each market design and its governance model is fully developed, as well as an indication of which market our neighboring utilities intend to pursue”
- Major Questions
  - How much pull does PacifiCorp have?
    - Could PacifiCorp West and East make different decisions?
  - What does Bonneville do?
    - Bonneville seems to be skewing toward Markets+, despite push from elected officials toward EDAM
    - Bonneville’s decision could influence nearby utilities
  - Will California change its current governance (i.e. AB 538)?
  - Who will be early movers and how will that impact the followers?
    - Who is at most risk of islanding: Everyone, but especially Arizona, New Mexico, small PNW utilities (Tacoma, Avangrid, Seattle City Light)

# Expectations of Who Will Join which Day-Ahead Market

Utility	State	CA EDAM	SPP Markets +	Notes
PacifiCorp West	OR/WA/CA	Confirmed		Confirmed EDAM participant
PacifiCorp East (Rocky Mountain)	UT/WY/ID	Confirmed		Confirmed EDAM participant
NV Energy (SPPC/Nevada Power joint IRP)	NV	Confirmed		Same parent company as PacifiCorp Also, early EIM mover and very connected to CA electricity
Portland General Electric	OR	Confirmed		Very connected to PacifiCorp electrically and isolated from the rest of the WECC by PacifiCorp and Bonneville Power Authority
APS/TEP/SRP	AZ		Likely	If Bill 538 passes, this may change. Current CA EDAM governance is a “non-starter” for these utilities.
Avista	ID/WA		Likely	Very connected to PacifiCorp, but state PUC chose not to participate in EDAM
Idaho Power	ID/OR	Likely		Very connected to PacifiCorp
Bonneville Power Administration	OR/WA/ID/CA		Likely	BPA staff favor Markets+

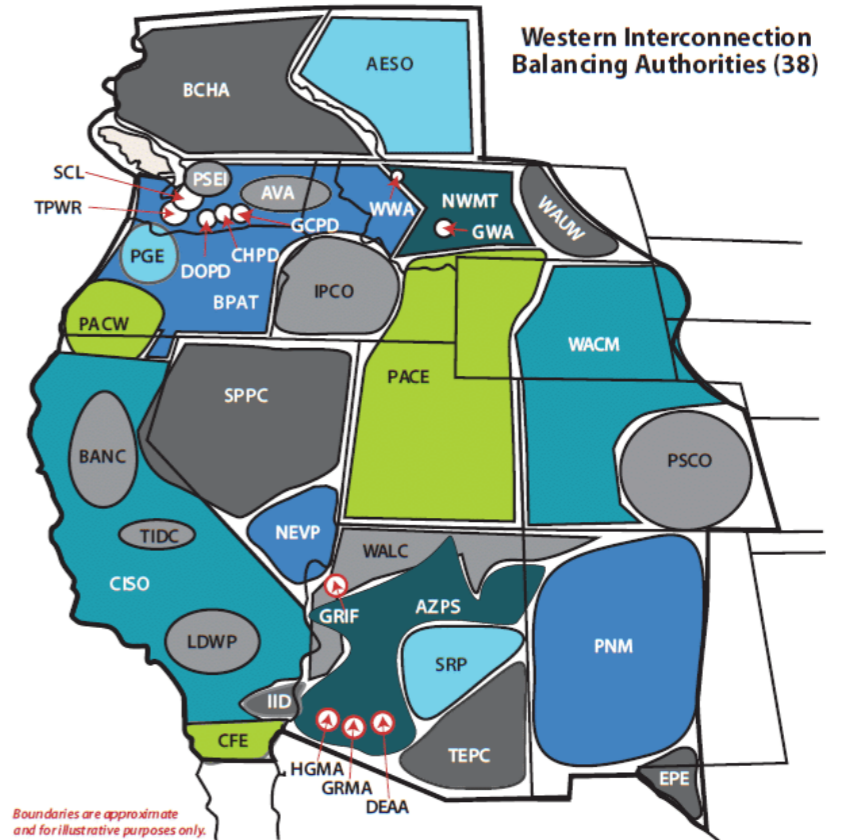


# Forecasting the Pacific Northwest



# PNW Market Context: Clean Energy Growing Across the West

- **California** — 60% RPS by 2030, 90% GHG-free by 2035, 95% by 2040, 100% GHG free retail sales by 2045
- **Oregon** — 100% GHG free by 2040
- **Washington** — 100% clean energy by 2045, Legislation to achieve 25% below 1990 levels by 2035, phase out coal by (end of) 2025
- **New Mexico** — 100% GHG-free by 2045
- **Idaho** — Idaho Power goal of 100% clean by 2045
- **Nevada** — 50% RPS by 2030 and 100% (non-binding) GHG-free by 2050



AESO - Alberta Electric System Operator  
 AZPS - Arizona Public Service Company  
 AVA - Avista Corporation  
 BANC - Balancing Authority of Northern California  
 BPAT - Bonneville Power Administration - Transmission  
 CISO - California Independent System Operator  
 CFE - Comision Federal de Electricidad  
 DEEA - Arlington Valley, LLC  
 EPE - El Paso Electric Company  
 GRMA - Gila River Power, LP  
 GRIF - Griffith Energy, LLC  
 IPCO - Idaho Power Company  
 IID - Imperial Irrigation District

LDWP - Los Angeles Department of Water and Power  
 GWA - NaturEner Power Watch, LLC  
 NEVP - Nevada Power Company  
 HGMA - New Harquahala Generating Company, LLC  
 NWMT - North Western Energy  
 PACE - PacifiCorp East  
 PACW - PacifiCorp West  
 PGE - Portland General Electric Company  
 PSCO - Public Service Company of Colorado  
 PNM - Public Service Company of New Mexico  
 CHPD - PUD No. 1 of Chelan County  
 DOPD - PUD No. 1 of Douglas County  
 GCPD - PUD No. 2 of Grant County  
 PSEI - Puget Sound Energy

SRP - Salt River Project  
 SCL - Seattle City Light  
 SPPC - Sierra Pacific Power Company  
 TPWR - City of Tacoma, Department of Public Utilities  
 TEPC - Tucson Electric Power Company  
 TIDC - Turlock Irrigation District  
 WACM - Western Area Power Administration, Colorado-Missouri Region  
 WALC - Western Area Power Administration, Lower Colorado Region  
 WAUW - Western Area Power Administration, Upper Great Plains West  
 WWA - NaturEner Wind Watch, LLC

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# Forecasting Supply Stacks (1)

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- Renewables are increasingly the lowest cost form of energy in most areas of the US
  - Most new resources will be renewables and storage
- Economics are not the only driving force for renewable buildout
  - Future policy, off taker demand, and stakeholder pressure will all drive renewable buildout *higher than that predicted* by a strictly economic model
  - This has been seen across the country, and many subregions of the Pacific Northwest are very suitable for renewables
- Thermal capacity will see declining capacity factors even when still needed for reliability
  - Flexible capacity will be the key resource for economically accommodating increasing renewable penetrations
- Utility resource plans show increasing levels of renewables and storage builds with retirements of coal and natural gas resources

# Forecasting Supply Stacks (2)

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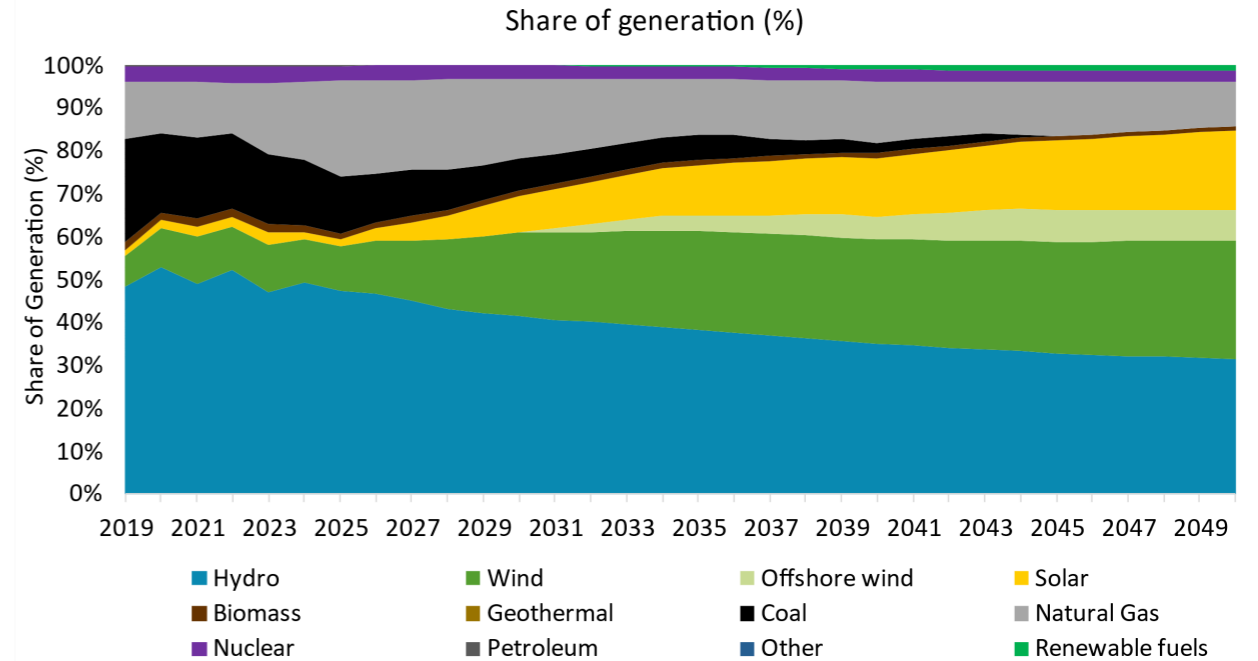
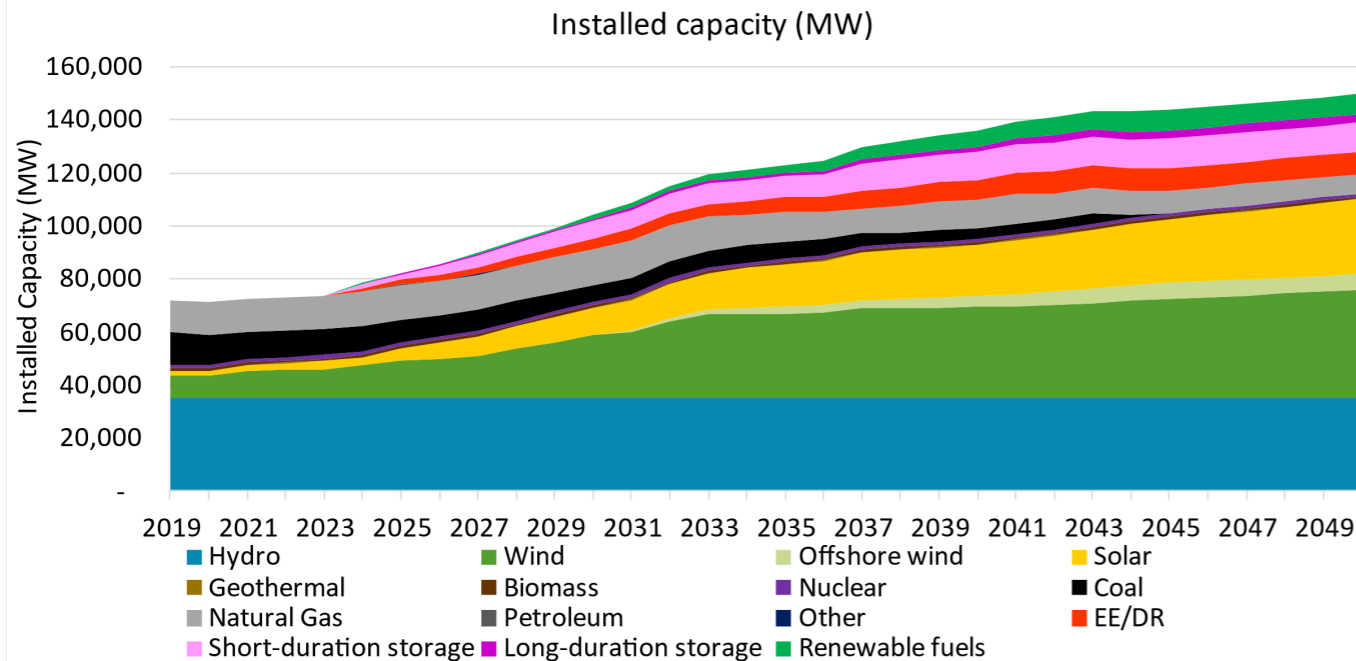
- Ascend's supply stack forecast incorporates:
  - IRP document reviews
  - Regional reports (NWPCC, PNUCC, NWPP, etc.)
  - WRAP developments (ELCC, reserve margins)
- Capacity is at risk of shortage in the near term due to fossil fuel retirements
  - WRAP has improved resource adequacy outlook for the region in the near term due to resource diversity
  - New resource builds should maintain regional adequacy despite capacity retirements
  - Transmission constraints in the Northwest affect deliverability of capacity to load centers
- Clean energy requirements will be met in Washington and Oregon
  - Idaho Power is aiming for 100% clean by 2045; Ascend projects Idaho will reach 90% clean energy by 2045
  - Montana has no stated goals, but NorthWestern is supplying 60% of energy with clean resources

# Challenges with Mid-C price forecasts

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- Market data is scarce compared to ISO/RTO regions where hourly data publicly exists for renewables, ancillary prices, system load, etc. that cannot be pulled for Mid-C
- Hydro power dominates the PNW, leading to high levels of seasonal and annual uncertainty (dry years vs wet years)
- Resource adequacy is evolving and uncertain
  - Peak demand is expected to see larger growth in summer months relative to winter months, with the potential for peaking in either season
  - WRAP introduction has led to better standardization of ELCC by subregion
- Ascend relies more on IRPs from utilities in the PNW to inform supply stack projections
  - Utility plans are not coordinated under a single framework

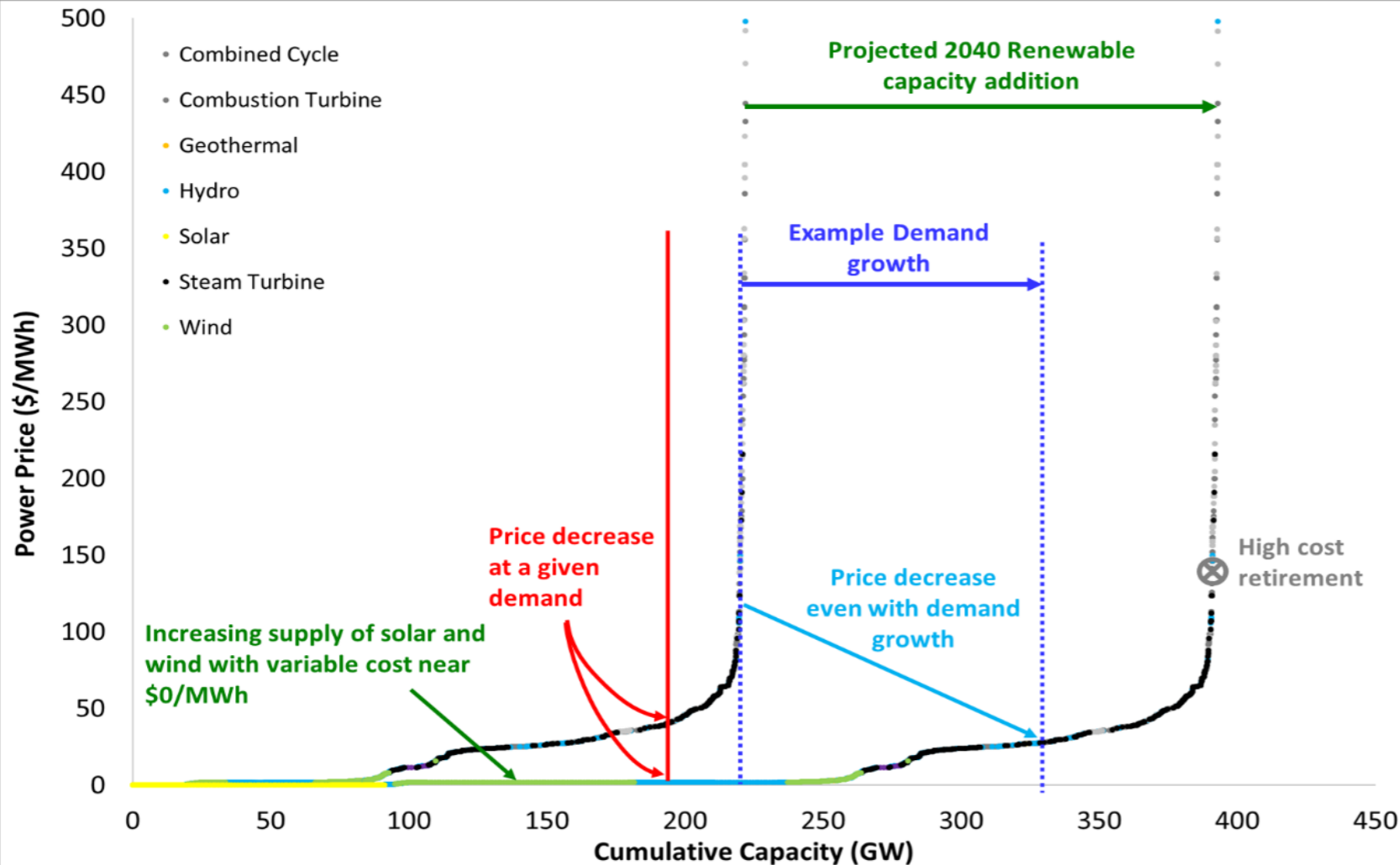
# PNW Supply Evolution: the Change Will Continue



- Coal in the PNW is expected to see significant retirements in the 2020s and 2030s
- Hydro will continue to be the primary contributor to generation, with solar and wind replacing much of the remaining thermal generation as PNW states and utilities pursue decarbonization and clean energy targets
- Offshore wind will grow in the 2030s through the 2040s as an additional renewable resource to meet state targets
- Storage will be the primary capacity replacement for retiring thermal generation, followed by renewable fuel generation
- Renewable fuel (H2) expected to be needed in WA and OR to meet clean energy mandates

# Renewables are the New Baseload

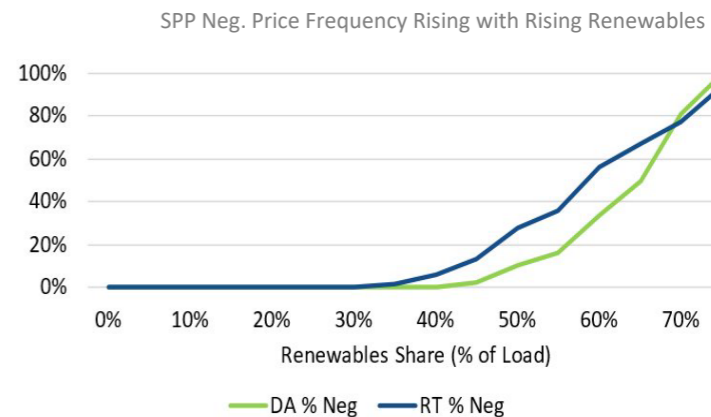
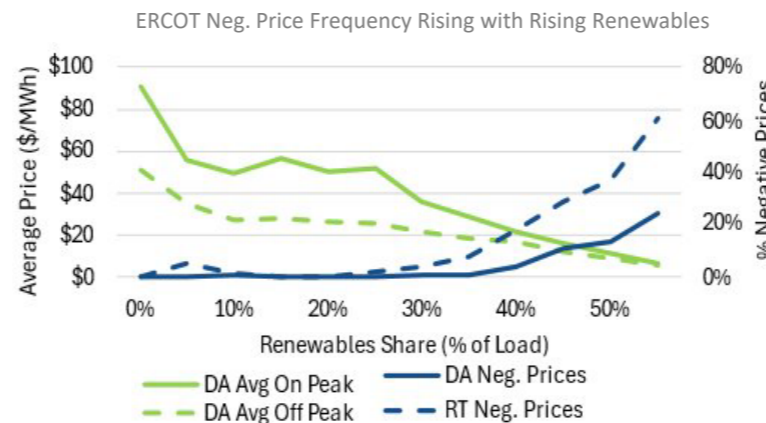
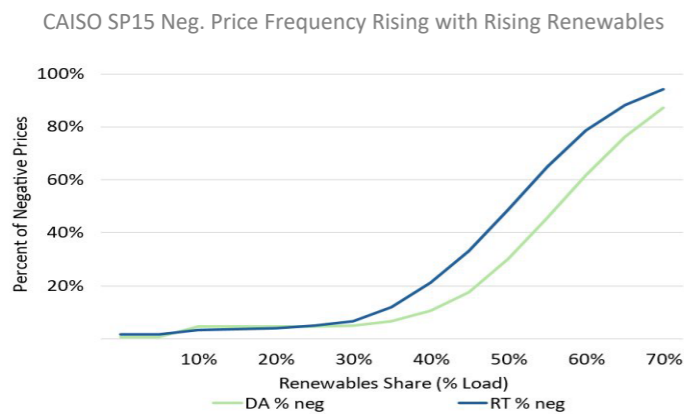
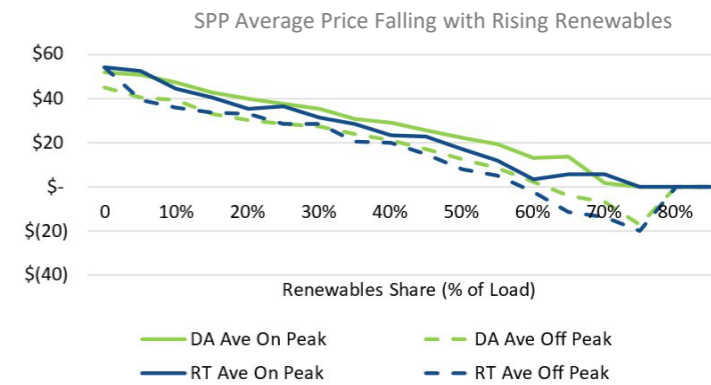
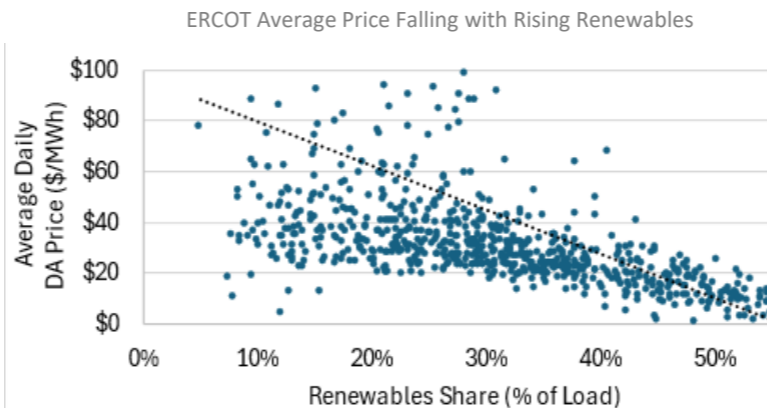
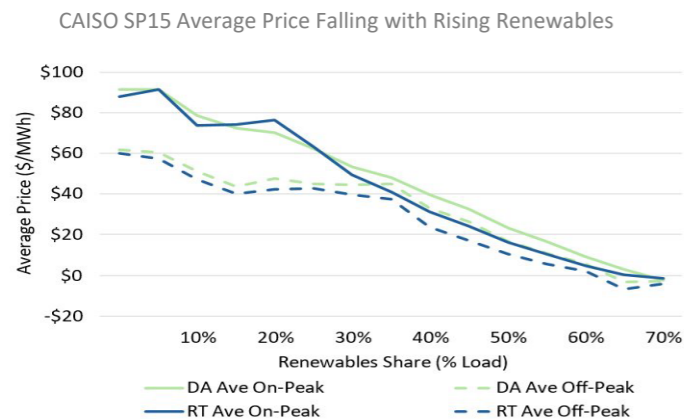
WECC's supply evolution will result in higher price volatility but a lower mean price



Renewables shift supply right, which reduces the **average** price of energy.

But their inherent intermittency increases the **volatility** of prices.

# Price Depression with Increasing Renewables Occurs Across Markets



**CAISO**

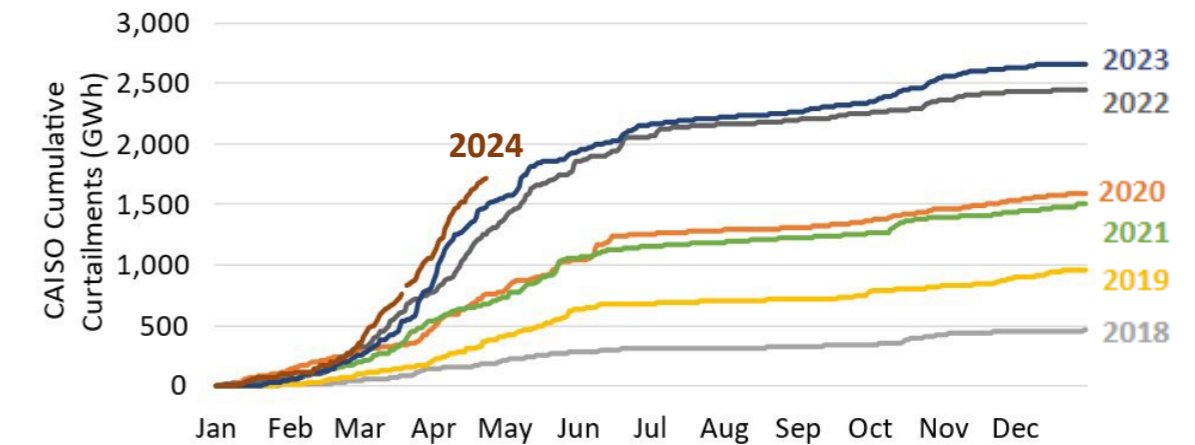
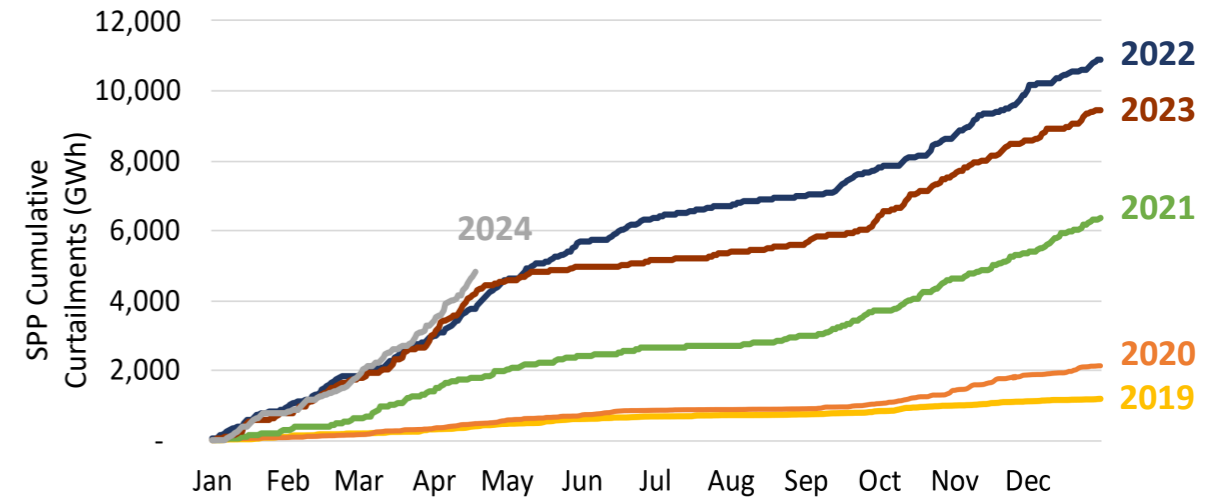
**ERCOT**

**SPP**

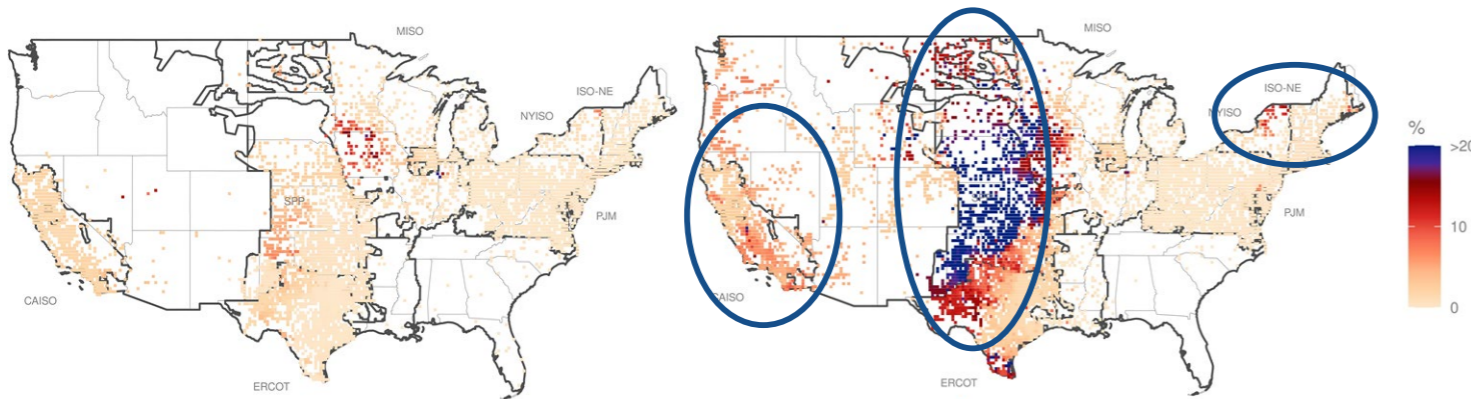
- Across all markets with substantial renewable penetrations, prices are negatively correlated with renewable generation in both the DA and RT markets
- With large amounts of renewables in the queue, these price dynamics are expected to manifest in PNW

# Curtailed Power Becomes Increasingly Common at High Penetration

- Curtailment and negative prices are increasingly occurring in high renewable penetration markets
- These price dynamics will become more frequent in PNW as renewable deployment grows

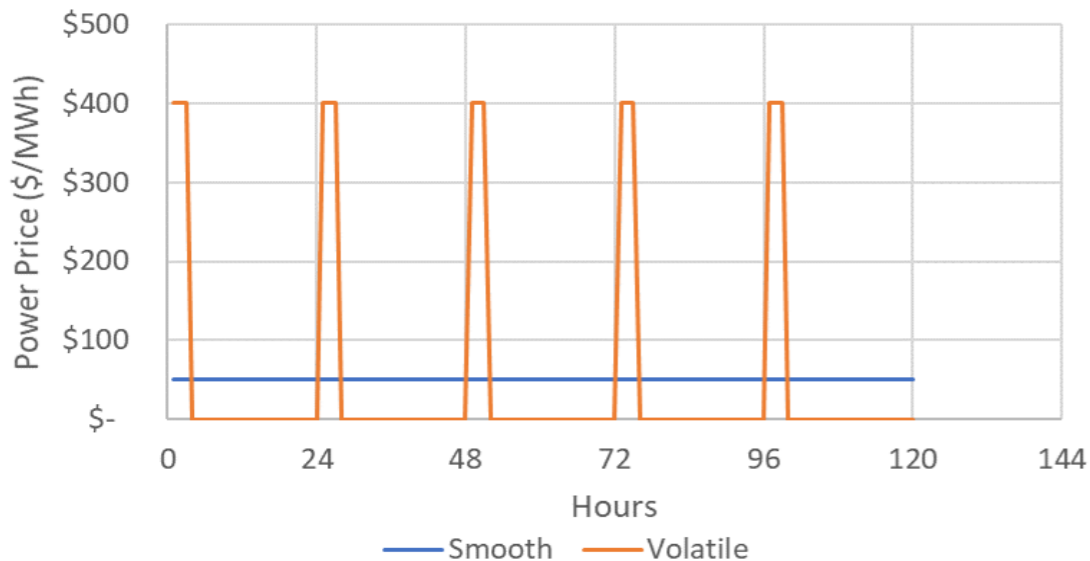


Negative Prices, 2013



# Why 'Average' Prices are not the whole story anymore: A Tale of Two Extremes

- Imagine 2 Price Extremes
  - But same average price (e.g. \$25/MWh)
  - One is **smooth**: constant prices
  - One is **volatile**: only 3h spikes
- Imagine Generators at 2 Flexibility Extremes
  - But same variable cost (e.g. \$30/MWh)
  - One is **flexible**: instantaneous on/off and ramp
  - One is **inflexible**: incapable of cycling or ramping



As prices decrease, inflexible resources must turn off or take losses

With volatile prices, flexible resources can still generate positive revenues despite average prices lower than the variable cost

Flexibility Type	Smooth Prices Daily Net Profit (\$/MW-day)	Volatile Prices Daily Net Profit (\$/MW-day)
Inflexible (must-run)	\$(120)	\$(120)
Inflexible (off)	\$0	\$0
Flexible	\$0	\$510

➤ While this is an extreme example, it demonstrates how **price volatility** creates risk for inflexible units and a premium for flexible resources such as batteries, RICE units, and CTs

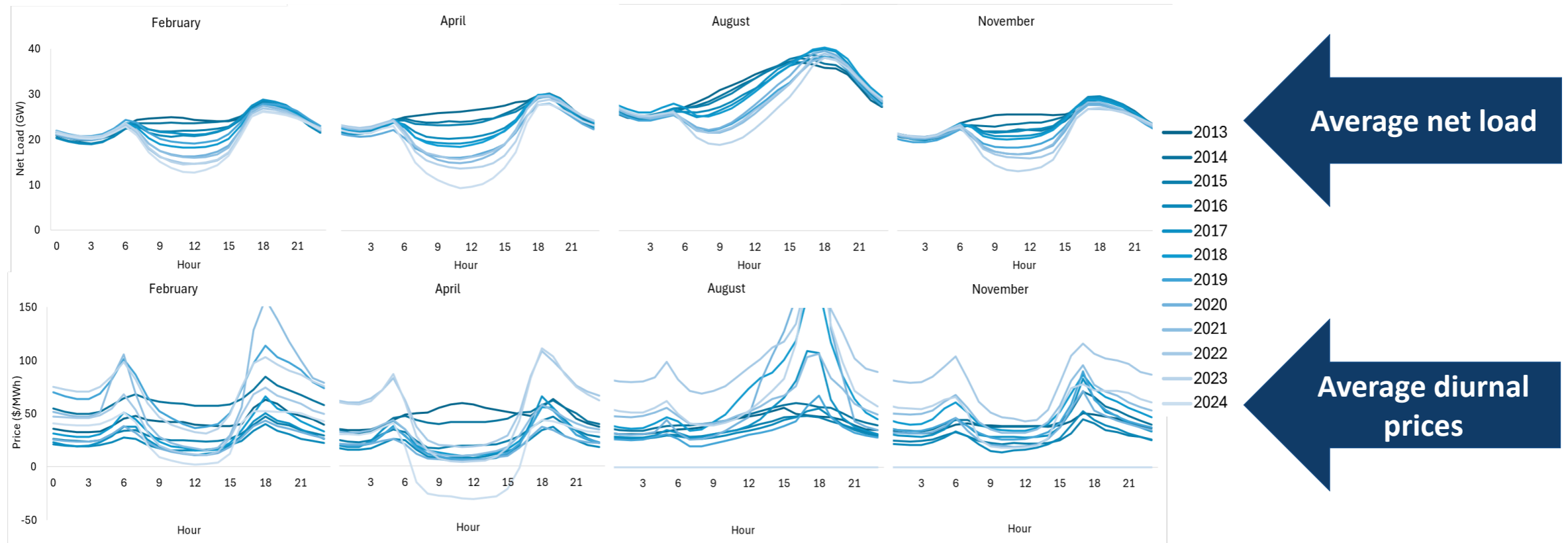


# Solar Penetration vs. Price: CAISO Duck Curve Coming to PNW

Solar will have pronounced impacts on net load and prices, as CAISO has already shown:



On its way to PNW...



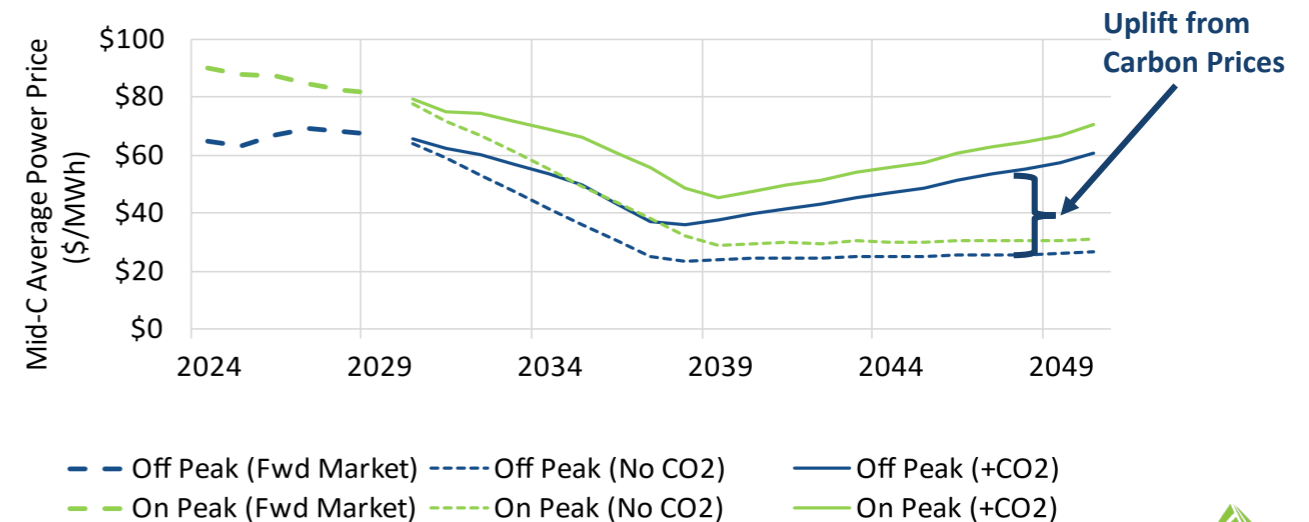
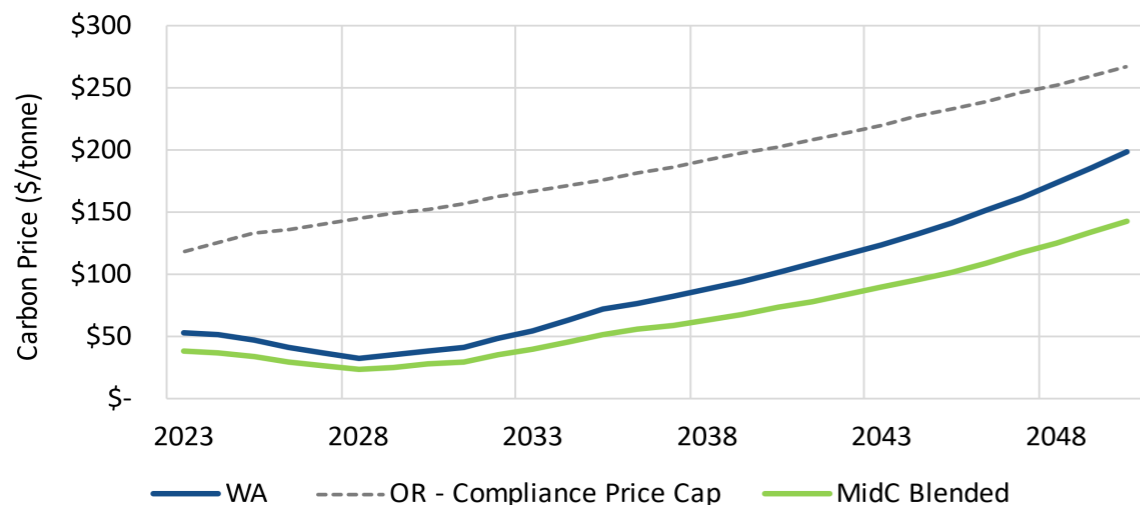
- Implied heat rates decline over time due to renewable entry. As solar penetration increases, mid-day heat rates decline when solar is at its peak production, while afternoon heat rates increase due to inflexible generation during peak load hours.
- As PNW solar penetration increases rapidly, the duck curve effects that CAISO already experiences will begin to impact the hourly price shapes at MidC

Source: Lawrence Berkeley National Lab

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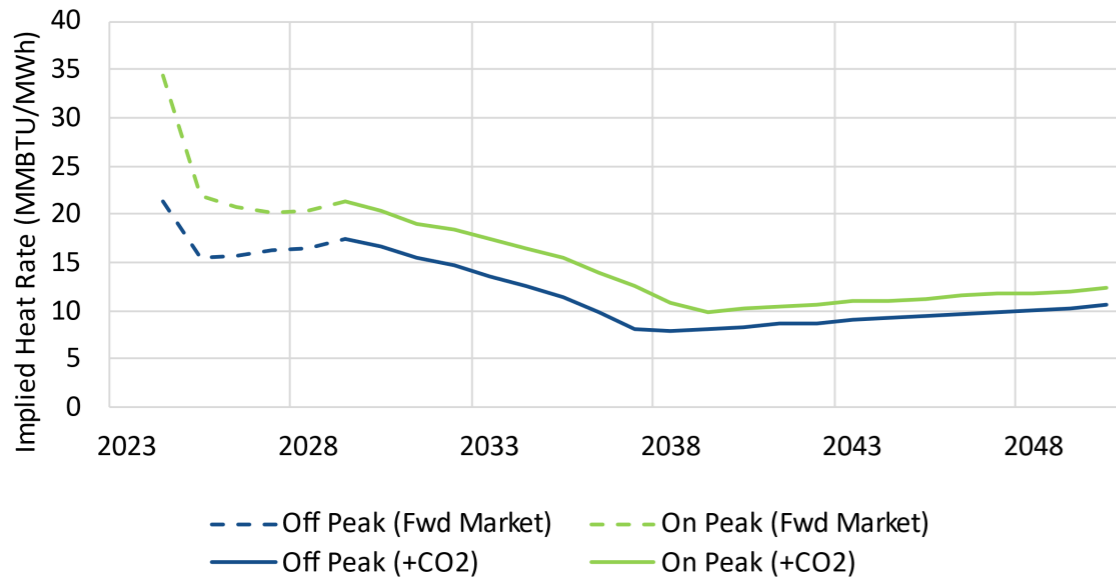
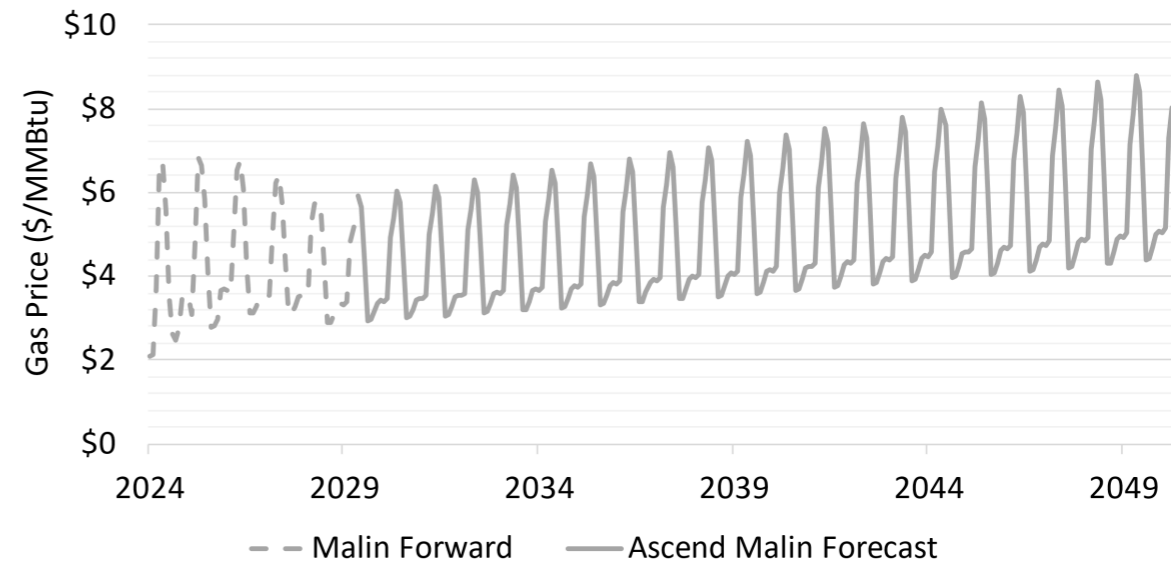
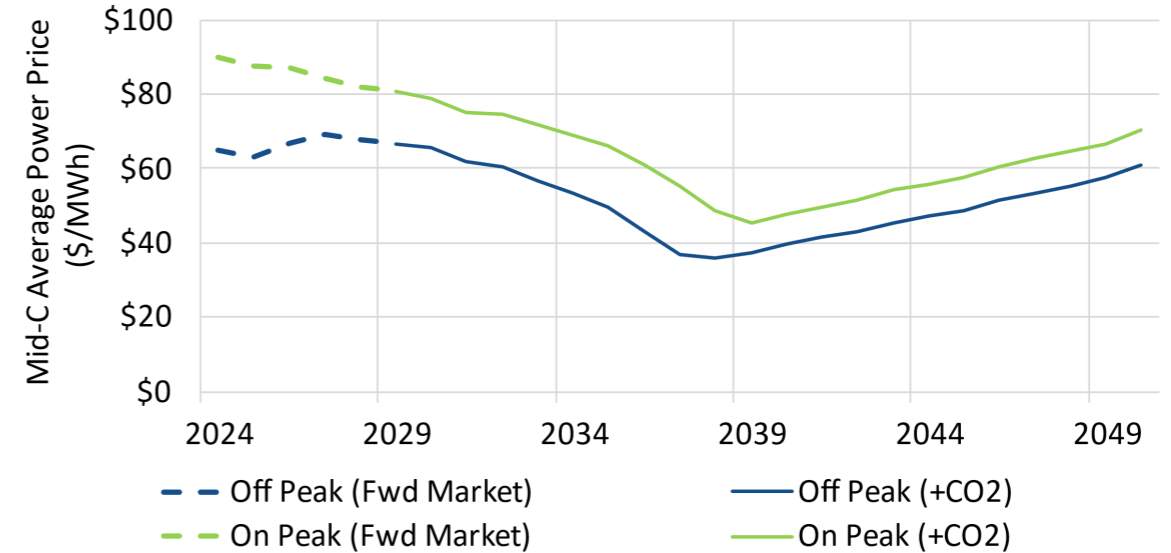
# State Carbon Markets Impact the Whole Pacific Northwest

- Washington and Oregon carbon markets were implemented in 2023
- Oregon has an alternative compliance carbon price cap, which applies when an entity's declining yearly allowance is exceeded. Begins at \$107/tonne in 2023 and increases \$1/year (in 2021 dollars) through 2050
- Washington cap-and-invest market is more nuanced, operating as an auction with an inflation-indexed price floor and ceiling. However, for entities which are required to procure carbon allowances, there is also a set of Allowance Price Containment Reserve (APCR) allowances withheld as a contingency for those who do not procure allowances in the auction.
  - Recent auctions settled around \$30/unit, approximately 20%, or \$5, above the floor price. APCR price is around \$50/unit.
- Carbon prices are not present in all PNW states, but they do impact marginal costs and energy prices across the region.
  - Ascend forecasts a load-weighted regional synthetic carbon price which reflects the impacts of carbon prices on regional energy prices.
  - Impact of Oregon carbon allowances on prices forecasted to be similar to WA carbon prices

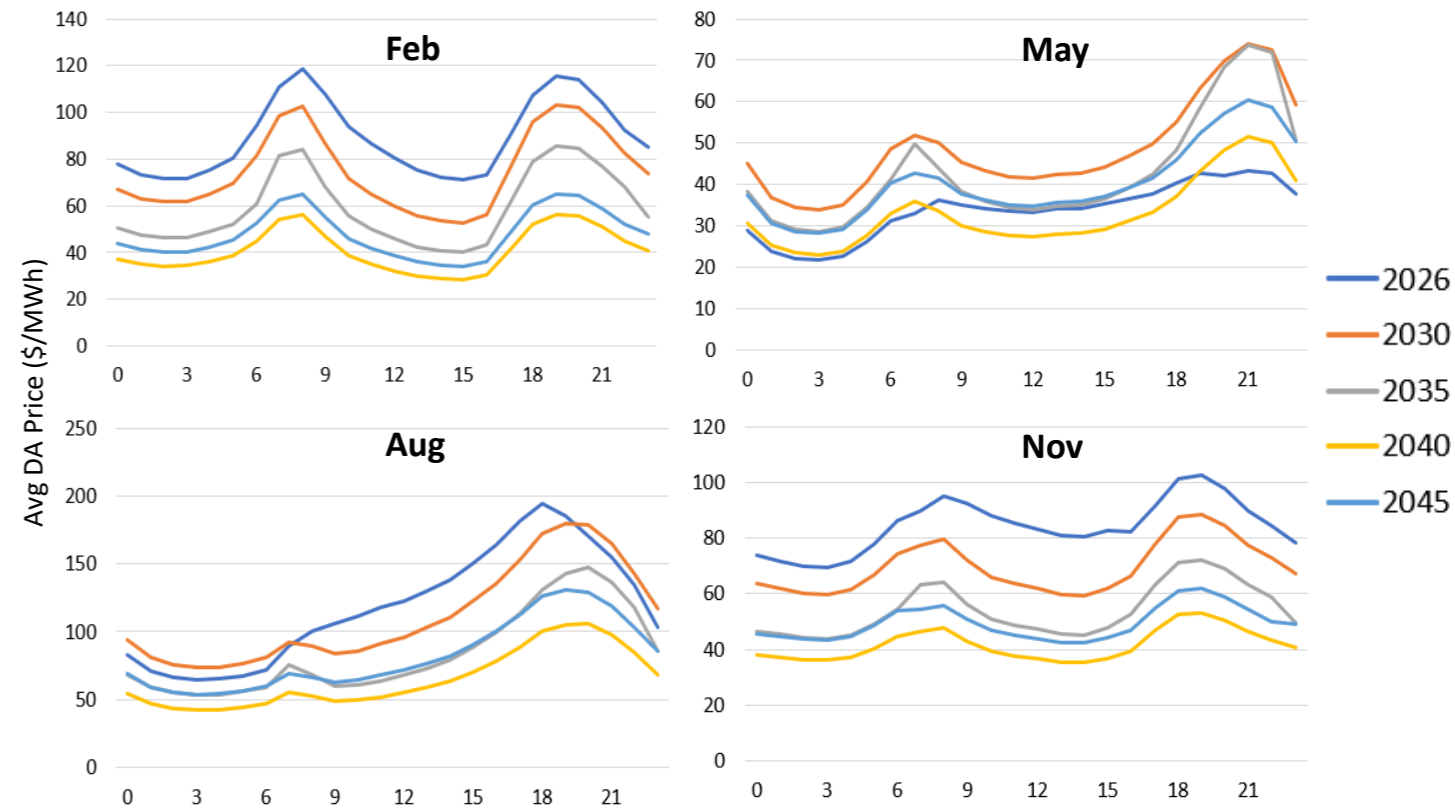
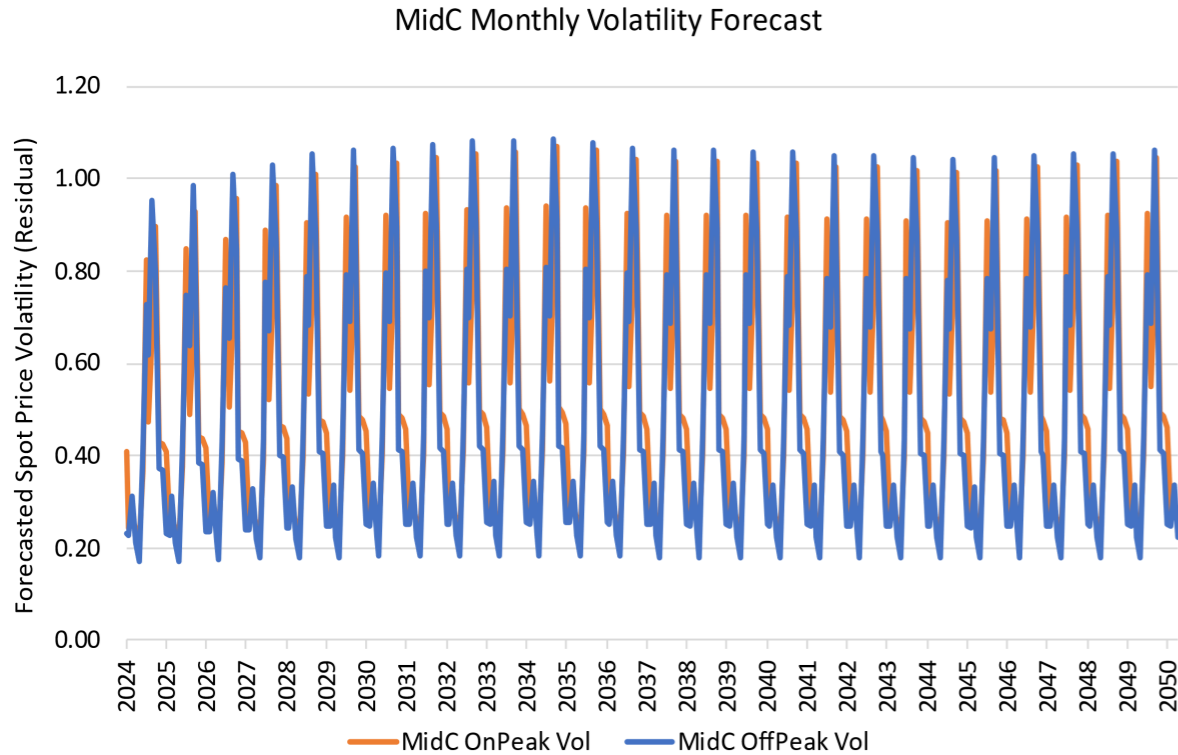


# The Narrowing On/Off-Peak Gap

- **Renewable deployment will depress wholesale prices**
  - Implied heat rates in market forwards are unsustainably high
  - Solar and wind additions to meet clean energy goals will decrease implied heat rates and depress prices
- **On-peak and off-peak power prices will converge over time with increasing solar deployment**
  - In CAISO, on-peak forwards are already dropping below off-peak
  - As solar buildout grows relative to wind, on-peak prices will experience greater downward price pressure
  - Carbon prices took effect in 2023 in OR and WA



# The Duck Curves Heading to the Northwest



- Volatility will grow through the 2020s due to increasing renewable deployment before beginning to taper back in the late 2030s with storage deployment.
- The belly of the duck continues to drop through the 2020s before beginning to rebound in the late 2030s. Meanwhile carbon prices will maintain or push up prices during sunset net load ramps.
- Volatility and duck shapes will not disappear because price deltas are needed to create the incentive for storage to dispatch

# Key Takeaways

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- **The Pacific Northwest will need flexible clean capacity resources** such as storage and renewable fuels in addition to continued solar and wind buildout to maintain reliability as clean energy targets become more aggressive, thermal retirements accelerate, and electrification drives continued load growth.
- **Utilities have increased solar and storage presence in their resource plans** following the passage of the IRA. However, in the face of supply shortage and reliability concerns, some utilities are reconsidering some renewable positions in favor of thermals.
- **Renewable development will depress both off-peak and on-peak energy prices** while increasing price volatility. On-peak prices will approach off-peak prices as solar deployment grows.
- **Carbon allowance markets in Washington and Oregon will put pressure on thermal units** across the region while providing economic support for renewable generation.
- **Most western utilities are expected to join one of the developing day-ahead markets in the WECC** (SPP Markets+ or CAISO EDAM), but concerns around governance drive significant uncertainty around which market different utilities will join.
- **WRAP began non-binding operations in 2023** and will phase in binding operations in coming years. This is expected to result in more efficient allocation of capacity resources across the region.
- **Transmission expansion in the greater WECC region is needed** and would both alleviate resource adequacy concerns and facilitate better integration of emerging markets.



Better models. Better decisions.

## Contact Information

Brent Nelson, PhD, Managing Director of Markets and Strategy

[bnelson@ascendanalytics.com](mailto:bnelson@ascendanalytics.com)

Gary Dorris, PhD, CEO

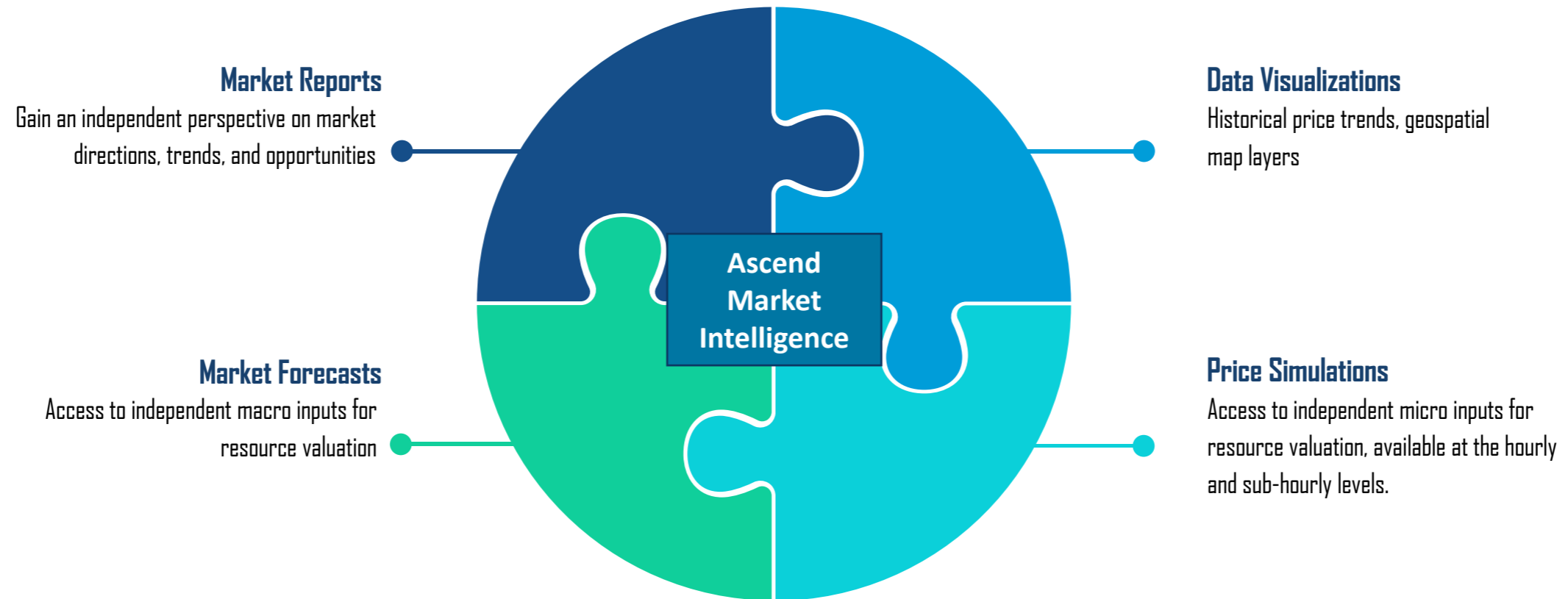
[gdorris@ascendanalytics.com](mailto:gdorris@ascendanalytics.com)

### Headquarters:

1877 Broadway St  
Suite 706  
Boulder, CO 80302  
303.415.1400

# Ascend Market Intelligence Product Offerings

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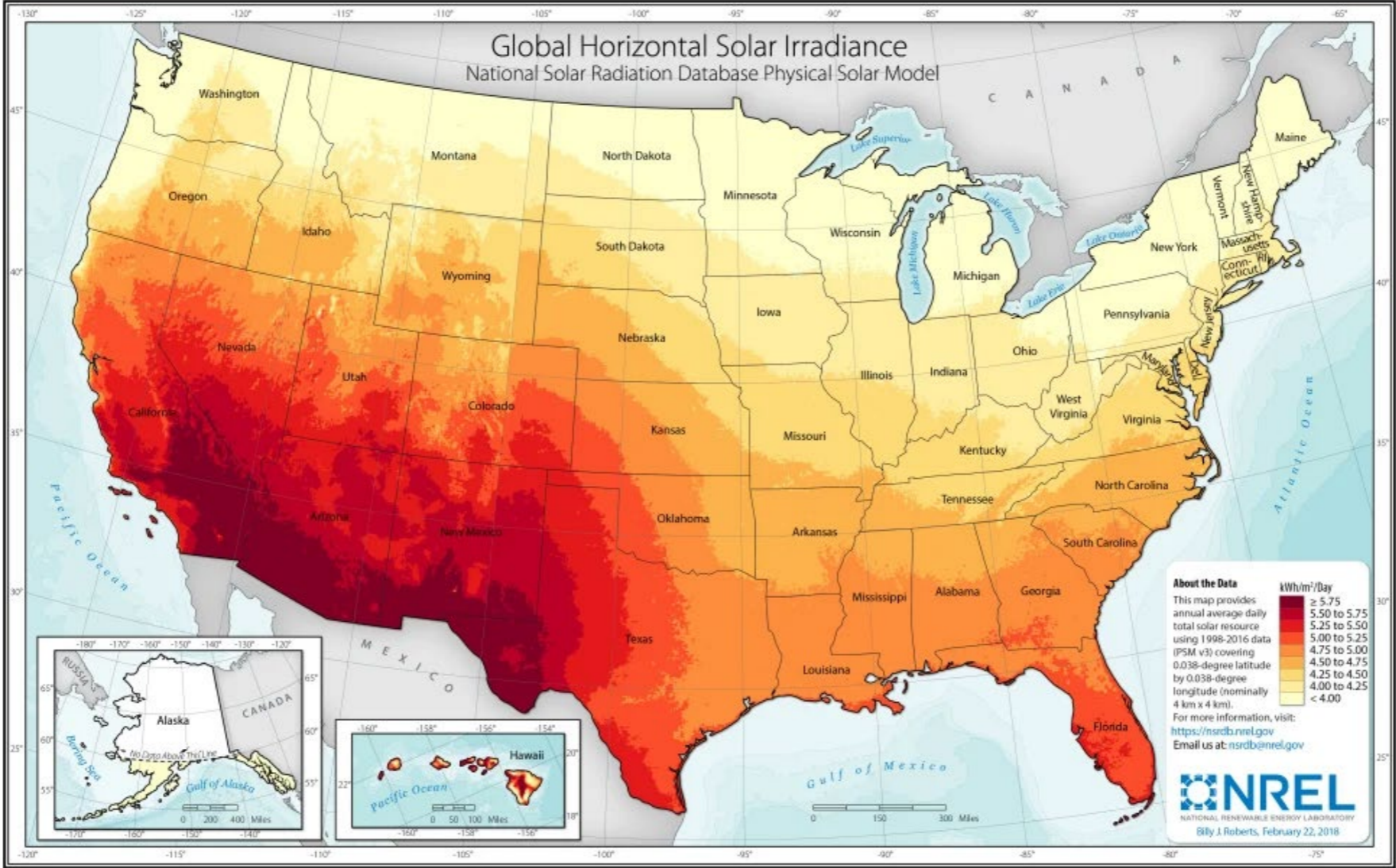
# Appendix



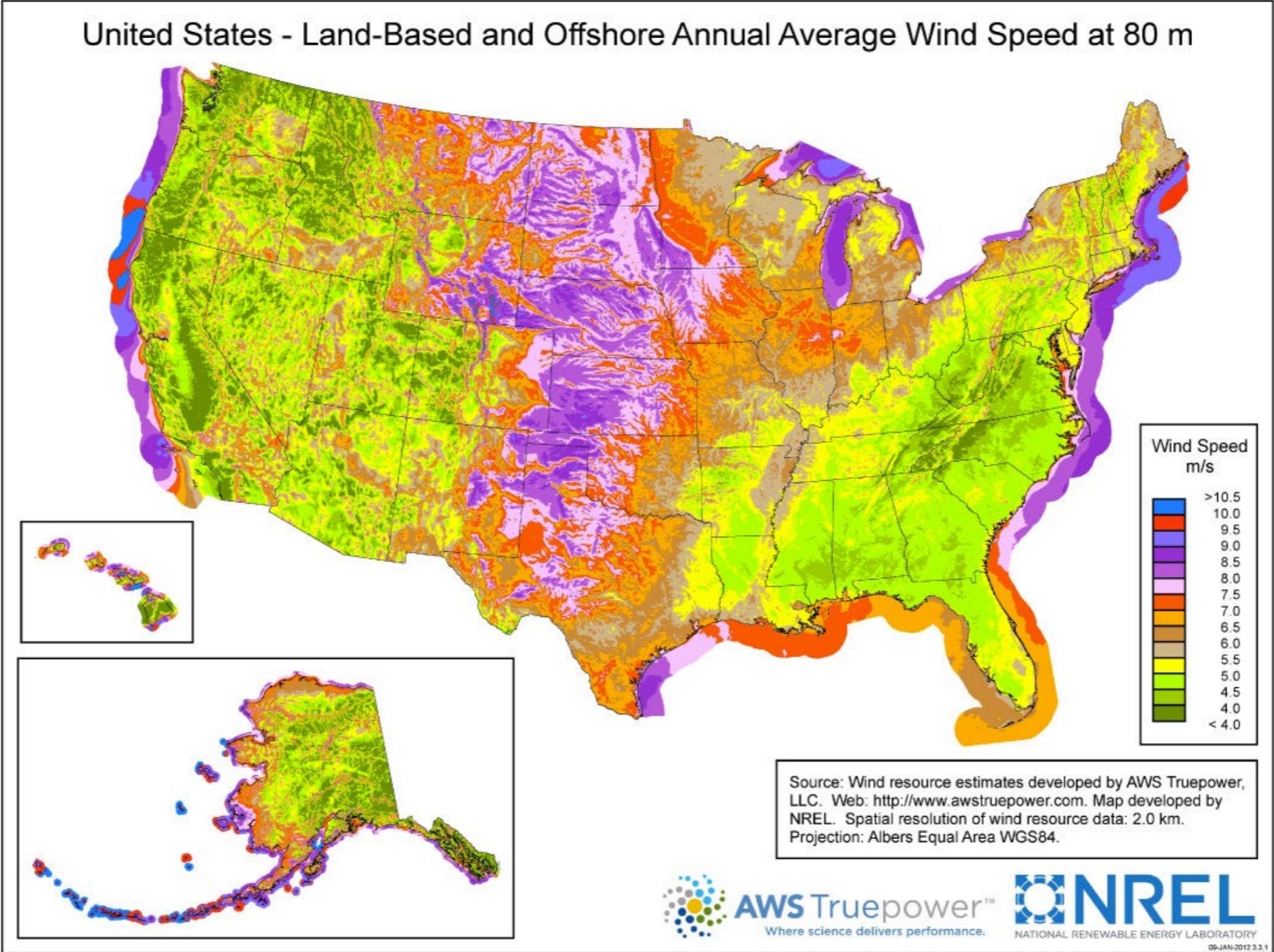
# WECC PUC Structures

State	Number of Members	Appointment Process
Arizona	5	Statewide election
Colorado	3	Governor Appointed Senate Confirmed
Idaho	3	Governor Appointed Senate Confirmed
Montana	5	Statewide election
Nevada	3	Governor Appointed
New Mexico	3	Governor Appointed Senate Confirmed
Oregon	3	Governor Appointed Senate Confirmed
Utah	3	Governor Appointed Senate Confirmed
Washington	3	Governor Appointed Senate Confirmed
Wyoming	3	Governor Appointed Senate Confirmed

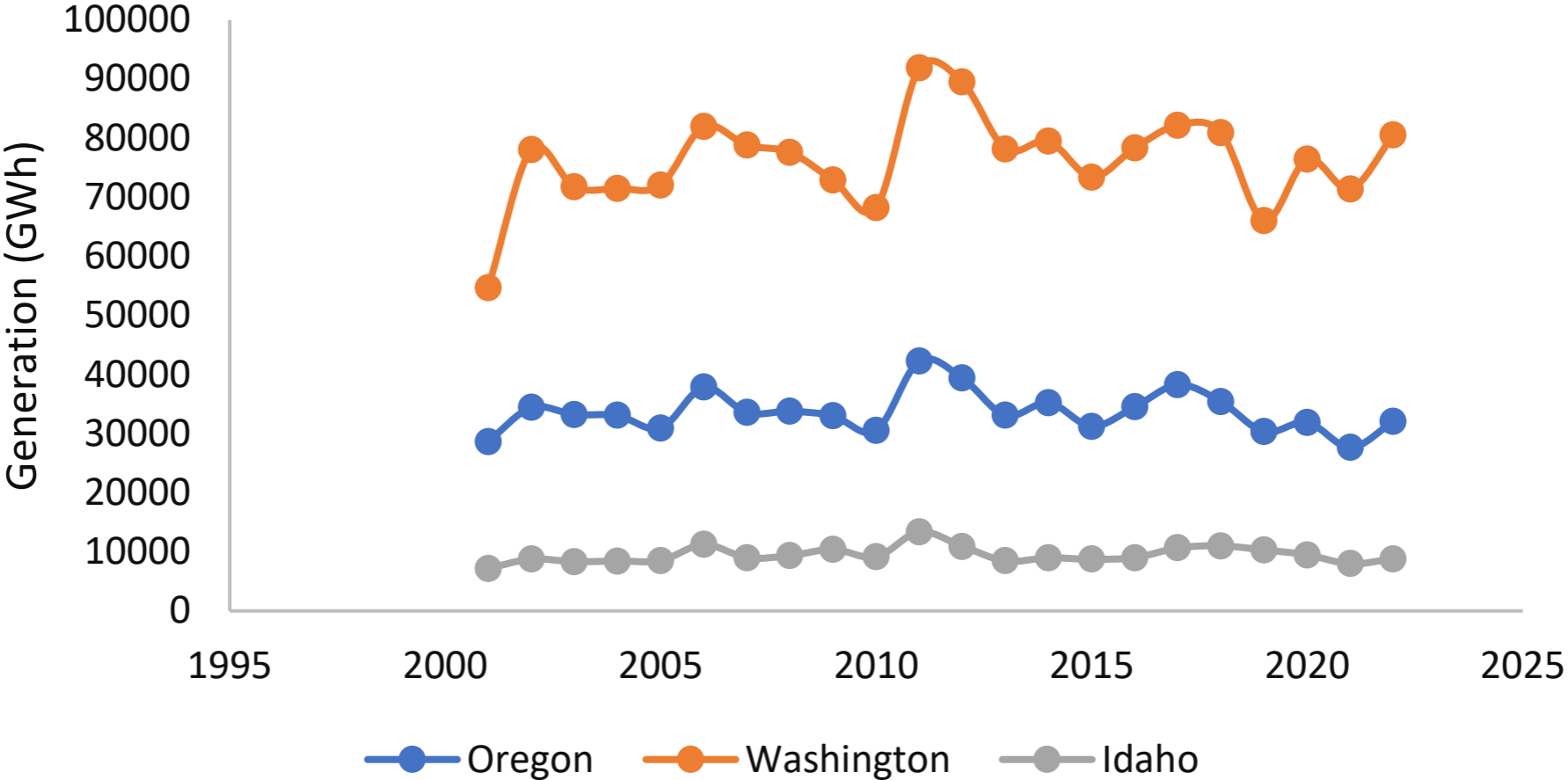
# US Solar Resource Map



# US Wind Resource Map



# Pacific Northwest Historical Hydro Generation by State



# Load Factor Comparison of WECC States

