

# Resource Planning Advisory Council Meeting

March 27, 2023

# Logistics & Introductions



Presenters will pause occasionally for clarifying questions.



Save in-depth comments and questions for the Q&A sessions.



During periodic pauses for clarifying questions:

- If joining remotely, raise your “hand” to provide comments or ask questions.
- Identify yourself and your organization.
- Please speak clearly.



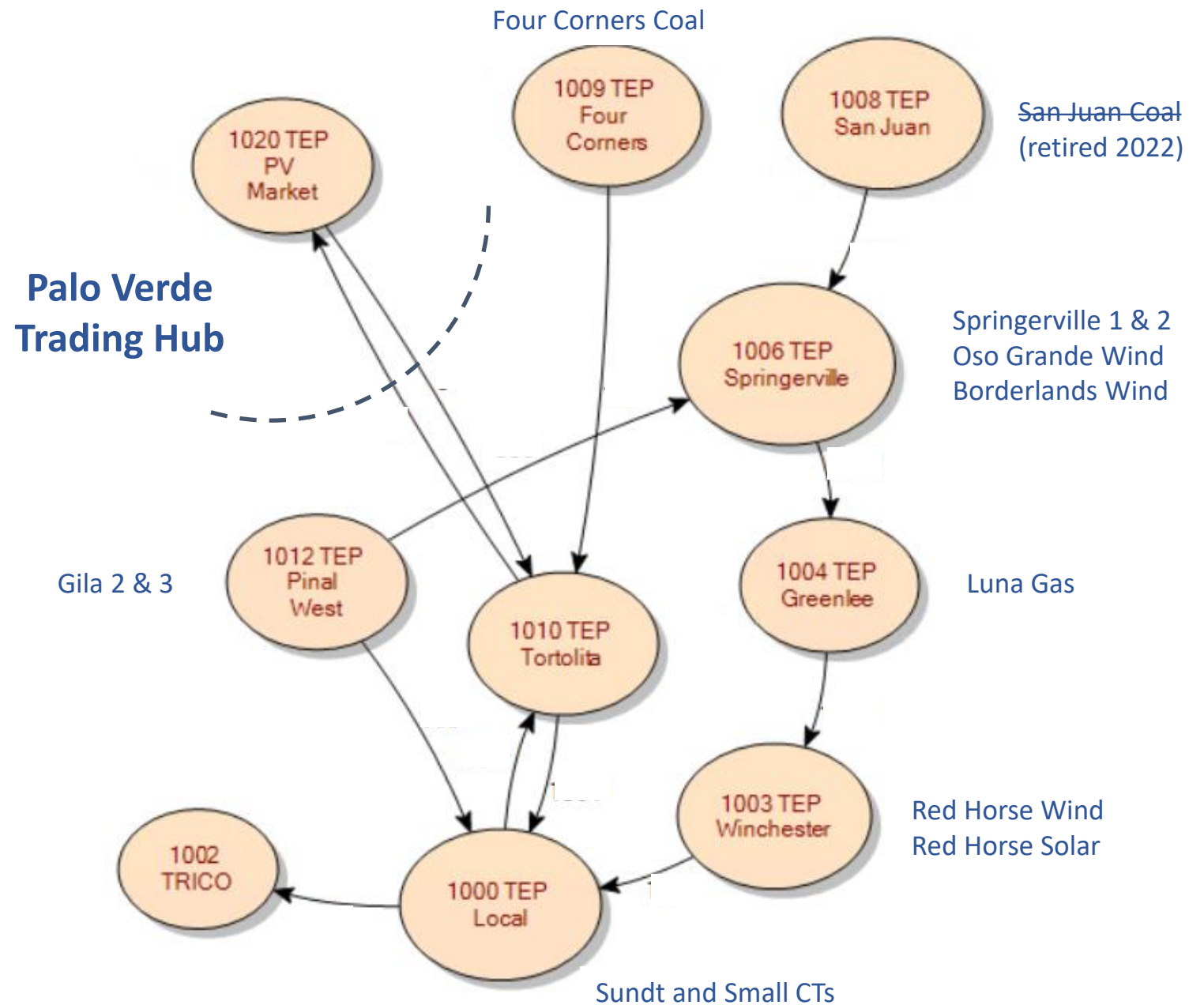
The chat box will **only** be monitored for reports on **technical difficulties**.

# Today's Agenda

- Modeling the Western Grid to Derive Wholesale Electricity Prices
  - Southwest market price forecast by E3
- IRP Status Update and Next Steps

# How TEP/UNSE Uses Wholesale Market Prices

- Resource planning rules require that we do not rely on the market for capacity / resource adequacy beyond 5 years
- Market “turned off” to determine resource-adequate portfolios
- Model re-run with market on to determine likely dispatch, net operational costs, emissions, etc.
- Market can be turned on for only portion of day to allow for some trading / battery charging but not much resource adequacy





# Southwest Market Price Forecast E3 Core Case

March 2023 edition



Energy+Environmental Economics

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# Disclaimer

*E3 created the following forecasts and analyses using the best available public information and our expertise and knowledge of the relevant markets, along with commercially available 3rd party software models and proprietary in-house energy market price forecasting tools. However, the future is uncertain, and these forecasts (along with underlying market expectations) may change due to many factors, including unforeseen events, new technology adoption or inventions, new market structures, regulatory actions, and changes in both state and federal government policies. E3 makes no guarantees related to these forecasts or the information presented herein and should not be held liable for any economic damages associated with independent investment decisions.*




# Energy Markets in the West: CAISO

## + CA Independent System Operator (CAISO) manages the only wholesale energy market in the West

- Day-Ahead Energy Market (hourly)
- Real-time Energy Markets (15-min and 5-min)
- Ancillary Services Markets
- Resource Adequacy Program (bilateral contract market)

## + CAISO also manages the Energy Imbalance Market (EIM)

- EIM is fully integrated within the CAISO real-time energy market
- Participants are Balancing Authorities across the West 
- Facilitates and settles transactions for energy transferred between BAs

## + Proposed Day-Ahead Regional Markets

- **CAISO Extended Day-Ahead Market (EDAM)** (proposed)
- **SPP Markets+** (proposed)
- CAISO and SPP offer competing proposals for WECC utilities to join
- Significant potential benefits, but these depend on which utilities participate in which initiative...

## CAISO EIM Participants



Map boundaries are approximate and for illustrative purposes only.

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# Energy Markets in the West: Bilateral Trading

- + Outside of the CAISO wholesale market, energy trading is done bilaterally in the West through exchanges which match buyers and sellers (for example, the Intercontinental Exchange or ICE)
- + Two major trading hubs exist:
  - Mid-Columbia (“Mid-C”) in Washington
  - Palo Verde in Arizona
- + Energy is traded in hourly “blocks” through standardized “Over the Counter” (OTC) contracts
  - “On-Peak” | hours ending 7 to 22 (7am to 10pm) Mon. to Sat.\*
  - “Off-Peak” | hours ending 23 to 6 (11pm to 6am) Mon. to Sat. and hours 1-24 Sun. + Holidays\*
  - These blocks are traded for the next day (Day-Ahead) and for specific months in the future (i.e. the On-Peak period in August)
- + Traded prices are set based on suppliers’ willingness to sell and buyers’ willingness to buy
- + Traded volumes of power (MWh) at bilateral hubs cover only a small portion of total electricity demand in each region → this is different from the CAISO market, in which 100% of generation is cleared at the market price in each hour of every day.

\* ICE Product Specification: [PSpec\\_OTC\\_Electricity.pdf \(theice.com\)](https://www.theice.com/Products/OTC_Electricity)



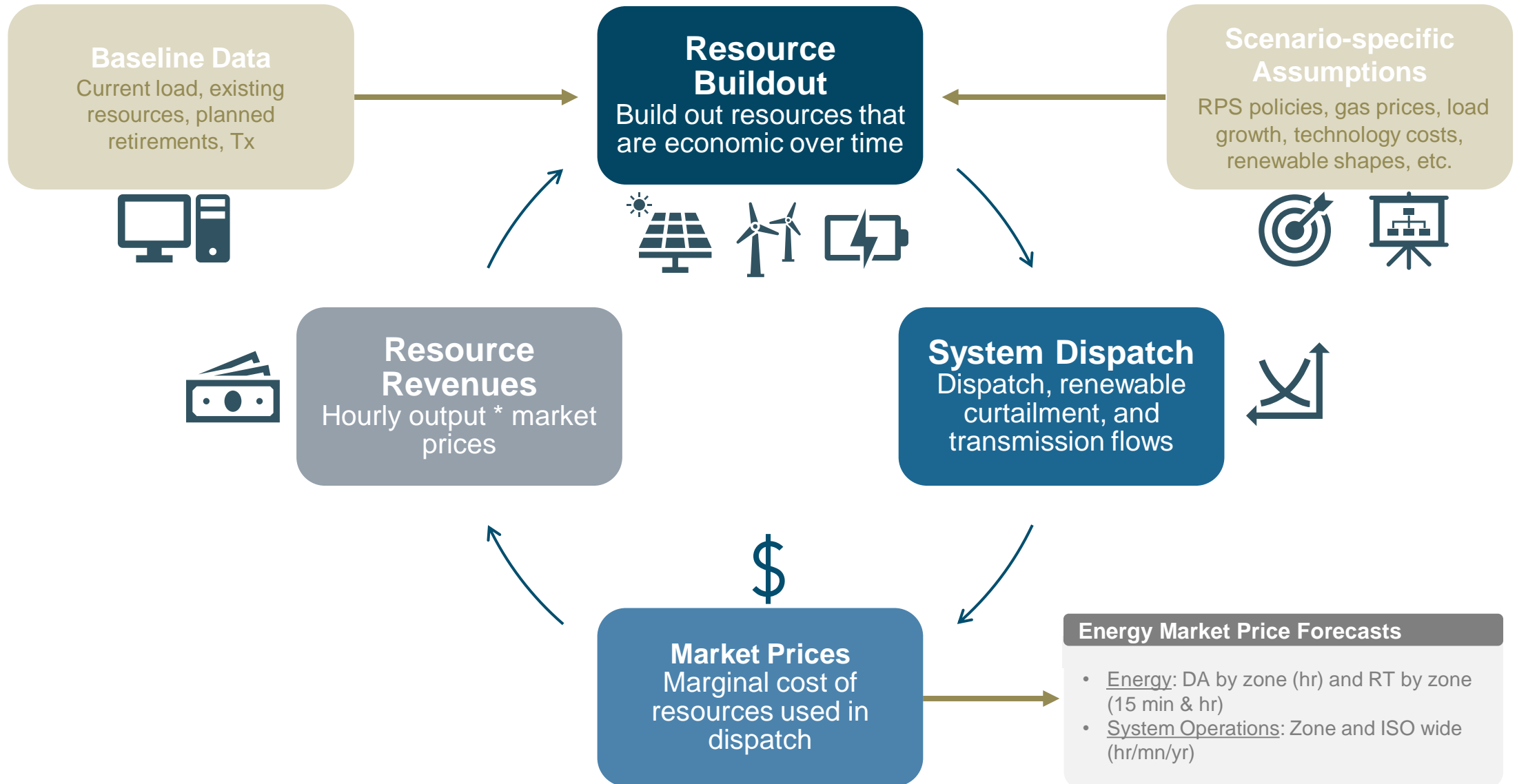


# What are E3's Palo Verde Market Price Forecasts?

- + E3 provides an hourly price forecast that reflects the market premiums and bidding behavior expected in future Day-Ahead On-Peak/Off-Peak trades at Palo Verde
- + These “future day-ahead prices” are different from month-ahead forward prices at Palo Verde
  - For example, forward prices (On-Peak energy for August next year) will be different from On-Peak energy traded one day in advance of a day in August of next year
  - This is because i) there is greater risk to sell power forward at a fixed price farther in the future (vs. tomorrow), and ii) the commitment to deliver power far in the future (next August) represents a firm commitment with capacity value, and this capacity value has a cost—for example, if a generator commits to selling power in AZ next August, this same generator cannot participate in California’s Resource Adequacy market for next August.
- + Why does E3 forecast an hourly price stream at Palo Verde and not simply an On-Peak and Off-Peak block price?
  - Hourly price shapes are more informative for resource planning and procurement decisions, especially because hourly price shapes are likely to change over time as loads and resources change (especially with renewables)
  - CAISO has a network point at Palo Verde which has a Locational Marginal Price (LMP) in CAISO’s Day-Ahead and Real-Time energy markets—these prices inform Day-Ahead traded block prices at Palo Verde
  - E3 produces hourly shapes by modeling the Western Interconnect on an hourly basis over the next 30 years.



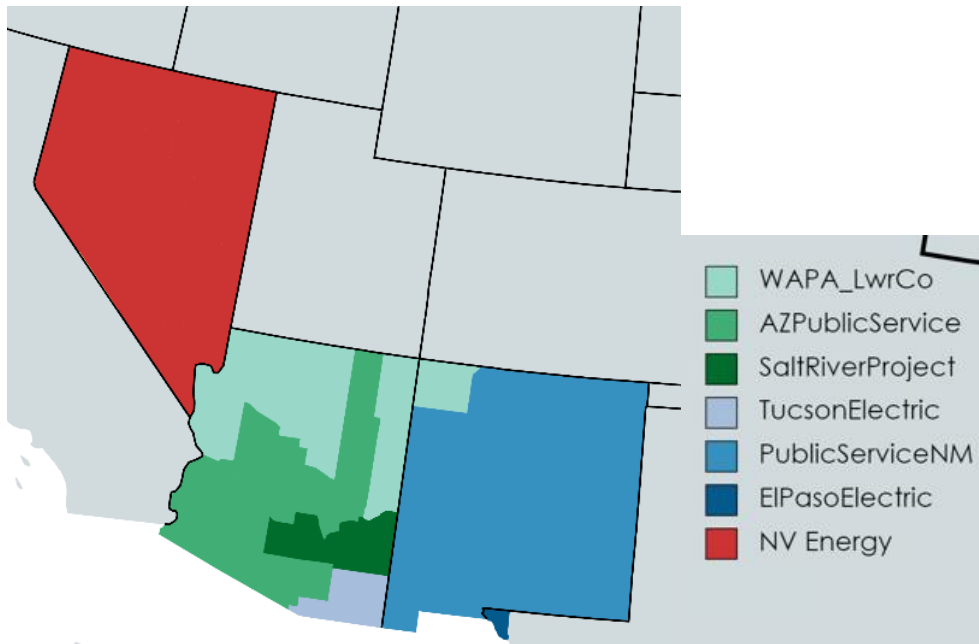
# Modeling Approach for E3 Price Forecasts





# Southwest Region: Model Footprint

- + E3's market forecasts of the Southwest region include 6 Balancing Authorities across 3 states:
  - Arizona: APS, SRP, TEP, WAPA Lower Colorado
  - Nevada: Nevada Energy
  - New Mexico: PNM, EIPasoElectric
- + Energy prices are forecasted as marginal costs of generation by Balancing Authority region



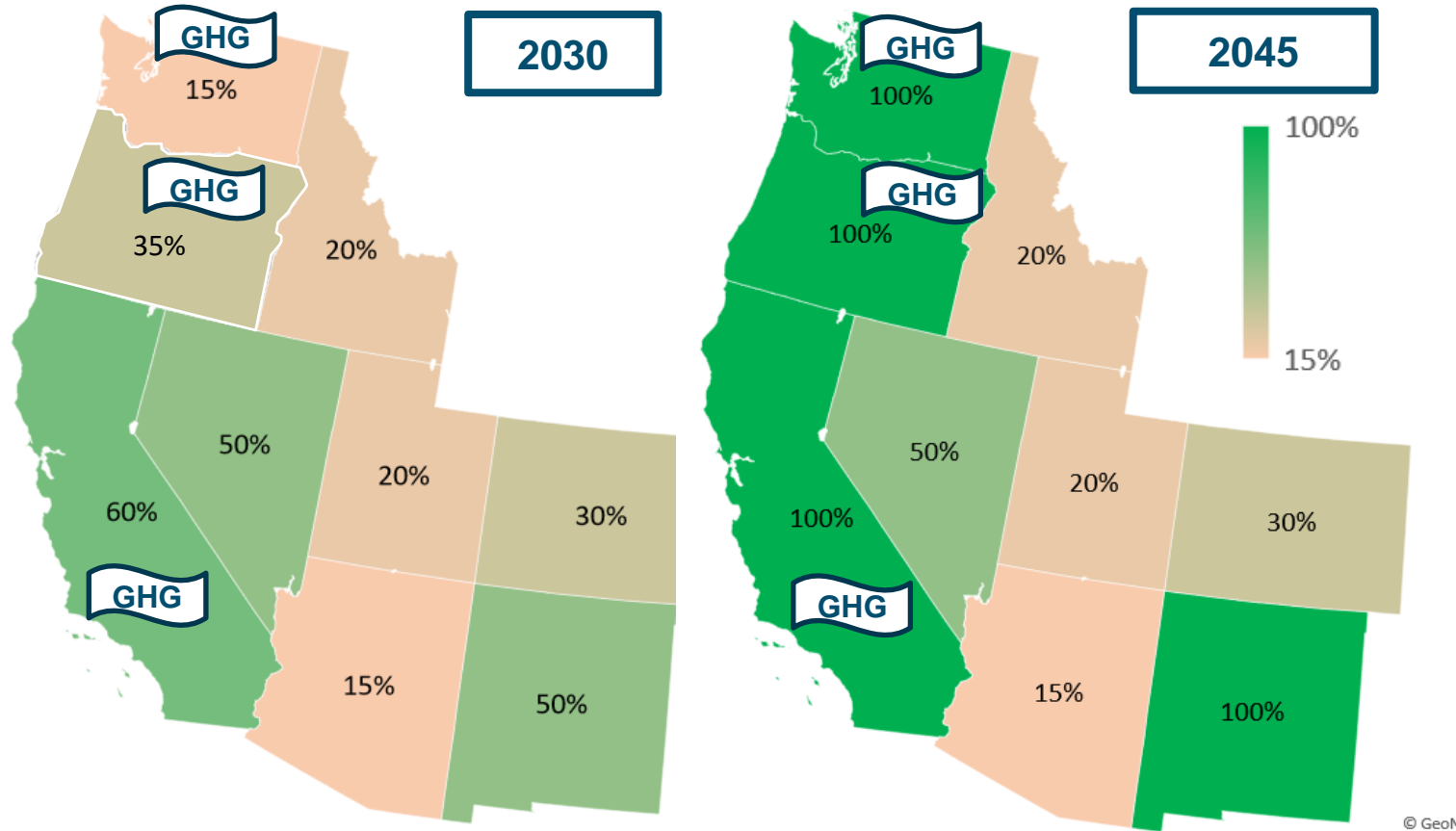
<https://www.wecc.org/epubs/StateOfTheInterconnection/Pages/Western-Interconnection.aspx>





# Clean Energy and Renewable Portfolio Standards (CES and RPS) by 2030 and 2045 in the West

## State Level Targets



Many utilities have commitments that exceed those of their states, especially in states with low or minimal policy goals

## Utility Targets

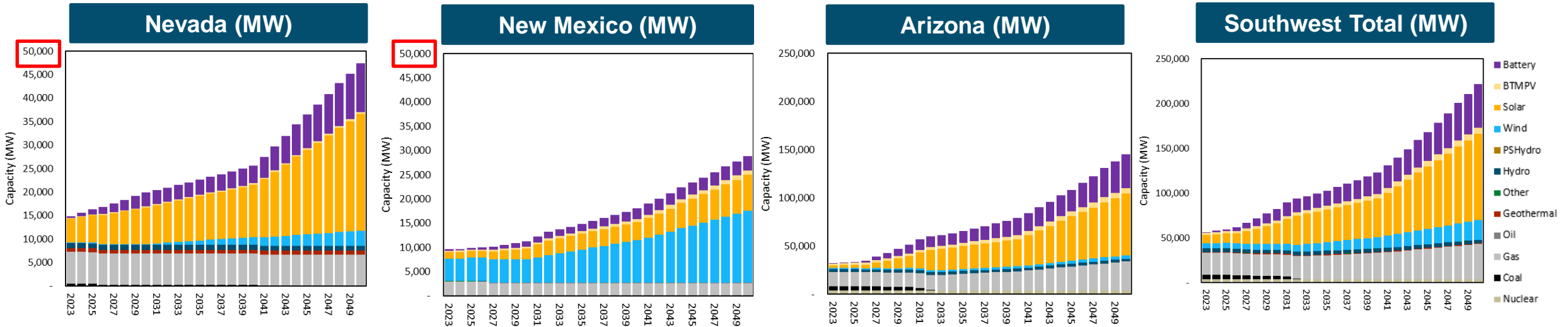
\*Utility has CES and GHG target

Region	Utility	2030	2045	2050
SW	SRP	GHG Target		
	APS	65%	65%	100%
	TEP	GHG Target		
	EPE		100%	100%
	PNM*		100%	100%
	NV Energy			100%
RMT	Black Hills	GHG Target		
	Xcel CO*			100%
	Tri-State*	50%	50%	50%
Basin	Idaho Power		100%	100%
	PacifiCorp East	GHG Target		
PNW	NW Energy			
	Portland General BPA			
	PSE			
	Avista			
	Seattle City Light			
	Tacoma Power	90%	90%	90%
CA	PG&E			
	SCE			
	SDG&E			
	LADWP		100%	100%
	SMUD	100%	100%	100%
	IID			



# Installed Generation Capacity (MW)

\*Note the difference in y-axes

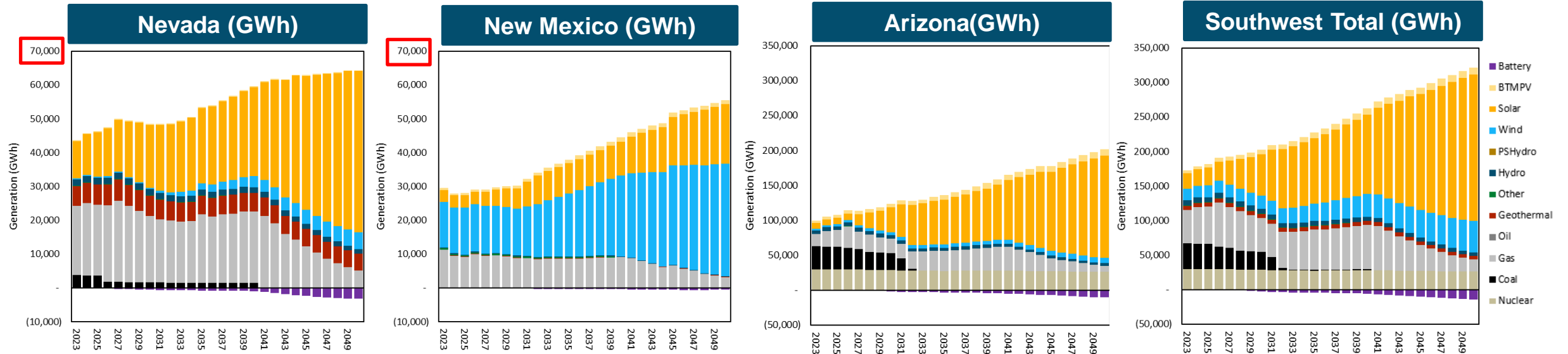


- + Solar is expected to be the largest renewable resource overall in the region over the forecast period
- + Wind is the largest renewable resource in New Mexico which serves in-state and out-of-state demand
- + Storage is added to integrate solar, shift solar generation into evening hours, and provide capacity value
- + All coal capacity is assumed to retire by 2040 (most by early 2030s based on public retirement dates)
- + Palo Verde assumed to remain online through 2050 (past current retirement date)
- + Some new combustion turbines are added to support system capacity needs (alongside battery storage), while gas generation declines over the forecast period to meet clean energy targets



# Annual Generation (GWh)

\*Note the difference in y-axes



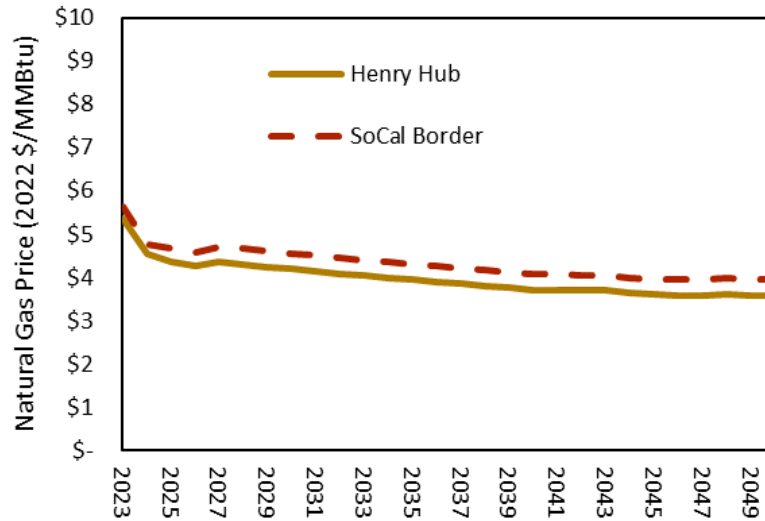
- + **Solar generation is the dominant new renewable resource in Nevada and Arizona, while wind is the most significant resource in New Mexico**
- + **Thermal generation decreases significantly over time and is replaced by solar and wind generation**
  - Most coal generation phases out by 2032 and the last coal plant in the region is retired in 2040
  - Gas generation remains flat through 2040 (while renewables increase to cover load growth)
  - Gas generation declines from 2040-2050 to meet long-term policy targets
- + **New Mexico wind is exported to other states as a low-cost complement to in-state solar resources**



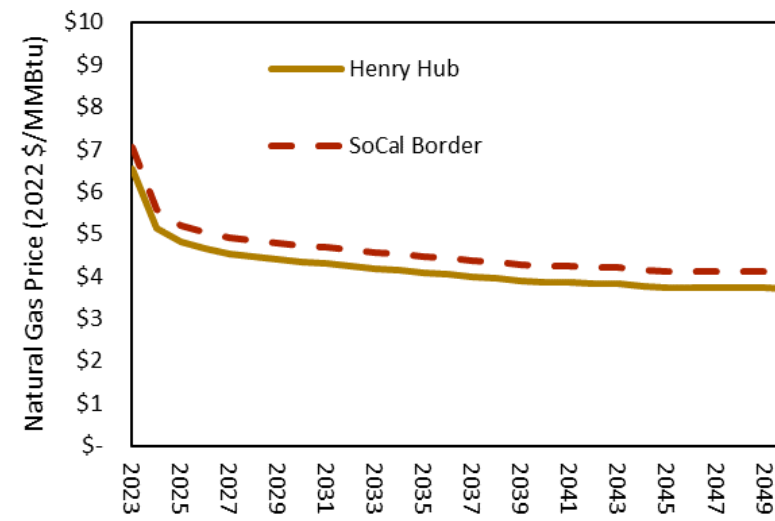


# Gas Price Forecast

### Summer Gas Price (2022 \$/MMBtu)



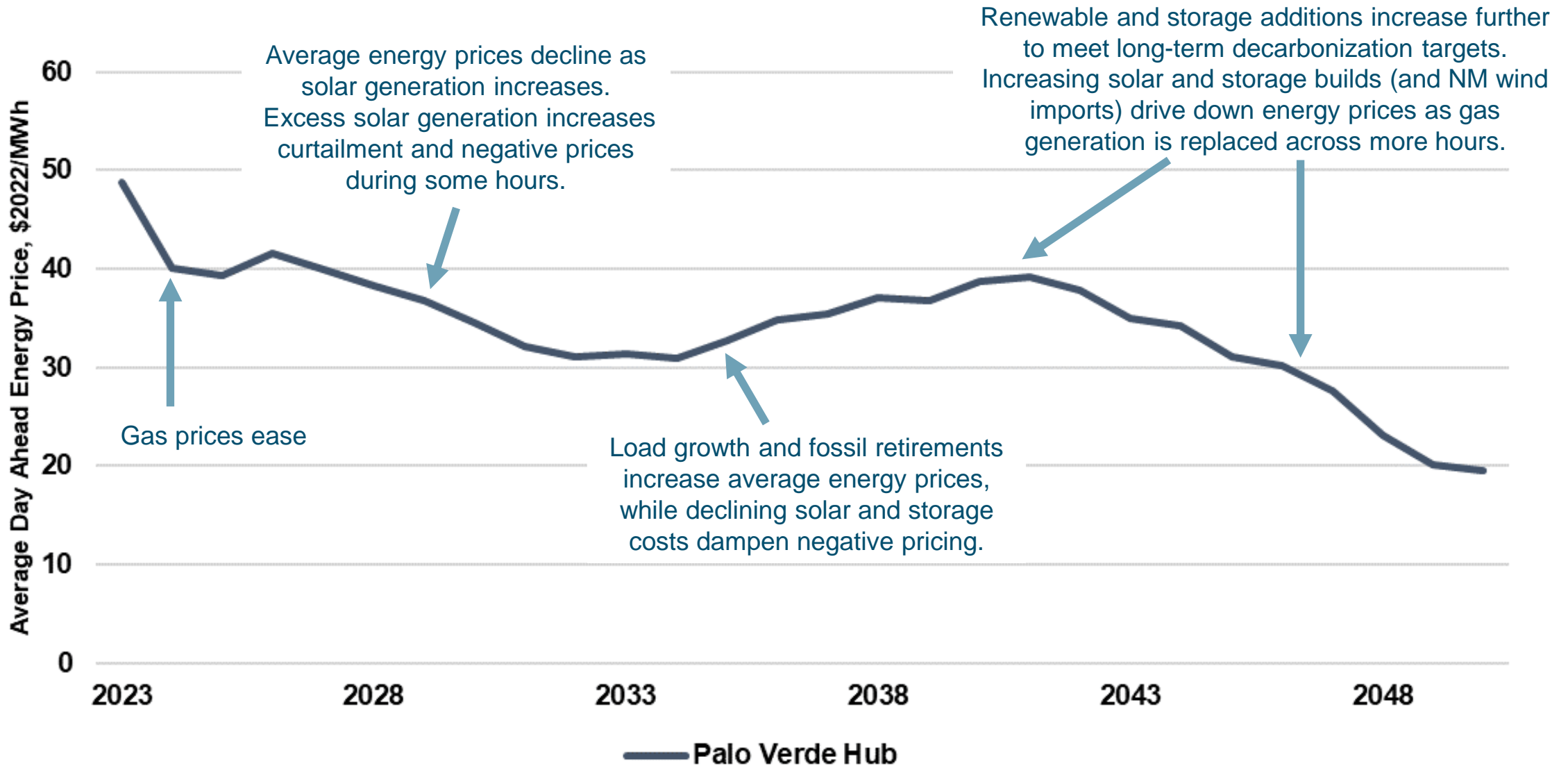
### Winter Gas Price (2022 \$/MMBtu)



- + Forecast incorporates a drop in prices from 2022 highs in the near term, with slower declines thereafter
- + Gas prices derived from forwards in the near-term and EIA Annual Energy Outlook in the long term
  - Monthly SNL forwards for Henry Hub used through 2026
  - Past 2026, Henry Hub forecast is trended to EIA forecasts in 2040 and beyond
- + For all other hubs, monthly basis differentials are derived from SNL forwards in the near term
  - 3 years of monthly basis differentials derived from forwards are averaged and assumed to hold constant longer term



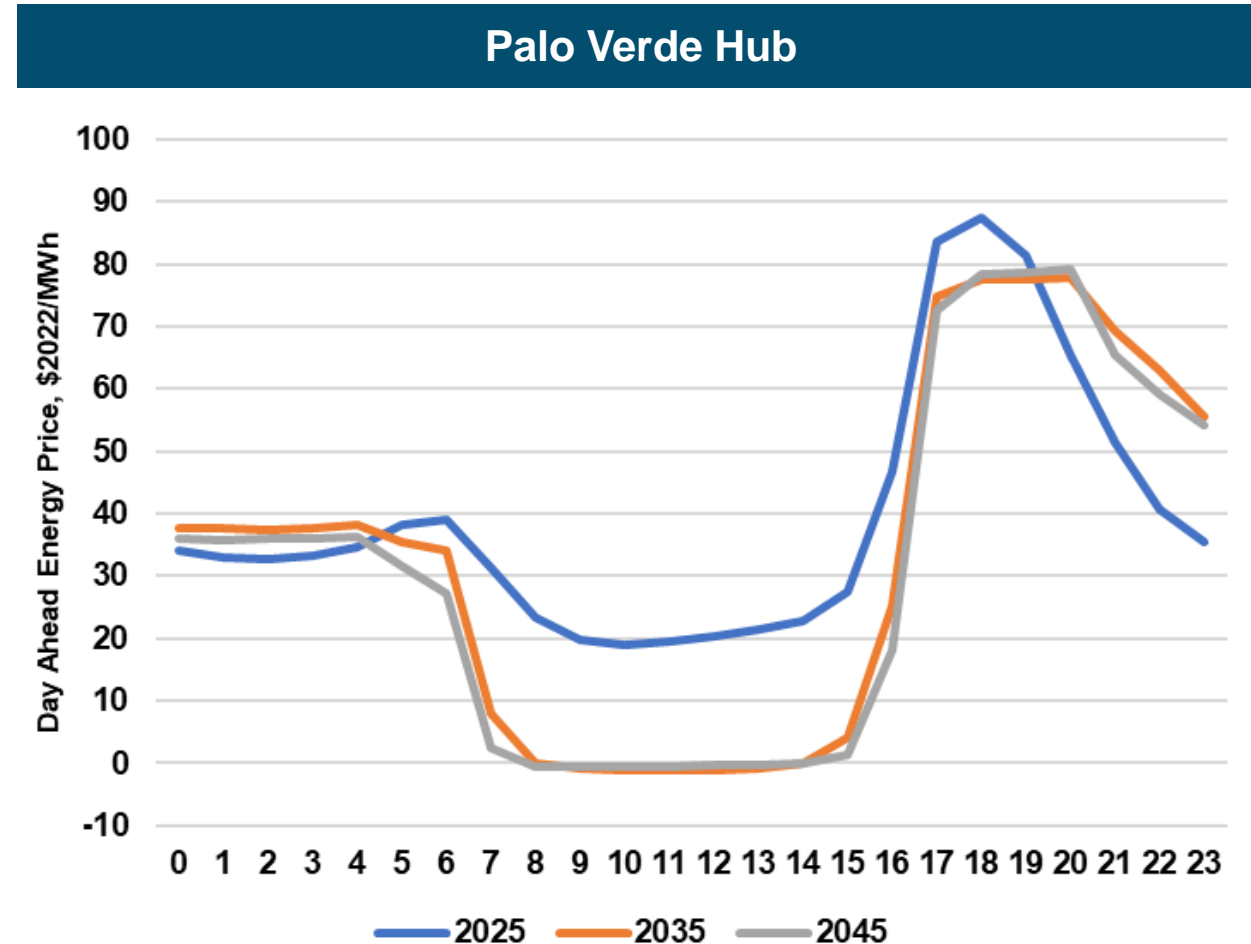
# Avg. Annual Day Ahead Energy Prices (\$2022/MWh)





# Solar and Storage Drive Hourly Price Patterns

- + Overall trend shows an initial deepening of the duck curve followed by flattening of high and low-priced hours due to storage charge and discharge
  - Increasing solar generation drives down daytime prices—midday price lows are somewhat mitigated by increased demand to charge batteries
  - Nocturnal prices are driven up by increasing electrification load and gas prices, but dampened by storage discharge
- + Relative changes year to year in the trough and the peaks of the duck curve are driven primarily by the balance of solar to storage installations over time and load growth







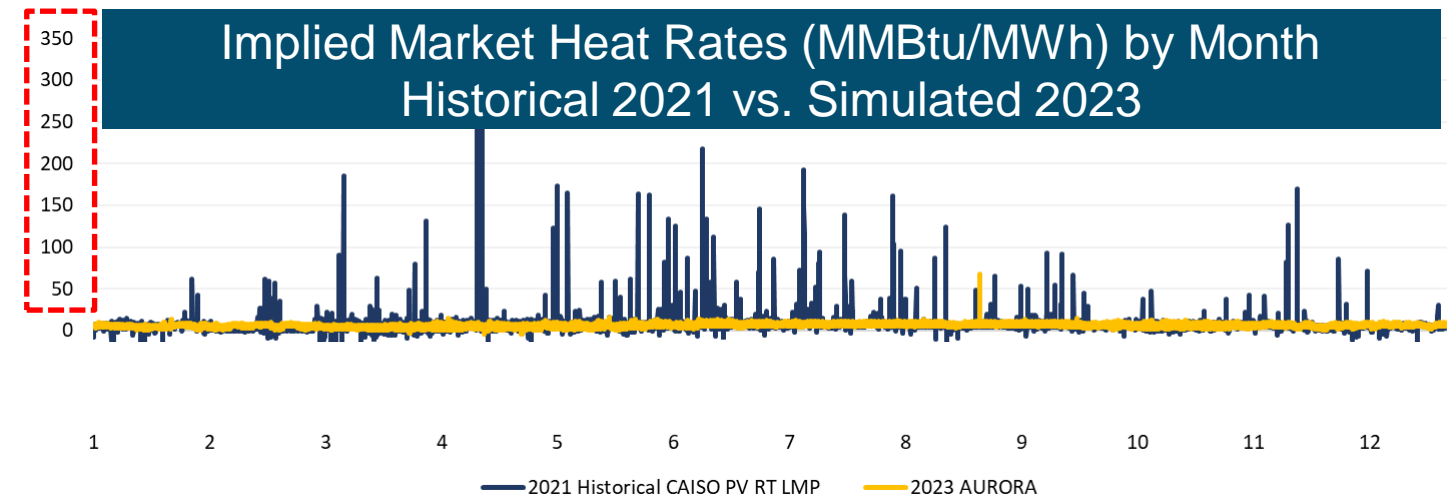
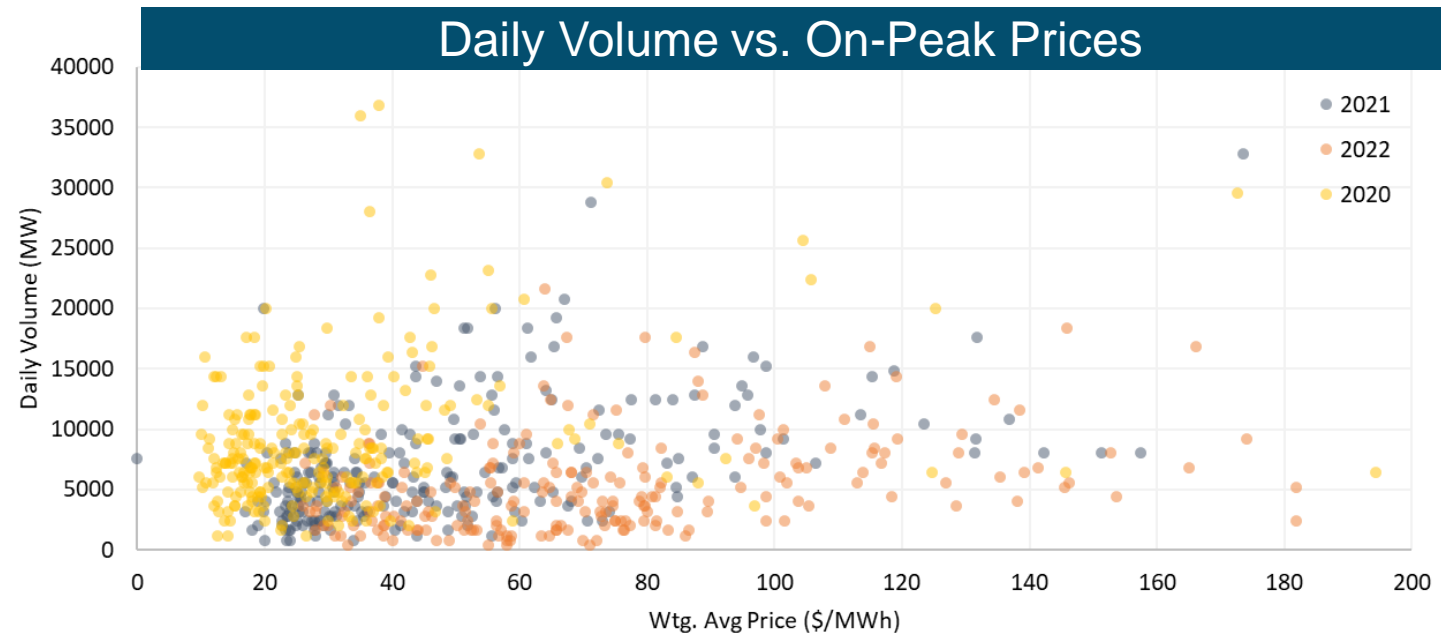
# Historical Palo Verde Price Trends

## + Intercontinental Exchange (ICE) offers on-peak/off-peak\* Day-Ahead and Futures products for the Palo Verde Hub

- Historical offers are much higher than realistic marginal peaking heat rates would imply
- Traded volumes at Palo Verde are consistently much lower than regional electricity demand

## + We observe a strong premium in historical prices versus simulated (modeled) prices in many hours

- Market behavior creates “scarcity pricing” in many hours in which prices are higher than short-run marginal costs
- Scarcity pricing enables generators to earn a premium to pay for their fixed costs, and persistent scarcity pricing acts as a strong price signal for new resources



\*On-peak hours are defined as hours ending 7am through 10pm, Monday through Saturday (16x6)



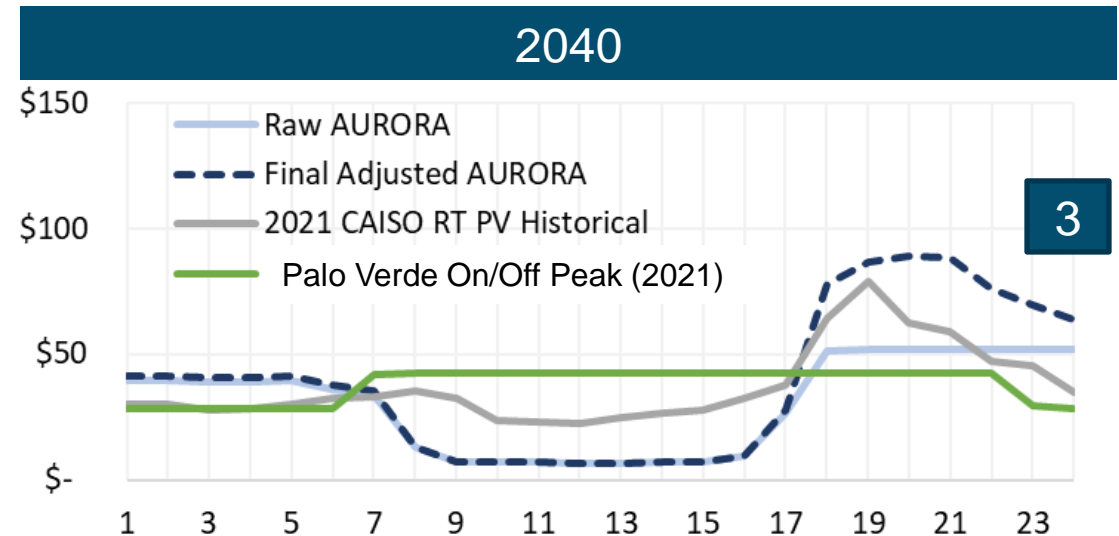
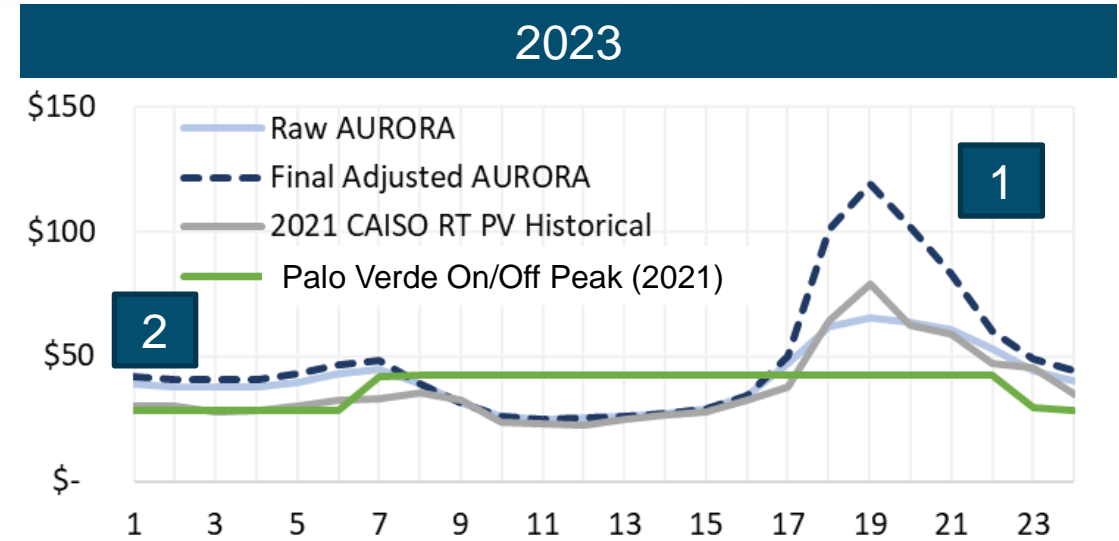
# Capturing Historical Price Premiums and Bidding Behavior in E3's Price Forecast

## + We apply three (3) post-processing steps based on our observations of historical price trends

- Prices in the evening and nighttime suggest a very high premium above marginal costs
- Prices during peak hours exhibit significant scarcity premiums
- Modeled forecasts indicate a fundamental shift in the nighttime peak driven by increasing nighttime loads and battery operations: peak is pushed later and becomes flatter/broader.

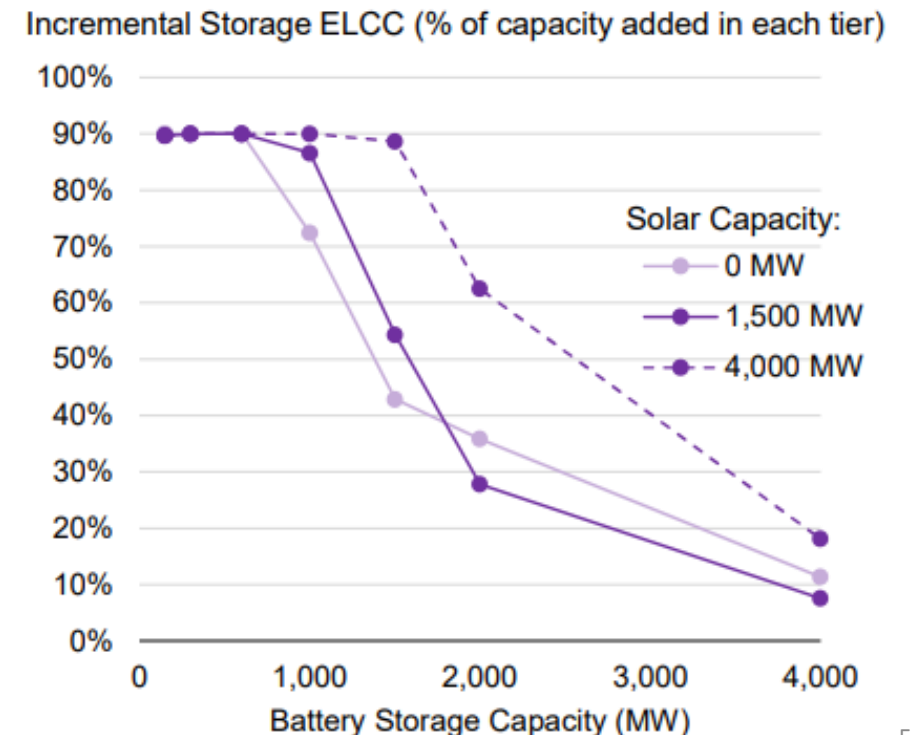
## + Post-process adjustments to fundamental price streams:

1. Scaled up pricing during system peak hours to reflect scarcity premiums
2. Nighttime off-peak periods are increased to reflect traded premiums during these hours
3. Scarcity pricing expected to moderate in extended late-night load hours



# IRP Status Update and Next Steps

- Market price forecast
- Working with APS to make IRPs consistent where appropriate
  - Coordinate IRP Market Report and workshop
    - Engagement, participation, anticipated development steps.
  - Align cost assumptions for new resources
  - Harmonize modeling techniques for resource adequacy, etc.
- Completed study with E3 to determine load-carrying capabilities (i.e., capacity values) of new solar, wind, and 4h and 8h storage
  - Overview at next meeting?



# IRP Status Update and Next Steps

- Modeling update
  - Working with EnergyExemplar to complete Participant License agreements
  - Working with TEP legal on non-disclosure agreement
  - Modeling of reference case and first few portfolios not complete
    - Lot of work “standing up model” (data sources, data cleaning, Aurora setup, workbooks)
    - Work up front will facilitate smoother analysis and stakeholder collaboration later
- Next steps
  - Next RPAC meeting April 12-14 or April 19-31 (mid-month update or call if latter?)