APS RPAC Meeting

2/13/2026

MEETING AGENDA

Welcome & Meeting Agenda
Adam Constable
APS

Resource Adequacy Update
Akhil Mandadi
APS

Break

Resource Costs Follow-up
Nathan Miller
E3

2026 IRP Timeline
Mike Eugenis
APS

Next Steps & Closing Remarks
Adam Constable
APS

Meeting Guidelines

Member Engagement

RPAC Member engagement is critical. Clarifying questions are welcome at any time. There will be discussion time allotted to each presentation/agenda item, as well as at the end of each meeting.

Action Items

We will keep a parking lot for items to be addressed at later meetings.

Meeting Minutes

Meeting minutes will be posted to the public website along with pending questions and items needing follow up. We will monitor and address questions in a timely fashion.

Preliminary Content

Meetings and content are preliminary in nature and prepared for RPAC discussion purposes.

November Meeting Recap

- APS kicked the meeting off by sharing an update on current procurement activity.
- APS provided an overview of its large customer subscription program.
- APS shared the sources for its resource cost assumptions and welcomed participants to provide alternative sources that APS should consider.
- Western Resource Advocates partnered with Energy Strategies to present a comparison of resource cost assumptions across multiple sources.
- APS presented the methodology used for the 2026 IRP load forecast.

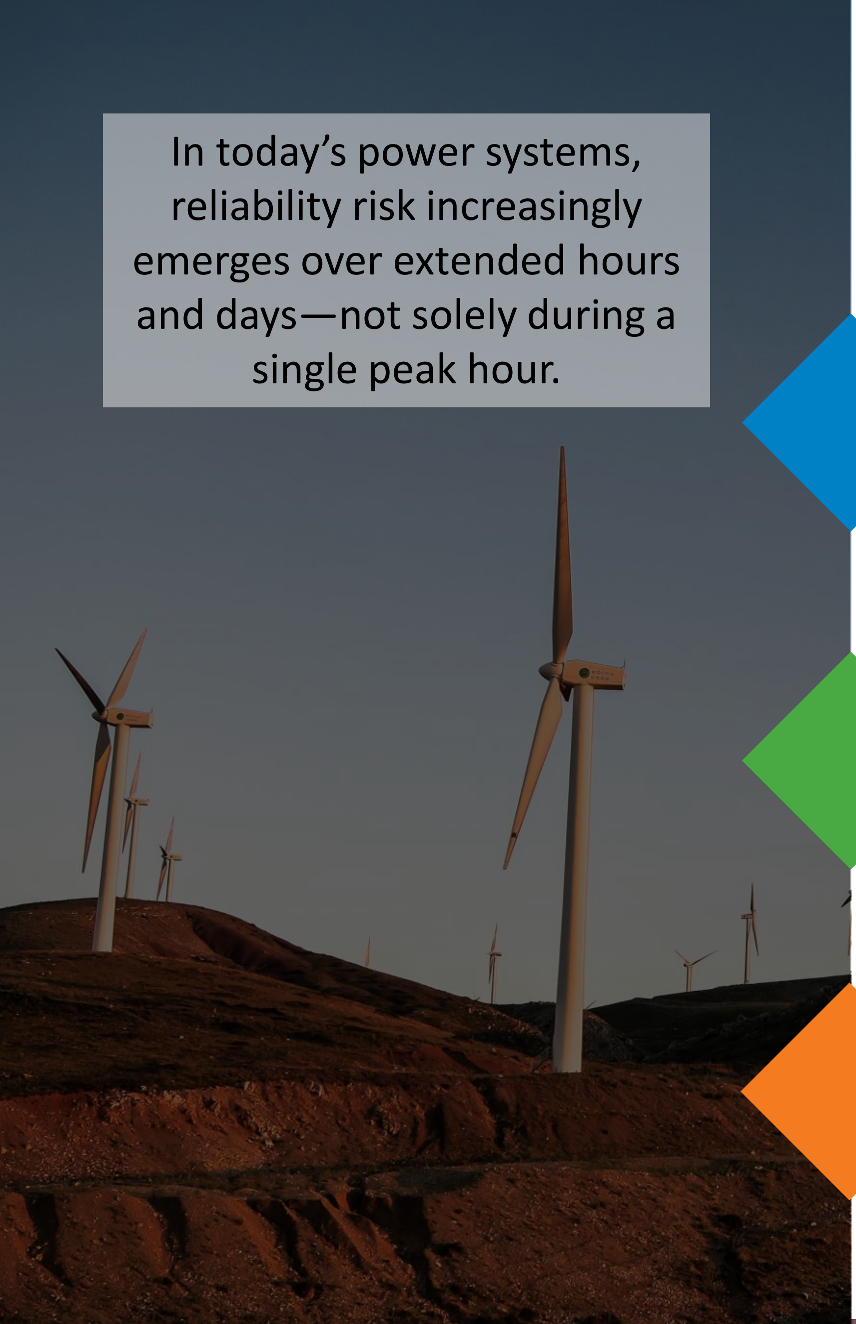
Following Up

- Action Items from Previous Meetings:
  - 2026 IRP Scenarios
- Ongoing Commitments:
  - Distribute meeting materials in a timely fashion
  - Transparency and dialogue
  - Respectful participation by all participants

Resource Adequacy Update

Akhil Mandadi, APS

2025-2026 APS Resource Adequacy Study Update – Foundation for 2026 IRP



In today's power systems, reliability risk increasingly emerges over extended hours and days—not solely during a single peak hour.

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Update Topics

How APS Evaluates Resource Adequacy

- Resource Adequacy primer: key concepts, metrics and terminology
- How Resource Adequacy fits into the APS IRP decision framework
- Milestone: 2023 APS Resource Adequacy Study

Deeper Dive: The APS Reliability Landscape is Changing

- Evolving system conditions - need for deeper and wider modeling
- 2025-2026 Resource Adequacy Study
- Investigating APS's Resource Adequacy landscape

Ensuring Reliability in the Coming Decades

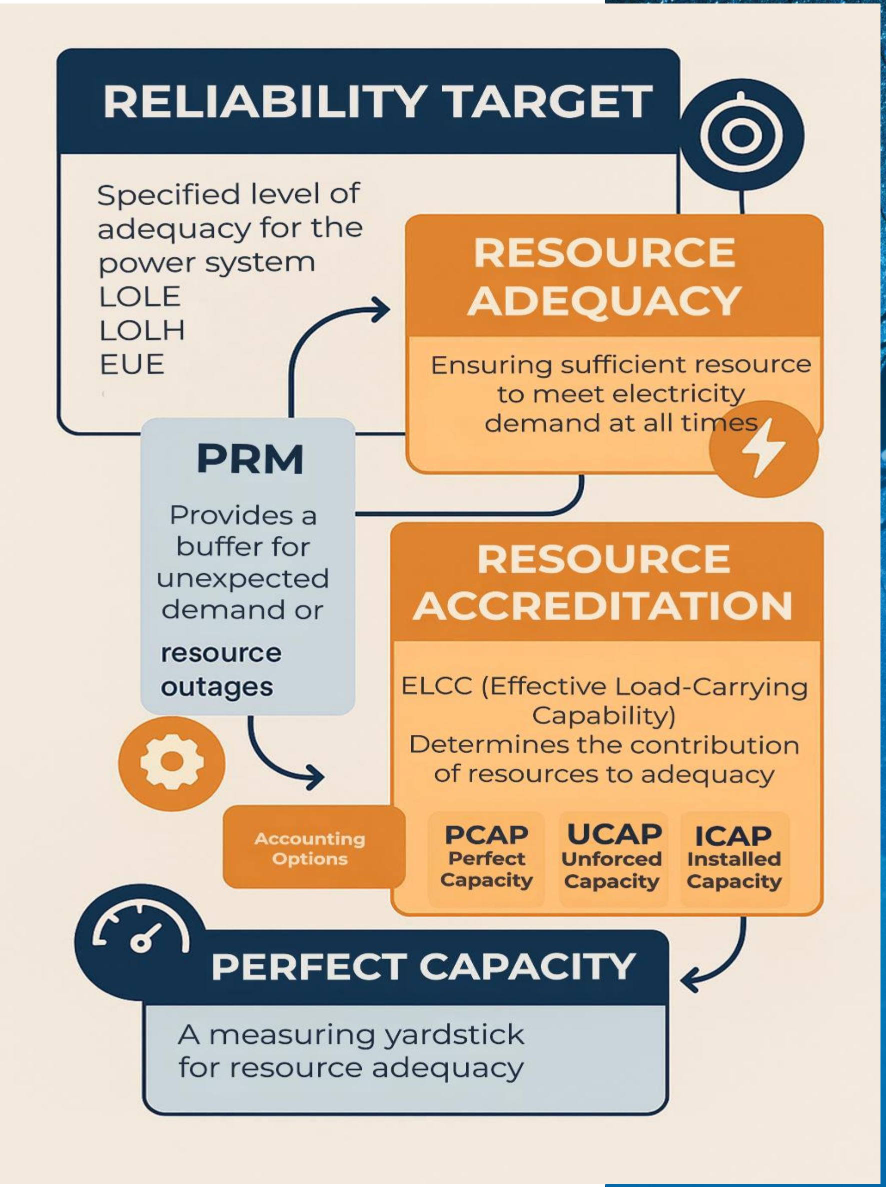
- Re-framing traditional adequacy methods
- Holistic system requirement – Energy and Fuel Deliverability along with Capacity

Approaching Resource Adequacy

Resource Adequacy Primer

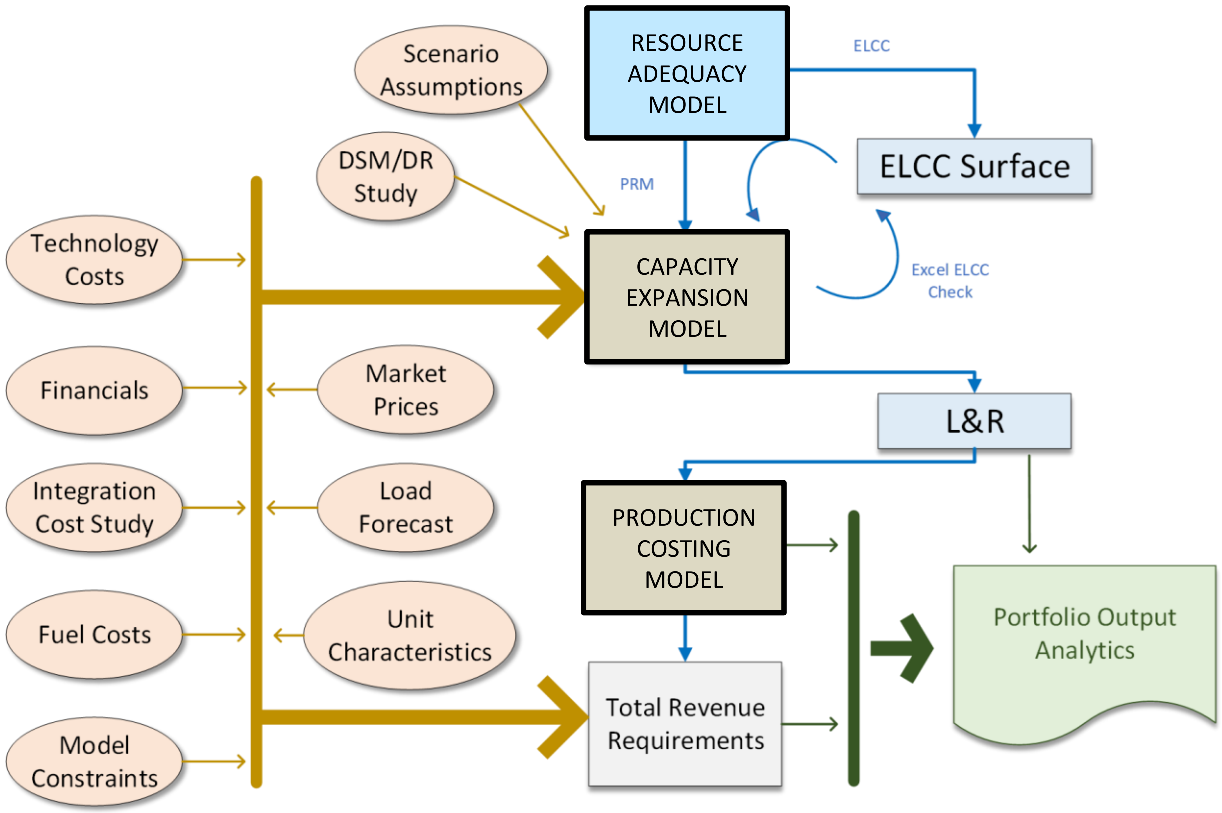
Resource adequacy (RA) is the ability of the electric system to reliably meet customers' power and energy needs over time, accounting for uncertainty in demand, weather, outages, and fuel availability.

LOLE	**Loss of Load Expectation**: The expected number of days per year in which the available generation capacity is insufficient to meet demand at least once during that day.
LOLH	**Loss of Load Hours**: The expected number of hours per year during which system demand exceeds available generating capacity.
EUE	**Expected Unserved Energy**: The expected annual amount of load that will not be served due to insufficient available capacity, summed over all hours of the year.
PRM	**Planning Reserve Margin**: The percentage of additional capacity above peak demand required to limit the probability of loss of load in a planning year to an acceptable criterion.
ELCC	**Effective Load Carrying Capability**: A measure of the amount of perfectly reliable capacity a resource or resource class can replace while maintaining the same system reliability level.
PCAP	**Perfect Capacity**: A capacity accreditation method in which all resources are measured in terms of their equivalent perfectly reliable capacity with no outages or energy limitations.
UCAP	**Unforced Capacity**: Installed capacity reduced by a unit's forced outage rate, representing the amount of capacity expected to be available during peak conditions.
ICAP	**Installed Capacity**: The nameplate or seasonal net dependable rating of a generating unit before accounting for forced outages or deratings.



How RA fits in the APS IRP Modeling framework

- Establishes the reliability baseline that underpins every step of the APS IRP
- Outputs the two critical inputs—PRM and ELCC—that drive all downstream resource planning modeling

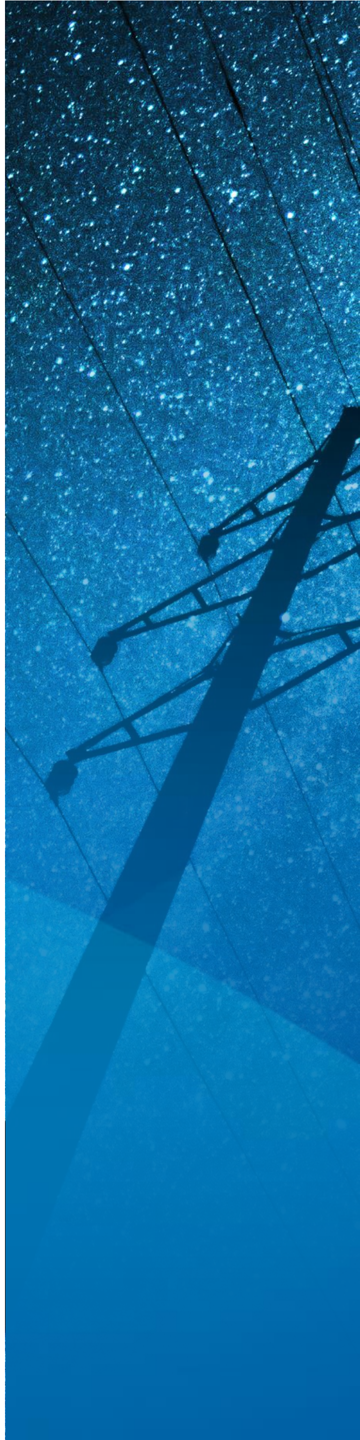


Building Today's Analysis on Yesterday's Milestone: The 2023 RA Foundation

First evolution of detailed chronological RA work
(Stochastic Monte-Carlo based probabilistic production costing model evaluating LOLE across weather and outage realizations)

Dynamic ELCC tool feeding iterative Capacity Expansion Modeling
(ELCC surfaces capturing interactive effects)

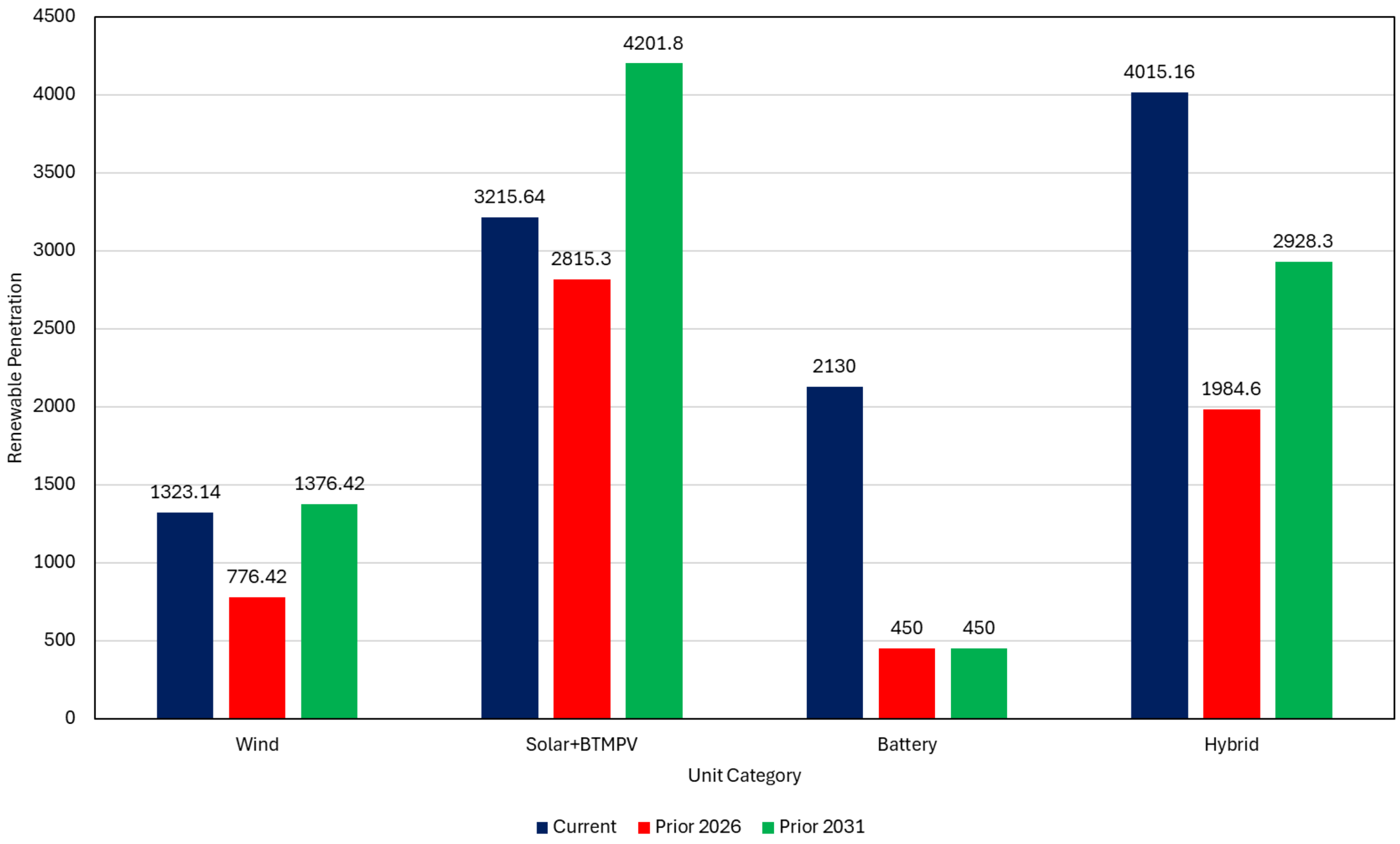
Transition to PCAP methodology starting in 2026
(Equitable resource accreditation)



Examining APS's Evolving RA Landscape

System in Transition

- A rapidly evolving resource portfolio, driven by high renewable penetration and a growing share of energy-limited resources.
- A changing load composition shaped by the rise of high-load-factor, around-the-clock industrial and data-driven growth.
- Natural gas fuel transportation rights that were designed for yesterday's peak conditions
- Increasing volatility and extremity in recent weather patterns



Nameplate capacity of renewable and energy-limited resources across the RA studies (in MWs). Note Current Study Year is 2030

2025-2026 RA Study: Adding Even More Rigor

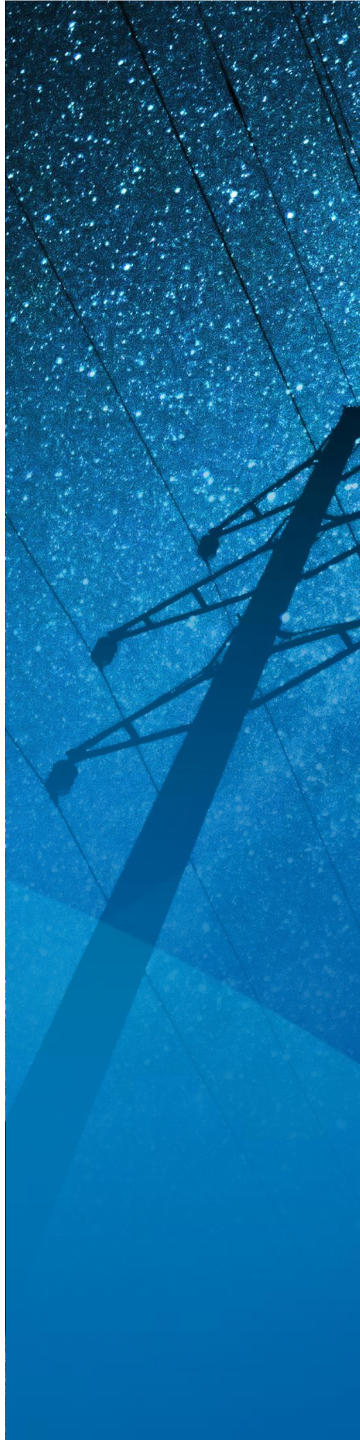
Models 44 weather years with full hourly chronology to capture the expanding range of weather-driven system risk.

Simulates forced outages through stochastic draws, allowing timing, duration, and coincidence to vary realistically across scenarios.

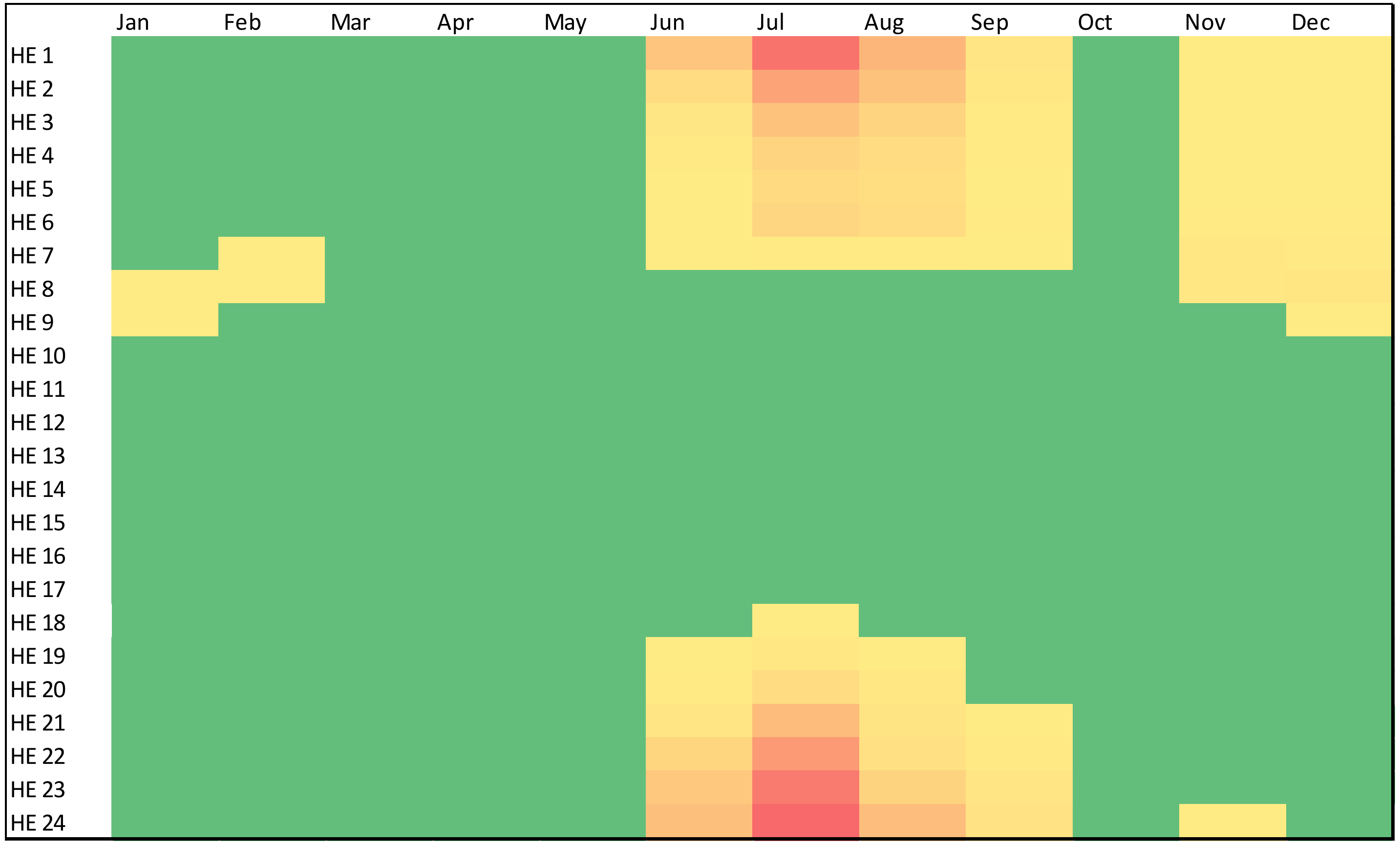
Tracks energy-limited resources (BESS and fuel-constrained gas) chronologically so depletion, recovery, and operational limits emerge naturally from system conditions.

Explicitly models gas-fuel availability with daily pipeline limits, interruptible transport rules, and conditional failover behavior—introducing state-dependent fuel risk rather than fixed derates.

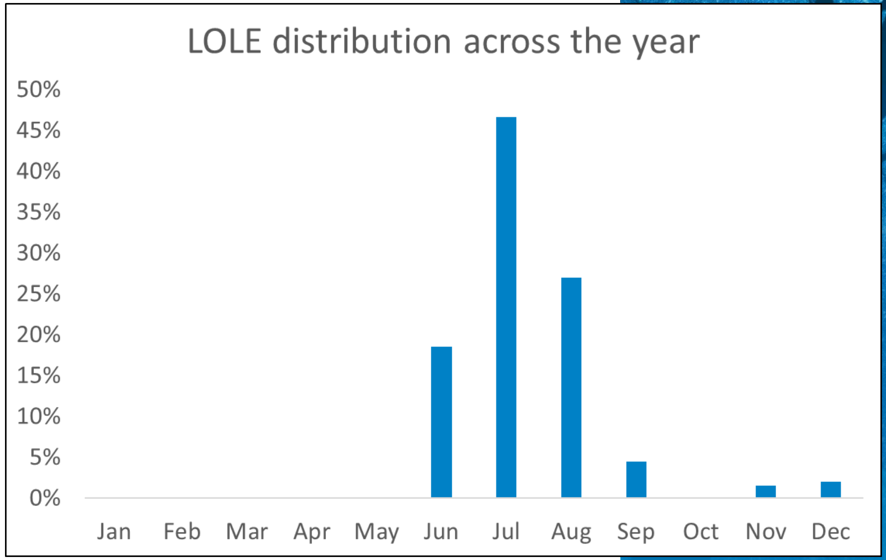
Calculates reliability outcomes (targeting 0.1 LOLE) as expected values across all stochastic weather-and-outage combinations, not single-case stress tests.



Before Fuel Constraints: Reliability Risk Concentrated in Summer Months

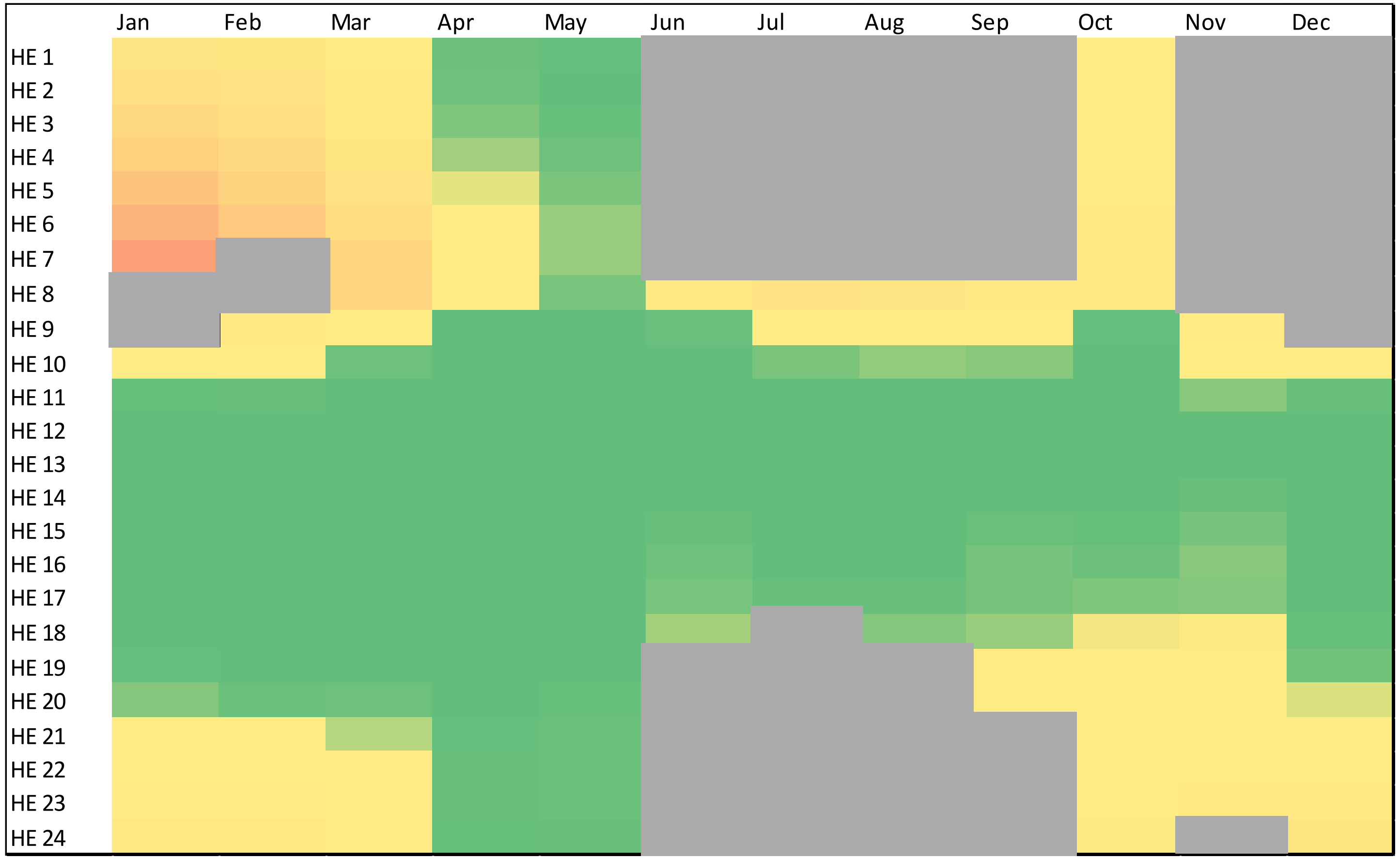


Heat map of EUE averaged across the hours of each month in the study year. Green = No EUE, Yellow to darker Red – more severe EUE noted.

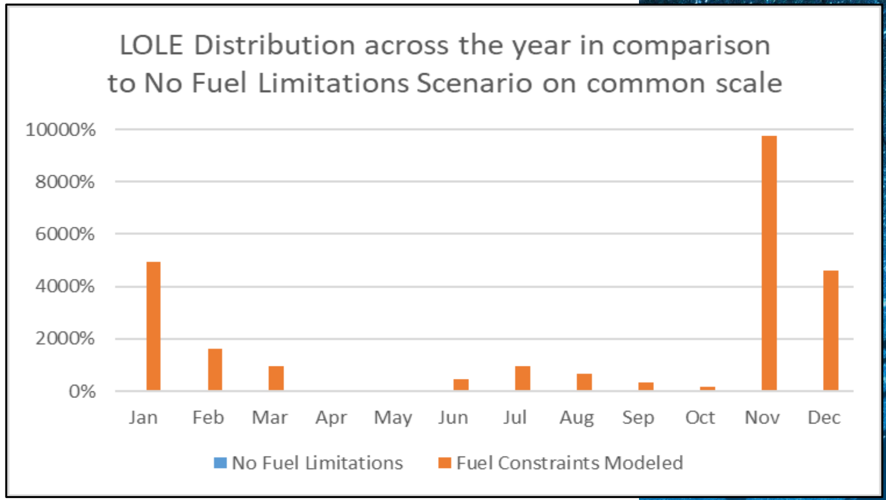


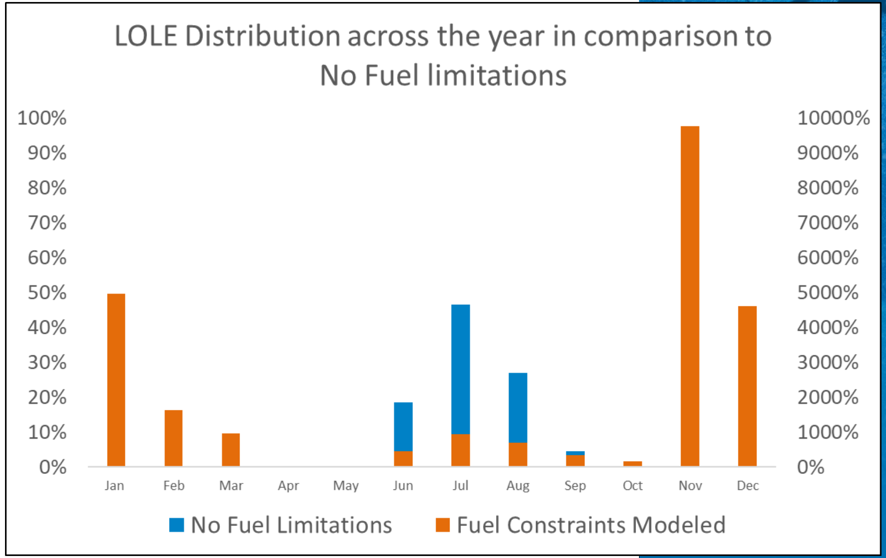
Monthly LOLE distribution as a % of annual LOLE observed corresponding to the EUE heat map

RA Landscape under pipeline-limited Fuel Availability



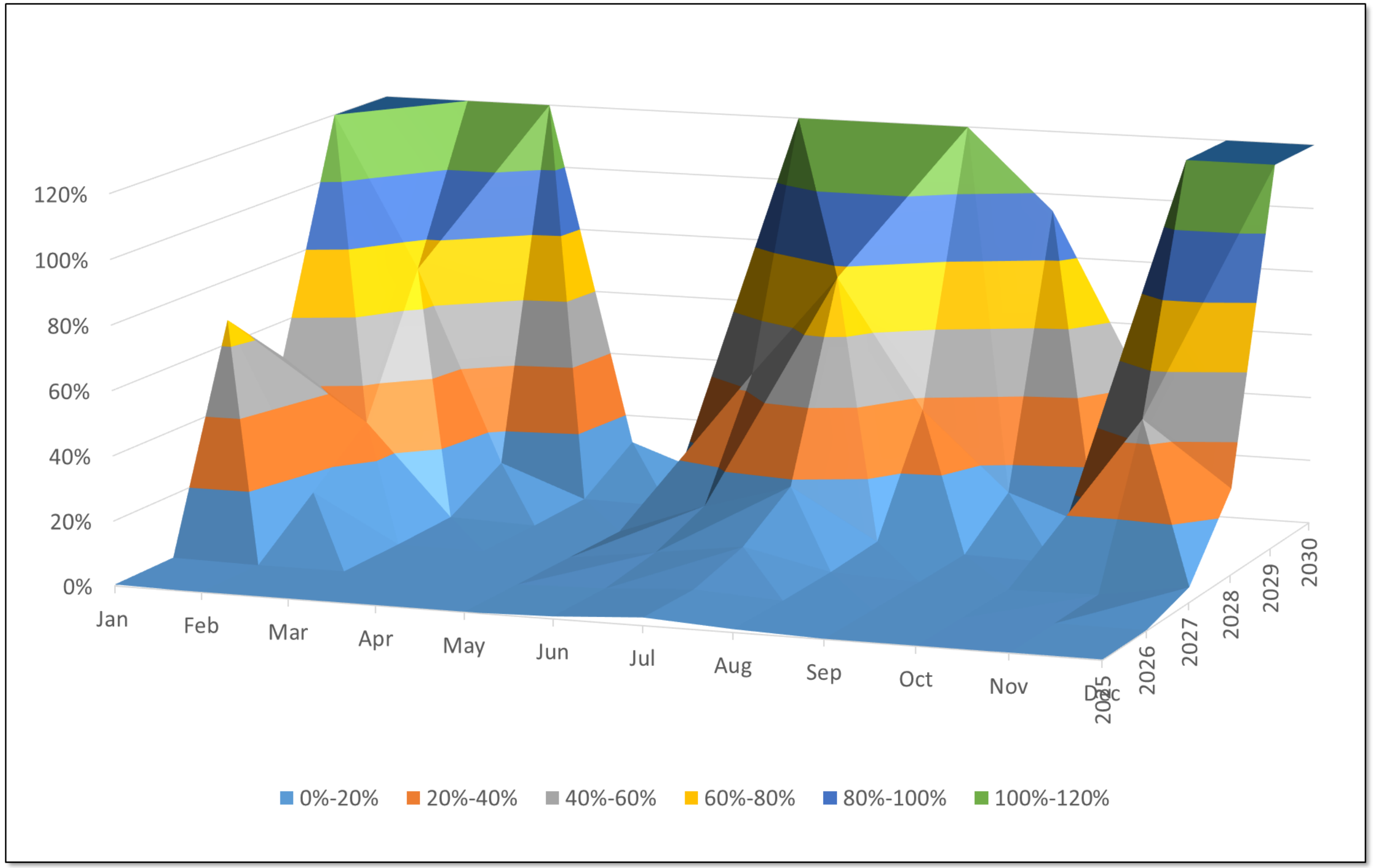
Heat map of EUE averaged across the hours of each month in the study year.
Green = No EUE, Yellow to darker Red – more severe EUE noted.
Grey boxes – areas of EUE observed in the unrestricted fuel scenario.

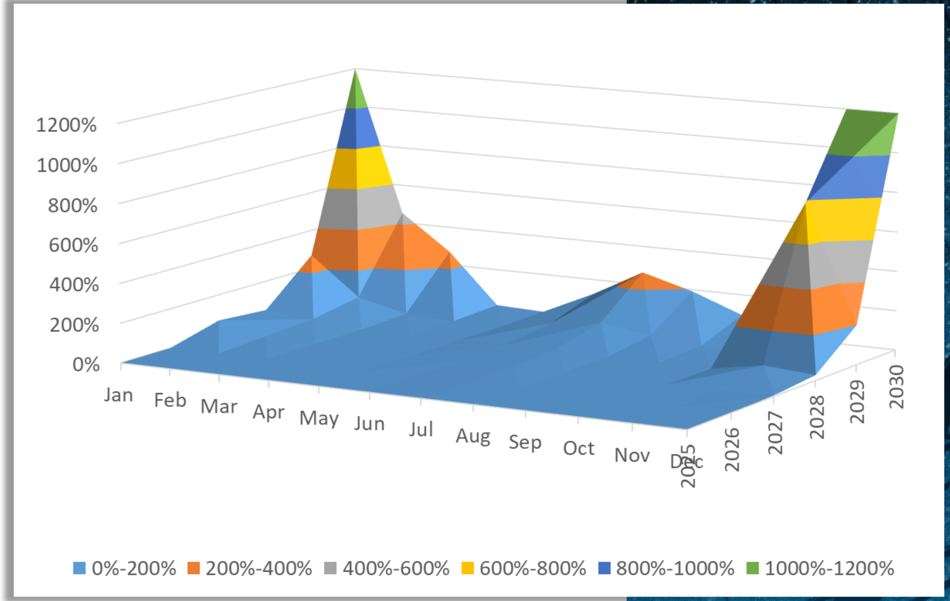




Monthly LOLE distribution as a % of annual LOLE observed corresponding to the EUE heat map

Evolution of RA Landscape in the near-term future under pipeline-limited fuel availability





Near-term RA Landscape (Monthly LOLE distribution progression as a percentage of distribution prior to modeling fuel limitations over the next 6 years)

Zoomed in Near-term RA Landscape (Monthly LOLE distribution progression as a percentage of distribution prior to modeling fuel limitations over the next 6 years) to appreciate more narrow monthly variations.

Ensuring RA for Decades to Come

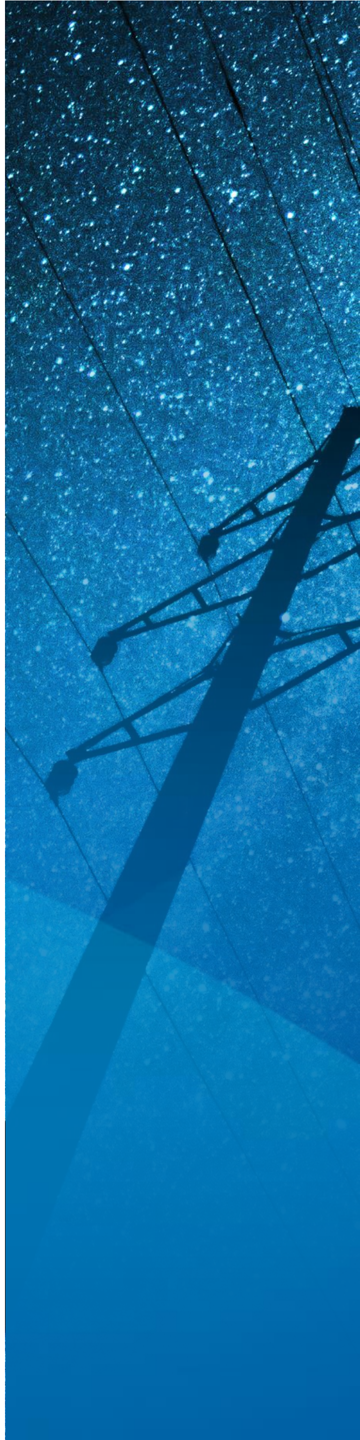
Solving Resource Adequacy Needs

Near-Term Opportunities:

- Delivered Natural Gas Fuel Purchases
- Market Support:
  - Energy Market Dependence
  - Term Market Capacity and Energy Purchases

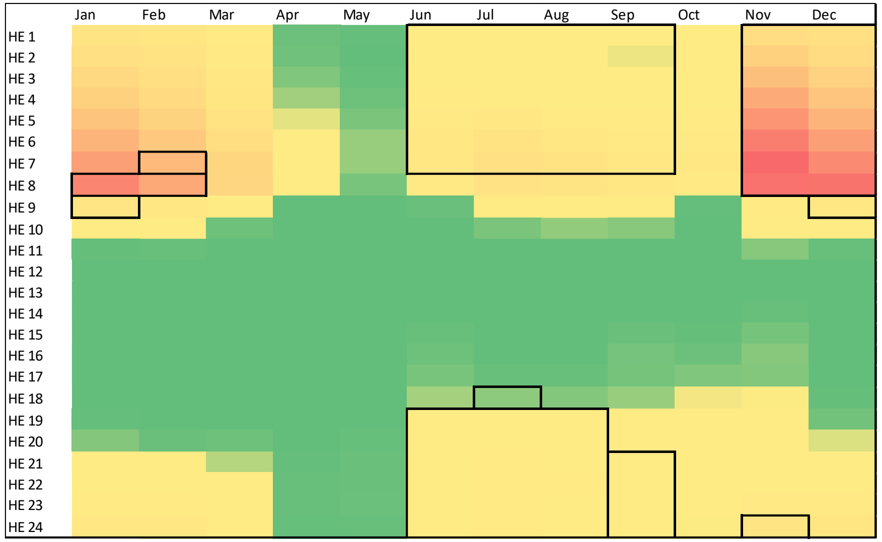
Long-Term Opportunities:

- New Resource Procurements
- Additional Pipeline Capability



ELCC Under Energy Inadequacy: PCAP positioning impacts

- ELCC is conditional on PCAP placement: in energy-inadequate conditions, ELCC reflects a resource's ability to displace the marginal PCAP—and that depends on first-in vs last-in.
- Evaluate by ΔLOLE: add incremental MW/MWh and observe LOLE movement under both assumptions; BESS saturation amplifies the difference

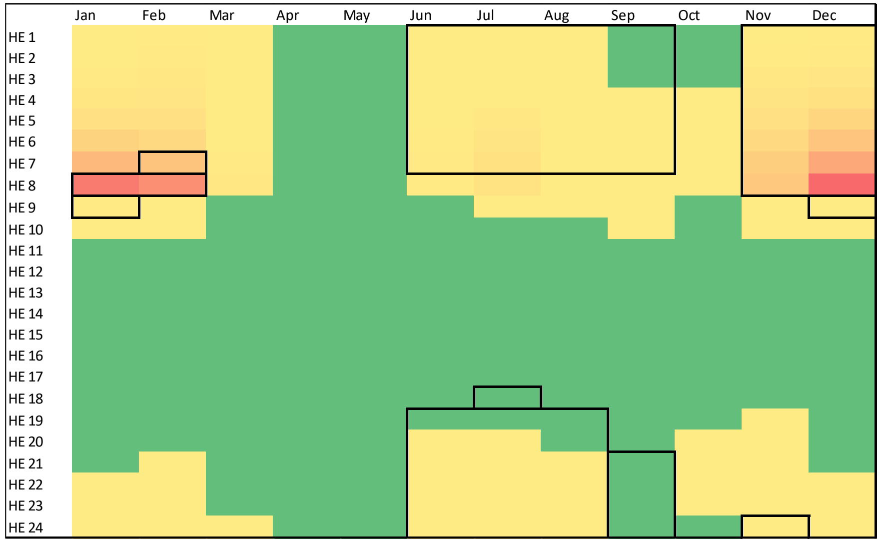


Heat map of EUE averaged across the hours of each month in the study year.

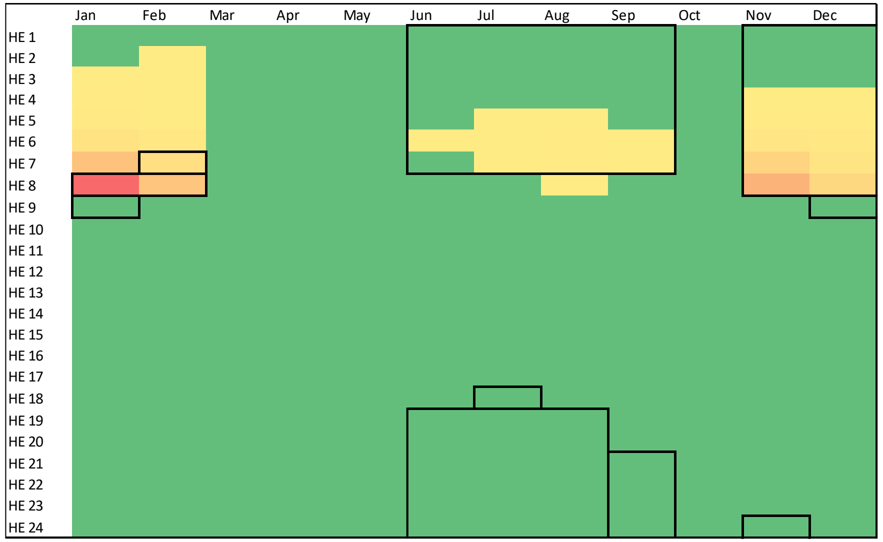
Green = No EUE, Yellow to darker Red – more severe EUE noted.

Black Boxes – areas of EUE observed in the Limited fuel availability scenario

FIRST-IN PCAP RESOURCE



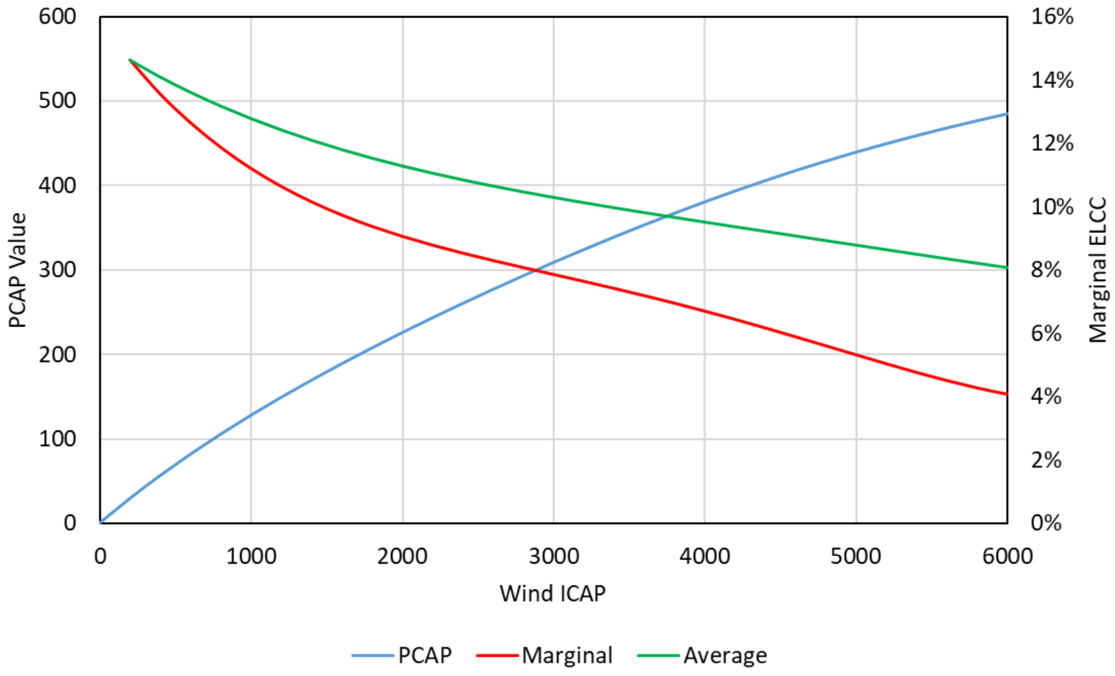
LAST-IN PCAP RESOURCE



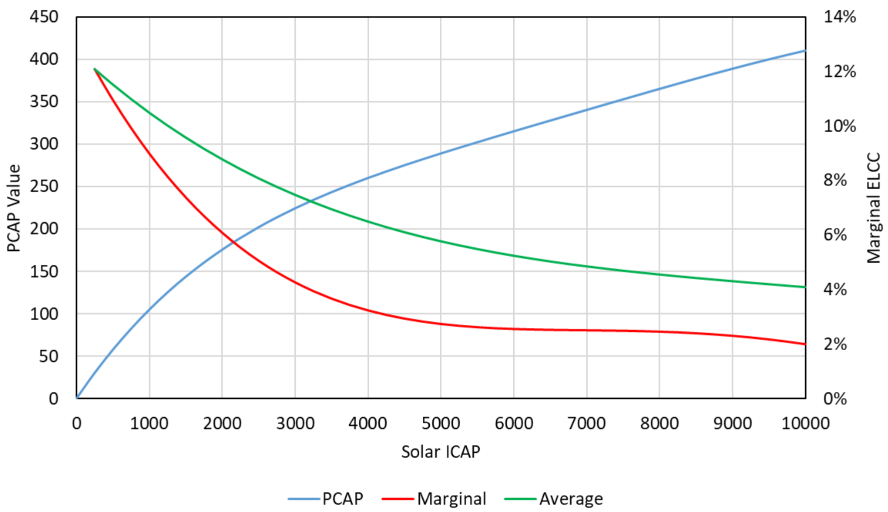
In long-term planning, ELCCs return to traditional capacity-planning fundamentals

- Back to more traditional ELCC framework: In capacity-adequate futures, last-in PCAP appropriately anchors marginal reliability needs.
- Incremental ELCC for renewables and storage enables consistent long-term planning—capturing how each MW/MWh contributes as the system evolves.
- High-fidelity modeling uncovers interactions: solar, wind and storage exhibit non-linear, amplifying interactions, captured through a joint ELCC surface.

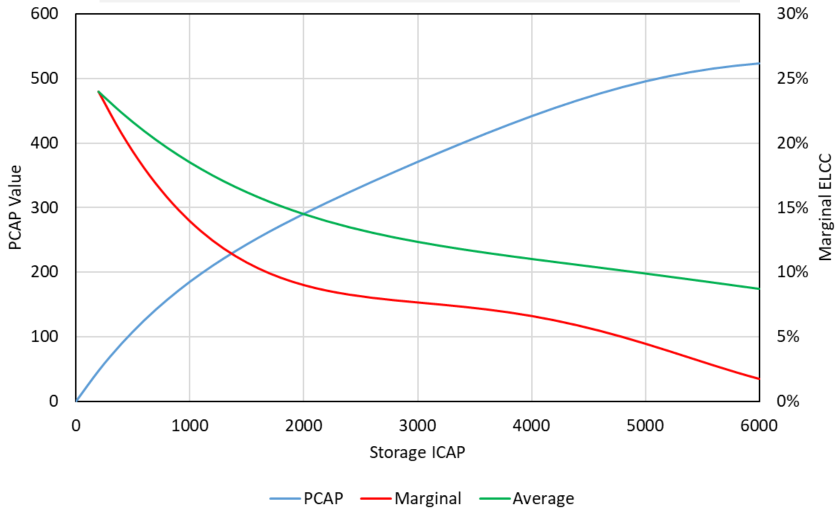
Single technology curves incremental to APS's portfolio for new standalone wind resources



Multidimensionality of ELCC



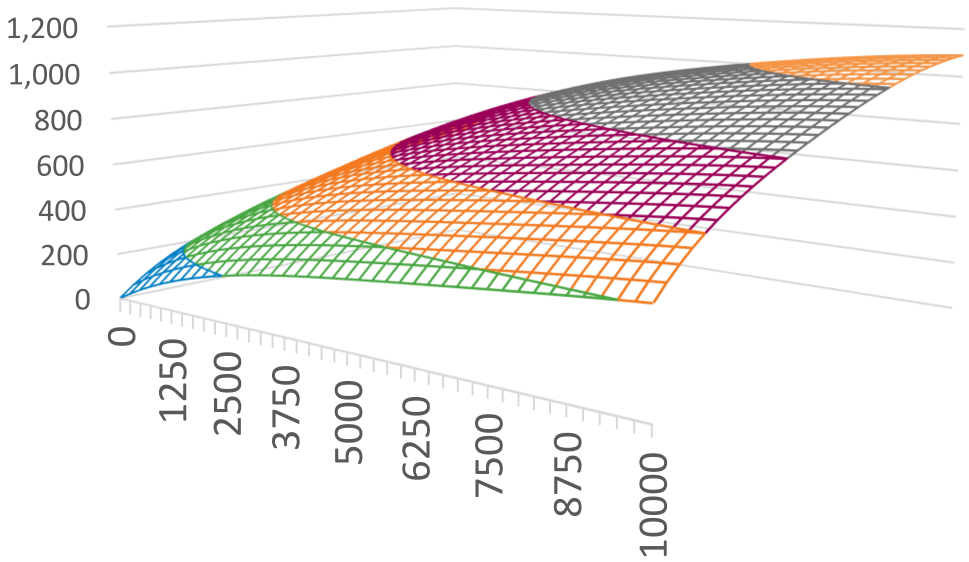
Single technology curves incremental to APS's portfolio for new standalone solar resources



Single technology curves incremental to APS's portfolio for new standalone BESS resources

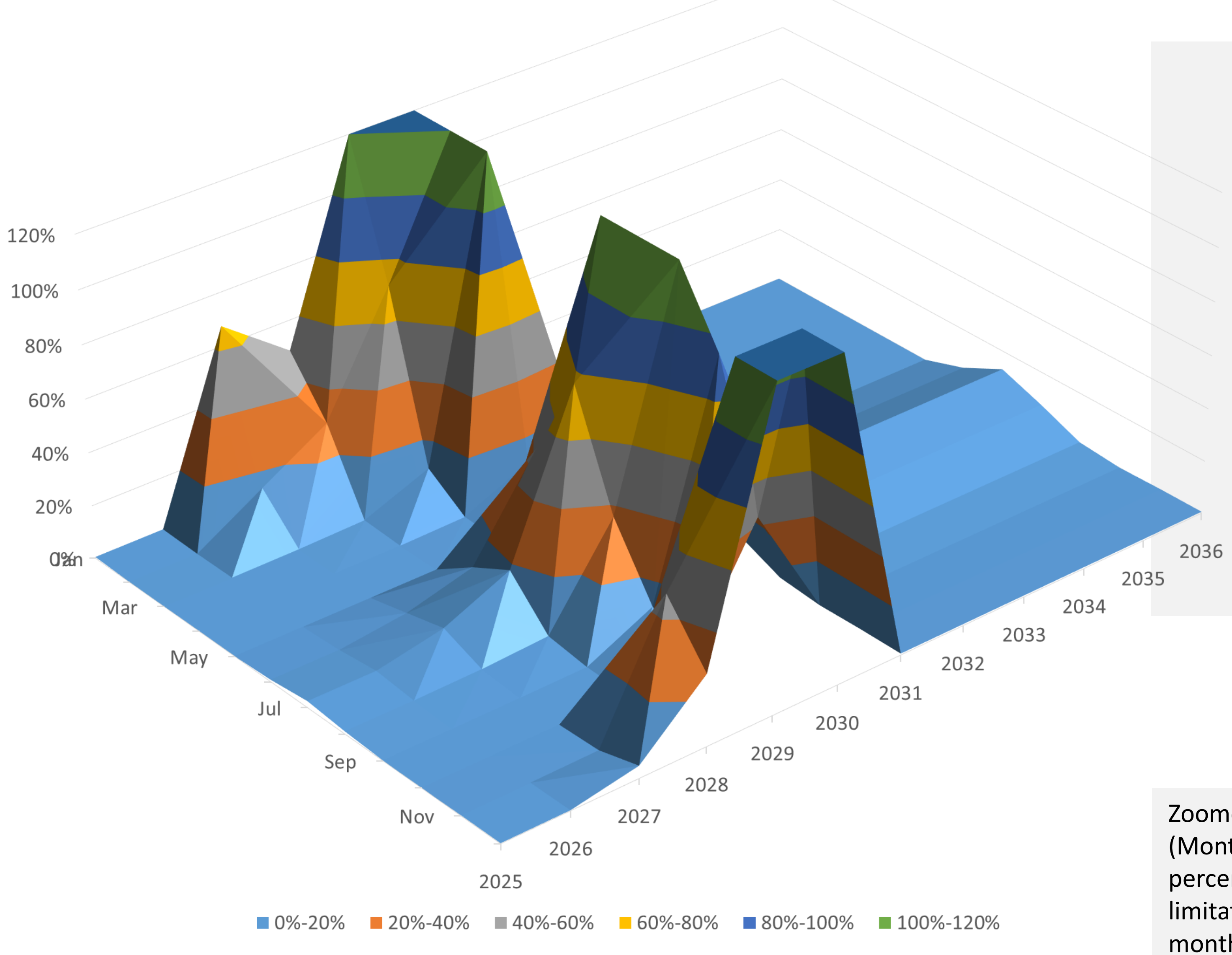
Multi technology curves incremental to APS's portfolio for new standalone solar and BESS Resources.

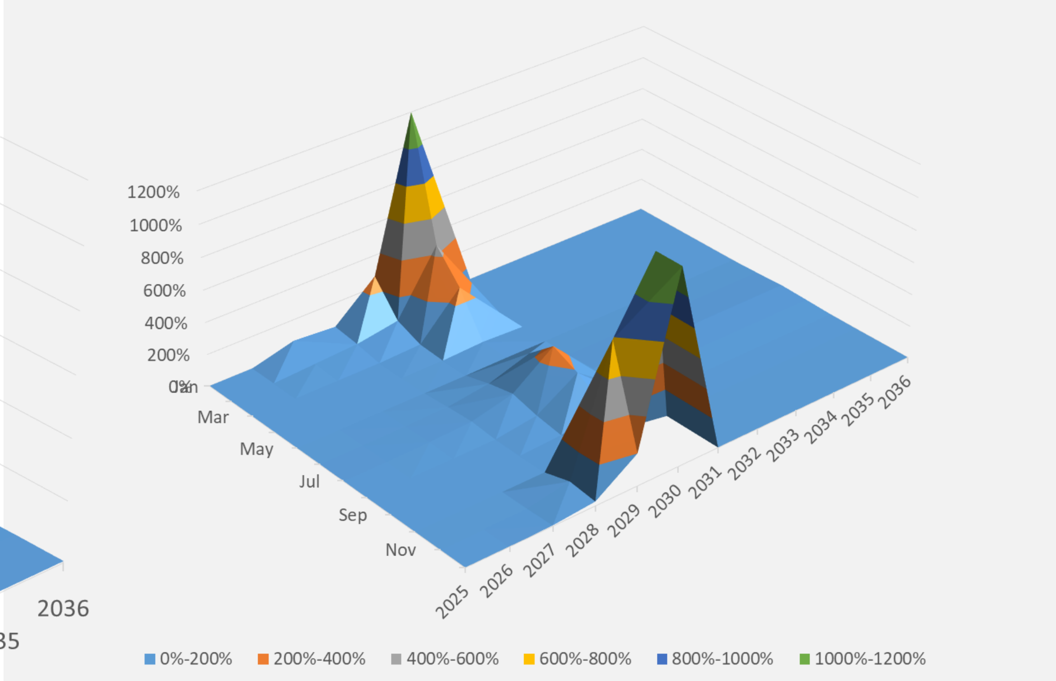
Solar on the x-axis, Storage on the y-axis and PCAP values of the portfolio on the z-axis



- Individual ELCC miss the story—the joint solar + storage surface reveals synergies essential for future portfolios.
- Advanced modeling quantifies how resource combinations reshape LOLE trajectories, not just marginal capacity.
- APS uses a tool that scales to wind + load-level dimensions, ensuring long-term planning reflects real-world system dynamics.

Crossing the Energy-Inadequacy Ridge with Fuel Resolution



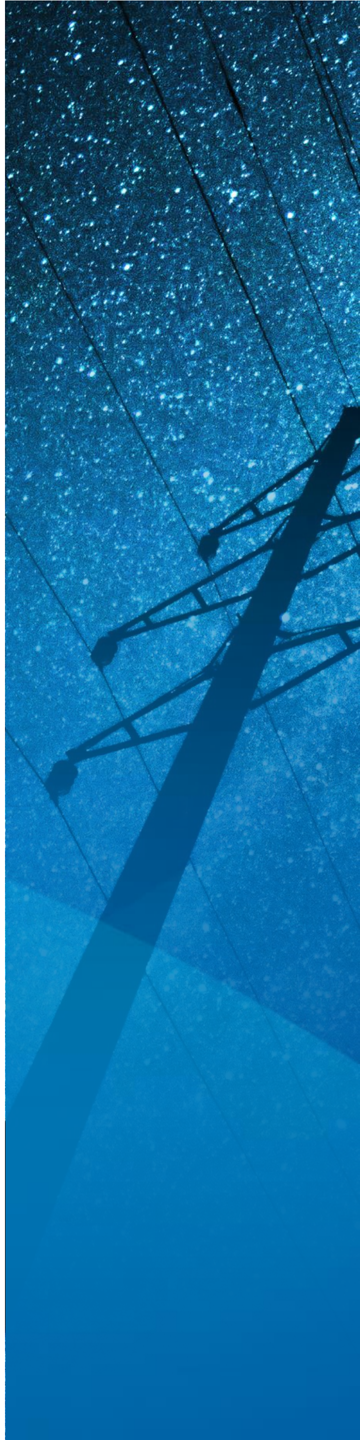


Longer-term RA Landscape (Monthly LOLE Distribution progression as a percentage of distribution with resolving fuel limitations)

Zoomed in Longer-term RA Landscape (Monthly LOLE Distribution progression as a percentage of distribution with resolving fuel limitations) to appreciate more narrow monthly variations.

KEY TAKEAWAYS

- Resource adequacy is no longer a peak hour exercise – and APS's methods reflect that reality.
- The Reliability Challenge Has Shifted from Capacity to Energy and Fuel Deliverability
- Incremental Reliability Value of Resources Decline as the Portfolio Saturates
- Energy Inadequate Systems need closer review with traditional Capacity Only Tools
- Resolving Fuel Deliverability Changes the Shape of the Resource Mix




Thank you !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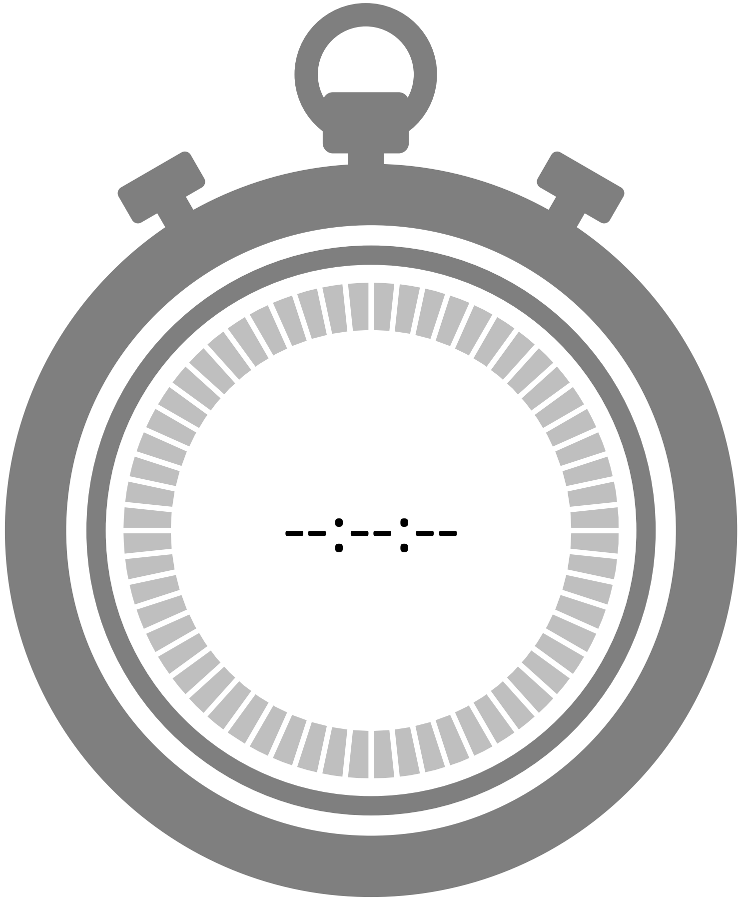
Break

Time for a Break



Break Duration 5 min.

Meeting will resume at hh:mm

Resource Pricing Follow-up

Nathan Miller, E3

Agenda

- **APS requested that E3 review its proposed capital cost assumptions for the 2026 IRP and provide an independent perspective**
- **This presentation addresses two related topics:**
  1. An overview of recent developments in generation cost landscape
  2. Review of APS's proposed planning assumptions

Industry Trends & Recent Developments

Energy+Environmental Economics

The Landscape for Generation Technology Costs Has Undergone Fundamental Shifts in the Past Five Years

+ Across the industry, utilities have faced rising and uncertain costs for electric infrastructure and increasing backlogs and wait times
+ Supply chain constraints, rising interest rates, and rising demand are all contributing to these dynamics, and some technologies will face additional cost pressures with tariffs and foreign content restrictions

Natural Gas

New project costs have doubled since 2020 due to demand outpacing supply of turbines and skilled labor

Solar

Relatively stable capital costs for six years, but PPA prices are rising quickly; impacts of tariffs not yet apparent

Storage

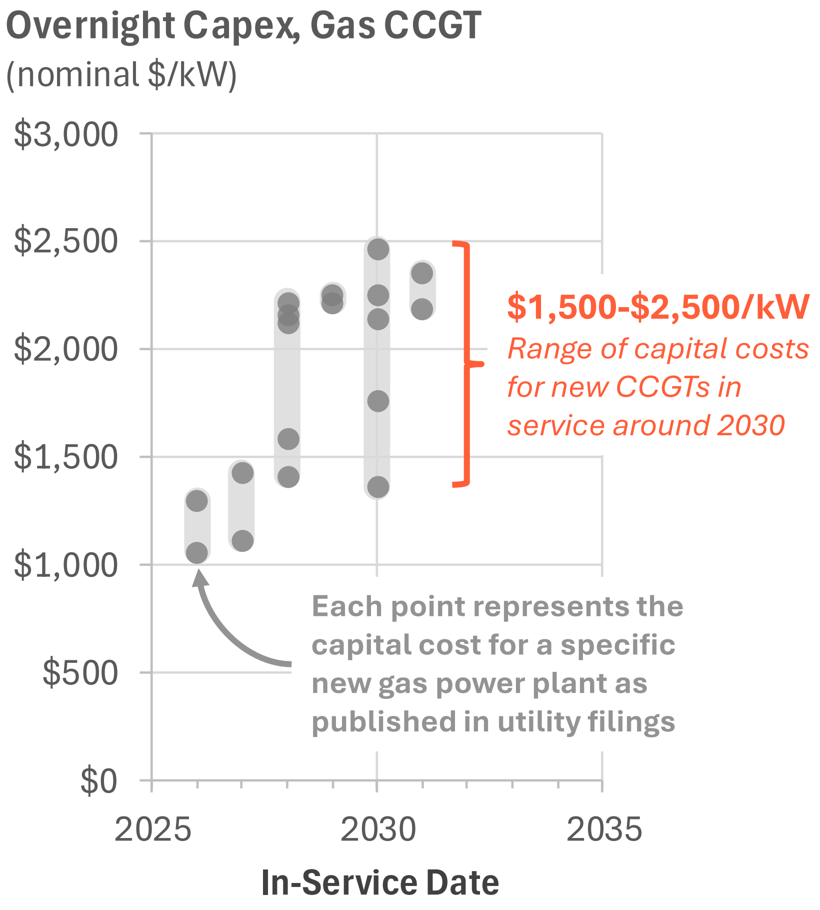
Large rises and falls in cost over the past five years, tracking volatile commodity markets and supply chain constraints

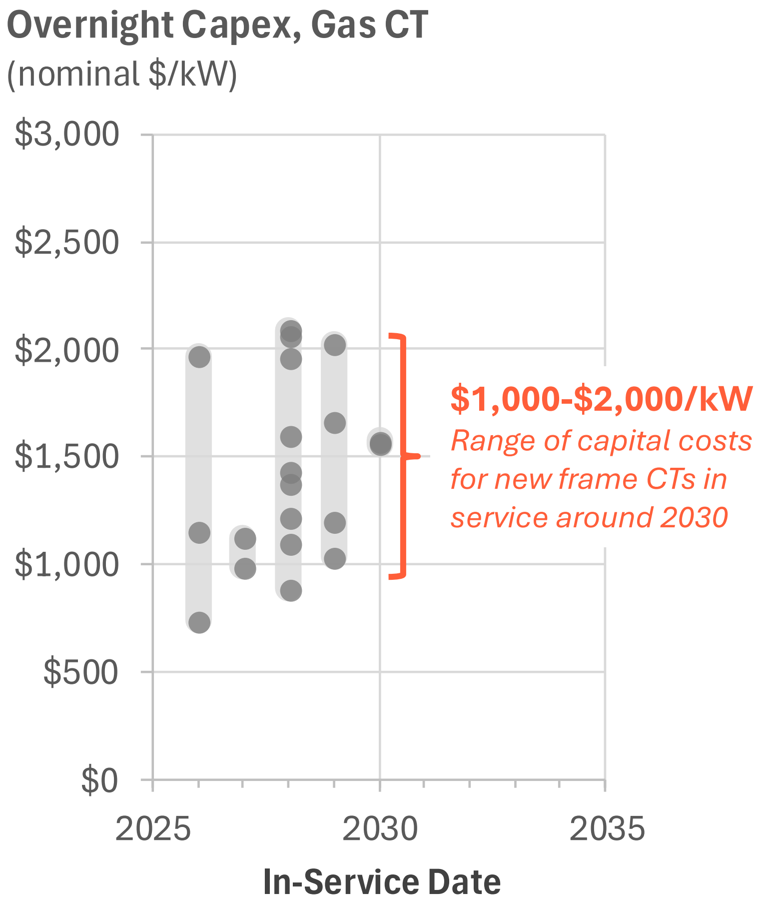
Wind

Moderate increases in capital costs, as well as permitting and siting challenges; impacts of tariffs not yet apparent

Capital Costs for Natural Gas Power Plants Have Doubled Relative to Historical Norms

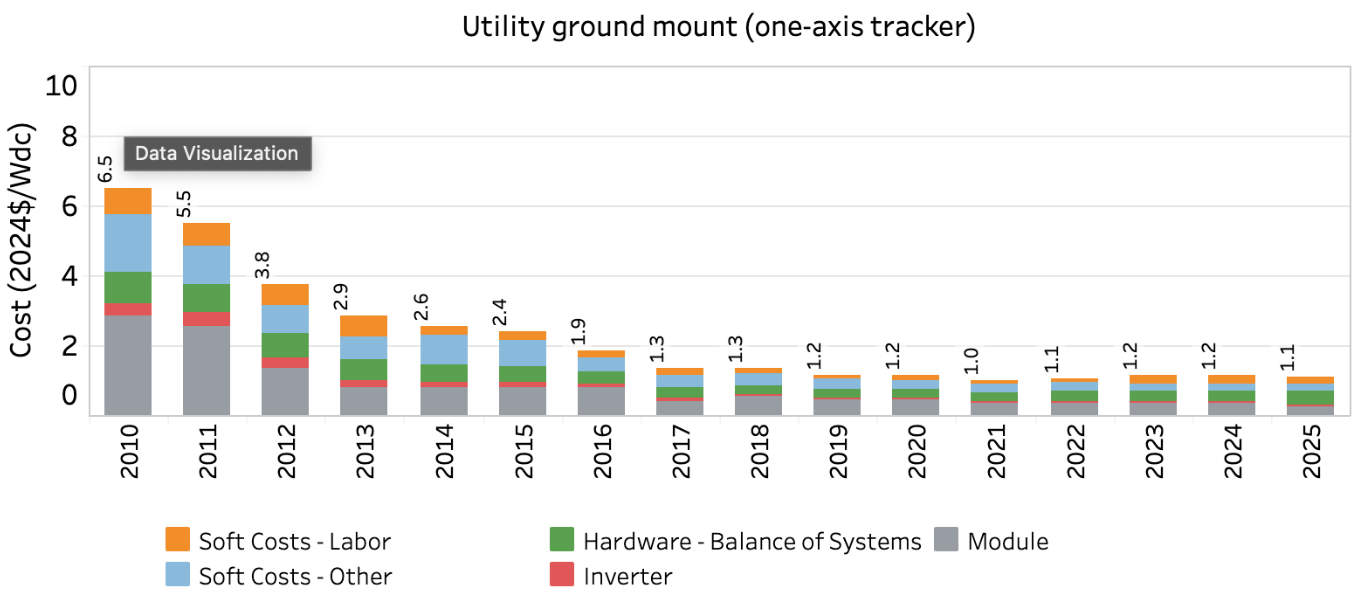
- **Since 2020, the reported costs of building natural gas power plants has increased by 2x**
- **Higher costs can be traced to scarcity in supply chains and shortages of skilled labor as demand for new gas infrastructure has risen**
  - **Plants in development:** commodity and labor cost increases
  - **Plants in the planning stage:** similar pressures, plus increases in costs (and significant backlogs) in the procurement of new combustion turbines from manufacturers
- **In a volatile market, reported costs span a wide range, and costs vary considerably across similar projects**



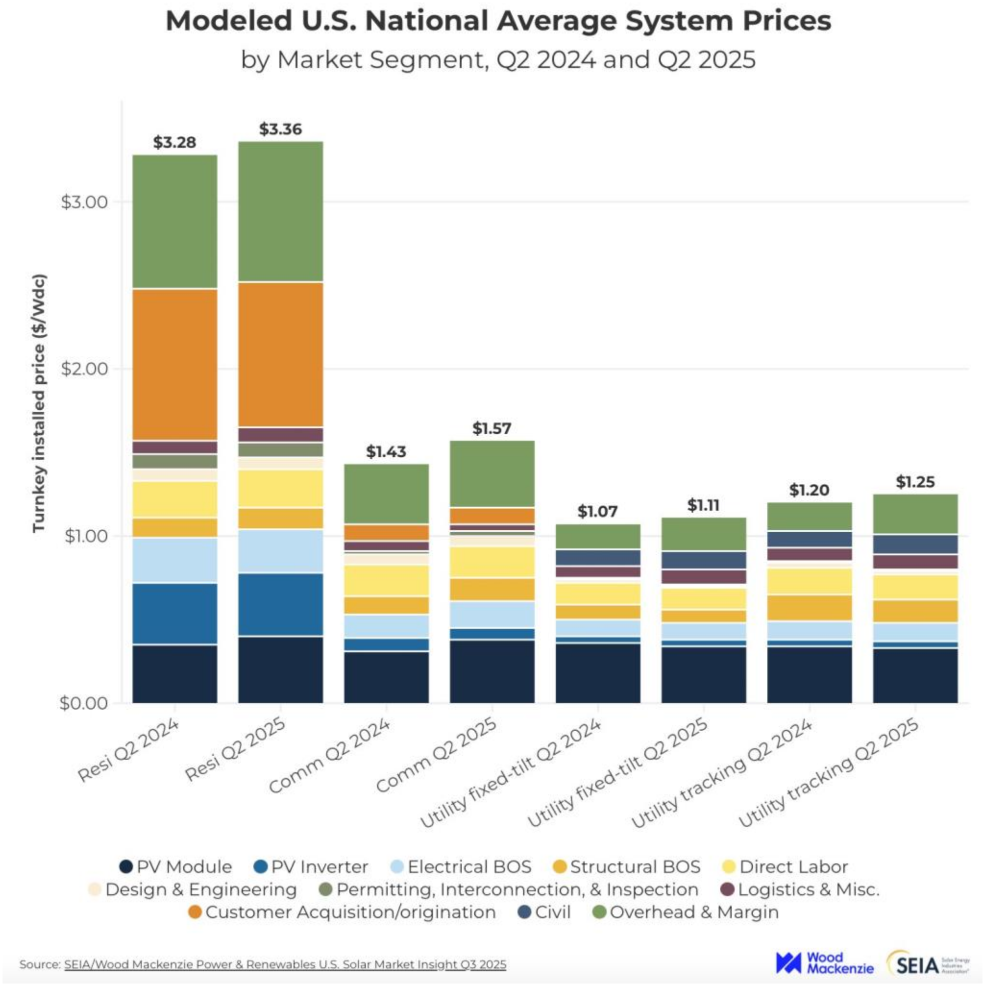


Data source for figures: Halcyon [Gas Power Plant Tracker]

Utility-Scale Solar PV Capital Costs Have Remained Flat Since 2020…and Increases are from Soft Costs, Not Modules



Source: https://www.nlr.gov/solar/market-research-analysis/solar-installed-system-cost

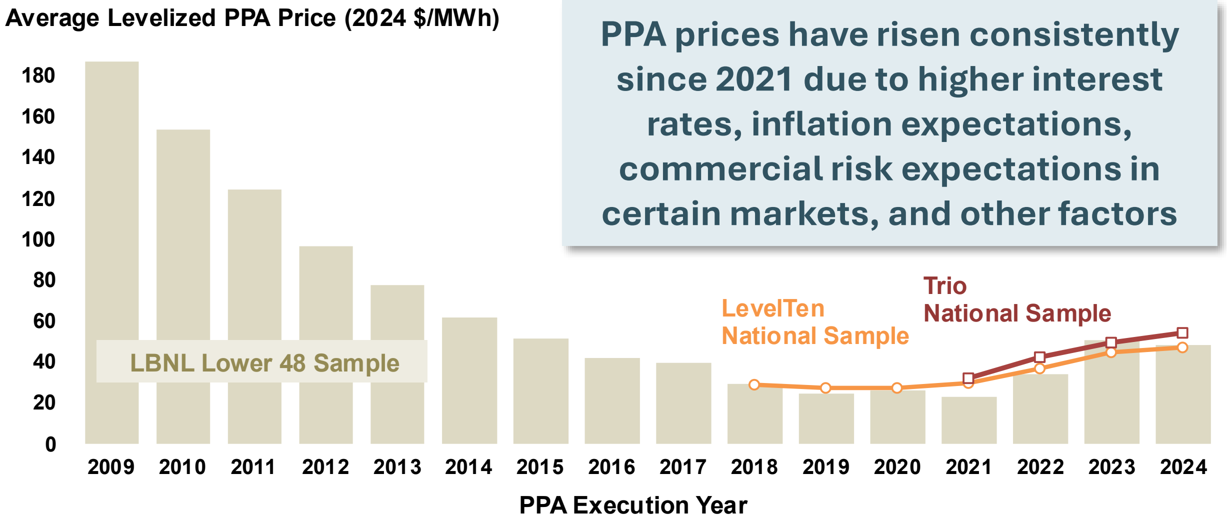


Source: https://seia.org/research-resources/solar-market-insight-report-q3-2025/

- **Solar PV system capital costs have been $1.00-1.20 / Wdc for 6 years after falling by 50% the previous six years**
- **Permitting, interconnection, and inspection costs have risen from 2024 to 2025 while inverters and modules combined have been flat**

Solar PPA Prices Have Risen Dramatically from All-Time Lows in 2019-2021

- **Since 2020, prices for solar power purchase agreements (PPAs) have increased by a factor of 2-3x**
  - In 2020, PPA prices between $20-30/MWh were common
  - Current PPA indices suggest pricing between $50-70/MWh
- **Increasing interest rates have been a major contributor to this increase**
  - Interest rates on BBB corporate bonds tripled from 2% to 6% from 2021 to 2024 and remain 5%, indicating cost of capital remains elevated (but not much higher than 2017-2019)



PPA prices have risen consistently since 2021 due to higher interest rates, inflation expectations, commercial risk expectations in certain markets, and other factors

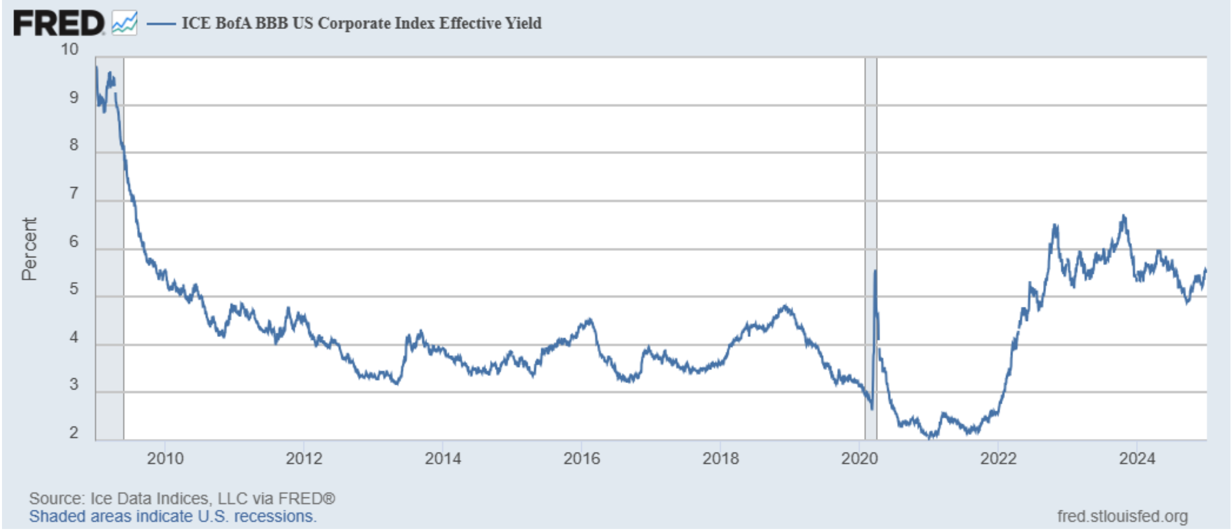
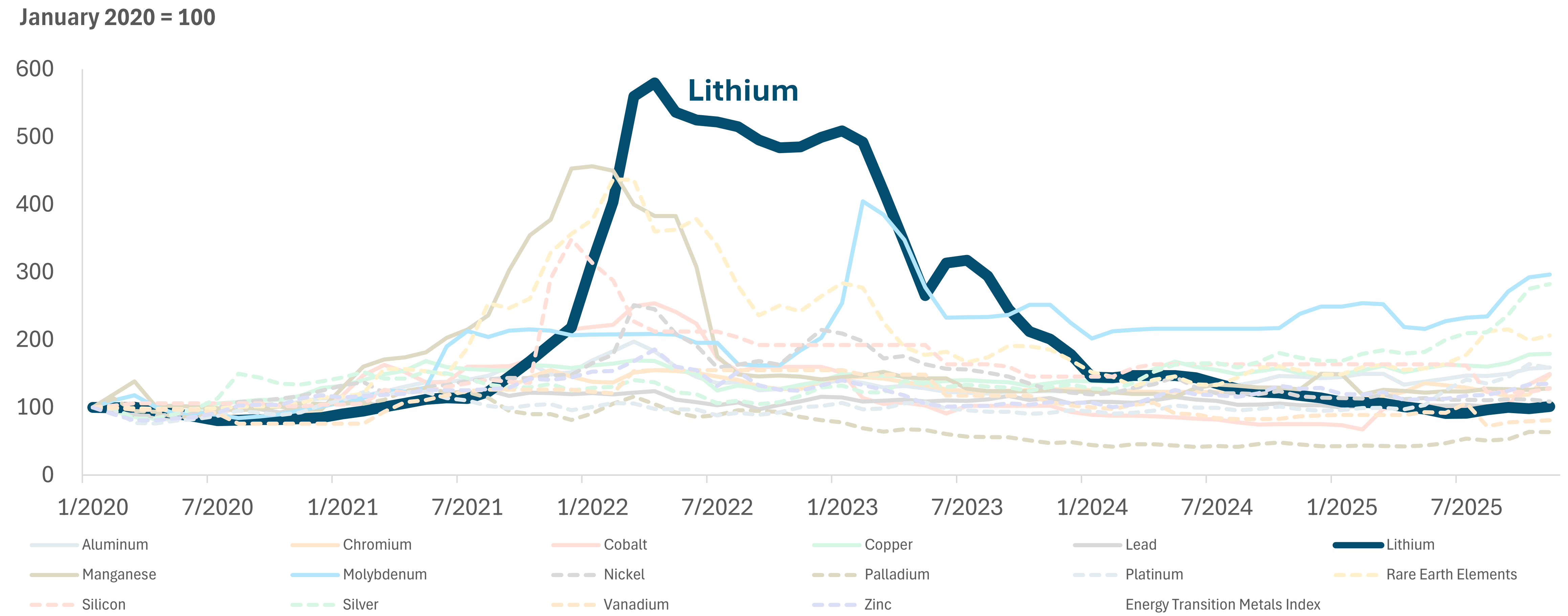


Image sources: (1) U.S. Utility-Scale Solar, 2025 Data Update, Lawrence Berkeley National Lab; (2) Federal Reserve Economic Data

Lithium-Ion Battery Costs have been Highly Volatile Since 2020

Key Commodity Input Price Index



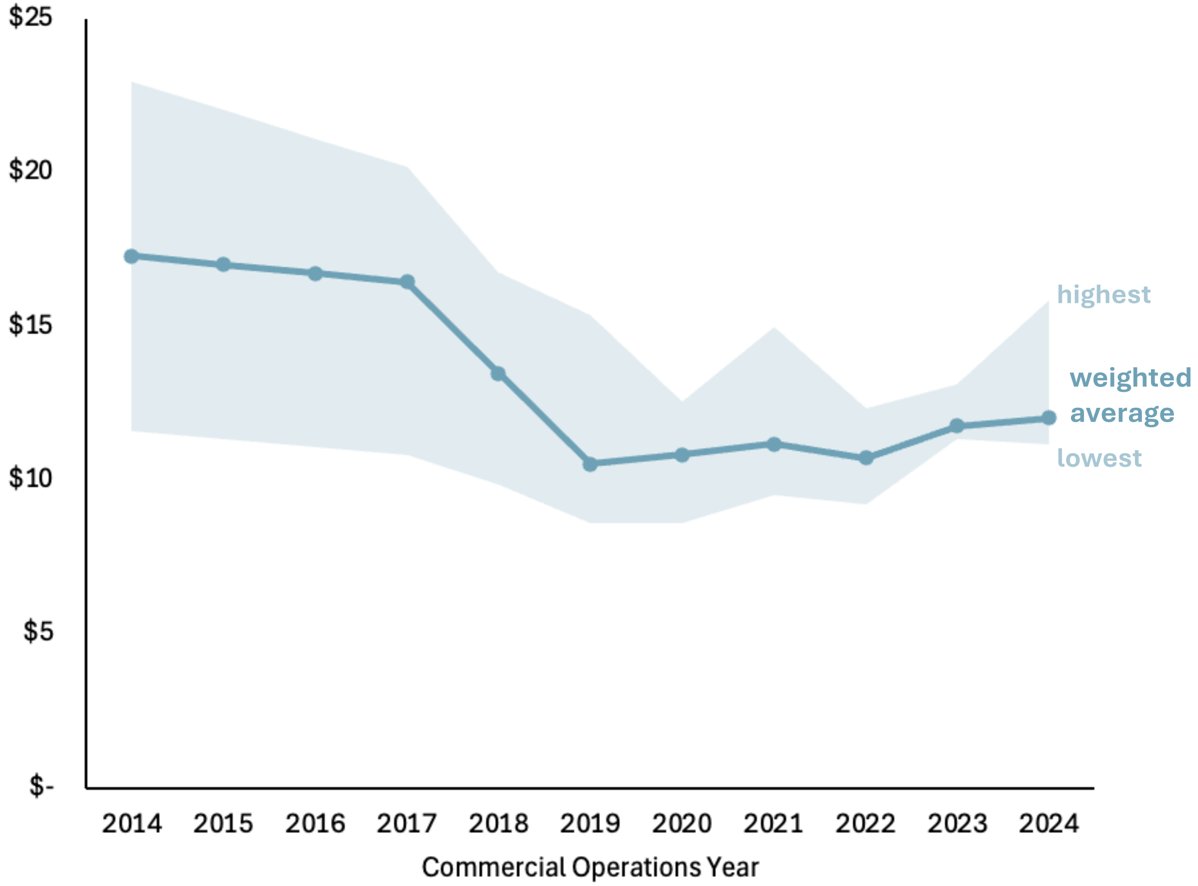
Other capex increase drivers include increases in soft (labor), EPC, and interconnection costs

Source: IMF Primary Commodity Price System (PCPS) Data as of December 2025 (https://data.imf.org/en/Data-Explorer?datasetUrn=IMF.RES:PCPS(9.0.0)).

Battery Contract Prices Have Been Flat or Increasing Since 2020, and the Market Data Does Not Yet Reflect Recent Federal Policies

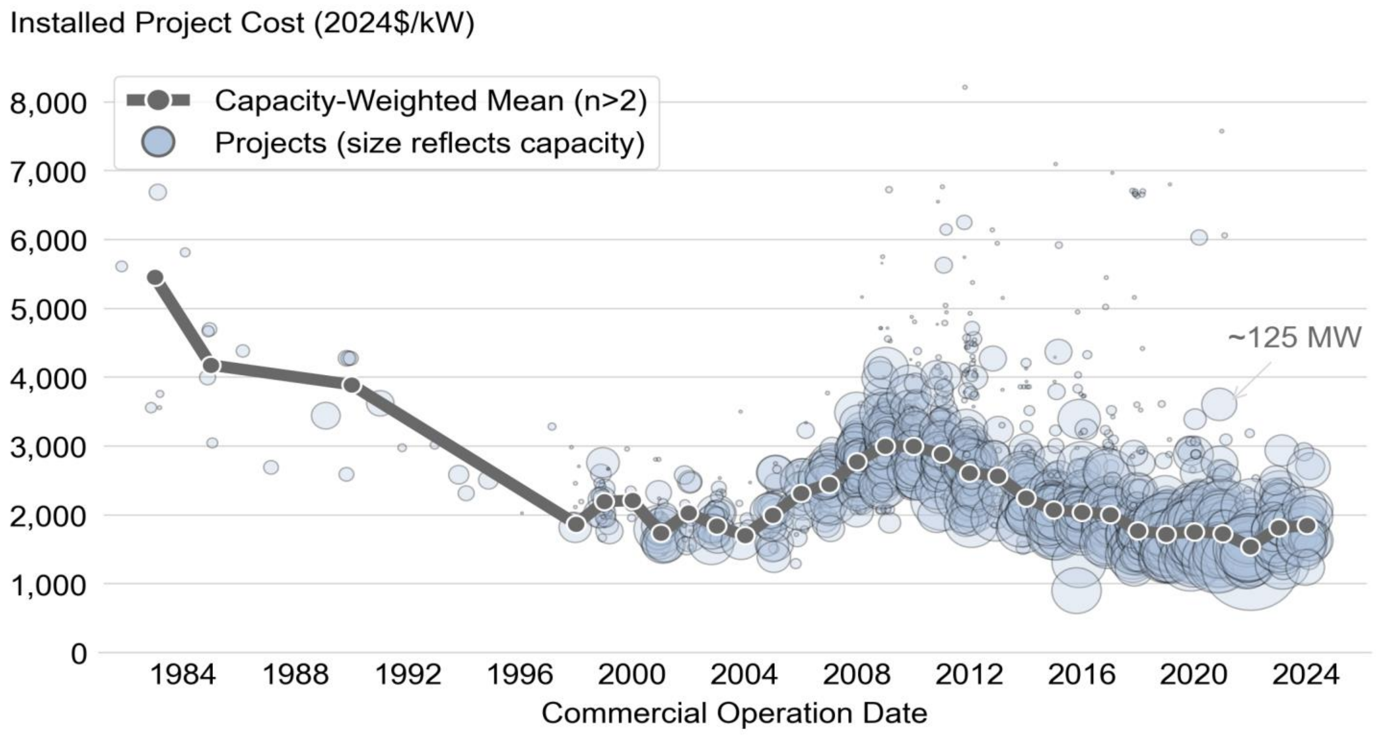
- Battery energy storage system (BESS) contract prices have been volatile over the last 10 years
- Prices fell significantly from 2014 to 2019, driven primarily by a decline in battery module costs
- Starting in 2020, supply chain constraints and incremental battery module demand (competition with EVs) led to a flattening—or even increase—in BESS costs and PPA prices
- BESS prices do not yet reflect the impact of tariffs and foreign content restrictions limiting access to the Investment Tax Credit from recent federal policies

U.S. Signed BESS Contract Prices
(real 2025 $/kW-mo)



Source: LBNL Solar-BESS Hybrid PPA Price Database, https://emp.lbl.gov/utility-scale-solar/

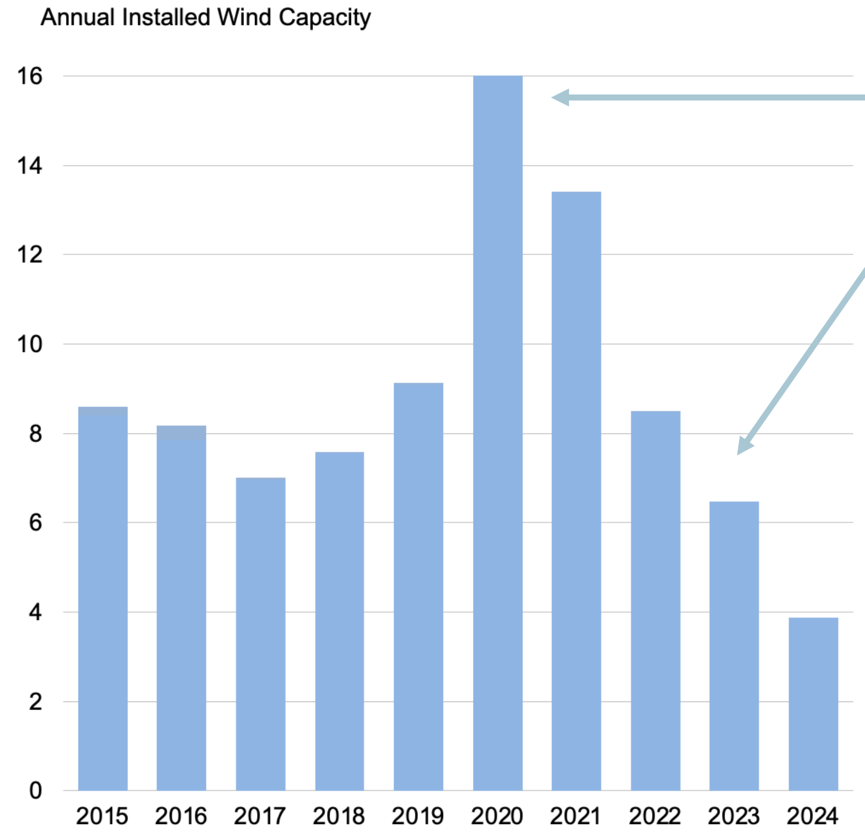
New Wind Project Capital Costs have Remained Flat in Real Terms for the Past 10 Years, Despite Technology Improvements



- **After significant cost declines from the 1980s to 2000, total capital costs for new wind projects have been flat (in real $ terms) for the past 10 years after rising from 2004-2010**
- **Wind costs in 2024 are roughly the same as in 2004, despite technology improvements in wind turbine performance.**

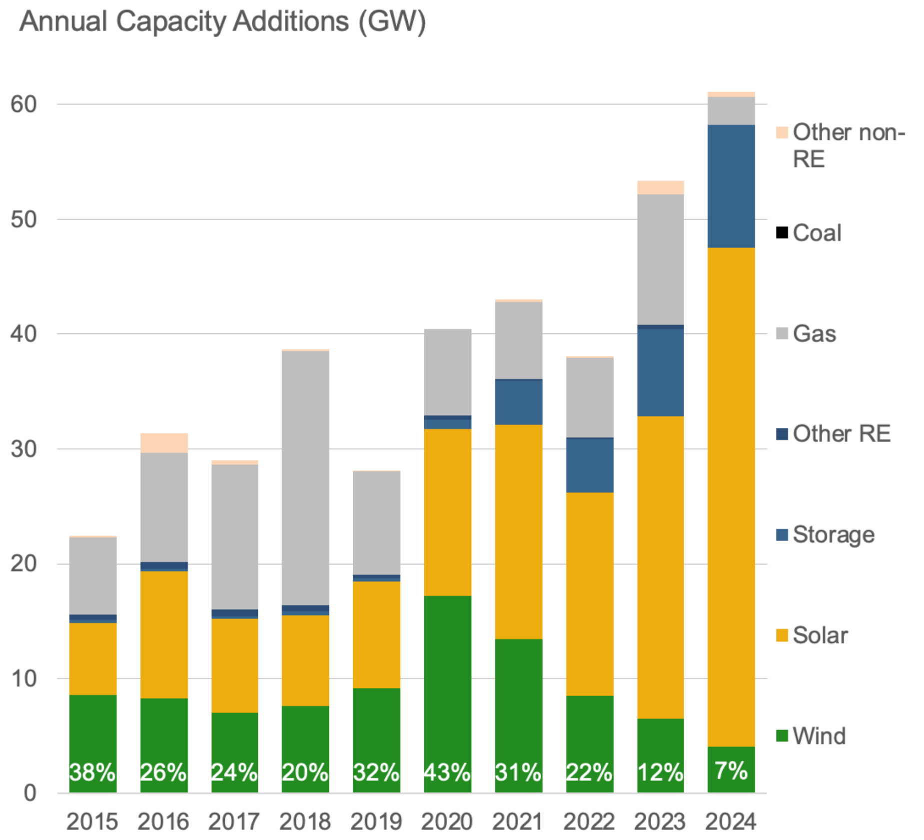
Source: LBNL "Land-based Wind Technology Update, 2025 edition," https://emp.lbl.gov/wind-technologies-market-report

New Wind Additions are Falling Nationally Since 2020 while Other Resources (Mainly Solar and Storage) are Growing Rapidly



Annual wind additions in the U.S. peaked in 2020 and have fallen each year since…

…while additions of other resources have grown, led by solar and battery storage.



Siting and permitting challenges are among the constraints on new wind projects, and recent federal actions against wind development in 2025 are creating more challenges for future projects.

Source: LBNL "Land-based Wind Technology Update, 2025 edition," https://emp.lbl.gov/wind-technologies-market-report

Diverging 2025 Federal Policy Impacts Among Technologies

Relative to the Baseline of Policy on January 19, 2025, E3 Evaluates the Following Policy Impacts on Selected Resource Costs

▼: Positive Impact (Cost Decline) ▲: Negative Impact (Cost Increase) ⇆: Impact Unclear /No Change

	Solar PV	Wind	Li-ion Batteries	Geothermal	Nuclear	Thermal / CCS
Tax Credits	▲ Final qualification year 5 years earlier than previous minimum, and >10 years earlier than prior target		▲ Qualification preserved through 2032, with no potential for extension allowed under the IRA			⇆ 45Q preserved, and 45X revision supports coal
Safe Harbor Provisions	▲ Safe harbor was ultimately preserved in August Treasury guidance, but 5% cost test was removed to ensure physical work test is necessary to comply		⇆ Safe harbor timeline preserved with same tests as pre-IRA			⇆ No change
FEOC Impact	▲ Compliance and cost impacts will look different across technologies due to dependence on imports, but novelty and severity of FEOC guidelines imposes near-term risk across technologies			⇆ FEOC unlikely to materially increase resource costs under current policy guidance		⇆ 45Q risk is elevated but underlying technology is derisked
Depreciation	▼ 100% bonus depreciation restored and extended indefinitely			⇆ Bonus restored, heat pumps excluded from 5-year MACRS (legacy only)	▼ 100% bonus depreciation restored and extended indefinitely	⇆ 45Q dynamics preserved but underlying technology unchanged
Tariffs	▲ Medium-high impact, high certainty	▲ Low impact, high certainty	▲ Medium impact, high certainty	⇆ Minor risk (potentially drilling equipment)	⇆ Nuclear fuel (commodity risk) currently exempted	⇆ Supply chain well-positioned
Non-Tariff Executive Orders / Agency Action	▲ DOI/BLM land restrictions likely to impact wind more than solar, but both exempted from actions intended to support additional generation		⇆ Li-ion unaffected by non-tariff actions, and LPO changes may support supply chain	⇆ Potential impact of DOI/BLM land restrictions but unlikely to target geothermal	▼ Multiple EOs supporting existing and emerging nuclear tech	⇆ EOs, EPA actions favor more gas generation but mandated generation may alter economics

Review of APS Capital Cost Assumptions

Energy+Environmental Economics

Scope of E3's Capital Cost Review

+ **APS requested that E3 review the proposed capital cost assumptions in APS's Resource Technology Assessment, derived from two sources:**
  - Natural gas generation: APS internal analysis
  - Other resources: NREL 2024 Annual Technologies Baseline (ATB)
+ **E3 assessed reasonableness of assumptions according to three criteria:**
  - **Transparency:** are assumptions developed in a manner that is clear to external stakeholders?
  - **Consistency with market conditions:** do cost assumptions align with current observable market intelligence?
  - **Internal consistency:** do cost assumptions across all technologies reflect a consistent underlying view of present and future conditions?
+ **Compare against E3's internal assumptions and other public benchmarks to assess reasonableness according to three criteria**

Technologies Considered	
Geothermal	Natural Gas CCGT
Solar PV	Natural Gas CT
Wind	Nuclear
Battery Storage	*Bioenergy**
*Solar CSP**	*Hydro**

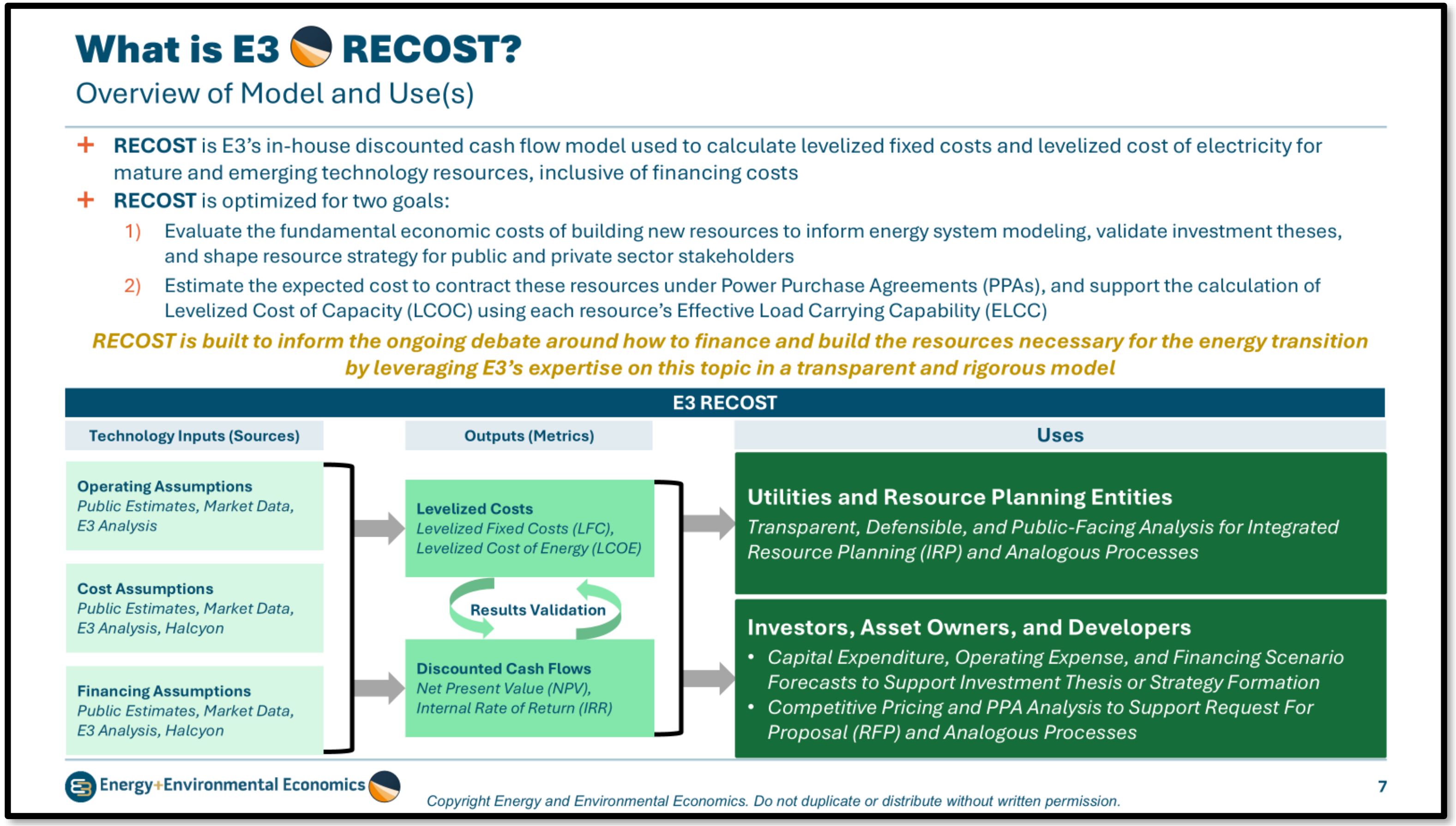
Primary Findings of E3's Review:

- While NREL's 2024 ATB inherently does not capture the most recent developments in the industry, its long-term cost trajectories remain useful for long-term planning and fall within the range of E3's internal projections; APS's reliance on this public source provides a reasonable basis for IRP planning assumptions
- APS's proposed natural gas capital cost assumptions fall within the range of observed capital costs for announced real-world projects, which reflect the significant current uncertainty in natural gas costs

** Due to lack of commercial data and other relevant benchmarks for these technologies, E3 deems the use of NREL ATB assumptions as inherently reasonable*

Benchmarking Against E3 RECOST Assumptions

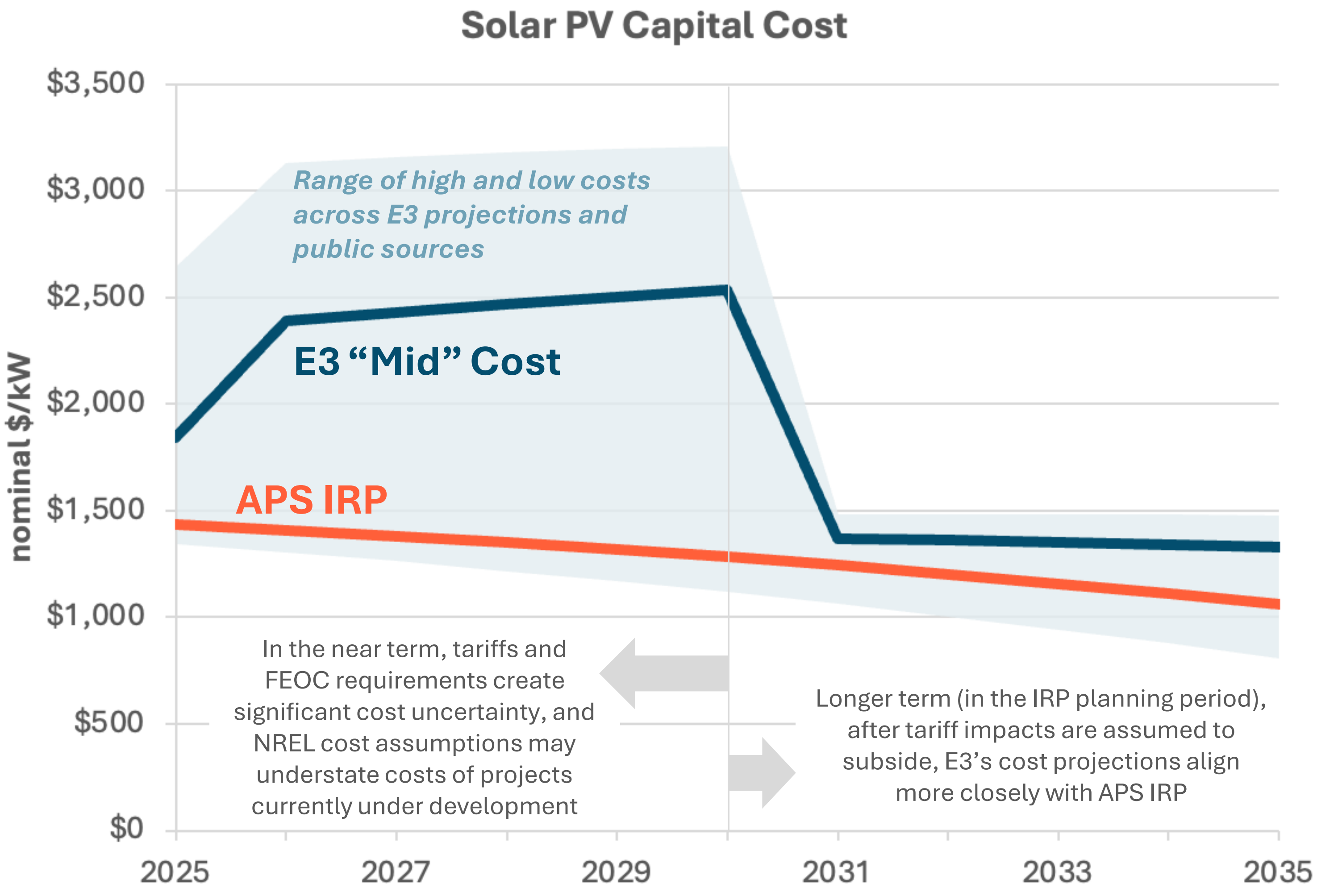
- E3 maintains and publishes semi-annual updates to RECOST, a repository for E3's internal technology projections and financial analysis tool
- Technology-specific cost assumptions are developed by E3's subject matter experts, leveraging both public sources (including NREL's ATB) and market intelligence
- Cost ranges from E3's most recent RECOST release (Q1 2026) are used as a benchmark for the projections used in APS's IRP, focusing on 2030-2035



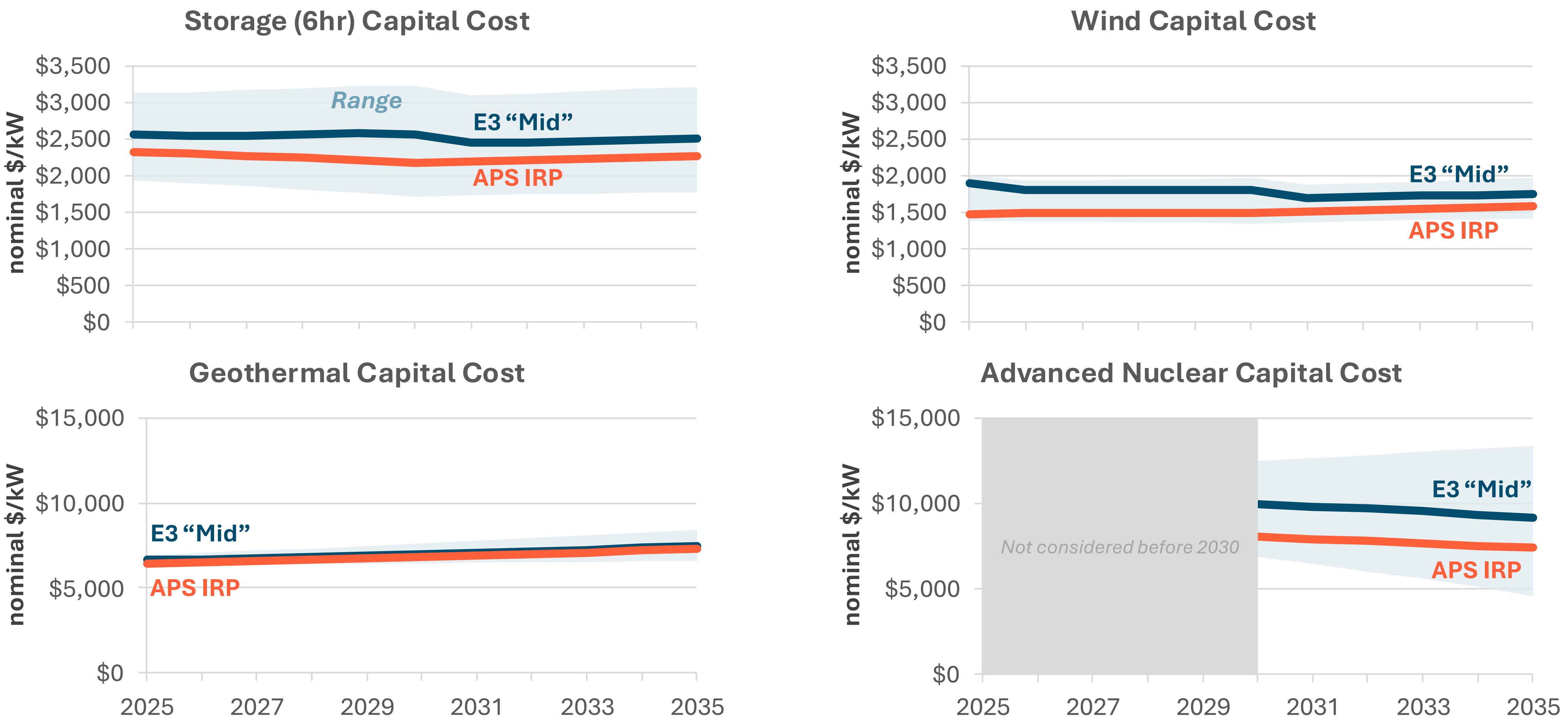
More information available at: https://www.ethree.com/wp-content/uploads/2026/01/2026.01_E3-RECOST_Public.pdf

Capital Cost Review: Renewables, Battery Storage, Nuclear

- **APS's proposed assumptions for renewables, energy storage, and nuclear are based on NREL's 2024 ATB, published prior to:**
  - ...most recent cost escalation dynamics
  - ...implementation of tariffs and FEOC requirements
- **In the near-term (pre-2030), NREL cost trajectories likely understate the capital cost for new resource development, especially for technologies most exposed to tariffs and FEOC requirements *(see Solar PV at right)***
  - Because opportunity to develop additional resources on this timescale is inherently limited, impact of these assumptions on IRP is small
- **Beyond 2030, E3's internal projections align more closely with NREL's assumptions for renewables, storage, and nuclear resources**
  - NREL 2024 ATB falls within the range of planning projections published by E3
  - E3's current "Mid" case is 10-20% higher than NREL 2024 ATB for most technologies

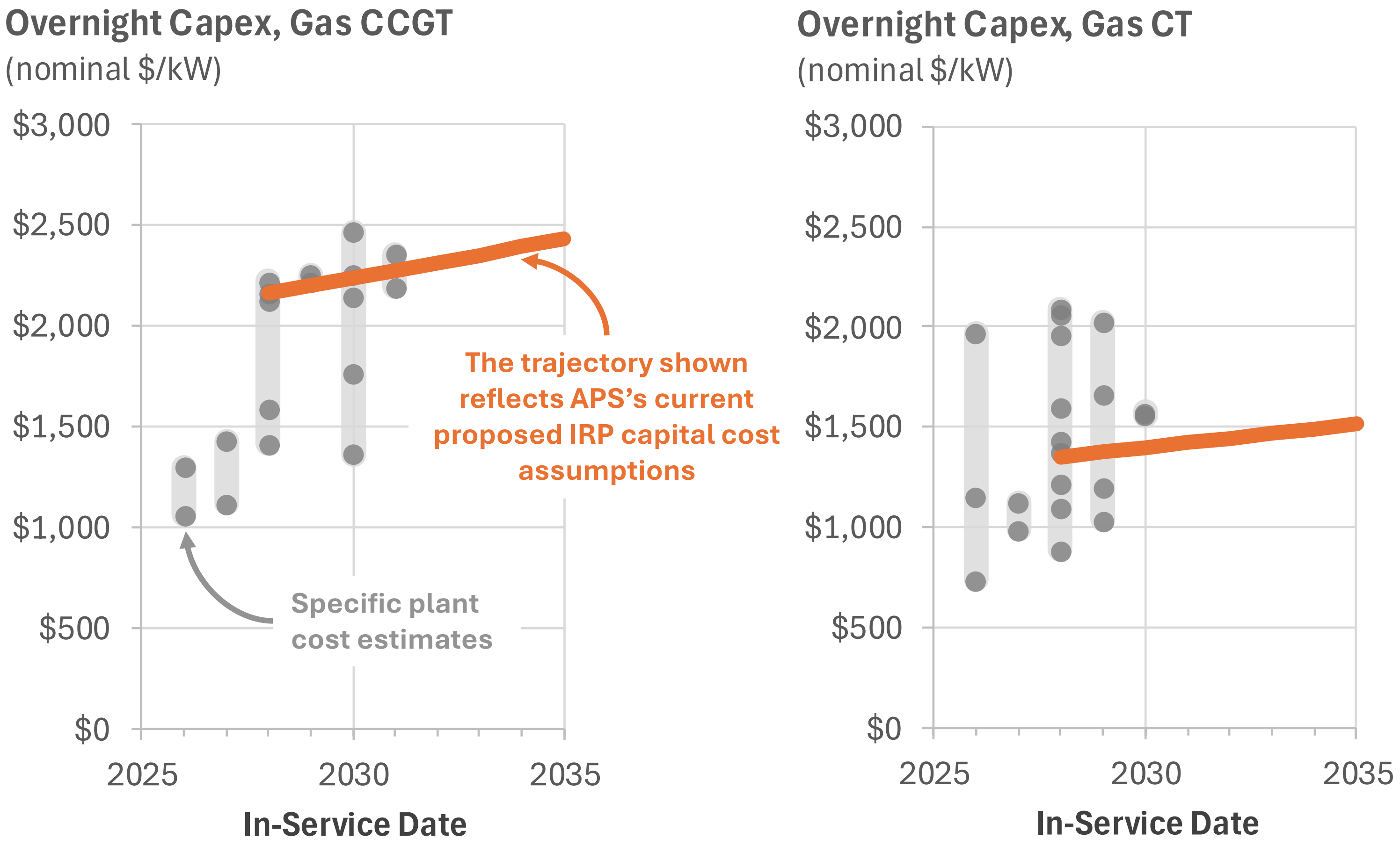


Capital Cost Review: Renewables, Battery Storage, Nuclear



Capital Cost Review: Natural Gas Power Plants

- APS's proposed assumptions for natural gas capital costs fall within the ranges established by published costs for announced new gas generation projects
  - APS's cost trajectories adequately capture the escalation recently observed in natural gas costs
- Directional relationship between CCGT and CT is preserved:
  - CCGT provides higher capex, higher efficiency resource (more suitable for intermediate duty cycle)
  - Gas CT is lower capex, lower efficiency resource (more suitable for peaking duty cycle)



Conclusions & Observations from E3's Review

+ **APS's proposed capital cost assumptions appear <u>reasonable</u>, leveraging public information where possible and falling within the ranges established by trusted public benchmarks**

+ **Future technology costs remain highly uncertain and could deviate substantially from these values, and sensitivity analysis to key input assumptions is an important tool to manage risk and ensuring robust long-term planning**

✓	**Transparency**	APS relies on NREL 2024 ATB, a widely used and familiar source for capital costs for new generation resources; where APS's assumptions diverge from the ATB, this divergence is justified by significant cost escalation observed since publication and is consistent with other public benchmarks
✓	**Consistency with Market Conditions**	APS's assumptions for all technologies fall within ranges established by (a) published cost estimates for announced plants and (b) E3's internal planning assumptions
✓	**Internal Consistency**	The relative costs of different technologies is consistent with recent historical observations and E3's internal future projections

2026 IRP Timeline

Mike Eugenis, APS

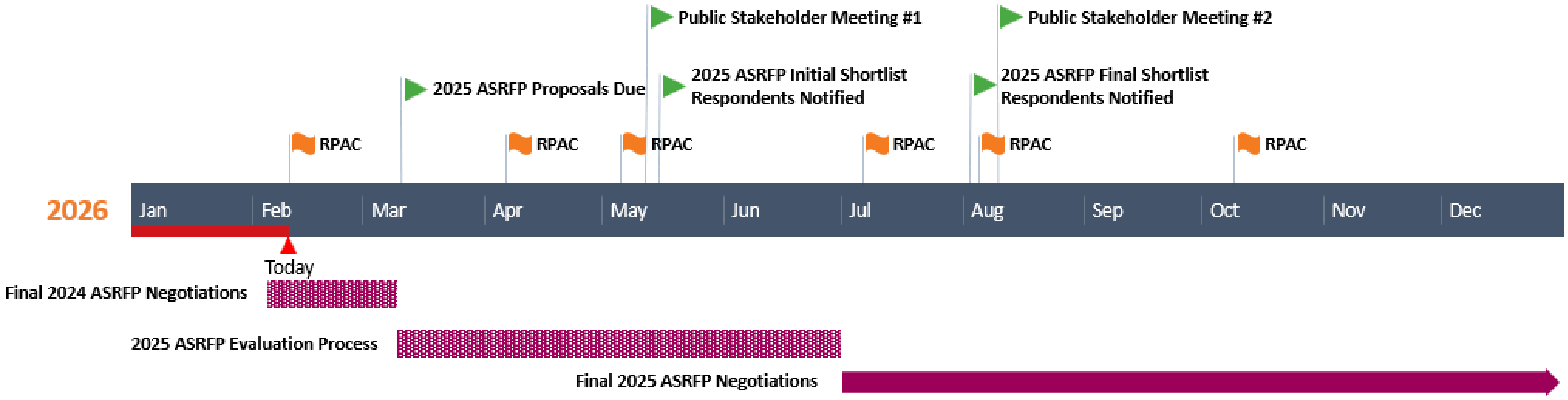
2026 IRP RPAC Timeline

February RPAC Meeting	April RPAC Meeting	May RPAC Meeting	July RPAC Meeting
• 2026 IRP Resource Adequacy Study • Preview 2026 IRP RPAC Topics	• Introduce 2026 IRP Scenarios • Integrated System Planning Approach • Base Case Assumptions	• Discuss IRP Scenario Results • Share Base Case	• Discuss Preferred Portfolio

Next Steps & Closing Remarks

Adam Constable, APS

Forward Plans and Meetings



Key Milestones

April RPAC Meeting: April 9, 2026
(Tentative)
Time: 10:00 am

Notice of Intent for IRP Modeling Licenses:
March 6, 2026