APS RPAC Meeting

2/17/2022

MEETING AGENDA

Welcome & Meeting Agenda
Matt Lind
1898 & Co.

ACC Open Meeting Updates
Justin Joiner
VP, Resource Management

Southwest Resource Adequacy Study
Nick Schlag
E3

APS Needs Review
Jeff Burke
Director Resource Planning

RFP Resource Options
Nick Schlag
E3

RFP Evaluation Criteria
Matt Lind
1898 & Co.

Discussion & Next Steps
Matt Lind
1898 & Co.

January RPAC Meeting

- APS to move forward with all-source RFP process over RFI focused on resource procurement for 2025 through 2027.
- Draft RFP will be provided in March for RPAC feedback on RFP language.
- Numerous entities in the west are planning to procure resources in the same time period and timeline is critical to ensure APS can deliver on its resource needs.

Following Up

- Action Items from previous meetings:

- Ongoing Commitments:
  - Distribute meeting materials in a timely advance fashion (3 bd prior)
  - Transparency and dialogue

Meeting Guidelines

- 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.
- We will keep a parking lot for items to be addressed at later meetings.
- 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.
- Consistent member attendance encouraged; identify proxy attendee for scheduling conflicts.
- Meetings and content are preliminary in nature, and prepared for RPAC discussion purposes. Litigating attorneys are not expected to participate.
- **Today**: After the break, certain RPAC Members will be excused from specific RFP agenda item discussions due to potential resource development interests.


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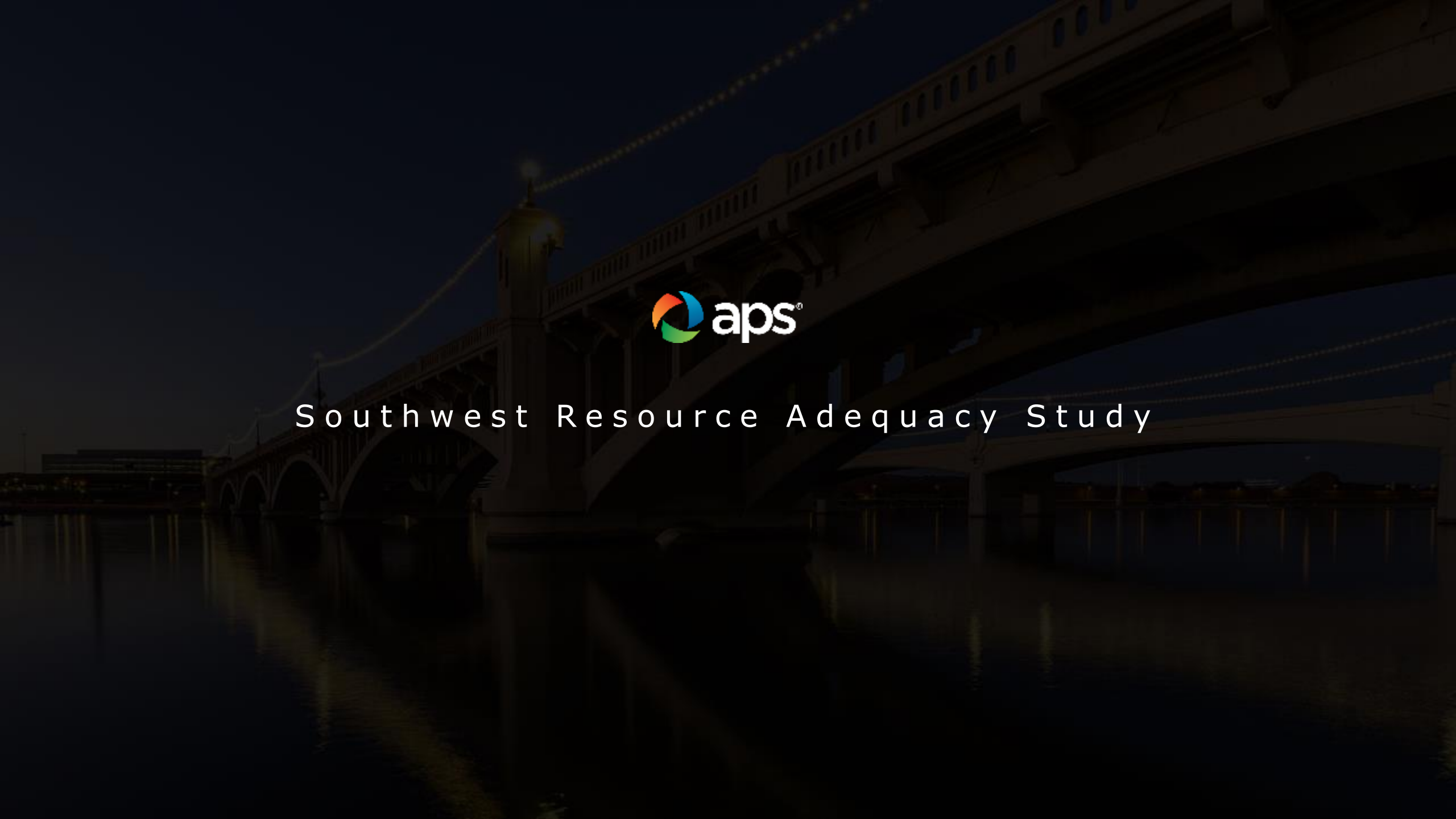
ACC Open Meeting Updates

Proposed Energy Rules/IRP

- On January 26th, the Proposed Energy Rules were not approved by the ACC
  - Several amendments to the energy rules were added and approved. The Proposed Energy Rules failed to pass by a vote of 3-2
- ACC voted to open a new rulemaking docket for all-source RFP and IRP rules
  - New docket expected to utilize aspects of the previously proposed Energy Rules
- On February 9th, the APS 2020 IRP was acknowledged by the ACC in a vote of 4-1
  - Several amendments were adopted in the ROO and APS will provide an update after the Final Order is issued

APS Resource Update

- Continued progress on APS clean energy additions:
  - Additional contract executed adds approximately 215 MW of solar and energy storage
    - 2020 RFP Renewable nameplate:
      - Solar and Wind ~ 665 (+215 since January) MW (Reliable Capacity: 243 MW) (+80MW)
    - 2020 RFP Energy storage nameplate:
      - Energy Storage ~ 575 (+215 since January) MW (Reliable Capacity: 375 MW) (+135MW)
  - APS continues to negotiate potential resource additions in the 2020 RFP
- Supply chain challenges are impacting near and intermediate term approaches to meeting resource needs around the region
  - Utilities continue to work around near-term challenges with alternate generation or short-term unit life extensions



Southwest Resource Adequacy Study

Study purpose

+ The project's funders retained E3 to conduct a study to characterize resource adequacy in the Southwest region over the coming decade

- Project materials available here

+ Purposes of this effort are threefold:

1. Characterize the challenges facing the region in the coming decade in a manner that is broadly accessible to regulators, policymakers, and stakeholders;
2. Identify industry best practices for resource adequacy and demonstrate these techniques to quantify regional capacity needs; and
3. Provide utilities with information that can enhance their individual planning efforts for resource adequacy

Key Trends that will reshape Resource Adequacy

Load growth
Expected 2% load growth resulting from net migration, electrification, and new large customers

Planned coal & gas retirements
Announced retirements total 1.4 GW by 2025 and 5 GW by 2033

Rapidly increasing reliance on renewables and storage
Resource additions driven by state policy, voluntary commitments, and economics

Climate change impacts on extreme weather
Increased frequency and intensity of extreme heat events results in more frequent extreme peak demand

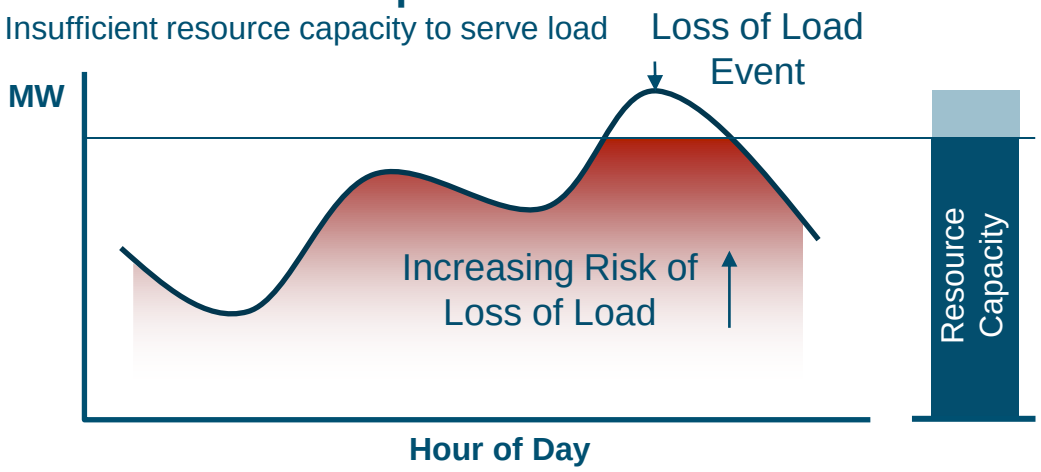
Increasing risk of sustained drought
Hydroelectric generation facilities susceptible to significant impacts under drought

Tightening Western markets
Changes & trends across the broader Western Interconnection reshaping market dynamics

What is resource adequacy?

- **Resource adequacy is one aspect of a utility's mission to plan and operate a reliable system**
  - A measure of the ability of a portfolio of generation resources to meet load across a wide range of system conditions, accounting for supply & demand variability
- **No system is planned to achieve perfect level of adequacy**
  - The most common standard used throughout North America is a "one-day-in-ten-year" standard

Loss of Load Example



NERC Definition of Resource Adequacy:

"The ability of the electric system to supply the aggregate electrical demand and energy requirements of the end-use customers at all times, taking into account scheduled and reasonably expected unscheduled outages of system elements."

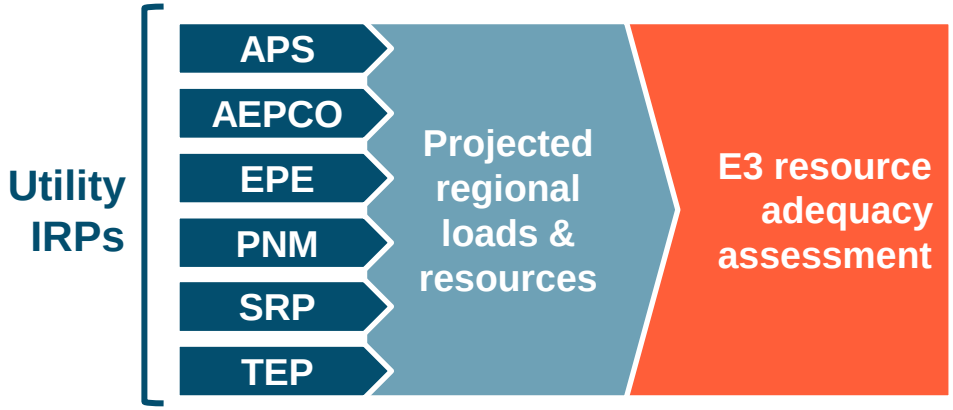
Source: NERC Glossary of Terms

Scope of technical analysis

Three questions addressed in this analysis:

1. **How much capacity is needed to maintain reliability in the Southwest?**
   (measured against a "one day in ten year" standard)
2. **To what extent will utilities' existing & committed resources satisfy this requirement?**
3. **What additional resources are needed to ensure regional reliability?**

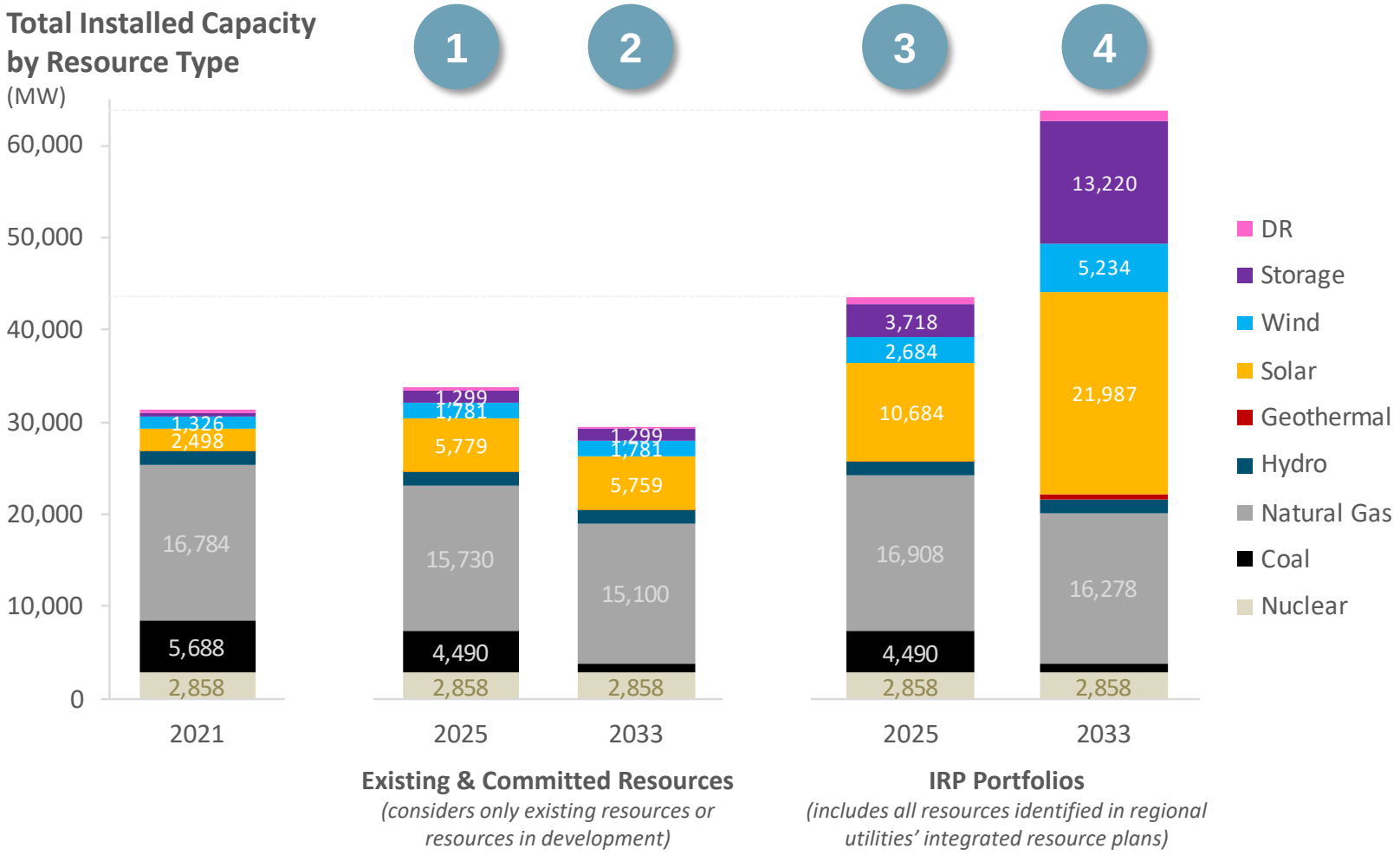
+ **This study builds upon the integrated resource plans of the Southwest utilities to address specific questions on how these plans will impact reliability within the region**



+ **Loss of load probability analysis used to study level of reliability achieved across the Southwest region, including metrics such as:**
  - Loss of load expectation (LOLE), expected unserved energy (EUE) and other statistical methods
  - A planning reserve margin (PRM) and effective load carrying capability (ELCC) values for different resources

Study scenarios and sensitivities

Four core scenarios examine regional adequacy of different portfolios:



Sensitivity analysis explores additional uncertainties:

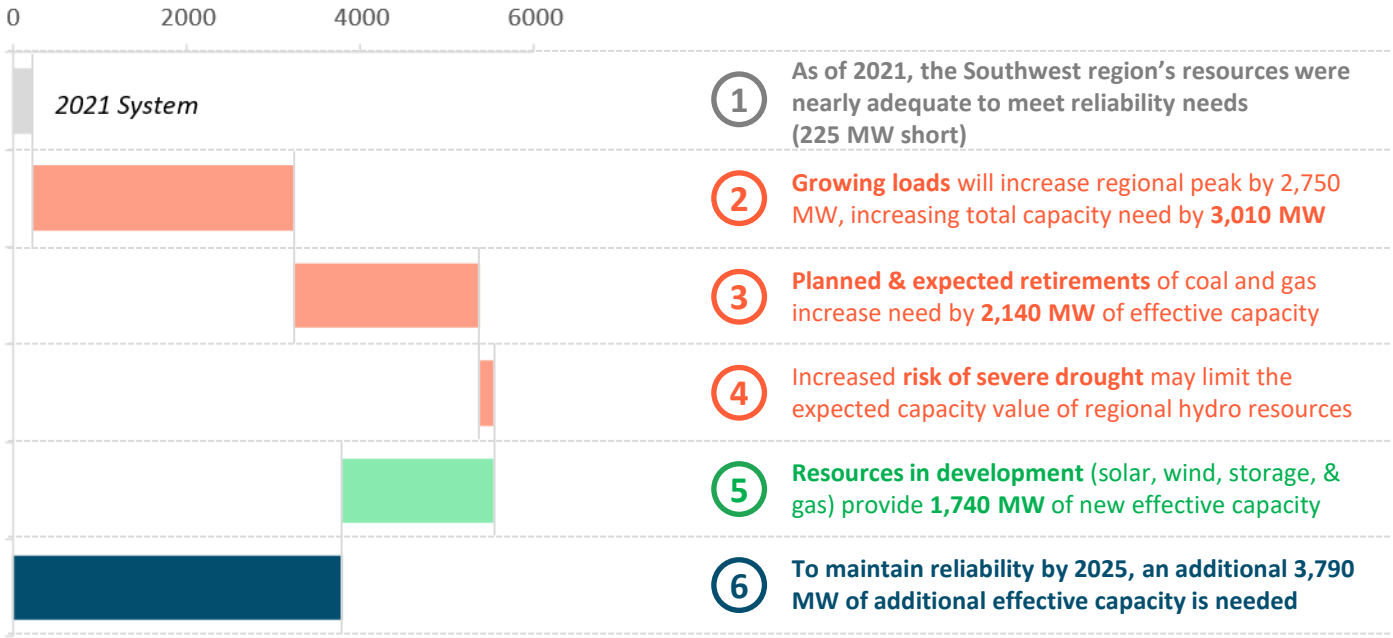
- + Battery storage performance
- + Hydro availability
- + Load impacts of more extreme weather
- + Natural gas generator performance
- + Interregional market dynamics
- + Timing of additions
- + "Summer stress test"

Load growth & resource retirements are creating an urgent need for new resources in the Southwest

- **Existing & committed resources will be insufficient to meet the region's rapidly growing resource adequacy needs**
- **By 2025, approximately 4,000 MW of *effective capacity* will be needed beyond resources already in development**
  - Load growth anticipated by utilities will increase regional peak by roughly 700 MW each year, resulting in a 2,700 MW increase by 2025
  - Retirements of existing coal and gas resources are expected to total 2,500 MW of nameplate capacity by 2025
- **By 2033, the continuation of these trends will require a total of 13,200 MW of *effective capacity* to maintain reliability**

Changes in Southwest Regional Load-Resource Balance, 2021-2025

(Effective MW)



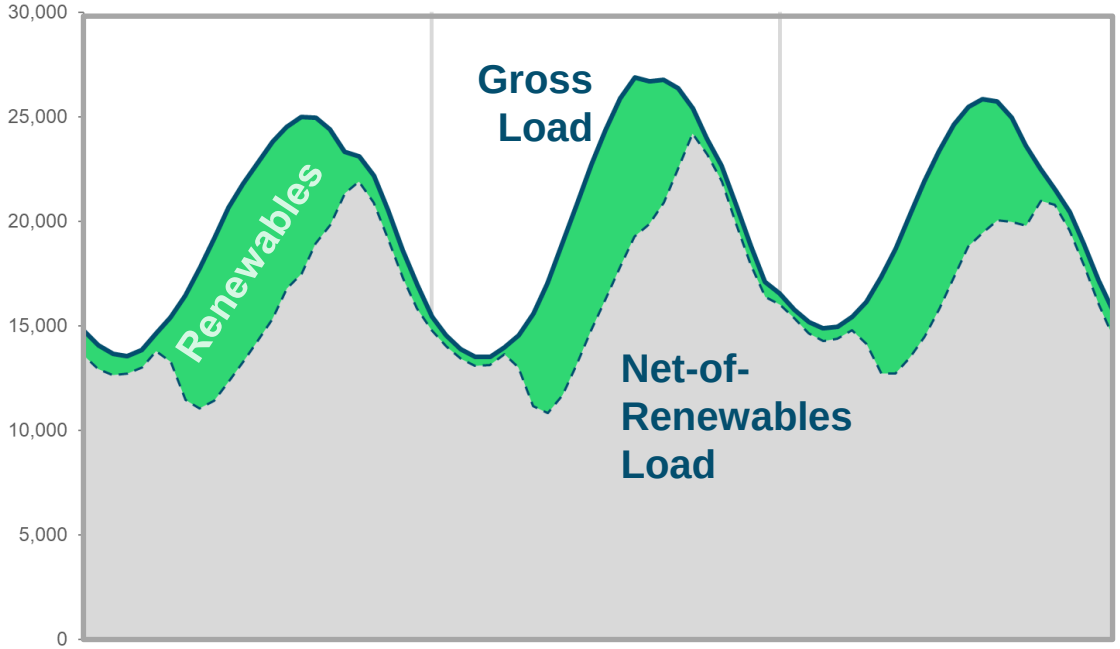
Notes

1. "Effective capacity" measures a resource's contribution to resource adequacy relative and is typically less than its nameplate capacity; the amount of new nameplate capacity needed to ensure resource adequacy will exceed – likely by a multiple of three to four times – the amount of new effective capacity needed
2. Resources in development within the region include solar (3,281 MW), storage (1,040 MW), wind (455 MW), and gas (228 MW)

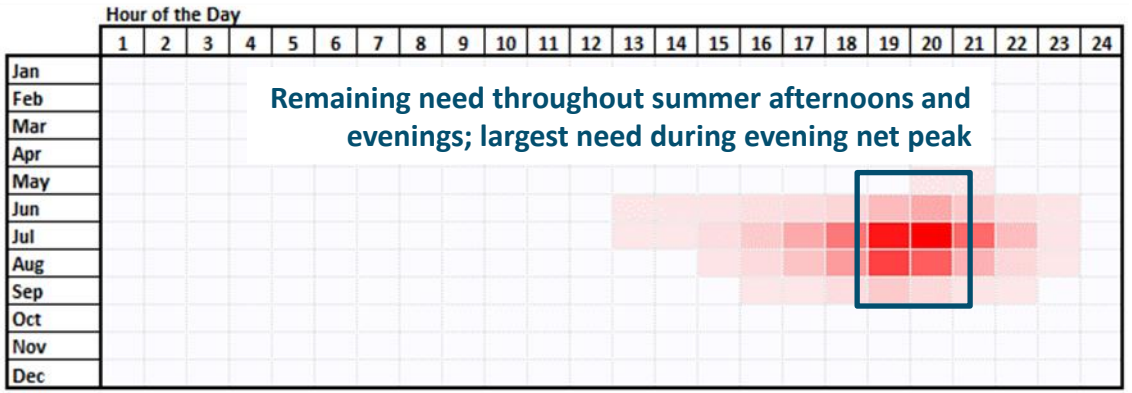
By 2025, the principal resource adequacy challenge in the Southwest is the evening "net peak"

- **With increasing penetration of solar resources, the highest "net peak" period occurs after sundown** *(i.e. the highest loss of load probability occurs when solar is not producing)*
- **This shift has direct implications for the relative capacity value of different types of resources**

2025 load & net load on representative summer peak days
(MW)



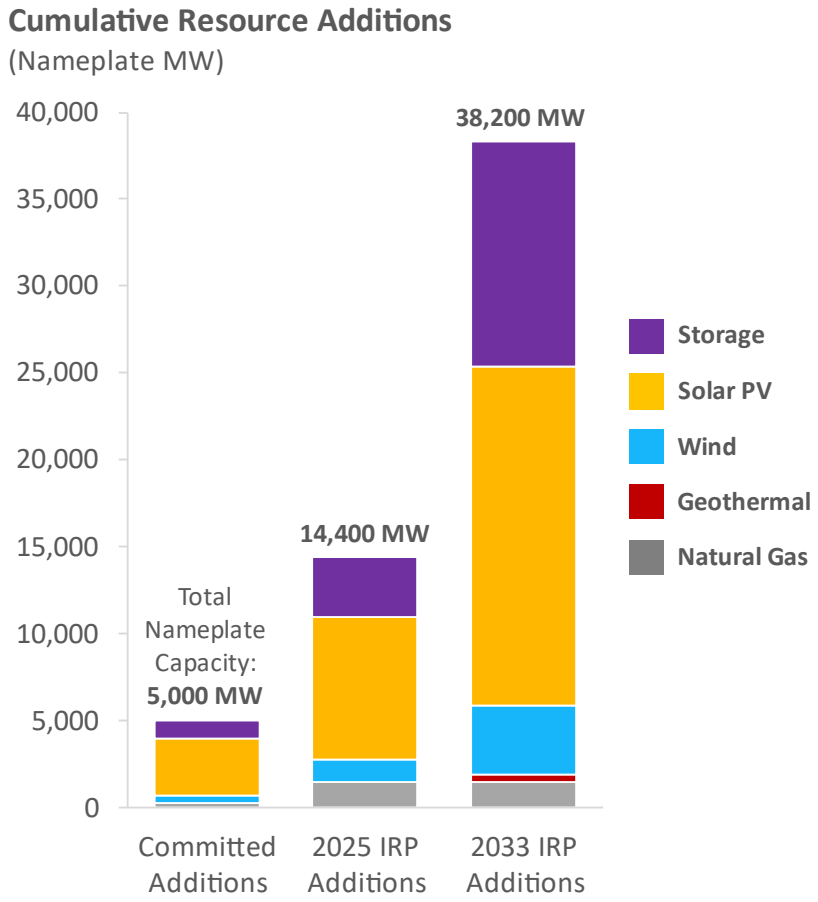
2025 Loss of Load Probability
Existing & Planned Resources



Utilities' current resource plans have identified sufficient capacity additions to maintain reliability

+ **Utilities' IRPs have identified total additions of roughly 14,000 MW of nameplate capacity by 2025 and 38,000 MW by 2033**

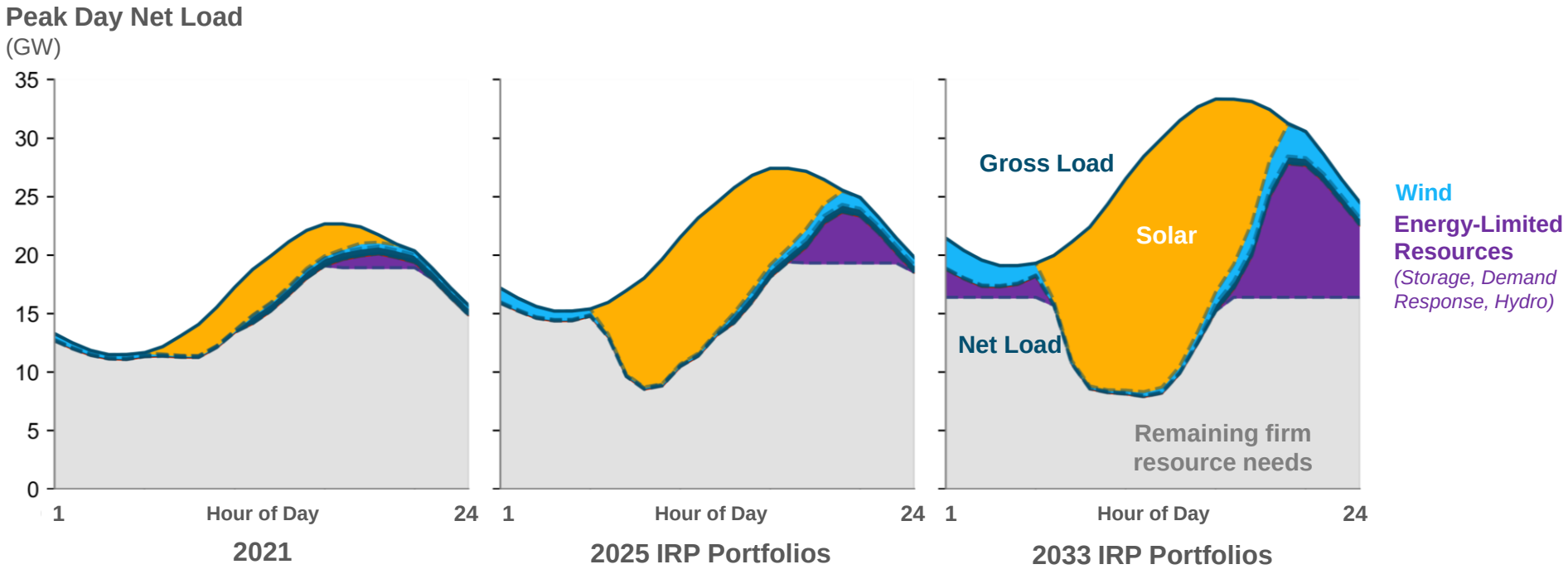
+ **The quantities and types of new resource additions included in utility plans are sufficient to maintain regional reliability under most scenarios**
  - If all resources included in utility IRPs come online during the timeframes identified, the region will maintain a small surplus of effective capacity over the next decade horizon under Base Case assumption
  - The amount of *nameplate* capacity needed to ensure reliability is much larger than the amount of *effective* capacity needed due to inherent limits on the capacity value of variable and energy-limited resources



A large share of the region's long-term needs will be met with solar, storage, and other "non-firm" resources

+ **A portfolio of variable renewables, storage, and other energy-limited resources can provide a significant contribution to regional resource adequacy needs**
  - Capabilities of solar and storage are particularly well-suited to matching high summer peak demands

+ **Non-firm resources will account for an increasing share of regional resource adequacy needs:**
  - Roughly 25% of regional needs by 2025
  - Roughly 50% of regional needs by 2033



Substantial reliability risks remain as the region's electricity resource portfolio transitions

Renewable Variability

As the region's supply becomes increasingly reliant on variable resources, weather variability introduces operating risks, including possible sudden, large drops in renewable energy output or extended renewable droughts

Climate Impacts

The possibility of significant changes to regional load patterns, e.g., due to climate warming, increases the potential capacity needed to meet load during heat waves

Battery Performance

Battery storage has not yet been widely deployed at grid scale, and if it does not perform as idealized in this study, could be less effective as a capacity resource

Recent examples of extended plant outages at existing battery storage projects due to heat or fire provide warnings

Fuel Supply

Reliance on just-in-time delivery of natural gas creates fuel security risks

The interstate natural gas pipeline system does not operate to the same reliability standards as the electricity system, and fuel deliveries have been interrupted during extreme cold weather events

Timing

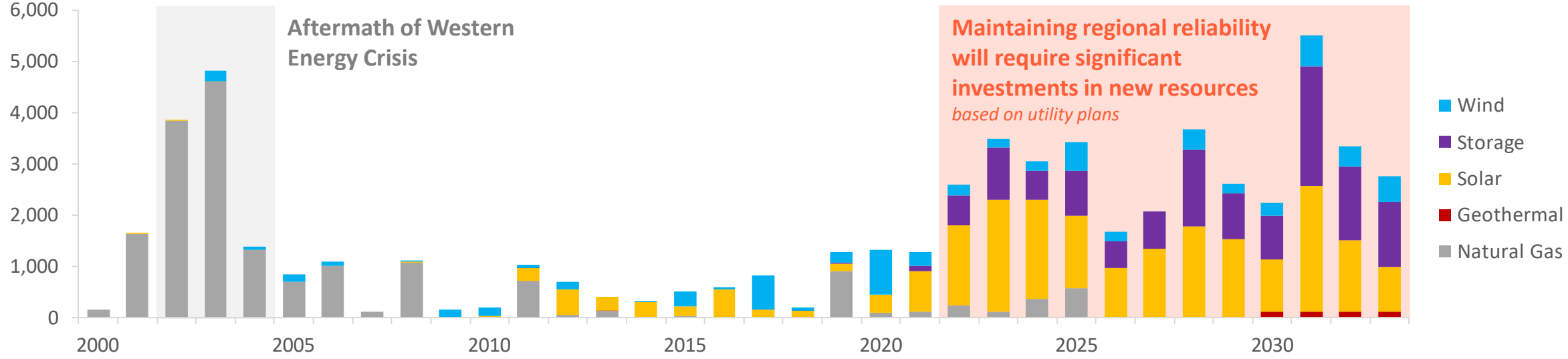
Processes for new resource development typically span multiple years

Project delays or cancellations could result in temporary resource shortfalls

Maintaining reliability will require immediate and sustained action over the next decade

- **The rate of new resource additions required in the next ten years is nearly unprecedented in the history of the Southwest**
- **With project development timelines measured in years and near-term supply chain risks looming, advance planning and prompt action by utilities are needed to avoid falling behind in the transition**
- **Utilities, regulators, developers and stakeholders will share responsibility for working cooperatively to ensure new resources are in place as needed**
  - Plans for new resource additions should account for reasonable risks of project delays and cancellations
  - Failure to develop new resources in a timely manner will either result in (1) a degradation of reliability or (2) the need to retain existing plants with scheduled retirements

New Installed Capacity Additions by Year (Southwest Region)
(Nameplate MW)

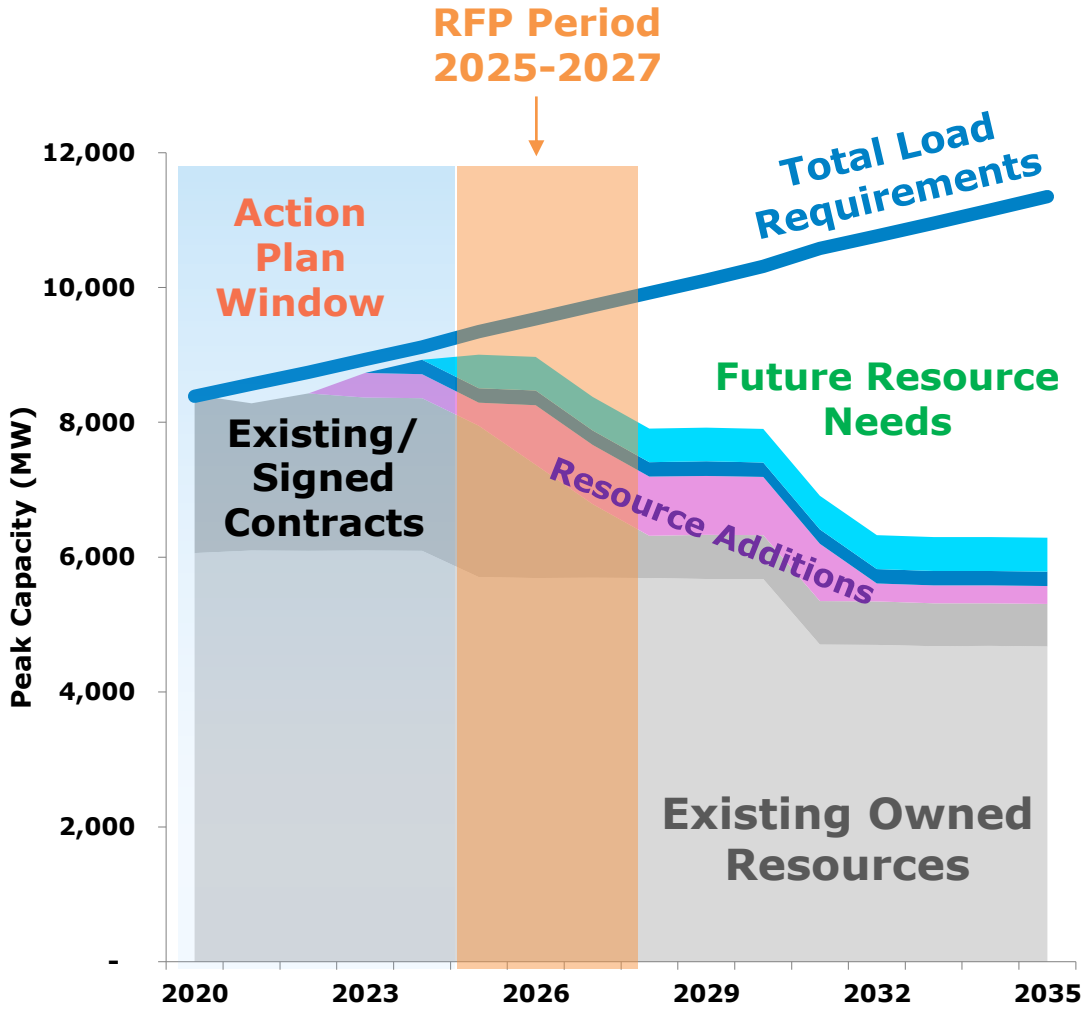


Discussion & Questions

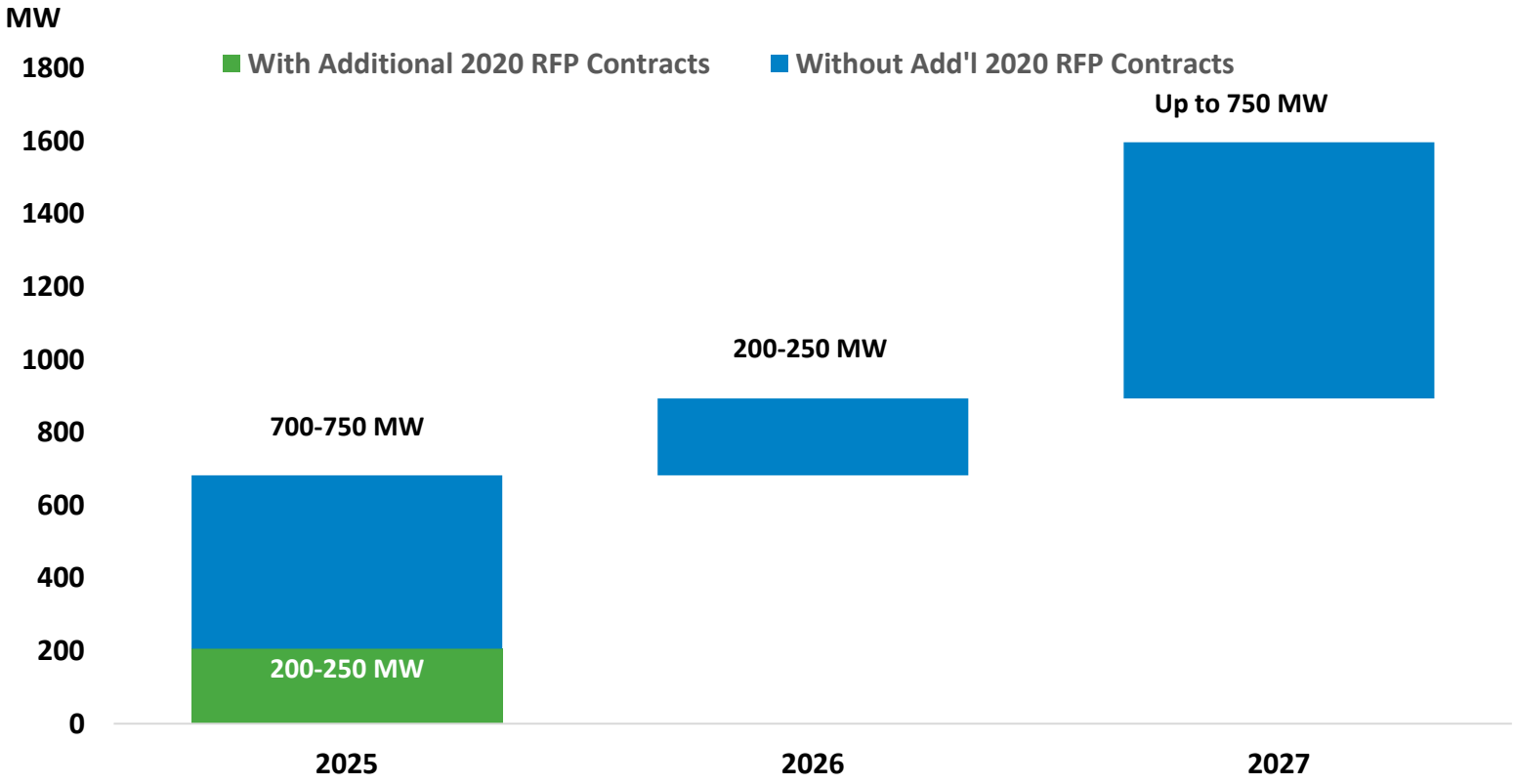
APS Needs Review

Resource Need Drivers and RFP Period

- Resource needs are driven by:
  - ❑ Increasing load growth
  - ❑ Reduced regional capacity availability
  - ❑ Unit retirements/contract expirations
  - ❑ Lead time for construction
  - ❑ Extreme weather conditions
- APS continues to negotiate contracts through the 2020 RFP
  - ❑ Next RFP needs are based on ranges until the 2020 RFP is completed
  - ❑ RFP approach reflects need for capacity/reliability and clean energy additions to meet or exceed CEC

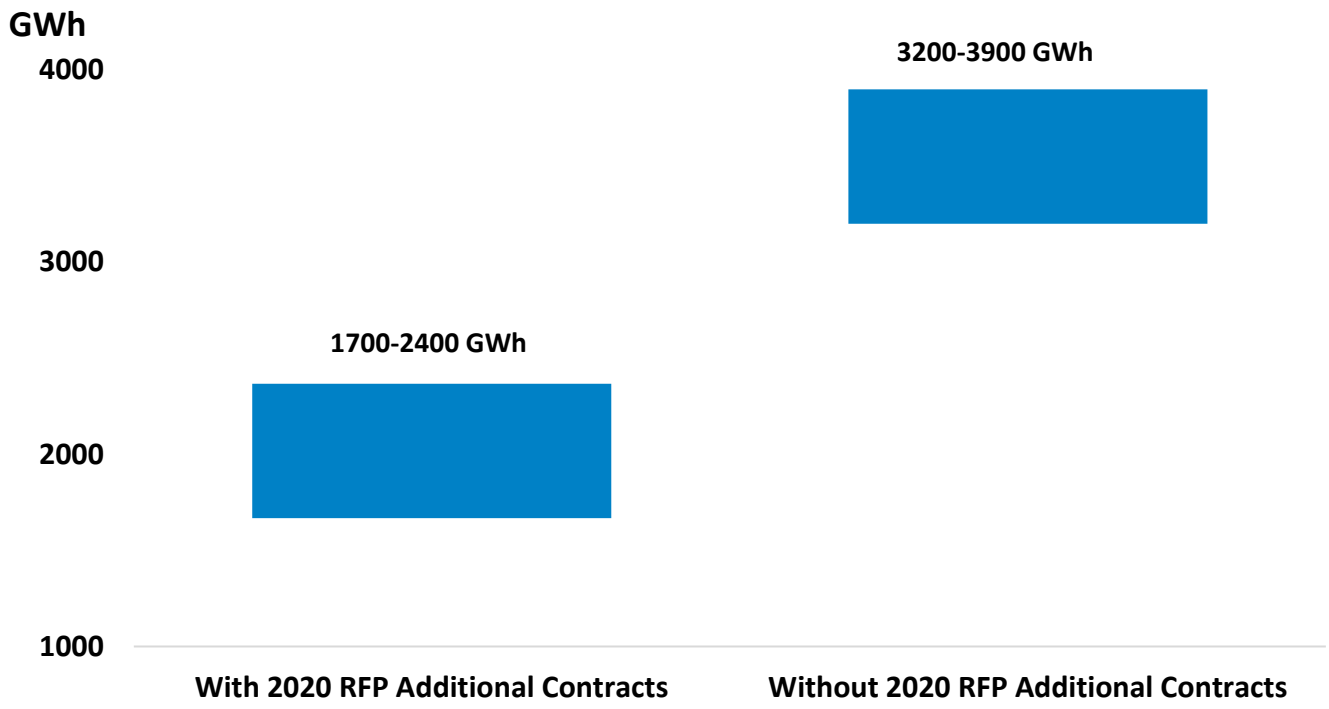


Capacity Needs Through 2027



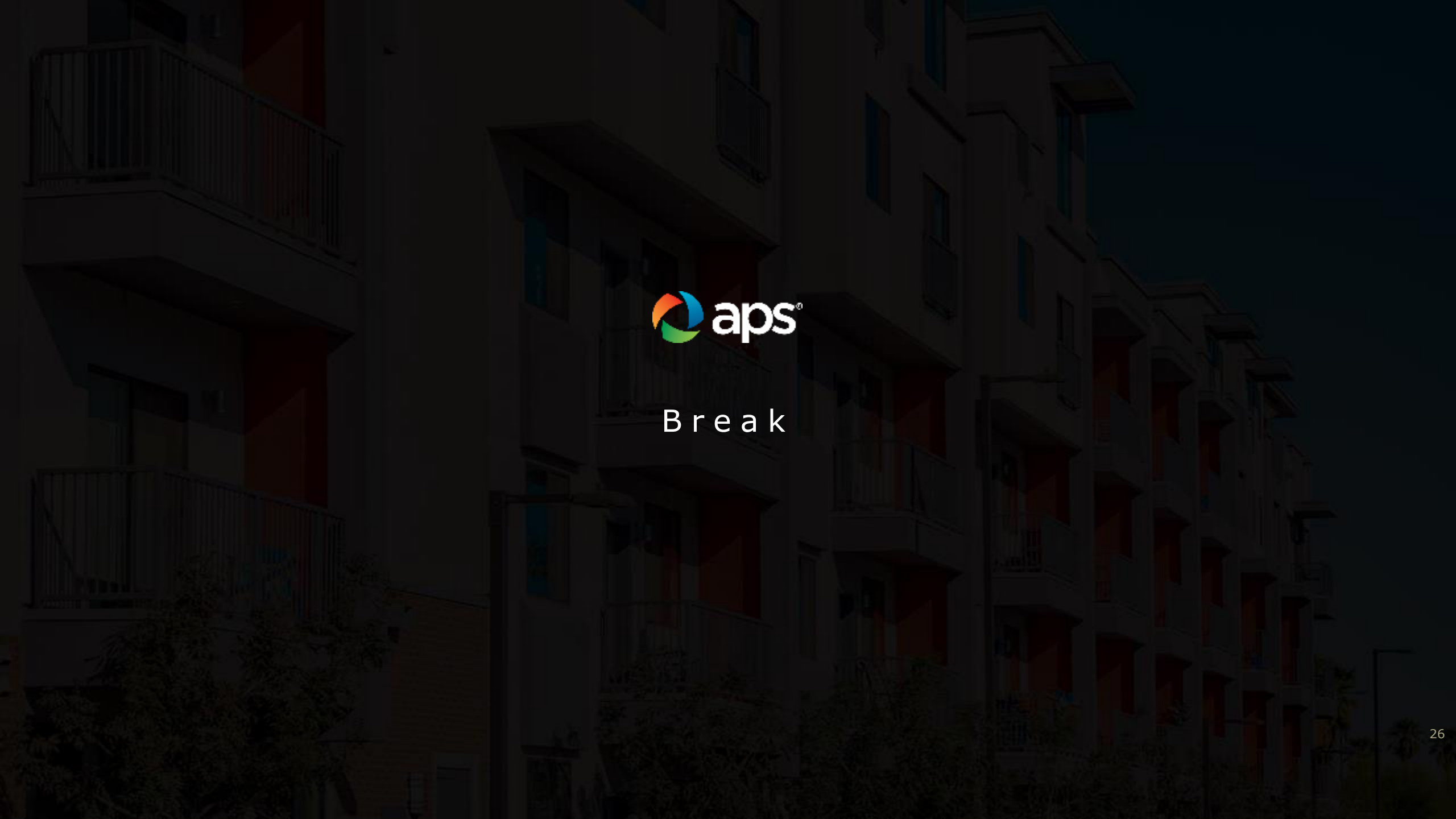
Under an "additional contracts" scenario in the 2020 RFP, APS may have less than 250 MW of resource needs for 2025 to meet reliability requirements

Renewable Energy Needs Through 2027



- Under an "additional contracts" scenario in the 2020 RFP, APS estimates a need between 150-250 MW of renewable resources annually depending on resource type
- Under a "no additional contracts" scenario in the 2020 RFP, APS estimates a need between 250-450 MW of renewable resources annually depending on resource type

Discussion & Questions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Break

Reminder – RPAC Members with potential resource development interests are excluded from the following discussions on RFP content.


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RFP Resource Options
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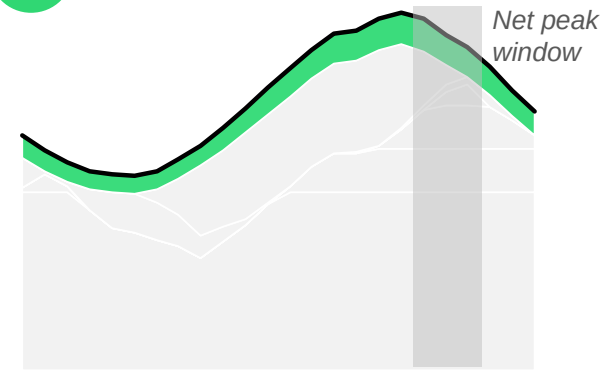
New resource options in an all-source RFP

- **All-source RFPs are designed to allow all resources to compete on a level playing field, including:**
  - Renewables (solar, wind)
  - Storage (batteries, other emerging technologies)
  - Hybrid resources
  - Demand-side resources (EE, DR)
  - Natural gas
- **Each resource provides a unique combination of values:**
  - **Energy:** the ability to deliver power to the grid throughout the year
    - Clean/carbon-free vs. fossil
  - **Capacity:** the ability to deliver power to the grid when needed most for reliability
  - **Flexibility:** the ability to contribute to balancing supply and demand

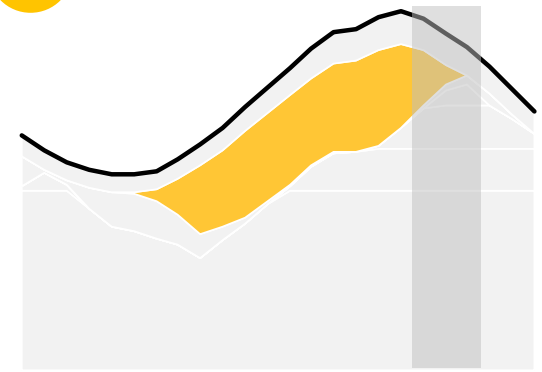
Each resource contributes to meeting customer needs in different ways

1 Energy Efficiency



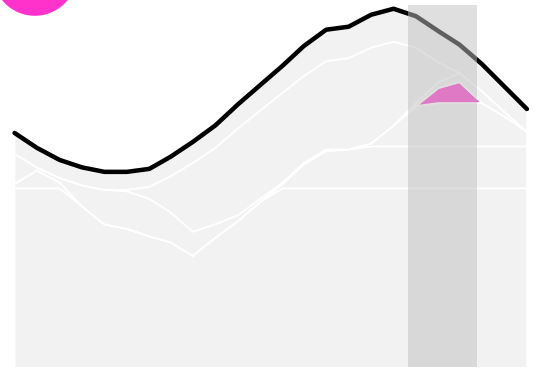
Reduces load in all hours, including peak periods

2 Solar PV



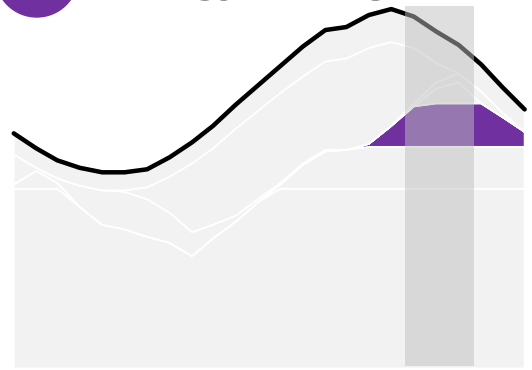
Provides low-cost, abundant energy during daylight hours

3 Demand Response



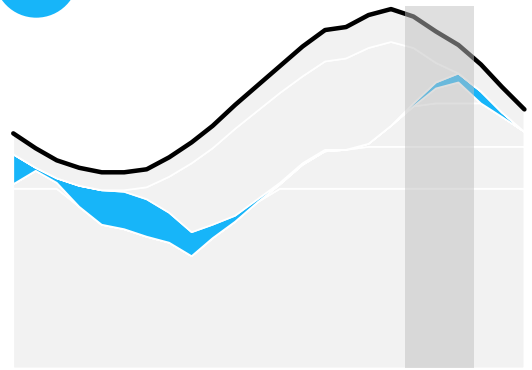
Meets peaking needs for short periods on most critical days

4 Energy Storage



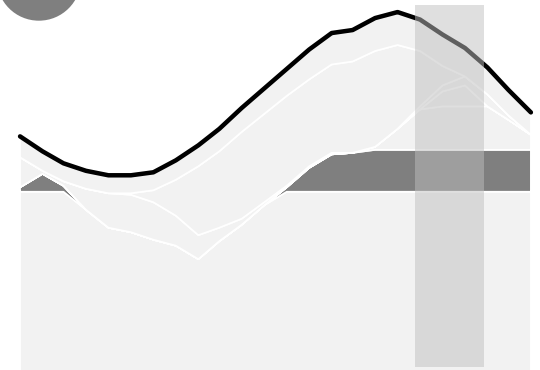
Meets peaking needs with limited duration

5 Wind



Provides low-cost energy with high variability

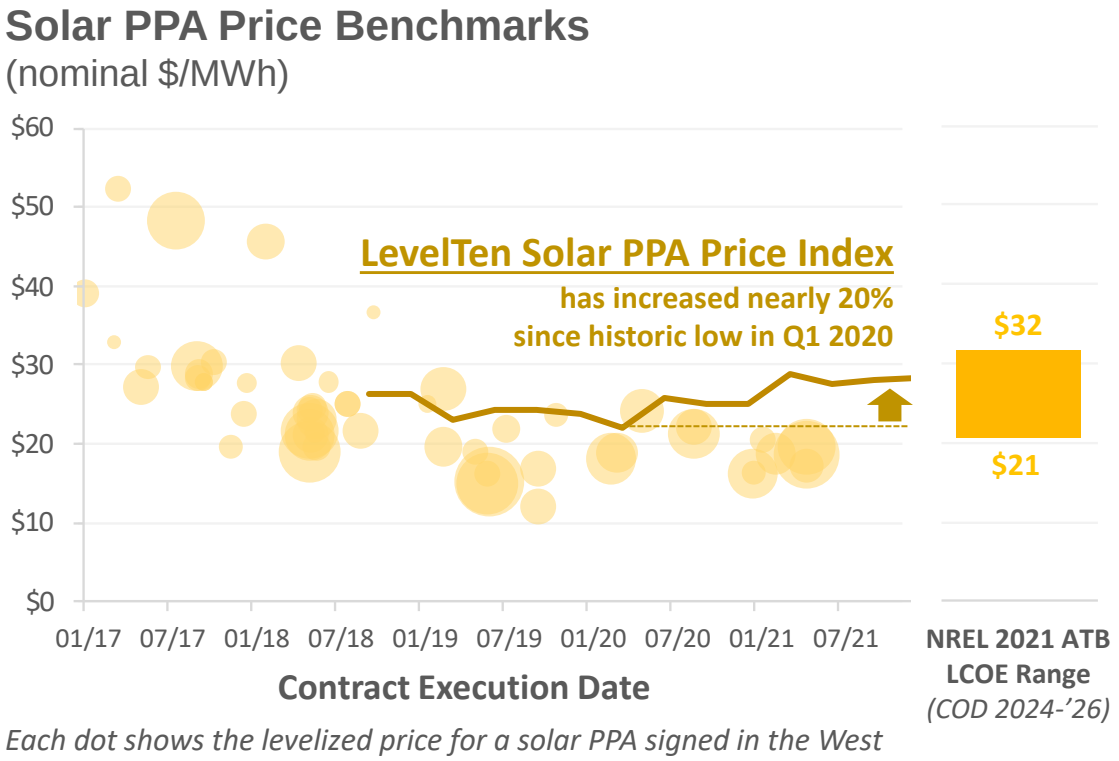
6 Natural Gas



Meets peaking needs and can generate for longer periods if needed

Resource highlights: solar PV

- **Cost trends: rapid cost declines over past decade have slowed, and looming issues are expected to place upward pressure on PPA prices**
  - Global supply chain issues and volatile commodity pricing
- **Primary value: low-cost, abundant carbon-free energy during daylight hours**
  - Capacity value limited by low output during evening net peak hours
- **Additional considerations:**
  - Supply chain issues create threats of project delays and contribute to expectations of higher costs
  - Growing penetrations of solar across the West will continue to reduce the value of daytime energy
  - Increasing trend towards hybridization with storage



Each dot shows the levelized price for a solar PPA signed in the West

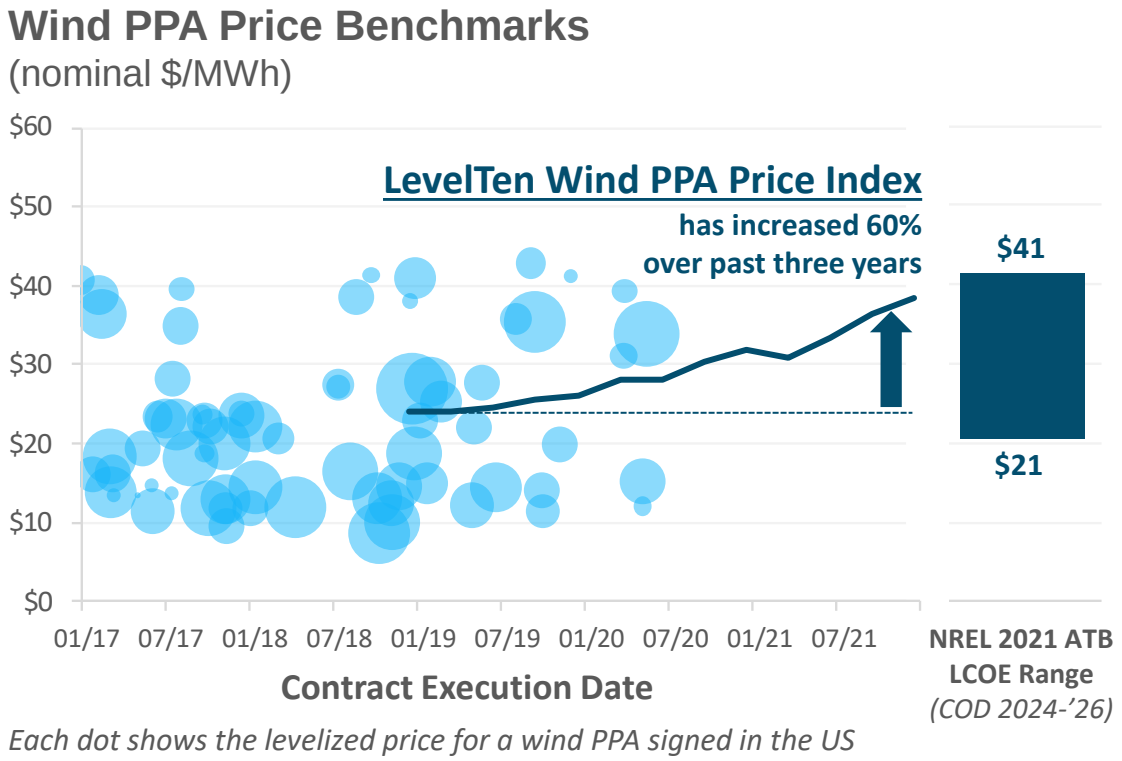
"As projects battle through developmental headwinds amid ballooning demand for renewable energy from the public and private sectors alike, available renewable supply is tightening and applying upward pressure on PPA prices."
-LevelTen Q4 2021 PPA Price Index

Resource highlights: wind

+ **Cost trends: prices for new wind resources are trending upwards, driven by some of the same market fundamentals as solar**

+ **Primary value: low-cost, abundant energy**
  - Capacity value limited by weather variability

+ **Additional considerations:**
  - Many wind resources – especially the highest quality ones – will require wheeling or new transmission to deliver to loads due to their locations



Each dot shows the levelized price for a wind PPA signed in the US

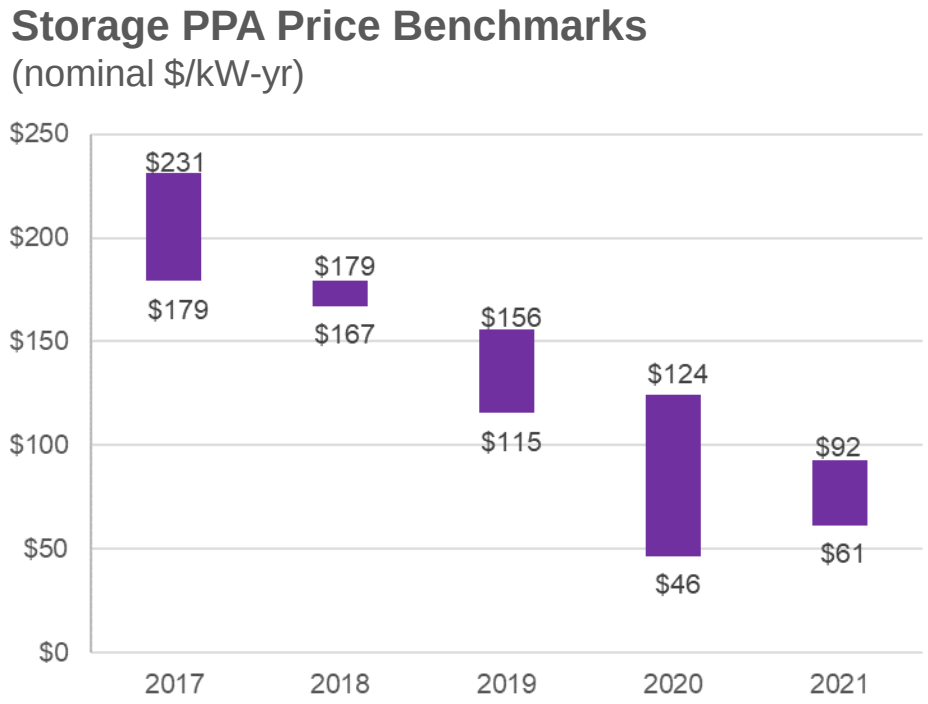
"As projects battle through developmental headwinds amid ballooning demand for renewable energy from the public and private sectors alike, available renewable supply is tightening and applying upward pressure on PPA prices."
-LevelTen Q4 2021 PPA Price Index

Resource highlights: storage

+ **Cost trends: significant cost reductions in past few years, but downward trend expected to stagnate with supply chain issues**

+ **Primary characteristics/value**
  - **Capacity:** able to dispatch during hours of highest need (within a limited time window)
  - **Flexibility:** supports balancing increasing levels of solar

+ **Additional considerations:**
  - Supply chain issues create risks of project delays and cancellations
  - Battery storage has not yet been widely tested at grid scale, and questions remain on whether its real-world performance will match expectations
  - Subject to diminishing capacity value – as more is procured, the marginal value of the next increment will be smaller



"Continuing cost reductions bode well for the future of batteries, which rely on lithium-ion technology. However, the impact of rising commodity prices and increased costs for key materials such as electrolytes has put pressure on the industry in the second half of the year."

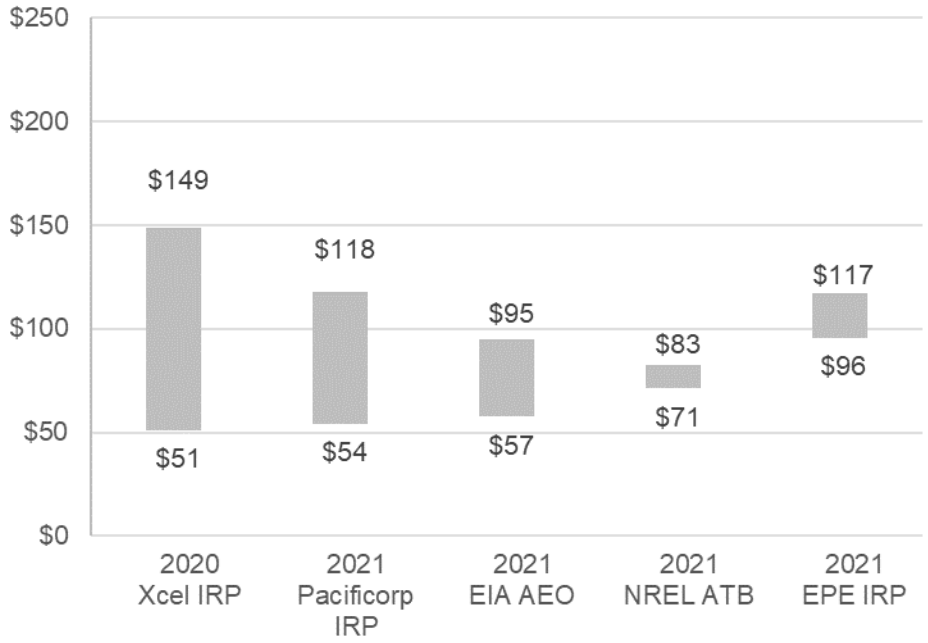
-BNEF 2021 Battery Price Survey

Sources for Data: Xcel, PNM, PG&E, SCE, Pacificorp, CPUC, SPGlobal, pv-magazine,

Resource highlights: natural gas

+ **<u>Cost trends:</u> costs of new gas infrastructure have generally been stable over time, but are subject to some of the same inflationary pressures as other resources**
  - Fuel costs increasing due to gas supply tightness
  - Costs depend on gas market volatility
+ **Primary characteristics/value:**
  - **Capacity:** available during all hours of need
  - **Flexibility:** able to ramp quickly and fill the gaps when renewables and storage cannot provide energy
+ **Additional considerations:**
  - Fuel price volatility & fuel security impact economics and reliability
  - Likely to play a more important role as a capacity (rather than an energy) resource in a future portfolio with increasing renewable penetrations

New Gas CT Cost Assumptions Comparison
(nominal $/kW-yr)



IRPs / Reports with New Gas CT Assumptions

Resource highlights: distributed and demand-side resources

+ Distributed and Demand Side Resource Costs and Options

- Varies across offerings for demand-side resources

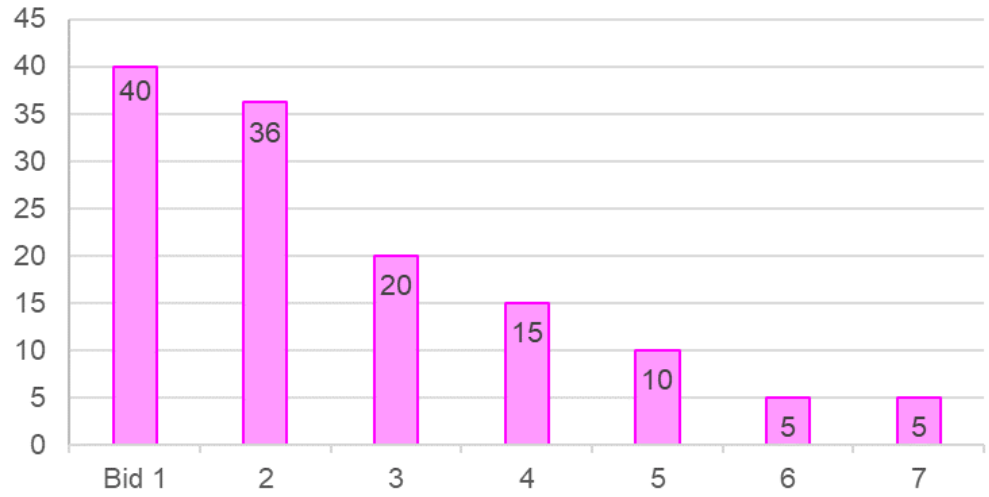
+ Primary characteristics/value

- **Capacity:** Demand response (within a limited time window)
- **Energy:** Energy efficiency, rooftop solar, and community solar reduce and provide energy from customers

+ Additional considerations

- Smaller-sized and time-use constrained resources
  - APS received bids ranging from 5-40 MWs
- Energy efficiency adoption subject to available low-cost offerings and customer inertia
- Customer participation uncertainty
- Performance / program characteristics must be well defined

2021 APS Distributed Demand Side Resource RFP Bid Sizes
(Nameplate MW)



Energy-focused DSR	Capacity-focused DSR
Energy efficiency programs	Demand Response
Rooftop solar / community solar	Curtailable Loads
	Managed EV Charging

Discussion & Questions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RFP Evaluation Criteria
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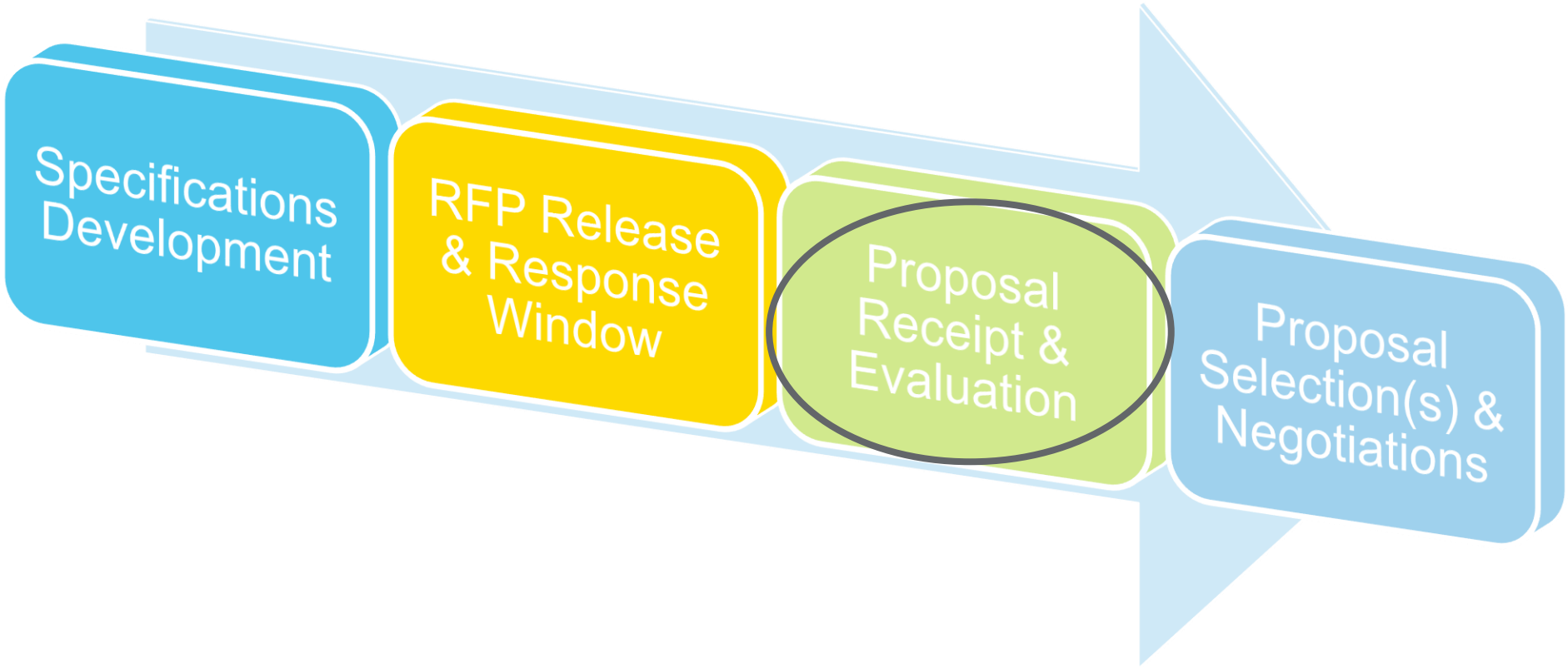
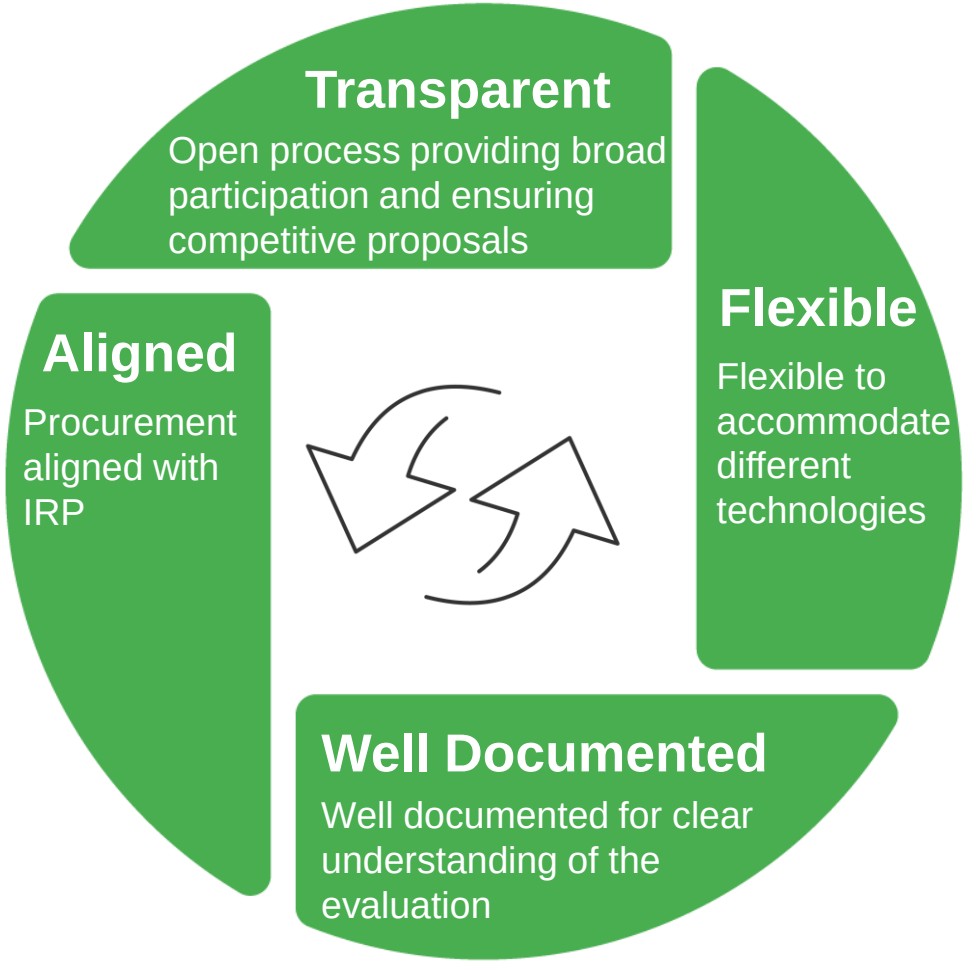
Request For Proposal (RFP) Process



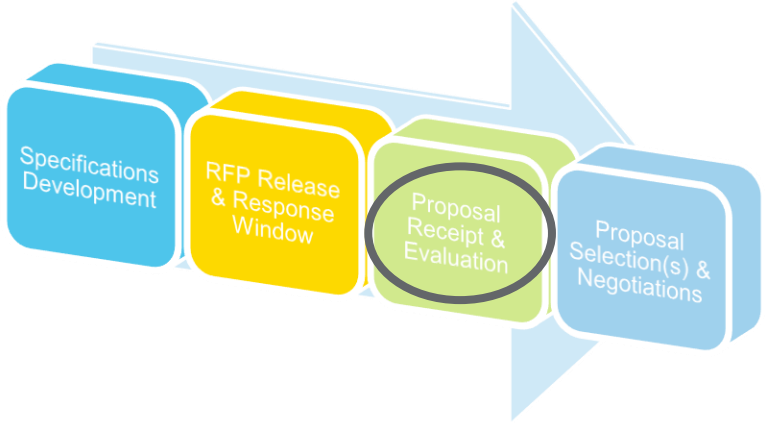
Key Attributes for Evaluation



Recommendations

- Early stakeholder involvement
- Clear definition of acceptable technologies
- Clear identification of information needed
- Consistent assumptions established early and “locked down”
- Evaluation process and criteria needs to be established early

What to Evaluate?

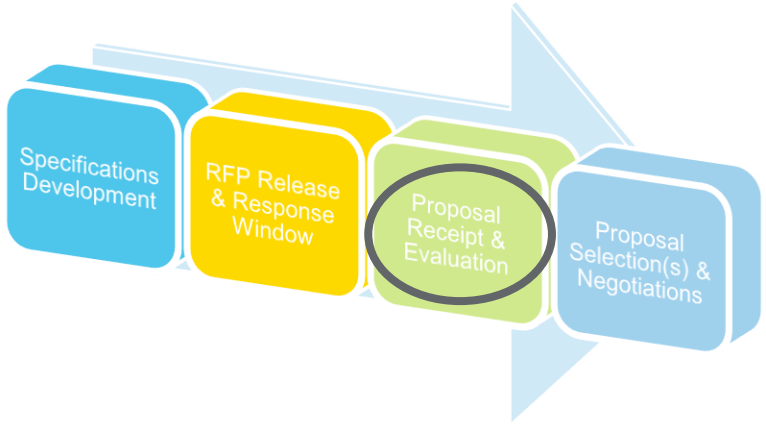


- Alignment with need(s)
- Cost to customer
- Counterparty's ability to perform
- Other project-specific risks

How to Evaluate?

- Criteria can include both quantitative and qualitative factors
- Compare apples to apples
- Portfolio analysis consistent with IRP methodology

Potential Criteria



Alignment w/ Need(s)

- Delivery date
- Delivery amount
- Time of day availability
- Environmental attributes

Cost to Customer

- Unit Cost
- Tax credit strategy
- Interconnection network upgrades

Counterparty Risk(s)

- Development experience
- Creditworthiness
- Ownership structure
- Term sheet modifications

Project-Specific Risk(s)

- Site control
- Technology / equipment

Discussion & Questions

Open Discussion & Next Steps