APS RPAC Meeting
07/19/2023
MEETING AGENDA

Welcome & Meeting Agenda
Matt Lind
1898 & Co.

Regulatory Update
Todd Komaromy
APS

Transmission Interconnection Reform
Jason Spitzkoff
APS

Climate Change Scenario Analysis:
Low-Carbon Transition
Steve Rose & Chris Roney
EPRI

2023 APS Resource Adequacy Study
Akhil Mandadi
APS

Next Steps & Open Discussion
Matt Lind
1898 & Co.
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.
June Meeting Recap

• APS detailed specific technical aspects of the 2023 ASRFP leading up to the June 30th release date.

• APS explained that Energy Exemplar has confirmed that all modeling licenses have gone through the NDA process. A technical discussion and training course on the tool was held on June 29th.

• APS announced that the 2023 IRP filing date has been moved to November 1st 2023.

• APS informed RPAC Members that the dates for the August RPAC meeting may conflict with various meetings in August. APS is proposing an August 4th date for the RPAC meeting.
Following Up

• Action Items from Previous Meetings:
  • No immediate action items

• Ongoing Commitments:
  • Distribute meeting materials in a timely fashion (3 business days prior)
  • Transparency and dialogue
APS Announcements

APS Milestones

• IRP due date moved to November 1st, 2023
• Public Stakeholder Meeting #2 in September

2023 ASRFP

• 2023 ASRFP Released on June 30th, 2023
• Bidders Conference Scheduled for July 26th, 2023

RPAC Modeling Group Meetings

Production Cost - June 29th, 2023
Capacity Expansion - July 11th, 2023

APS RFP Website

www.aps.com/rfp
ACC Regulatory Update

On May 1, 2023 TEP, UNSE, and APS filed a request with the ACC for a 90-day extension of the filing date for IRPs.

Request would extend filing deadline in order to give the Companies and RPAC additional time to complete aspects of Decision No. 78499.

The request from APS, TEP, UNSE was granted on June 28, 2023.

**Deadline:** November 1, 2023
APS Large/Small Generation Interconnection Reforms
Agenda

- Application Process
- Customer Engagement Window
- Study Process
- Withdrawal Penalties
- Additional Modification
- Transitional Process
New Process Diagram

Phase 1: Power Flow/Voltage 90 days
Phase 2: Stability/Short Circuit 75 days
Phase 3: Re-study 90 days
Phase 4: Facilities Study 90 days

30 to 40 days between Phases

45 Day Request Window
75 Day Engagement Window

Withdrawal penalty
M1 1x
M2 3x
M3 5x
M4 7x
M5 9x

LGIA
• **Annual Cluster Window**
  • Window to open annually on April 1st
  • 45 day window
  • Application and associated requirements complete prior to window close
• **Valid Interconnection Request**
  • $105,000 initial deposit
  • Application and models
  • Site Control
  • Commercial Readiness Demonstration
Customer Engagement Window

- Holding Scoping meeting(s)
- Modeling reviews and validation
- Letter of Credit
- All demonstrations, models, and deposit deficiencies must be cured prior to close of window
- Close of Customer Engagement Window starts Phase 1 study: M1 milestone
• SIS is broken into two phases
• Phase 3 (re-study) will be as needed
• Phase 4 – No changes to existing process
Withdrawal Penalties

- Tiered Level of Penalties
  - Penalty is multiple of $100,000 deposit (1x up to 9x)
  - Alternate structure using payment in lieu of commercial readiness demonstration
  - Letter of Credit has to be in place prior to close of Engagement Window

- Use of Withdrawal Penalties
  - Fund re-study costs
  - Applied to Network Upgrades
  - Applied to APS formula rate
Additional Modifications

- **Suspension Provision**
  - Suspension no longer a right
    - Demonstration of delays
  - Maintain site control and commercial readiness demonstrations

- **Small Generators in same clusters as Larger Generators**
  - Requests that do not qualify for fast-track or invertor process
  - Do not require Commercial Readiness demonstration
  - Are required to provide Site Control
  - Are subject to Withdrawal Penalties
  - Require posting a LOC
Transitional Process

• **Projects with executed FaS**
  - Provided 60 days to request cancellation of their LGIA without withdrawal penalties
  - Must provide LOC of $900,000 to maintain their LGIA
  - If project does not achieve commercial operation subject to withdrawal penalties

• **Projects in SIS or FaS**
  - Subject to new requirements
  - 60 days to provide site control, commercial readiness, and appropriate LOC
  - Failure to provide will be deemed withdrawn by APS
  - Remaining projects included in a single new Transitional Cluster Study
  - Withdrawals after start are subject to withdrawal penalties
• Complete w/in 2 years
• Designed not to overlap Phase 1-3 studies
Discussion & Questions
Climate Change Scenario Analysis – Low Carbon Transition
Project overview

- APS initiated this project with EPRI to explore climate and energy system transitions to inform their climate risk management thinking

- Three analyses
  1. Initial Physical Climate Risk Assessment Analytical Foundation (discussed previously, final report forthcoming)
  2. Arizona Low-carbon Transition Risk Analysis (draft scenario design and analysis started)
  3. Low-Carbon Transition Strategy & GHG Goals Contextualization (analysis started)

- Motivation
  - The climate is changing and will continue to change
  - There is significant interest in decarbonization to limit climate change
  - Companies need to evaluate potential climate and transition risks and develop risk management strategies

Critical issues for companies in climate risk assessment
- Uncertainty
- Uniqueness
- Multiple objectives
- Flexibility
- Robust strategies (resilient to possible futures)
- Assessing climate risk requires knowing more than whether there are emissions and climate change

Rose and Scott (2020, 2018), EPRI (2022), Rose et al (2022)
Arizona Low-carbon Transition Risk Analysis
AZ low-carbon transition risk analysis

- **Objectives**
  - Inform APS strategy & risk management by assessing potential low-carbon energy-system transitions and risks
  - Supplement APS’ analyses and processes with broader and longer-term strategic perspectives of potential energy transitions, markets, and policies
  - Provide a scientific basis and grounded insights regarding transition risk in a manner aligned with TCFD

- **Approach**
  - Use tailored, well-designed scenarios and Arizona energy-system modeling analysis to evaluate the opportunities and uncertainties, risks and risk management options, signposts, trade-offs, enabling conditions, and potential no-regrets strategies – not modeling the APS system, but providing relevant strategic insights

- **Analysis steps**
  1. Scenario design: custom, alternative plausible extreme transition scenarios
  2. Modeling: evaluating Arizona energy-system transition implications of the alternative scenarios
  3. Results: key insights regarding risks, risk management options, etc.
  4. Communications: a written report & executive summary to communicate insights

- **Today, discuss draft scenario design. In the future, discuss draft modeling results.**
Electric Generation

- Energy and capacity requirements
- Renewable integration, transmission, storage
- State-level policies and constraints

Energy Use

Synchronized

Hourly Load, Renewables, and Prices

Detailed representation of:
- Customer heterogeneity across end-use sectors
- End-use technology trade-offs
- Electrification and efficiency opportunities

Documentation, articles, and reports available at https://esca.epri.com
Focus on potential decarbonization pathways for Arizona (in the context of neighbor and national transmission connections & actions)
Modeling outputs

Modeling to 2050 and state level results

1. **Capacity and Generation**
   - State-level capacity and generation

2. **Hourly Load**
   - Aggregated and disaggregated by end-use

3. **CO₂ Emissions**
   - Electric sector and energy system carbon emissions

4. **Electricity Prices and Costs**
   - Generation component of retail pricing and sector costs

5. **Transmission**
   - Size of additional regional transmission capacity

6. **End-use Service, Electricity & Fuel Demands**
   - Evolution of end-use service, electrification, other fuel demands

7. **End-use Vehicle and Equipment Stocks**
   - Electric vehicle adoption, building heating and cooling systems, and other equipment decisions

8. **Others**
   - Additional reporting potentially available (e.g., water use) as areas of uncertainty and interest decided

Providing statewide, long-run insights to inform APS strategic thinking, analyses, and risk management
# Scenario design 2x2 concept - plausible extremes

Simple 2x2 scenario design for defining company-specific alternative plausible extremes to bound the decarbonization risk space, and explore sensitivities within.

<table>
<thead>
<tr>
<th>Uncertain non-climate-policy conditions (technology, markets, etc.)</th>
<th>Facilitate</th>
<th>Challenge</th>
</tr>
</thead>
<tbody>
<tr>
<td>Uncertain climate policy conditions (incentives &amp; options)</td>
<td>Broader</td>
<td>Broader &amp; Facilitate</td>
</tr>
<tr>
<td>narrower</td>
<td>Narrower</td>
<td>Narrower &amp; Facilitate</td>
</tr>
</tbody>
</table>
# Draft scenario specification - broader/ narrower policy extremes

## SPECIFICATION FOUNDATION (all scenarios)
- AZ power net zero by 2050 (linear glide path from 2025), and 2030 45% renewables & 65% CES requirements
- Inflation Reduction Act (IRA) active nationally, and current state electric sector GHG policies outside AZ

<table>
<thead>
<tr>
<th>Uncertainty</th>
<th>Broader</th>
<th>Narrower</th>
</tr>
</thead>
<tbody>
<tr>
<td>AZ decarbonization incentive/scope</td>
<td>AZ economy-wide 80% CO₂ reduction in 2050</td>
<td>AZ power sector net zero in 2050</td>
</tr>
<tr>
<td></td>
<td>• Renewables (wind, solar, bio, hydro)</td>
<td>• Renewables (wind, solar, bio, hydro)</td>
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<tr>
<td></td>
<td>• Nuclear (extensions)</td>
<td>• Nuclear (extensions only)</td>
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<tr>
<td></td>
<td>• Advanced nuclear (additions)</td>
<td>• Storage</td>
</tr>
<tr>
<td></td>
<td>• Gas</td>
<td>• Electrolytic Hydrogen only</td>
</tr>
<tr>
<td></td>
<td>• Gas w/CCS</td>
<td>• Fossil reserve eligibility declines to zero in 2050</td>
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<tr>
<td></td>
<td>• CDR (biopower w/ CCS only)</td>
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<tr>
<td></td>
<td>Storage</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Hydrogen</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Low-carbon power imports</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Fossil reserves permitted (within emissions constraint)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Biomass carbon neutrality</td>
<td></td>
</tr>
<tr>
<td>Outside AZ</td>
<td>Economy-wide decarbonization incentives similar to AZ</td>
<td>Only current state-specific policies</td>
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</table>
## Uncertainty Facilitate/Challenge

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<tr>
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<th>Facilitate</th>
<th>Challenge</th>
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<tbody>
<tr>
<td>Load growth</td>
<td>Lower 30% industry growth by 2040</td>
<td>Higher 150% industry growth by 2040</td>
</tr>
<tr>
<td>(factors: relocation of industry, population, market structure, consumer electro technology preferences, DERs)</td>
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<tr>
<td>Renewable &amp; battery storage cost improvements</td>
<td>Faster Lower costs</td>
<td>Slower Higher costs</td>
</tr>
<tr>
<td>Electricity capacity additions</td>
<td>Enabling Build as economical</td>
<td>Constrained Annual additions constrained</td>
</tr>
<tr>
<td>(factors: supply chain issues, siting and permitting environment, etc.)</td>
<td></td>
<td></td>
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<tr>
<td>Interregional transmission additions</td>
<td>Enabling Build as economical</td>
<td>Constrained Annual additions constrained</td>
</tr>
<tr>
<td>(factors: infrastructure investment support, realized costs, siting and permitting environment, etc.)</td>
<td></td>
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</tr>
<tr>
<td>Water stress</td>
<td>Lower Default residential builds; generation water costs lower</td>
<td>Higher Restricted residential builds; generation water costs higher</td>
</tr>
<tr>
<td>Fuel supply</td>
<td>Lower prices (abundant) AEO 2022 reference path</td>
<td>Higher prices (scarce) AEO 2022 low oil &amp; gas recovery path</td>
</tr>
<tr>
<td>(factors: resource availability, pipeline capacity/augmentation)</td>
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<tr>
<td>End-use technology cost improvements</td>
<td>Faster Lower EV component costs, range anxiety lower, EV availability higher</td>
<td>Slower Higher EV component costs, range anxiety higher, EV availability lower</td>
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RPAC Feedback Request

Eric Massey (APS)
RPAC feedback request

- Your thoughts on the four plausible extreme future conditions proposed for evaluating Arizona decarbonization?
  - Extreme enough/too extreme?
  - Add/remove characteristics?
  - Other thoughts?

- Your thoughts on potential intermediate sensitivity scenarios for exploring the space between the plausible extremes?

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<td>Lower load growth, Faster generation cost improvements, Enabling capacity additions, Enabling transmission additions, Lower water stress, Lower fuel prices, Faster end-use tech improvements</td>
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<tr>
<td>Narrower</td>
<td>AZ power sector net zero policy &amp; Fewer decarbonization options</td>
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Together...Shaping the Future of Energy®

Steven Rose
srose@epri.com

Chris Roney
croney@epri.com
About EPRI

- A non-advocacy, nonprofit, scientific research organization with a public benefit mandate
- EPRI strives to advance knowledge and facilitate informed discussion and decision-making
- Recognized expertise in, among other things, climate scenarios, climate-related risk assessment, energy and societal transitions, climate impacts, policy evaluation, sustainability
  - Including research community leadership and participation in related activities, e.g., Intergovernmental Panel on Climate Change (IPCC), research community studies, the Task Force on Climate-Related Financial Disclosures (TCFD) Advisory Group for Scenario Guidance
- EPRI climate-related risk research informing companies and stakeholders
Resources


Discussion & Questions
Break
Overview of the 2023 Resource Adequacy Study

• Key Objectives
• Key Findings
• Study in relation to the overall 2023 APS IRP Modeling Process

Deeper Dive

• Key Assumptions
• Planning Reserve Margin
  • Different Flavors – ICAP and PCAP
  • PCAP Accounting Methodology
• ELCC Assessment

Concluding Remarks

• Discussion
Key Objectives

Determination of APS’s Planning Reserve Margin (PRM) based on current planning and operating conditions

Determination of the Effective Load Carrying Capability (ELCC) of various resources and their reliable capacity contribution to APS’s system demand
# Key Findings

<table>
<thead>
<tr>
<th>PRM Determination:</th>
<th>20.2 % (ICAP Accounting Methodology)</th>
</tr>
</thead>
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<tr>
<td>PRM Accounting Mechanism Recommendation:</td>
<td>Transition to PCAP Methodology Starting in 2026</td>
</tr>
</tbody>
</table>
| ELCC Assessment: | ELCC values for various resources, accounting for
  a) Increasing resource Levels
  b) Interactive effects among key resource types
  c) Changing demand and impacts of demand modifiers |
Study in relation to overall 2023 APS IRP Modeling Process

IRP 2023: MODELING PROCESS FLOW DIAGRAM

Foundation to the entire Modeling Process

Capacity Expansion Tool Utilizes

a) Established PRM
b) ELCC as the qualifying capacity to meet Demand

Needs = Total Capacity Needs

+ PRM = Total Demand

Scenario Assumptions

DSM/DR Study

Technology Costs

Market Prices

Integration Cost Study

Load Forecast

Fuel Costs

Unit Characteristics

Model Constraints

AURORA LTCE Model

ELCC Surface

AURORA PCM Model

L&R

Total Revenue Requirements

Portfolio Output Analytics

Excel ELCC Check

SERVM

PRM

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SERVM

PRM
# Key Assumptions

<table>
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<tr>
<th>Assumption</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating Reserve Used</td>
<td>6%</td>
</tr>
<tr>
<td>Transmission Connectivity</td>
<td>Transport Zonal Model with ties to all immediate neighbors modeled</td>
</tr>
<tr>
<td>Market Resource Adequacy</td>
<td>Neighboring market has a shortfall in meeting 0.1 LOLE by 3%</td>
</tr>
<tr>
<td>Load and Weather Modeling</td>
<td>Utilized 23 weather years data adjusted to the trend of the last 10 years of weather data</td>
</tr>
<tr>
<td>Battery Energy Storage Held for</td>
<td>Yes</td>
</tr>
<tr>
<td>Reliability</td>
<td></td>
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</table>
Determination of PRM

• Study Year: 2026

• Study Framework: Utilized SERVM software – combines hourly production costing with Monte Carlo outage simulation.

<table>
<thead>
<tr>
<th>Uncertainty Addressed</th>
<th>Supply</th>
<th>Demand</th>
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<tr>
<td></td>
<td>Weather Based</td>
<td>Weather Based</td>
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<tr>
<td></td>
<td>• Intermittent Resource Output</td>
<td>• Fundamental Demand</td>
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<tr>
<td></td>
<td>• Temperature Derates</td>
<td>characteristics</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Extreme temp Impacts</td>
</tr>
<tr>
<td></td>
<td>Availability Based</td>
<td>Forecast Based</td>
</tr>
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</table>

![Graph showing availability based forecast vs. planning reserve margin]
Flavors of PRM Accounting

- **Installed Capacity Accounting**
  - Conventional/Firm Resources accredited with summer-rated installed capacity
  - ELCC Resources such as solar, wind, storage, energy efficiency, etc. accredited with ELCC values
  - APS currently has a PRM of 15%, which was established using the ICAP accounting methodology

<table>
<thead>
<tr>
<th>Resource Type</th>
<th>Capacity</th>
<th>ELCC</th>
<th>Equivalent Capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conventional Resources</td>
<td>7518</td>
<td></td>
<td>7518</td>
</tr>
<tr>
<td>ELCC Resources</td>
<td>6992</td>
<td>55.23%</td>
<td>3861.8</td>
</tr>
<tr>
<td>MW Adjustment</td>
<td>973</td>
<td></td>
<td>973</td>
</tr>
<tr>
<td>Total Capacity</td>
<td>15483</td>
<td></td>
<td>12352.8</td>
</tr>
<tr>
<td>Load (including Adjustments)</td>
<td>10333</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reserves</td>
<td></td>
<td></td>
<td>2019.8</td>
</tr>
<tr>
<td>PRM</td>
<td></td>
<td></td>
<td>20.2%</td>
</tr>
</tbody>
</table>

- **Perfect Capacity Accounting**
  - All resources are accredited ELCC values (i.e., removes from the reserve margin an allowance for forced outages of conventional resources)
  - PCAP PRM is more durable to portfolio changes
  - APS will transition to using the PCAP accounting method starting in 2026

<table>
<thead>
<tr>
<th>Resource Type</th>
<th>Equivalent Capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>PCAP Capacity</td>
<td>10369</td>
</tr>
<tr>
<td>Load</td>
<td>9696</td>
</tr>
<tr>
<td>Reserves</td>
<td>673</td>
</tr>
<tr>
<td>PRM</td>
<td>6.9%</td>
</tr>
</tbody>
</table>
ICAP Accounting Mechanism

ICAP PRM = 20.2% of Total Adjusted Gross Load

Total Adjusted Gross Load
(Managed Peak + Total DG + Incremental EE + XHLF Load + EV Load)

Demand/Need = Resource Requirement (Installed MW for Firm Resources)

Summer Capacity of Additional Resources to meet PRM

ELCC Resources

Summer Capacity of Conventional/Firm Resources
PCAP Accounting Mechanism

ELCC of XHLF Load
ELCC of EV Load
PRM = 6.9% * Gross Load

Gross Load
(Managed Peak + Total DG + Incremental EE)

DEMAND

DEMAND/NEED

RESOURCE REQUIREMENT (ELCC/PREFIX MW)

ELCC of Demand Response

ELCC of Total DG
ELCC of Energy Efficiency (DSM)
ELCC of Demand Response

ELCC of all Supply-side Resources = Conventional Resources + Traditional ELCC Resources

SUPPLY
ELCC ASSESSMENT

No Resource is Perfect
• ELCC measures a resource’s contribution to the system's needs relative to “perfect” capacity, accounting for their capabilities and constraints across all hours.

Indefinite loop between Resource Adequacy and Capacity Expansion Modeling?
• Changing capacity values and interactive effects between resources imply a Chicken or Egg problem.
• No current commercially-available tools to perform overall optimization in a single step

Functional Exit:
• ELCC Surfaces to meaningfully capture the interactive effects between key resource types
• ELCC curves to address other resource types and effects of changing demand
• Out-of-model ELCC checks and potential re-runs
ELCC Surface for a Portfolio of Solar, Wind, and Battery Energy Storage

ELCC of Portfolio of different penetrations of Solar and Storage at 500 MW of Wind

Captures changes to ELCC due to penetration levels as well as interactive effects between Resource Types
ELCC was also established for
- Conventional/Firm Resources
- Load-Modifiers
Concluding Remarks and Discussion

✓ 2023 Resource Adequacy Study provided a deeper understanding of the impact various resource types have on achieving resource adequacy of the APS system.
✓ Recommended findings will be incorporated into the 2023 Integrated Resource Plan.

Thank you!
Discussion & Questions
IRP Timeline

Key Milestones

August RPAC Meeting: 8/04/2023

Public Stakeholder Meeting #2: September
IRP Filing: 11/01/2023