

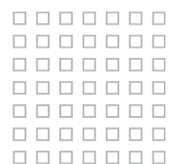
APS July RPAC Meeting Minutes

Meeting Objectives

- Recap the June RPAC meeting and provide status of previous action items.
- Review the latest regulatory changes and updates.
- Explain APS’s transmission interconnection process and key milestones.
- EPRI to share an update on the climate change scenario analysis study.
- Share how APS evaluates resource adequacy in the 2023 IRP.
- Discuss next steps and future RPAC engagement opportunities.

Meeting Subject: July RPAC Meeting
 Meeting Date: 07/19/2023
 Start Time: 09:00am
 End Time: 12:00pm
 Location: Virtual

Attendees	Organization	Title/Role
Ann Becker	APS	Vice President, Sustainability
Tara Beske	APS	Business Advisor, Resource Management
Vern Braaksma	APS	Senior Account Manager, Data Centers & Large Manufacturing
Jill Freret	APS	Director, Resource Integration & Fuels
Michael Gerlach	APS	Corporate Strategy Advisor
Brent Goodrich	APS	Advisor, State Regulatory
Todd Komaromy	APS	Director, Resource Planning
Rachael Leonard	APS	Manager, State Regulatory Affairs
Akhil Mandadi	APS	Engineer, Resource Planning
Nicole Rodriguez	APS	Consultant, Strategic Communications
Jason Smith	APS	Manager, Regulatory Affairs & Compliance Adm
Jason Spitzkoff	APS	Manager, Transmission Expansion
Hilary Waterman	APS	ESG Reporting Consultant
Michael Eugenis	APS	Manager, Resource Planning
Yessica Del Rincon	APS	Communications Consultant
Eric Massey	APS	Director, Sustainability
Ashley Kelly	APS	Manager, Regulatory Compliance
Jeffrey Allmon	Pinnacle West - APS	Senior Attorney
Evan Lipsitz	1898 & Co.	Consultant






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Matthew Lind	1898 & Co.	Director of Resource Planning
Chase Kilty	1898 & Co.	Consultant
Keaton Clark	1898 & Co.	Analyst
Steve Jennings	AARP	Associate State Director
Chaunce De Roos	Arizona Corporation Commission	Policy Advisor
Diane Brown	Arizona PIRG	Executive Director
Gary Dirks	ASU	Senior Director
Walter Clemence	Capital Power	Senior Advisor, US Regulatory
Nick Schlag	E3	Partner
Chris Roney	EPRI	Research Lead, Economy Analysis & Electrification
Steven Rose	EPRI	Principal Research Economist
Austin Jensen	Holland & Hart	Associate Attorney
Sam Johnston	Interwest Energy Alliance	Policy Manager
Nitin Lumar	Mitsubishi Power	Regional Director
Nicole Hill	Nature Conservancy	AZ Thrives Program Lead
Tyler Fitch	Rocky Mountain Institute	Manager
Sandy Bahr	Sierra Club	Chapter Director
Alondra Regalado	Strategen	Policy Analyst
Michael Kenney	SWEEP	Senior Program Manager
Devi Glick	Synapse Energy Economics	Senior Principal
Autumn Johnson	Tierra Strategy	CEO
Kate Bowman	Vote Solar	Regulatory Director
David Millar	Wärtsilä Energy	Principal, Markets, Legislative, and Regulatory Policy
Alex Routhier	Western Resource Advocates	Senior Clean Energy Policy Analyst
Murphy Bannerman	Western Resource Advocates	AZ Gov. Affairs Manager
Claire Michael	Wildfire	Director of Climate Equity
Mylie Biggs		

Matt Lind (1898 & Co./Director of Resource Planning) – Introduction / Meeting Guidelines / June RPAC Recap

▪ Slide 4 – June Meeting Recap

- APS detailed specific technical aspects of the 2023 All-Source Request for Proposal (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 extended to November 1st, 2023.
- APS informed RPAC Members that the dates for the August RPAC meeting may conflict with other meetings. After researching dates, APS has proposed August 4th for the next monthly RPAC meeting.



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- **Slide 6 – APS Announcements**
 - APS Milestones
 - IRP filing due date extended to November 1st, 2023.
 - Public Stakeholder Meeting #2 will be in September – date TBD.
 - 2023 ASRFP
 - 2023 ASRFP was released on June 30th, 2023.
 - Bidders Conference is scheduled for July 26th, 2023.
 - RPAC Modeling Group Meetings
 - Production Costing Module – June 29th, 2023.
 - Long-Term Capacity Expansion Module – July 11th, 2023.
 - APS RFP Website (www.aps.com/rfp)

Todd Komaromy (APS/ Director, Resource Planning) – ACC Regulatory Update

- **Slide 8 – ACC Regulatory Update**
 - On May 1st, 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 the filing deadline 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 28th, 2023.
 - Deadline: November 1st, 2023
 - Docket No. E-99999A-22-0046
 - Decision No. 79017

Jason Spitzkoff (APS/ Manager, Transmission Expansion) – Transmission Interconnection Reform

- **Slide 10– Agenda**
 - Application Process
 - Customer Engagement Window
 - Study Process
 - Withdrawal Penalties
 - Additional Modification
 - Transitional Process
- **Slide 11 – New Process Diagram**
 - The illustration shows the different steps and the key milestones for each phase.
- **Slide 12 – Application Process**
 - The existing process
 - The first window opens April 1st and closes September 30th.
 - The second window opens October 1st and closes March 31st.
 - APS will take Interconnection requests in either window, but APS is proposing to consolidate to one window that will run from April 1st and run through May 15th.



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- The valid interconnection request would include a \$105,000 initial deposit.
 - Application and required models.
 - Site Control – A project has to have site control.
 - Commercial readiness demonstration
- **Slide 14 – Customer Engagement Window**
 - Once the 45-day request window closes, the 75-day engagement window opens.
 - Scoping meetings are held.
 - After the initial scoping meeting is held for all valid requests, interconnection customers can request a custom scoping meeting on an individual basis.
 - Model reviews and validation.
 - Site control must be sufficient for the project that is being requested. APS will have a business practice that will be posted that will likely be acres per MW for various generation types, such as wind, PV solar, and storage projects.
 - APS will need a letter of credit.
 - All demonstrations, models, and deposit deficiencies must be cured prior to closing of window.
 - \$900,000 will cover the maximum withdrawal penalty for projects that use a Commercial Readiness Demonstration.
 - As the engagement window closes, everything must be cured prior to the close of that window. If a customer has been notified that there is a deficiency with their model, and they provide a cure for that on the 74th day of the window and it is determined that what they have provided is not sufficient, then they will be withdrawn from the interconnection queue.
 - APS will provide notification of deficiencies early in the first half of this window to give interconnection customers time to cure any deficiencies before the closing of the window.
 - Anyone who has provided all demonstrations, deposits, and the letter of credit is moved into the Phase 1 study (M1 milestone), from this point forward if any projects withdraw, they are subject to withdraw penalties.
- **Slide 15 – Study Process**
 - The system impact study (SIS) is broken out into discrete phases.
 - Phase 1 consists of power flow and voltage studies. Most network upgrades are identified and put into a report by APS so customers can decide to move forward if desired.
 - Phase 2 looks at stability and short circuit studies. Customers are subject to M2 withdrawal penalty at this point (3x the initial \$100,000 fee).
 - Phase 3 is for re-study if necessary.
 - Phase 4 is the facilities study.
 - Finally moving to LGIA
- **Slide 16 – Withdraw 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. Usually a \$/MW fee with an upper-level cap.
 - Letter of Credit must be in place prior to closing of engagement window.



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- Use of withdrawal penalties
 - Fund re-study cost due to a withdrawal.
 - Applied to network upgrades if funds remain after re-study costs.
 - Any remaining funds are applied to APS formula rate.
- **Slide 17 – Additional Modifications**
 - Suspension provision
 - Suspension no longer a right
 - Demonstration of delays
 - Current process is typically used when a customer does not have an off-taker for the project not because of development delays.
 - Maintain site control and commercial readiness demonstrations.
 - Small generators in same cluster as large generators
 - Request that does not qualify for fast-track or inverter process.
 - Do not require commercial readiness demonstration.
 - Are required to provide site control.
 - Are subject to withdrawal penalties.
 - Require posting a letter of credit (LOC)
- **Slide 18 – Transitional Process**
 - Projects that have a completed and posted facility study
 - Provided 60 days to request cancellation of their LGIA without withdrawal penalties.
 - Must provide LOC of \$900,000 to maintain their LGIA.
 - If a project does not achieve commercial operation, it is 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.
- **Slide 19 – Process Timeline**
 - There are 30 to 40 days between phases
 - The first cluster kicks off April 1st, 2024. The 2024 projects would be at the end of Phase 3 by the time the 2025 cluster starts the Phase 1 study to prevent reliability studies from overlapping.
 - The idea is to make sure that APS is done with power flow study work prior to starting the next round of power flow study work on the cluster of projects.
 - APS is looking at the whole process to be completed in 2 years.
 - If there is only a single re-study, then it is just short of a 2-year process.

Steve Rose (EPRI/Principal Research Economist) – Climate Change Scenario Analysis: Low-Carbon Transition

- **Slide 23 – Project Overview**



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- 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.
- **Slide 25 – 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:
 - Scenario design: custom, alternative plausible extreme transition scenarios
 - Modeling: evaluating Arizona energy-system transition implications of the alternative scenarios
 - Results: key insights regarding risks, risk management options, etc.
 - Communications: a written report & executive summary to communicate insights
- **Slide 26 – US-Regen**
 - Modeling framework.
 - EPRI has built a model that has a detailed representation of:
 - Energy and capacity requirements
 - Renewable integration, transmission, and storage.
 - State-level policies and constraints
 - Synchronized hourly load, renewables, and prices.
- **Slide 27 – Customized regional resolution for APS**
 - The model has been customized to isolate Arizona. This resolution includes potential interactions with Arizona's neighbors through power flows.
 - Focus on potential decarbonization pathways for Arizona (in the context of neighbor and national transmission connections & actions)



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- **Slide 28 – Modeling outputs**
 1. Capacity and generation
 2. Hourly load
 3. CO2 emissions
 4. Electricity prices and costs
 5. Transmission
 6. End-use services, electricity & fuel demands
 7. End-use vehicle and equipment stocks
 8. Others (water use or additional reporting available)
- **Slide 29 – Scenario design 2x2 concept – plausible extremes**
 - The table represents the logic with the scenario design.
 - This is a risk exercise. EPRI wants to better see what extreme cases look like.
 - There are two categories of uncertainty: policy-related conditions and non-policy conditions.
 - The combination of these two conditions allows EPRI to define the risk space for APS.
 - Broader vs narrower policy conditions represent more flexibility vs. less flexibility
 - Facilitate and Challenge are two views of the non-climate policy conditions examined.

Chris Roney (EPRI/ Research Lead, Economy Analysis & Electrification) – Climate Change Scenario Analysis: Low-Carbon Transition

- **Slide 30 – Draft scenario specification – broader/narrow policy extremes**
 - EPRI is looking for feedback in this space and wants RPAC members to help contribute ideas.
 - The Inflation Reduction Act (IRA) is incorporated into this analysis.
 - There are three sections of the policy condition that look across different levels of policy extremes.
 1. Emission reduction targets
 2. Arizona decarbonization
 3. Outside of Arizona
 - Question – RPAC Member: It would be helpful to know what the specific assumptions are for each of the resources listed and breaking out the renewables, similar to how you have broken out the other resources. Basically, having wind be its own category and solar be its own category. I think this would help to compare resources.
 - Response – Chris Roney: I think it may be worthwhile to talk about how the model works under the hood, we separately model the renewable technologies, and we have different continuation of wind arrays and solar arrays. Some of the resources consist of centralized solar, wind, distributed energy resources as well so that we can model community rooftop solar and the distinction between that and utility-scale solar, and there are a couple utility solar configurations. When we talk about the decarbonization option set, all those technologies are available in all cases. We don't have cases where we are not building any additional wind or solar, but in the non-policy context, thinking about the market drivers, we do vary the cost and performance of those technologies individually based on those numbers coming out of the technology options report that is looking at detailed cost assessments of those individual technologies over time.



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- Response – RPAC Member: I appreciate that, and I figured that's how you did it, it just struck me that those are all categorized together when you are not categorizing some of the other resources together. I think it's helpful to see what the specific assumptions are, as we get more details in terms of where APS is at right now with these resources compared to where it may go into the future, it's helpful to have a more apples-to-apples comparison. I know we have talked about this before, so I won't belabor it, but I would also throw out energy efficiency to see how it fits into the overall picture. I think this is something that would be beneficial.
- Response – Chris Roney: That's helpful feedback for our results reporting too, jumping ahead to future meetings, we might have with you in terms of being able to report back accurately on the wind and solar deployment more specifically and individually for those technologies.
- **Slide 31 – Draft scenario specification – facilitate/challenge non-policy extremes**
 - There are 7 uncertainties being studied:
 - Load growth
 - Renewable & battery storage cost improvements
 - Electricity capacity additions
 - Interregional transmission additions
 - Water stress
 - Fuel supply
 - End-use technology cost improvements
 - For each uncertainty, there are both facilitate and challenge categories that help look at different extremes .
 - Question – RPAC Member: For the end-use technology cost improvements, does this include other electric equipment like air source heat pumps and heat pump water heaters?
 - Response – Chris Roney: It could, but it is not currently. Currently, we are looking at the evolution of electric vehicles. We do have joint modeling of heating and cooling demand in our end-use model so that we can capture the dynamics of heat pumps and the deployment of heat pumps relative to traditional electric resistance and natural gas heating. We do have cost and performance assumptions in place for those technologies, and they would be simple to vary in a high and low case aligned with thoughts around the electric vehicles as well.
 - Comment – Steve Rose: Part of the feedback we are looking for now is how we might modify these different specifications. We want to think about making things more extreme, less extreme, how might we nudge these things? One of the possibilities as Chris just highlighted is instead of just doing the sensitivity on the costs with respect to EV technologies, we could do it more broadly across electric technologies.
 - Question – RPAC Member: With the previous comment about energy efficiency, we want to see energy efficiency and flexible load and demand response as resources in your studies. I do not see them in either of the lists. When you are talking about your scope for both the broader and narrower, I'm curious how you came up with the scope, the 80% carbon dioxide reduction by 2050 because on slide 29, you talked about modeling extremes, and your scope is not in line with climate science. The Intergovernmental Panel on Climate Change (IPCC) is saying we need to eliminate carbon economy-wide by 2050. If we are modeling extremes, why are we not modeling what is in line with climate science?
 - Comment – RPAC Member: I want to echo the energy efficiency and offer the economy-wide modeling we've been doing with Evolved Energy uses the assumptions in this peer-reviewed paper:
<https://agupubs.onlinelibrary.wiley.com/doi/epdf/10.1029/2020AV000284>



- Response – Steve Rose: I will offer a couple of thoughts on the earlier points since the theme of providing insights regarding energy efficiency and load management and demand response. That is certainly a part of the output and the insights that we want to provide. We need to have them called out here as being a part of the solution in terms of thinking about these overall energy system transitions. We need some more oversight in terms of communicating that here. The question about extremes raises an interesting question about how we think about economy-wide policies in terms of what is happening. We have been doing a lot of work looking at global emissions pathways and pathways that are consistent with limiting warming to different temperature outcomes, and we are finding a broad range both in terms of their net-zero timing as well as their emissions reductions by 2050. This 80% falls in that space, it is consistent with that broader set of scenarios that are available in the literature, and we could certainly push harder. We are getting significant transitions already in terms of trying to implement this early scenario design, and we can talk more about how much more that would affect the outcome. If we think about what the policies in place on a state basis are or what could be in place, that is a question that others might want to think about in terms of where we are with Arizona policy and economy-wide strategies by 2050.
- Comment – Chris Roney: I think it is worth mentioning that this goes back to the other tasks that we are not focusing on today, which is, thinking about and contextualizing Arizona and APS’s climate commitments in the context of global climate commitments. Thinking about how that relates to climate science and temperature stabilization question more directly. We are looking forward to more analysis in that space too.
- Question – RPAC Member: Just to clarify, your narrower scope, the Arizona power sector, net-zero in 2050, that is linked back to APS’s commitment? Is that correct?
- Response – Chris Roney: That is correct.
- Comment – Steve Rose: It is also a common theme in what we are seeing from other companies and where the national strategy is in terms of the power sector. Trying to think about if the power sector were to be pursuing a net-zero outcome by 2050, what does that imply if that is the primary decarbonization policy in place?
- Comment – RPAC Member: If you are talking about modeling extremes, then just modeling your goal is not really an extreme. We see the power sector as a foundational path to decarbonization, it is foundational to decarbonizing transportation and heating and buildings, and many other things. We want to see decarbonization in the grid much sooner than 2050, something closer to 2035. If you are talking about modeling extremes, I would say that 2050 is not an extreme view.
- Response – Chris Roney: I think it brings up a good point that is hidden underneath this line of text that is not directly communicated. In the broader case, underlying that economy-wide reduction, you see a much faster net-zero power sector. This is more in line with that 2035 timing.
- Comment – Steve Rose: One of the things that we can learn from scenario design and your input right now is valuable as we think about how to define these extremes. What are the different conditions associated with those outcomes and what might be some of the related enabling factors. Setting aside the goals and the timing and looking at an economy-wide policy versus a power sector only policy is an important part of understanding the near-term and long-term transformation. It helps us think about how incentives for decarbonization and possibly using low-carbon electricity in the in the broader economy affect the decarbonization strategy for the power sector. We get a lot of insights by exploring that broader economy-wide policy versus the power sector only policy, and we can certainly



spend more time thinking about what we should do for variations of the levels and the timing with which those goals are set. I wanted to emphasize the importance of looking at that economy-wide versus power sector only incentive.

- Question – RPAC Member: I wanted to follow up on the question that an RPAC member previously asked. You said something about how it is not just power sector net zero in 2050 and how something was happening by 2035. Could you say a little more about that because I do not see that reflected on slide 30.
- Response – Chris Roney: I can clarify what I said earlier, it is maybe a failure of communication in the top left box, but essentially implied in this target is a more stringent target on the power sector as well. In the broader case, if you think about the top line and the bottom line coupled with each other, there is both a federal target, so it is economy-wide across all sectors and it is also federal, so it is across all the states. There is additional ambition in the power sector stipulated in the policy design and in the economics of meeting that target. We are seeing a net-zero power sector by 2035 in the broader case specifically.
- Question – RPAC Member: My second question might be a question for APS, I wanted to just talk a little bit more about the 2030 requirement. It is not super fresh in my mind and something that has come out in the rate cases is a little bit of a nuance in some of those percentage targets. Can you remind us, are there caveats to 45% renewables? Is that just retail load for instance? We learned in the TEP rate case that there is specific accounting going on as far as whether it is annual or day. For the 65% clean energy standard (CES), can you be a little more specific as far as what is included in the 65% clean energy? Does that include energy efficiency?
- Response – Eric Massey Yes, that is correct. 65% clean by 2030 is the target. What we have said is that with 45% of our generation portfolio coming from renewable energy is the stated goal, but I have seen Michael Eugenis come off mute so Mike, if you wanted to jump in first, I'm happy to also address.
- Response – Michael Eugenis: You are correct, there are some nuances to both of those calculations. The 65% clean is based off our energy mix, and it does include energy efficiency and distributed energy, and it serves as a more holistic view of our entire system. The 45% renewable calculation is based off retail sales, and it is slightly different. We can dive into those nuances at some time in the future. But you are correct, there is a little bit of a change between the two.
- Question – RPAC Member: Is the 45% retail sales calculated on an annual basis, and do you know what percent of your sales are retail sales?
- Response – Michael Eugenis: Yes, that is calculated on an annual basis. Regarding the retail percentage, I will have to get back to you on that. In the operations space, there are many different quantifications of load. I think that is what you are driving - the difference between retail sales and BA load. I can follow up with an answer for that to give you a comparison.
- Comment – RPAC Member: I'm just curious about 45% of retail sales, how does that compare to your overall generation? I think most of us are probably thinking 45% of renewables means 45% of the power that you generate is renewables and I do not think that is exactly what you mean.
- Response – Michael Eugenis: Correct, retail sales is the lion's share of all our generation, but we can tie that out to be more quantitative for you.
- Comment – RPAC Member: That is a great question, and I would love for you to follow up with more info.

▪ Slide 32 – RPAC feedback request

- The goal of the chart on slide 33 is to help categorize feedback in an appropriate section.
- Are there specific thoughts on the four plausible extreme future conditions proposed for evaluating Arizona decarbonization?
 - Are the conditions extreme enough or too extreme?
 - Should characteristics be added or removed?
- Question – RPAC Member: There is no scenario that is looking at 100% economy-wide decarbonization by 2050, is that correct? Even though that is what climate science says that we need to do.
- Response – Chris Roney: That is correct.
- Comment – Steve Rose: We are not modeling that now. It is something we can talk about whether we want to include that. The global pathways suggest a broad range of potential 2050 outcomes, and that is part of the uncertainty that we need to be thinking about in terms of where we might go. You are correct, right now we are modeling this 80% goal for the economy.
- Question – RPAC Member: When you talk about load growth and water stress is that nationwide or specific to Arizona, if it is the latter, it is hard for me to imagine a situation in which we have lower water stress. Maybe there will be some radical change, but with increasing transportation electrification and the load growth that the utilities are projecting over the next several years, it is hard for me to imagine that we are going to have low load growth.
- Response – Chris Roney: I should highlight that both of those lowers are relative to the other scenario rather than the current conditions. The lower load growth case I think is 30% increased load relative to today and the lower water stress is fixing it at current conditions. It is not getting better, but relative to the other scenarios. Your point is well taken.
- Question – RPAC Member: On both of your facilitate scenarios here, you are talking about lower load growth, but you are also saying that you are modeling faster end-use technology improvements. If you are more rapidly adding electric vehicles to the grid, I am not sure why the load growth would be so much lower. Can you talk about how you model EVs and other technological improvements that you are talking about and how does that fit in with a lower load growth scenario?
- Response – Chris Roney: Part of that is the distinction is a little lost in the in the three-word summary. The lower load growth is particularly with respect to the evolution of industrial load demand reflecting that relocation of high-demand industries, things like data centers to Arizona from other regions of the country. You are right that the faster end-use technology improvements would drive additional electricity demand coming out of the transportation sector. In some ways, those can have an offsetting effect where we see lower industrial demand and higher demand coming out of the transport sector. We are thinking about the framework from a system neutral perspective, not necessarily directly on the power sector, but how easy and how broad are the options set, or how facilitating the conditions in that economy-wide context. If we imagine lower electric vehicle costs, we think of that as a facilitating condition, even though it might drive additional demand on the power sector specifically.
- Response – Steve Rose: These are itemizing the assumptions and what happens in terms of how they interact with each other. We will learn from modeling to see what happens to the load when you have this different combination of factors.



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- Comment – RPAC Member: Just like those two things that we are talking about, like you are not changing those combinations, you have lower load growth and faster end-use improvements in two scenarios. In the other two scenarios, you have high load growth and slow technological improvements. You never have high load growth and faster technology, or low load growth and slower technology improvements. In my opinion, you are not varying those variables against each other.
- Response – Steve Rose: That is part of the feedback we are looking for from you. What are interesting sensitivities for us to do that are inside this space. The first thing is to really think about and ask if we are capturing the risk space with these four scenarios? You have given us a lot of great feedback on how to potentially define these and maybe refine them, but what might be interesting to explore in between. You have given us an idea; and one possibility would be to look at the different combinations between those two assumptions.
- Comment – RPAC Member: Are we going to get any more details on this? Or how will this factor into the Aurora modeling work? I think we should be modeling what the IPCC says we need to do to address climate change, and those should probably have high load growth and high-water stress sensitivities.
- Comment – Steve Rose: Thank you for the helpful and constructive feedback!
- Comment – Eric Massey: Agree with Steve – thank you for all the feedback and insights. Very valuable to our analysis!
- Comment – Chris Roney: Yes, I'll echo Steve and Eric, thank you all, we'll take your feedback and use it to inform the scenario design. Really appreciate it.

Akhil Mandadi (APS/ Engineer, Resource Planning) – 2023 APS Resource Adequacy Study

▪ Slide 41 – Agenda

1. Overview of the 2023 Resource Adequacy Study
 - Key objectives
 - Key findings
 - Study in relation to the overall 2023 APS IRP modeling process
2. Deeper Dive
 - Key assumptions
 - Planning reserve margin (PRM)
 - Different flavors – ICAP (Installed Capacity) and PCAP (Perfect Capacity)
 - PCAP accounting methodology
 - Effective load carrying capability (ELCC) assessment
3. Concluding remarks
 - Discussion

▪ Slide 42 – Key Objectives

- Determination of APS's PRM based on current planning and operating conditions.
- Determination of the ELCC of various resources and their reliable capacity contribution to APS's system demand.
- Study began with Astrapé Consulting in late 2022 using its SERVIM software.



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- **Slide 43 – Key Findings**
 - PRM determination
 - 20.2% - using the ICAP accounting methodology
 - PRM accounting mechanism recommendation
 - Transition to PCAP methodology starting in 2026
 - ELCC assessment
 - ELCC values for various resources, accounting for
 - Increasing resource levels
 - Interactive effects among key resource types
 - Changing demand and impacts of demand modifiers
- **Slide 44 – Study in relation to overall 2023 APS IRP Modeling Process**
 - Foundation to the entire modeling process
 - Capacity expansion tool utilizes values from study
 - Established PRM
 - ELCC as the qualifying capacity to meet demand plus reserve margin
- **Slide 45 – Key Assumptions**
 - Operating reserve used: 6%
 - Transmission connectivity: Transport zonal model with ties to all immediate neighbors modeled.
 - Market resource adequacy: Neighboring market has a 3% resource adequacy shortfall in meeting 0.1 loss of load expectation (LOLE) metric
 - Load and weather modeling: Utilized 23 weather years. The last 10 years were more heavily weighted, to reflect the trend in increasing temperatures.
 - Battery energy storage (BESS) held for reliability: The model has two options: allowing battery arbitrage or a more conservative approach where storage is reserved for reliability. APS opts to reserve storage for reliability.
 - Question – RPAC Member: You are talking about how you need the model to be really accurate and then you talked about using a transport zonal model with an operating reserve assumed. I am curious why you used a zonal transport model and not a security constraint flow-based model if you are looking for accuracy. You also talked about needing to derate the natural gas resources and other stuff during the summer and you also need to derate transmission assets during hotter time periods, and you are not going to capture that in a transport zonal model. Can you talk about that a little?
 - Response – Akhil Mandadi: I am sure you are aware of all the trade-offs we would need to do in terms of the complexity of the problem versus the items that have lower impact, we did two things. The first one is internal to APS's zone. We do not see prolonged or consistent congestion that impacts the ability of resources to meet their adequacy within the APS system. That helps us make a zonal approximation of APS system to start with. Regarding our neighbors, we are not included in the total transmission capability. Doing that on a transmission basis is complicated, even from an ownership perspective, and marrying that with the transmission service that you provide. The end result of what we did was we looked at a net import limit that was informed by our Open Access Same Time Information System (OASIS) in terms of the average Available Transfer Capability (ATC), we expect to see, which is much narrower, so we were not very aggressive modeling every transmission unit available, but more so with a reasonable expectation of what it is.



Accounting for those two mechanisms, we think accurately captures the bigger picture without the finer details, would be less impactful.

- Comment – RPAC Member: Do you think it is a reasonable assumption to say that your system is not transmission constrained now so in the future it will not be transmission constrained, especially when we are talking about adding additional generation resources to the system? That seems like a tentative assumption to me.
- Response – Akhil Mandadi: That is a very fair point. The way we address that is we are focusing on the existing system, and then we have had extensive study work from our transmission planning folks to establish at what reasonable point we cannot add additional transmission before having congestion on the system to your point. At that point in the capacity expansion model, we give the model the opportunity to build new transmission, but we require the model to build new transmission because it has exhausted the ability to use the existing system with congestion. To your point, there could be an optimization where you could stretch the system more with different congestion management practices, but given the nature of this problem, we have addressed it from the point of view of up to a certain level, we do not expect internal congestion. Loading the system any further, to your point, is going to cause congestion, but at that point we are going to build a new transmission to unlock that.
- Question – RPAC Member: When you are doing this, are you using sample days for your assumptions or are you using 8760?
- Response – Akhil Mandadi: We are using 8760 on the resource adequacy modeling.
- Question – RPAC Member: I think it would be helpful if APS addressed about how you hit an all-time high as far as peak goes, I think that would be helpful to talk through at some point, if we have time regarding the load growth and other peak projections within the IRP and if that changes anything. My questions for this presentation are just two. Is APS going to move to a 20% reserve margin?
- Response – Akhil Mandadi: In 2026, yes.
- Question – RPAC Member: I think it would be helpful if someone could address how both this study and the EPRI work that is going on are going to fit into the overall Aurora modeling. Are the people that have the Aurora licenses going to have access to the inputs and assumptions of this or is the presentation we are getting now what we are going to have as far as assessing how all that fits together with the preferred portfolio?
- Comment – RPAC Member: Great question for IRP implications!
- Response – Akhil Mandadi: I will request somebody else to answer the first part of your question on relation with the earlier presentation. But to answer your question on assumptions, the Aurora model already has the assumptions in the model, so the modeling committee participants should be able to access it. This presentation is more of an explanation for why those assumptions are in. All of that is already available through the modeling committee.
- Response – Todd Komaromy: The EPRI presentation has a different scope than the IRP. Its results are multi-phased and are going to be available to us in a different time phase. It will certainly help inform the overall IRP, but it is not a direct input to the work that we are doing for the IRP. I think Steve mentioned that, but I wanted to put a final point on that.
- Question – RPAC Member: Can you remind us what the timeline is for that because it seems like it would be fairly important for the IRP work as far as planning what we are going to do over the next 15 years and a lot of those clean commitments obviously are going to happen at that time.
- Response – Todd Komaromy: I can get that for you.



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- **Slide 46 – Determination of PRM**
 - Study year: 2026
 - Strategic Energy and Risk Valuation Model (SERVM) software – Combines hourly production costing with Monte Carlo outage simulation.
 - This model looks at a combination of both deterministic and stochastic determination of uncertainty. Some of the uncertainty includes:
 - Weather
 - Intermittent resource output
 - Temperature derates
 - Fundamental demand characteristics
 - Extreme temp impacts
- **Slide 47 – Flavors of PRM Accounting**
 - Installed capacity accounting (ICAP)
 - 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.
 - Perfect capacity accounting (PCAP)
 - All resources are accredited ELCC values (removes from the reserve margin an allowance for forced outages of conventional resources)
 - PCAP PRM is more durable for portfolio changes.
 - APS will transition to using the PCAP accounting method starting in 2026.
- **Slide 48 – ICAP Accounting Mechanism**
 - Total adjusted gross load includes grossing up the:
 - Total distributed generation (DG)
 - Incremental energy efficiency (EE)
 - Extra high load factor (XHLF) load
 - Electric vehicle (EV) load
 - To have demand plus the PRM equal the ICAP, the supply stack would consist of the conventional firm resources plus the ELCC resources and the summer capacity of additional resources. This will equal the load stack.
- **Slide 49 – PCAP Accounting Mechanism**
 - The load for PCAP includes:
 - Gross Load = Total DG + Incremental DG + Managed Peak
 - $PRM = 6.9\% * \text{Gross Load}$
 - ELCC of EV load
 - ELCC of XHLF load
 - The supply is made up of ELCC measurement of all supply-side resources, this is made up of conventional resources and traditional ELCC resources. This also has ELCC of energy efficiency (DSM) and ELCC of DG.



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- APS recommends utilizing PCAP moving forward, and the PCAP mechanism is being utilized in APS's capacity expansion tool.
- Question – RPAC Member: In this accounting mechanism, I am curious how you account for flexible load nature of EVs? I see you have ELCC of EVs, but how does that capture the flexible load nature of EV's either through passively managed or actively managed EV charging to be able to push that off peak or other flexible load assets? How does this account for those types of things?
- Response – Akhil Mandadi: What is handled on the left is passive, non-dispatchable load modifiers. The EV charging profile is not dynamic, it is not based on a rate, it is a profile that is in the load forecast. For all demand response that is dispatched below that would show up on the supply side and there would be an ELCC contribution associated with it. I should have another tranche that shows the ELCC of demand response because we do include it.
- Question – RPAC Member: As you move forward and start to think about different time of use plans and different use patterns, how is that captured in this overall paradigm?
- Response – Akhil Mandadi: It could be captured in two ways. Obviously, none of these models are retail models, they cannot react to a retail price, so the easiest way is to set profiles outside the model to meet that expectation. More specifically, you could set up price points in the model that says you have a target price to which your demand responds in a certain way. It is called load control in Aurora, and then it will help you set those profiles where it reacts to the system Lambda on the wholesale price and then changes load or reduces it. In some programs with smart thermometers, you have the snap back after the event and the precooling. Some of those are more challenging in Aurora to be able to fully capture, but to your point, it could be established based on load control if those rate plans can be converted to a wholesale price. Otherwise, they can be treated outside the model and treated as a load modifier to capture most of its effect.
- Question – RPAC Member: On slides 48 and 49 what is your y-axis? Is it capacity or energy?
- Response – Akhil Mandadi: That is capacity.
- **Slide 50 – 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.
- **Slide 51 – ELCC Surface for a Portfolio of Solar, Wind, and Battery Energy Storage**
 - The surface is aiming to show the different penetrations of solar and storage at 500 MW of wind.
 - The colors of the surface help to differentiate between the levels. The range z-axis of the chart shows capacity values, the range is from 0 to 5,000.
 - The x-axis represents storage penetration while the y-axis represents solar penetration.



- The height of the portfolio represents the average ELCC value and the slopes of represent the marginal ELCC.
- Question – RPAC Member: With this surface, I can imagine it as a big matrix. Is Aurora able to take that as input and then it is dynamically choosing ELCCs temporally? There will be a build phase, and then the model will reassess what the ELCC and marginal ELCCs are and then it will build again using those ELCCs and then reassess going forward. Is that how it works?
- Response – Akhil Mandadi: I am going to answer that in 2 steps. It does not have the ability to take the multidimensional information, but it does account for two big pieces of it, one is the saturation impact with penetration change and load change. All ELCC values with the declining marginal or incremental ELCC values are inputted into the model, so it is dynamic in that sense, it accounts for each individual penetration of resource and what that does with changing load. However, Aurora cannot, and this is common for most capacity expansion tools today, simultaneously solve because it is making an optimization decision on which resources it picks, which it does based on their peak contribution in meeting the PRM. At the same time, it does not know the impact that its picking has based on what else it picked, so that is where there is an out-of-model adjustment. The first piece knows exactly, and it does it temporarily with changing years, but to account for the second piece, we have broken it down into multiple tranches. The first thousand MW gets a certain ELCC value, the second 1000 MW gets the next ELCC value. We must assume that if the model picks the first thousand, all of it gets the same, and then once it has picked all of it, it goes to the next tranche. That is dependent on what it is doing with the tranches of wind and storage simultaneously, which is where it becomes a complex optimization that that the model cannot inherently do.
- Question – RPAC Member: How are you adjusting for that, if for example, it builds a bunch of solar, the ELCC is different depending on whether it built a bunch of storage or it did not. How do you make adjustments?
- Response – Akhil Mandadi: We give the model the opportunity to build multiple tranches of solar, wind, and storage. First, it starts with the first tranche and of each of those resources before it goes to the next one. Once it is done with one set of its capacity expansion results, we go outside the model, and because we have the surface, we look at the portfolio that it picked and then see what the delta between what the model knew and what the real expectation is, if it is more, then we see how much more or how much less it is. This allows us to adjust it so we can come back to a balanced portfolio.
- **Slide 52 – ELCC Trends with Isolated Resource Penetration**
 - The first graph refers to the battery ELCC value when 2500 MW of solar and wind are fed in.
 - The second graph refers to solar ELCC value when 2500 MW of battery and wind are fed in,
 - The third graph refers to wind ELCC value when 2500 MW of solar and battery are fed in.
 - The fourth graph shows the ELCC for increasing energy efficiency penetration.
 - ELCC was also established for:
 - Conventional/firm resources
 - Load-modifiers
- **Slide 53 – 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.



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- Comment – Todd Komaromy: I know I am very biased, but there is an incredible amount of rigor in these studies. Akhil and the team have been hard at work for many months to bring this information to you. We think it is important to reliability. I think it really moves the ball forward for us as a company and understanding this space. Thanks to Akhil, this is really good work that helps this work move forward.

Matt Lind (1898 & Co./Director of Resource Planning) – Next Steps & Open Discussion

- Slide 56 – IRP Timeline
 - 2023 ASRFP Bidders Conference Wednesday, July 26th, 2023
 - August RPAC meeting Friday, August 4th, 2023
 - The agenda will not be a long meeting due to the quick turnaround time between the July meeting and August 4th.
 - APS will do their best to get meeting materials out as early before the meeting as possible.
 - Public Stakeholder Meeting #2 will be in September.
 - September and October would be good opportunities if the members of the modeling team had reports that they would like to share.
 - Question – RPAC Member: I would like APS to comment on the peak load record that was hit this weekend and how that impacts the IRP and load growth projections.
 - Response – Todd Komaromy: We were just under 8,200 MW on Saturday. It was a new peak for APS. We had adequate power supplies, so if you compare that to the low forecast that we have shared with you a couple of times, it is very close. It took a lot of effort, but we had all our infrastructure working properly and we had done the work to make sure we had the resources available in advance to be able to have the reserve margin in place so that if there was any kind of additional concerns, we would be well positioned to accommodate it. The heat dome was mostly focused on the Desert Southwest. We did not see that impacting our neighbors over in California at the same time.
 - Question – RPAC Member: Is it surprising at all that the peak record was hit on the weekend? Maybe that fits into the 20% reserve margin conversation, but does that cause any concern as far as what if that had happened on a weekday? I would assume that there is more load on weekdays than weekends. I do not know if you want to comment on that or if it had happened during an on peak period what that would have looked like.
 - Response – Todd Komaromy: The peak has been hit on weekend days before. I think it was more of the factor that the 118-degree day that we saw was on the weekend, that was the largest driving factor, but we had adequate supply. Had it happened on a different day, I think we would have been similarly situated.

Action Items:

- In a future RPAC meeting, APS to present the details behind how the Company qualifies and calculates the percentages of clean and renewable resources included in its Clean Energy Commitment.