Meeting Notes

Meeting Objectives

- Provide recap of September RPAC meeting and provide status of previous action items.
- Summarize RPAC feedback and suggestions for future RPAC meetings.
- Provide a recap of 2022 Summer Reliability.
- Introduce Climate Change Scenario Analysis performed by EPRI.
- Discuss IRP requirements and ways that RPAC members will be able to participate in the IRP.
- Discuss risks associated with new resource technology, primarily focused on battery storage resources.
- Provide an update on the 2022 RFP schedule and negotiation process.

Meeting Subject: October RPAC Meeting
Meeting Date: 10/26/2022
Start Time: 09:00am
End Time: 12:00pm
Location: Virtual

Attendees	Organization	Title/Role
Ann C Becker	APS	Vice President, Sustainability
Charlene A Saltz	APS	Sustainability Storyteller
David Peterson	APS	Advisor, Corporate Strategy
Eric Massey	APS	Director, Sustainability
Hilary Waterman	APS	ESG Reporting Consultant
Justin Joiner	APS	Vice President of Resource management
Kayla Wolfe	APS	Manager, Content & Channels
Michael Eugenis	APS	Manager, Resource Planning
Pamela Nicola	APS	Manager, ESG Policy
Sadiya Jama	APS	Business Analyst, Resource Management
Timothy B Rusert	APS	Director Fuel Procurement and Ops
Todd Komaromy	APS	Director, Resource Planning
Jason Smith	APS	Manager, Regulatory Affairs
Yessica Del Rincon	APS	Communications Consultant
Matthew Lind	1898 & Co.	Director of Resource Planning
Evan Lipsitz	1898 & Co.	Consultant
Keaton Clark	1898 & Co.	Analyst
Adrian AU	E3	Partner
Lakshmi Alagappan	E3	Partner

Nick Schlag	E3	Partner
Daniel Schwiebert	ACC	Policy Advisor
Gary Dirks	ASU	Senior Director
Erik Smith	EPRI	Climate Resilience Analyst
Francisco Ralston Fonseca	EPRI	Engineer/Scientist
Heidi Scarth	EPRI	Engineer/Scientist
Steven Rose	EPRI	Principal Research Economist
Sam Johnston	Interwest Energy Alliance	Policy Manager
Nitin Luhar	Mitsubishi Power	Regional Director
Nicole Hill	Nature Conservancy	AZ Thrives Program Lead
John Mitman	OBODO Energy	Founder & CEO
Amanda Ormond	Ormond Group LLC	Principal
Teresa Brown	PG&E	Operating Clerk
Dugan Merieb	Pine Gate Renewables	Regulatory Associate
Rachael Leonard	Pinnacle West	Senior Attorney
Sandy Bahr	Sierra Club	Chapter Director
Nate Blouin	Strategen	Western Policy and Markets Consultant
Caryn Potter	SWEEP	Arizona Representative
Alex Routhier	Western Resource Advocates	Senior Clean Energy Policy Analyst
Murphy Bannerman	Western Resource Advocates	AZ Gov. Affairs Manager
Cynthia Zwick	Wildfire	Executive Director
Phil Jones	Alliance for Transportation Electrification (ATE)	Executive Director
Scott Henry	Griffith Energy	Plant Manager
Steve Jennings	AARP	Consultant

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

- Slide 3 – Meeting Guidelines
  - RPAC member engagement is very important. Questions and comments are welcome throughout the presentation.
  - APS will publish meeting minutes on their website that includes questions and action items.
- Slide 4 – Following Up
  - No action Items from previous meetings
  - Ongoing commitments:
    - Distribute meeting materials in a timely manner
    - Transparency and dialogue
- Slide 5 – September RPAC Meeting Recap
  - 2022 All Source RFP update

    - Discussed effective load carrying capability (ELCC) and how it was applied to different resource technologies
- Illustrated how the recent extreme weather events in California impacted reliability and how APS exports played a vital role.
- Highlighted the updated load forecast tool and how it will help members with load assumptions and total energy usage.
- APS will be filing an application with the ACC to update their rate case.

Timothy Rusert (APS/Director of Fuel Supply) – 2022 Summer Reliability Review

- Slide 8 – Summer Conditions and Impacts
    - Summer of 2022 was hotter than normal.
        - 22 days of 110+ degree vs 21 normal.
    - Mid-July was an active monsoon season that brought around 200% of normal rainfall.
    - Transmission and distribution replaced 811 poles compared to 290 on average.
    - In January, one of the PPA Wind facilities was repowered resulting in 110 MW of additional wind capacity in New Mexico.
    - APS experienced exceptional thermal generation reliability (95%).
- Slide 9 – Peak Coverage
    - Minimal generation outages during peak demand
        - Nothing larger than 50MW out of service.
    - The peak day in 2022, July 11th, was coincident with the 2022 peak temperature of 115 degrees. This temperature was two degrees cooler than what was forecasted.
    - APS was not reliant on imports to meet peak demand and the system was not heavily stressed on the peak day.
    - During the weekend of July 16th, there was 700 MW offline due to outages, a large 500 MW unit was forced offline mid-day Saturday, and an additional 1000 MW was lost due to a lightning strike.
        - Significant power was imported from other areas.
        - Prices did not raise significantly because the July peak was much earlier than CAISO's peak.
    - Peak load was within 10 MWs of APS' all-time peak demand even though the temperature was two degrees cooler. This implies that APS has experienced load growth. APS' weather adjusted peak demand would have been substantially higher than their all-time peak and would have exceeded what was in the load forecast.
- Slide 10 – September Regional Heat Wave
    - Regional diversity is extremely critical in the electricity industry.
    - In August of 2020, heat impacts were experienced across the entire west and led to power outages in California.
    - The September 2022 event impacted some areas of the west, but temperatures in Arizona did not reach record highs. This allowed APS to export power to support the region.
    - Arizona was able to export significant power to support the rest of the region and sales exceeded $74M during this event. All of that revenue goes back directly to customers through the PSA.

- In August of 2020 there were 15 Energy Emergency Alerts (EEA), primarily in CAISO. In 2021, there were significantly fewer EEAs due to lower peak demands and peak demand periods that were more spread out across the region. September 2022 had the same number of EEAs as August of 2020.
- Regional heat is a challenge, and it is a key issue that APS is planning around to improve reliability.

- Slide 11 – Natural Gas Delivery Challenging
  - Natural gas delivery was a challenge for most utilities in the Desert Southwest.
  - APS has over 5,000 MW of gas fired generation that is relied upon in the summer. APS also has two pipelines, both of which had challenges this year.
    - A portion of the El Paso pipeline experienced an explosion in August of 2021. The explosion removed 33% of the capacity of the pipeline that is still out of service.
    - 65% of summer days were alert days for the Transwestern system.
    - APS was balancing between the two pipelines and between power purchases to ensure load was served. Although there was never an issue with serving load, gas was an everyday challenge to manage.
- Slide 12 – 2022 Summer Reliability Review
  - 2022 weather was not very challenging to manage.
  - APS was more lucky than good in September because it was not as hot in Arizona as neighboring areas in the west.
  - Gas was an everyday challenge for APS to manage.
- Slide 13 – Discussion & Questions
  - Question – RPAC Member: Going back to the point you just made about being able to support the Southwest. Presumably, you're bringing standby gas generation on stream to do that. Is that right? When you said you were making sales into California, I'm assuming APS was ramping up gas generation to do that?
  - Response – Timothy Rusert: That's correct, the economics supported gas.
  - Comment – RPAC Member: You talked earlier about the importance of diversity of supply sources. So, for the entire region, not just for the state, having spare gas capacity available turns out to be handy? Is that correct?
  - Response – Timothy Rusert: Dispatchable capacity is always of value. Having the ability to ramp units up when the region needs help for a certain period is critical, and gas generation is built very well for situations like that.
  - Comment – RPAC: Is it primarily gas that is sold because there is nothing else to ramp up?
  - Response – Timothy Rusert: We had our remaining coal units running all out due to economics throughout the summer. If you recall, natural gas prices have been extremely high since last October, so our coal was fully dispatched. Our renewables were also run without curtailment in the summer. The only other flexible resource remaining was gas.
  - Question – RPAC Member: Was gas the marginal dispatchable resource that provided reliability to the region mostly because there are not enough renewables and there is so much gas? Referring to the pipeline issues mentioned on slide eleven, there are also clearly challenges with gas.
  - Response – Timothy Rusert: Gas is typically our on the margin resource and is especially when ramping into peak periods. All the solar we have, and the region has, will be online, but the load will well exceed that in the summer. We need to facilitate additional generation and the flexible generation that we maintain out there is going to be gas fired. That applies to the entire region. The Pacific Northwest has a little hydro to work with, but for the most part, the whole south section of the west uses gas as a dispatchable, flexible resource.

- Comment – Matt Lind: To your question or comment, I think many different regions are looking at ways to increase clean energy. A lot of the renewable energy technologies out there today are resources like wind and solar, which are intermittent or potentially energy limited. An option is to add storage to capture excess production, but folks are still evaluating this option from a reliability standpoint to ensure that the production is available when it is needed. Last month's presentation indicated that California's additional storage capacity was very valuable for the region this year compared to 2020. It is also very valuable to ensure production is available when needed and there are still some challenges with storage that we're learning how to deal with from an operational perspective. Dispatchable, flexible resources that are available to be ramped up when production is needed are going to be highly valuable in the future. Utilities and regional grid operators are looking at how we can maintain flexibility in production resources in order to be able to respond to reliability events as they happen. Reliability events are often unpredictable, so there is tremendous value in the flexibility of dispatchable resources. As Tim mentioned, there were also challenges with gas. From a flexibility and dispatchability standpoint, resources need to be able to produce when needed. If you are not able to supply gas plants with natural gas, the value goes away.

Eric Massey (APS/Director of ESG Policy and Reporting) – Climate Change Scenario Analysis

- Slide 14 – Climate Change Scenario Analysis
  - APS is planning to conduct several climate change scenario analyses. APS has engaged the Electric Power Research Institute or EPRI to help us with these analyses.
  - A climate change scenario analysis is an iterative process that is used to analyze plausible future scenarios to identify where climate change can have a potential impact on APS' operations. The end product of this analysis will allow APS and the stakeholders in this group to better understand the physical risks that climate change presents to APS' operations as well as the transition risks we might encounter while working towards the APS Clean Energy Commitment.
  - The analyses will also demonstrate how the APS Clean Energy Commitment compares to US and international climate policy objectives.
  - This kind of analysis is very common in the utility industry. Our investors are always seeking information to better understand the risks of their investments and to make more informed, efficient capital allocation decisions.
  - APS expects the SEC to eventually require entities to perform climate change scenario analysis for ESG reporting purposes and APS sees this as a good opportunity to get ahead of the curve.
  - APS' goal is to help everybody better understand what the climate change scenario analysis project is and also to obtain input regarding what variables should be considered in in the analysis. APS will take the input it receives, work with EPRI to complete the analysis, and then present the results at a future RPAC meeting in early 2023.
  - Ultimately, when the analysis is complete, the final report will be brought back to the RPAC for review and the report will be used to inform our future risk management strategy decisions.

Steven Rose (EPRI/Principal Research Economist) – Climate Change Scenario Analysis

- Slide 16 – About EPRI
  - EPRI is a nonprofit, non-advocacy research organization with a public benefit mandate. The data is designed to inform the public.

- EPRI has been heavily engaged in the scientific community, not only as contributors with respect to analysis and studies, but also as a part of key scientific assessments such as work done by the Intergovernmental Panel on Climate Change (IPCC).
- EPRI has been directly working on climate related risk for 50 years.

- Slide 17 – The Climate is Changing – How Much More is Uncertain
  - The climate has changed, and more climate change will come. There are many factors that play into our climate, and we need to be thinking about adaptation for that change.
  - Even the most ambitious emission reduction pathways moving forward include some sort of climate change associated with total emissions.
- Slide 18 – Climate Change Scenario Analysis: How it Helps
  - Scenario analysis is performed because planning for one future is very risky.
    - Scenario analysis is a way to explore the "what ifs"
    - Scenario analysis is valuable for assessing uncertainties, risks, opportunities, and managing risk.
    - Scenario analyses are not predictions, they are really designed to explore future possibilities.
  - What is climate change scenario analysis?
    - Climate change scenario analysis (CCSA) – scenario analysis with climate dimensions.
    - Physical climate changes and low carbon transition pathways are two key climate dimensions that should be considered.
  - Three categories of uncertainties and potential risks that should be evaluated:
    - Physical climate conditions
    - Climate policy conditions
    - Non-policy conditions
  - Value to both internal and external stakeholders.
  - In order to be meaningful, CCSA should be done in a customized way to reflect local conditions, local markets, and local policies to define uncertainties.
- Slide 19 – Climate Change Scenario Analysis: Technical Considerations
  - Having emissions or climate change does not imply risk.
    - Risks need to be explicitly evaluated with proper assessment and metrics.
    - Greenhouse Gas (GHG) targets have risks that need to be assessed, managed, and communicated.
  - Company specific circumstances matter
    - Each company has different contexts, uncertainties, risks, and opportunities.
    - Companies will have different cost-effective strategies and pathways.
    - There is no "right" emissions pathway due to uncertainties.
    - Global pathways are poor benchmarks or guides for companies.
- Slide 21 – Project Overview and Objectives
  - Task 1 – Initial physical climate risk assessment analytical foundation
    - Providing a physical climate risk assessment conceptual framework
    - Characterizing past, present, and future potential physical climate change

    - Identifying types of potential impacts and responses to climate change to assess
  - Task 2 – APS low-carbon transition risk analysis
    - Develop customized, plausible scenarios to evaluate transition uncertainties and risks for APS
    - Identify key risks, signposts, and tradeoffs for APS as they continue to make progress towards the APS Clean Energy Commitment
    - Provide a scientific basis and grounded insights regarding transition risk in a manner aligned with TCFD
  - Task 3 – Low carbon transition strategy & GHG goals contextualization
    - Evaluate APS' GHG targets and transition scenarios relative to international goals
    - Educate on the relationship between global pathways and companies, including limitations of global pathways as guides for company targets
- Slide 22 – Full Physical Climate Risk Assessment is a Series of Several Assessments
  - A physical climate risk assessment requires knowing more than whether the climate is changing. It is a set of assessments that define potential conditions, risks, and responses.
  - Data requirements include hazard, exposure, vulnerability & response, and risk management.
  - Hazard
    - Are local physical conditions changing?
  - Exposure
    - What's in harm's way?
  - Vulnerability & Response
    - Does it matter? How might we respond?
  - Risk Management
    - Is the risk large? What are robust and resilient strategies?

Erik Smith (EPRI/Climate Resilience Analyst) – Climate Change Scenario Analysis

- Slide 23 – Two Levels of Physical Climate Change Assessment
  - Regional Assessment
    - Assess information from published studies to characterize regional climate change. These include:
      - Fourth National Climate Assessment
      - NOAA National Center for Environmental Information
      - State climate assessments
  - Local Assessment
    - Identify locations or sub-regions of interest with APS to dive deeper using localized data
      - Historical observations and climate model projections
      - Downscale information to specific location
      - Also consider data availability
- Slide 24 – Climate Data and Hazards
  - Physical hazards can consist of a single climate variable or a combination. Hazards are listed below from least to most complex.

    - Extreme heat
    - Low wind and/or solar
    - Drought
    - Lightning
    - Streamflow & stream temperature
    - Flooding
    - Wildfire
- Slide 25 – Example of Local Climate Change Information
    - Temperature can be observed in a lot of different ways. One way is to look at how the temperature distribution shifts over time.
- Slide 26 – Concluding Remarks
    - Important in low carbon transition and physical climate risk assessments to:
        - Consider plausible and relevant future conditions and extremes
        - Assess the science and use it properly
        - Evaluate the implications of climate, policy, and non-policy uncertainties
        - Perform company specific analysis
    - EPRI is at the beginning of this process and does not have data or results yet to share. As results are gathered and the study is completed updates will be provided to RPAC members.
    - Question – RPAC Member: What type of models are you using to run this analysis?
    - Response – Steven Rose: There are two different types of analyses. The work that we will be doing under the scope of the physical climate risk assessment uses a variety of different data sources. I will let Eric speak to those data sources and models. For the transition risk analysis, we will be doing energy systems modeling. We have our own tool that EPRI has been developing over the past 10 years. It is the Region Model if you are familiar with it. The tool allows us to redefine the regional resolution in the model so that we can isolate individual states and their neighbors to evaluate those interactions as well as the individual state themselves. We are able to evaluate all the way down to dispatch planning, we can think about some capacity investments within the electric sector, and we can think about fuel markets and end use demands and adoption of technologies on the end use side. It gives us a complete picture and the ability to evaluate economy wide decarbonization and how the electric sector might participate within those decarbonization outcomes.
    - Question – RPAC Member: So, the Region Model is an EPRI model?
    - Response – Steven Rose: Yes. Eric, do you want to say a little more about the physical climate risk assessment models?
    - Response – Eric Smith: For the physical risk side, we are pulling climate model data from the CMIP6 model intercomparison project. We are pulling specifically from a bias corrected modeling group that's called the intersectoral impact model intercomparison project. This subset of models has five models that span a range of sensitivities, so it has a warm model, a cold model and a few in between. We are not getting a bunch of models or pulling a bunch of data that is on the extreme warm side or the extreme cold side. That is a really important component. We are pulling two different climate scenarios, and we might end up pulling more. We want to make sure that we are capturing a lower end climate scenario and higher end climate scenario that are plausible and not the highest or lower scenarios possible.

We will end up pulling five models with a few different scenarios that span a range of sensitivities. There is a lot of effort that goes into exactly what we are going to pull and evaluate.

- Comment – Steven Rose: I will just add that we are combining that climate related information with other sources of climate data. So certainly, from the historical records, we are looking at observations. We are looking at reanalysis data. We are also interested in near term trends, so if we think about trying to inform planning for a very short time horizon, as opposed to decades, we want to be thinking about the near-term trends which are in many ways more reliable than the longer-term projections. It is important to construct a meaningful picture of historical, current, and future climate change trends.
- Comment – RPAC Member: I think it is good that APS is doing this, and I'm glad to see that EPRI is playing a role in this because it is an area of expertise for you. As I think about this, in its entirety, it feels like what we are doing here is related to internal governance for APS. You are producing a scenario landscape and an assessment of risks associated with that. Then, presumably, APS will be building up internal capacity to govern what is coming out of your study. There were many references to education. Interestingly, education was referenced with respect to the international goals, so presumably there is also an intent to socialize what these risks look like, mainly at a local level, but not necessarily just at a local level. Is that a fair summary of what this is? It is complex and to be honest, it's not straightforward to get your head around this in the first hearing.
- Response – Steven Rose: I do not have an answer to the internal governance question. I will let APS colleagues respond there. Certainly, we are trying to inform strategic decision making. Being able to consider these different uncertainties and evaluate their implications both in terms of physical climate change and in terms of low carbon transitions is really a primary goal. With respect to education, that is exactly true. There is a lot of information that we have found in the engagements we have had over the last several years that indicates most of the stakeholders are not that familiar with the science. It is not surprising since it is not their day job and suddenly, they are being asked to think about this and even make decisions on it. We can be very helpful, not only in terms of informing with respect to the contextualization element of this work, but also with respect to climate models and helping stakeholders understand the different scale with respect to different variables. The fact that there are already different types of data can be somewhat new for people to understand, so there is a real opportunity here, not only in terms of level setting the conversation and helping people better understand the kinds of considerations that are scientifically justified, but also how to design the scenarios themselves to be able to characterize the risk space and provide useful insights.
- Response – Ann Becker: I wanted to respond to your question about whether we will be using the results of this study for internal governance purposes, and the answer is yes, absolutely, that is one of our intentions. I think the intent is broader than simply internal governance, but a key goal of ours is to develop an analysis that will be useful for us in terms of risk management and strategic planning going forward. My team and the executive team at APS spend a lot of time talking about climate adaptation and resilience, but we don't have any scientific grounding in how we focus on adaptation and resilience. What are the real challenges or the plausible challenges that we will be faced with? So, this is going to give us some strong and clear guardrails as we are thinking about how to develop an appropriate strategy for climate adaptation and resilience moving forward. I just wanted to chime in and share our perspective on the internal use and then again, a second important purpose here is to be very transparent with all our stakeholders about our findings. We will be using this internally, but we also will be sharing this externally with all our stakeholders and

that includes our customers, the RPAC, and our investors. We've got investors who have been asking for climate scenario analysis, and we know the time is right for us to be doing this for a host of reasons.

- Response – RPAC Member: That all sounds very good and I suppose more directly this study has a very large capacity building internal to APS, which all big organizations need to be concerned about going forward. Just out of curiosity the three tasks from slide 21, why the highlight on international education. What is it? What do you think you're seeing on the international side, that would cause education to be one of your goals?
- Response – Steven Rose: That was not meant to exclude education from the other tasks, it was included there because in many ways it is a smaller task than the other two. We were just trying to highlight two of the contributions into the overall project, one being this contextualization in terms of trying to provide a connection between APS' strategy and the scenario analysis that we will be doing related to low carbon transitions and international goals. We also want to provide some discussion text that will be helping people understand how you think about the relationship between scientific information that defines the relationship between international goals and companies, and what are important considerations associated with that relationship. The important considerations really are all these different types of uncertainties that affect how an individual company might be consistent with international goals and also contribute to realizing those international goals.
- Response – RPAC Member: Well, there are some very large potential, second order implications for what's going on internationally, particularly from a standpoint of security architectures of big nations and supply chains, but it sounds like that's not what you're pointing at.
- Response – Steven Rose: No, this is really about using some of the key prominence, sort of global science information that many people are using to inform their thinking about companies. For example, we see the IEA Net Zero Scenario as one that people frequently refer to. We see some of the IPCC global emissions pathways scenarios as others that they refer to, and our goal is to help people understand what that information even is. How is it created? How to even think about a company in the context of this very aggregate modeling that isn't capturing the individual markets that are relevant to companies. What are the uncertainties that are represented when you look at scenario data and not just one scenario, but many scenarios? How does that inform our thinking in terms of scenario design? Because there are key pieces of information that many people are considering, I think it's important to be able to help them understand what that information represents and be able to help them understand what that implies for a company.
- Question – RPAC Member: Thank you for this presentation. I just wanted to clarify if this assessment is going to also consider APS' upstream and downstream greenhouse gas emissions, especially the 15 different categories within downstream. I think that's from a higher, 360 look at APS' risk. I think those supply chain categories are going to be crucial.
- Response - Steven Rose: A quick point of clarification is that we're not trying to model with this APS specifically for the low carbon transition risk analysis. We're trying to provide high level strategic inputs, and how might Arizona transition in terms of potential low carbon transitions and what might that mean economy wide as well as for the power sector. We're not going to be in a position to characterize specific APS emissions categories. We are looking at more of those changes that might occur under different contexts, and what might those represent both in terms of the nature of the transition and also the challenges and enabling conditions associated with different transitions. In some ways it will be informing different emissions categories because we will be talking about emissions across the economy, but it won't specifically be focused on the greenhouse gas accounting specific to APS.

- Response – RPAC Member: Would you say that this final analysis would be something that could be useful for all of Arizona utilities and some of their decision making? Whether it's their resource planning work or other procurement generation decisions that they must make?
- Response – Steven Rose: In terms of these general insights, it's not meant to explicitly model any individual utility system, or even individual assets, but really trying to think about how the system as a whole transitions. That would certainly provide insights not only to the other utilities, but also to other sectors in the Arizona economy.
- Comment – Charlene Saltz: I did want to let you know that this study is not looking at those upstream and downstream greenhouse gas emissions, but that is something our team is actively working on with making sure we can start to get a better handle on what that means for the utility industry. We are working with EPRI and other partners in that space on that issue.
- Response – RPAC Member: I'd be very curious to know what that looks like. I don't know if that's something that the RPAC would be able to review once it's in a place that we can discuss, but I think, as it relates to APS, the key takeaways from this work could be applied to some type of mitigation analysis of greenhouse gas emissions and how the mitigation analysis applies to both the upstream, midstream, and downstream emissions.
- Comment – Charlene Saltz: I love the idea of bringing it back to the RPAC, so I am going to keep that idea while we move down that path.
- Question – RPAC Member: Has APS invited SRP and TEP to participate in this work or have you talked with them about it if there are economy-wide or Arizona-wide implications?
- Response – Ann C Becker: We have not invited SRP and TEP to participate with us in this work. Part of that is because the work is going to focus on specific areas, and it will look at APS' service territory and there's not a broader look beyond our service territory in regard to those location specific analyses.
- Comment – Steven Rose: To clarify, in the physical risk task, one of the key activities is to identify some select locations with APS to evaluate and really do a deep dive and develop some of that custom information in terms of physical climate change over both the historic and current projection period. Identifying those sites will be something that APS has to work through in terms of considering different criteria for choosing sites. There is a variety of different factors that others have thought about in terms of how they might prioritize one site over another, not only in terms of whether the conditions might be different between the different sites, but also in terms of what they imply in terms of those locations relative to load center or relative to certain assets. So that is really an APS specific decision process in this analysis as well as thinking about some of the specific metrics that that they're interested in. The low carbon emissions analysis I was referring to is much more general, though there are very specific considerations for APS, in terms of developing the scenario design and trying to identify the uncertainties and different types of uncertainties as well as ultimately to define a risk space that's meaningful for APS given their own set of assets and operations.
- Comment – RPAC Member: You mentioned the analysis being economy wide, so I'm thinking outside the electricity sector, and this work is really complex, and the state has not done any mitigation risk on carbon. I totally get that you're not inviting other utilities to participate, but I think it's really important to start having this conversation. I think it's great you are doing this report to start saying what are the risks we're going to face because they are real and by not studying them or not talking about them, we're just putting the entire state in a more risky position. I think as you go through this study, thinking about how it can be shared and how it can be used to educate policymakers and other folks is really important.

Pamela Nicola (APS/Manager of ESG Policy and Reporting) – RPAC Feedback Request

- Slide 28 – RPAC Feedback Request
  - What do you see as important uncertainties for APS to evaluate for each of the following:
    - Physical climate condition changes – with respect to heat, drought, lightning, or events like low wind during extreme heat?
    - Climate policy conditions – ambition, type, coverage, options?
    - Non-policy conditions – local economy, load, energy supply or demand technologies, markets, public perception?
  - Comment – Ann Becker: APS has a list of physical climate conditions that we think are important to consider, but it is really important to hear from the RPAC Members so that APS' list is comprehensive. The feedback is very valuable. The items that were listed are just a starting point and hopefully the list will continue to grow.
  - Comment – RPAC Member: As we continue to see changes in Arizona, I'm curious how EPRI is looking at things like 100-year extreme weather events and how likely it is that those might happen? They are happening much more frequently than 100 years and I would be interested in what EPRI is doing to evaluate how these events are making an impact on forecasts or other assumptions
  - Comment – RPAC Member: Region-wide heat events
  - Comment – RPAC Member: I think the biggest risk that I see is down in the third bullet, non-policy conditions. It is not actually specifically stated but I don't think there's very good alignment amongst stakeholders of what constitutes an appropriate response to these risks and what appropriate timescale is to make those responses. We skirt around that conversation a lot in Arizona and in Maricopa County, and do not take it head on very often. I'm not recommending anything for this group to do, I think this is a conversation we must have more of in Arizona, in APS' service territory, and in SRP's service territory.
  - Response: Pamela Nicola: I want to make sure that we are understanding your feedback. You are saying that one of the non-policy risks is a distinct lack of alignment amongst stakeholders on what an appropriate response to climate change looks like.
  - Comment – RPAC Member: Yes, as well as the timescale that is appropriate to make those responses. In my opinion, there is quite deep misalignment that will increasingly get in the way of things.
  - Comment – RPAC Member: Another challenge is the lack of alignment around the very existence of climate change, and/or the politicization of climate change in Arizona. Also, as climate risk increases, it is the local community that is going to have to deal with the impacts. People look for shelter in local communities when there are fires, when there are floods, and when there are high temperatures. I think about building Arizona communities so they can be more resilient. Does that mean microgrids specifically? Maybe, maybe not. We have built the electric system on very large generators that are very far away from load with long transmission lines, but as we move into the future, we are going to have to be thinking about local resilience more and I think that has big impacts on how APS builds their system.
  - Comment – RPAC Member: Emerging technology and markets: long duration storage, more regional coordination.
  - Comment – RPAC Member: You've included non-policy conditions and climate policy conditions. I think it's important to also discuss how federal stimulus opportunities are going to have an impact on how APS evaluates all these questions and evaluates the assessment. I think just from the Inflation Reduction Act alone, the opportunities for tax

credits and all of the rebates are going to have a significant impact on the outcome of the IRP and how we're evaluating clean energy resources.

- Comment – RPAC Member: Related to energy supply technologies, with the generation mix being increasingly gas dominant and in the face of weather changes, we just want to see how the gas plant reliability is being modeled.
- Comment – RPAC Member: Appropriate responses need to be sensitive to more than climate. Justice, equity, reliability, and affordability are also integral to viable strategies.
- Comment – Steven Rose: Thank you for all of the feedback. It might be useful to provide some clarification on the scope of the project. The work that we're doing in terms of the physical risk is building this initial foundation. It'll get us characterizations of those physical changes and help us understand how things have changed and could change in the future, but it will not necessarily answer the question of how does that then modify your investment strategy? That's part of this more comprehensive analysis that would then follow up from this initial foundation that we're developing, so we'll be able to inform that conversation and inform the development and design of that future analysis. We will be in an interesting position at the end with the physical risk information and with the physical change information as well as the transition risk analysis to begin to put together those two pieces of information, to inform how do you then go forward to evaluate vulnerabilities with respect to different possible transitions and thinking about how you respond to it and how might it even impact your transition. So, the work that we will be doing wll facilitate that conversation. It'll provide a lot of great content in terms of being able to see, on the surface, where there might be a high priority analysis that needs to be done to really dive into those questions.
- Comment – RPAC Member: I like that the study is thinking about the specific geography and its specific risks. In general, Arizona is a pretty low risk state in terms of earthquakes and other things, but climate change is going to change all that. We have the Cholla power plant that is going to be closing and will become something else or maybe nothing else. I'm wondering whether you could consider looking at that area and its risk profiles because it is an asset that's going to be changing from coal to something else. The physical risks in and around that area might be helpful when thinking about repurposing.
- Response – Pamela Nicola: Excellent point, thank you.

Michael Eugenis (APS/Manager of Resource Planning) – IRP Requirements

- Slide 35 – Considerations Informing the 2023 IRP
  - APS has made updates to the load forecast. Some of those assumptions will come in later RPAC meetings.
  - The ACC sets forth portfolio requirements and defines attributes needed to be considered in the IRP process.
  - APS will not have a specific portfolio for each attribute. Where appropriate, APS intends to create portfolios that combine some of the attributes in order to reduce the number of portfolios that need to be evaluated.
  - ACC sets a minimum of 10 resource portfolios that are designed to achieve the emissions reduction goals specified by the 2020 IRP.
  - APS will continue to include a portfolio that does not consider emission reduction goals or renewable energy standard to analyze the least cost case.
- Slide 36 – Considerations Informing the 2023 IRP Continued
  - The ACC has created a list of analyses that they are interested in for the 2023 IRP.
  - Retirement of four corners will be a consideration in the 2023 IRP.

- Power system resiliency and resource adequacy concerns are of interest.
- Hydrogen continues to be of interest. There are higher needs for clean dispatchable generation and the recent news of additional investment in hydrogen infrastructure in California will be a topic that is addressed.

- Slide 37 – APS Resource Planning Model
  - Licenses will be provided for users to model and verify APS' results using Aurora.
  - Aurora is a mixed integer optimization software package.
    - Energy Exemplar is the software developer and APS plans to work with Energy Exemplar to provide training materials to users.
    - There will also be workshops to help participants acclimate themselves to the software.
    - There is confidential information with the tool so users will be required to sign an NDA with APS to respect the confidentiality.
    - Only a handful of licenses are available, but APS encourages RPAC members who are interested in modeling using the software to reach out to an APS member or through the RPAC email to get their name on the list.
  - Question – RPAC Member: Is there a reason that must-run designations were only mentioned for coal?
  - Response – Michael Eugenis: I think where it comes from is the ACC order. In past discussions, there has been the utilization of must run characteristics specifically for coal plants. Coal plants are typically base load resources that don't have as much cycling capability as other natural gas resources. The order is specific to coal plants in that way. In our production cost modeling, we use a host of constraints to best model the economics of every unit. The modeling characteristics of the natural gas fleet, including combined cycles, include start costs, fuel costs, and fixed and variable O&M to make the determination if it is economic to start those facilities. I appreciate the comment that there isn't anything in the model that would indicate that combined cycles and combustion turbines are set to must run as well, but I would say that it is pretty rare to see that specific constraint placed on natural gas resources.
- Slide 38 – December Meeting Topics
  - APS load forecast
    - APS is taking the most up to date information and making sure that the base scenario is up to date and accurate.
  - Base case key inputs
    - Some of the topics will include planning reserve margin, resource accreditation for different resource types, transmission costs, carbon tax assumptions, and future resource costs based on the results of the 2022 All-Source RFP.
  - Proposed scenarios and sensitivity for the 2023 IRP.
  - All these iterations of portfolios will ultimately lead APS to find the optimal portfolio that balances reliability, affordability, and APS' Clean Energy Commitment.
- Slide 39 – Discussion & Questions
  - Comment – RPAC Member: When thinking about location specific assessment, consider evaluating plants/areas that are the most highly polluting and have the greatest negative impact on the local community. This would allow the company to have information to address equity.

- Question – RPAC Member: You mentioned resource accreditation, APS is participating in the Western Resource Adequacy Program, which is looking at a region wide accreditation. I don't know if that's ready to be included in this round of IRP, but can you comment on that at all?
- Response – Michael Eugenis: We are interested in the WRAP program; however, it is currently in a non-binding phase, and we don't think it's appropriate to put a stake in the ground for our entire IRP to say that it's going to align with things that may change as that program gets fully defined and moves into a binding phase. We are looking forward to a path in the future on our participation in both the WRAP and potentially any kind of day-ahead market and you should expect to see commentary within the IRP that supports next steps for market participation. Many of those programs are non-binding today, so we won't be including their specific requirements in the 2023 IRP.
- Comment – RPAC Member: It surprises me that your models don't include a lot of gas reliability must run because, in my experience, a lot of times they do. The other thing I've seen models doing is that they pick gas instead of looking at what is the resource need like, do you need capacity? Do you need voltage support? I think that is always something I try to watch in the modeling exercise is how does gas show up? It tends to be the default resource, and now that we have storage and renewables, a lot of those resource needs that only could be provided by gas, can be provided by other options. I just want to make sure that as you do your modeling it changes to reflect the new technologies that we have.
- Response – Michael Eugenis: A lot of the updates that we have been doing over the last couple of years have been done to handle the differences in technologies that have become more prevalent and more viable than in the past. It is more difficult as you get an increasing percentage of penetration of your intermittent resources as well as storage technologies. There are some assumptions that we have made in the past, and models that we have utilized in the past that don't handle those technologies and the treatment of those technologies as well as we would like them to and don't necessarily recognize the unique challenges from an operations perspective as well as the benefits that those technologies bring. A lot of the work that we are doing behind the scenes is to utilize models that do a fair job at evaluating these resources.
- Response – Todd Komaromy: To your earlier comment, we are planning on providing a market update in the December RPAC meeting as we certainly see a lot of interest there. We plan to accommodate those interests during the next session.
- Question – RPAC Member: I was wondering if APS is considering collaborating with the other utilities in regard to the modeling licenses. It seems like the order is fluid enough that it would allow for collaboration amongst all the utilities to share the cost of that, so I don't know if you all are thinking about that, but it might be worth surveying all the RPAC members to see how many people are interested in the licenses and see if that could be a good way to cut costs as well.
- Response – Michael Eugenis: We have reached out to TEP. We have regular discussions with them on IRP related topics. There may be some nuances to how Energy Exemplar, who is the software developer, treats these licenses and we are trying to figure out the specifics around that. If we have the ability to do something like you have mentioned then that is something we are going to explore, but it sounded like there may be some restrictions. Regardless, we want to make sure that the opportunity to use the software package was open to all RPAC members that are interested.

Nick Schlag (E3/Partner) – New Technology Risks

- Slide 41 – Key Reliability Risks as the Region's Electricity Resource Portfolio Transitions
  - There are many risks at hand:
    - Climate Impacts
    - Battery Performance
    - Renewable Variability
    - Fuel Supply
    - Timing
  - Even though the conversation today primarily focuses on batteries specifically, I would like you all to think a little more broadly about the lessons that we can take from battery storage and apply to newer technologies that will experience common issues.
- Slide 42 – Energy Storage is Poised to Play an Increasingly Important Role in Supporting Reliability
  - There was approximately 2GW of battery storage and this was a crucial part of the successful outcome on September 6th, 2022 in California.
  - Storage will continue to be a very important component in providing clean and reliable energy.
- Slide 43 – The Short Operational History of Grid-Scale Battery Storage Has Highlighted Performance Risks
  - Grid planning models have often incorporated idealized treatment of energy storage resources.
  - In the few years that grid-scale battery storage resources have been in operations, newsworthy outages have highlighted several performance vulnerabilities including:
    - Overheating during extreme high temperatures
    - Battery fires resulting in extended plant outages
- Slide 44 – Performance Risks in Early Years of Deployment are a Normal Part of the Emerging Technology Lifecycle
  - When new technologies enter the electricity system it is normal to have low-capacity factors in early years of the resource.
    - Looking at Nuclear as an example, early in its life it showed similar results to where batteries are at now. A lot of these lower capacity factors were due to lack of availability as there were more outages and instances where the units were unavailable due to bumps in the road with the new technology.
- Slide 45 – Utility-Scale Battery Outage Rates in California
  - In California there is approximately 4GW on the system.
  - All of CAISO's data is public for all to reference.
  - The types of outages we can look at are planned outages and forced outages
    - Planned outages are scheduled.
    - Forced outages are important to keep in mind when looking at reliability.
  - Roughly 10% of storage capacity has consistently been offline due to forced outages.
  - During the tightest periods on the grid, planned outages are limited but forced outage rates for storage facilities have approached 15%.
  - Outage rates for energy storage are higher on average than what we have seen for natural gas in the past.
  - Question – RPAC Member: Does the data differentiate by battery chemistry?

- Response – Nick Schlag: This does not differentiate by battery chemistry. Most of the batteries online in California are lithium-ion, below that level of battery chemistry, I don't know the specifics of what subtype they might be, but most of our batteries in California are lithium-ion batteries.

- Slide 46 – What Does this Mean for Planning and Procurement of New Technologies?
  - General lessons for planning for new technologies:
    - Unexpected operational challenges should not necessarily deter continued development, but they should provide important opportunities to learn and improve.
    - Planning for outage rates in the near term between 10-15% is reasonable based on recent history.
    - The new battery storage facilities must be built to withstand stresses of extreme weather and high temperatures.
- Slide 47 – Discussion & Questions
  - Question – RPAC Member: Do the outage figures (5% gas) take into account the magnitude of the outage? When you look at hours and durations, it can change the impact of a particular situation and I am wondering if that is being considered.
  - Response – Nick Schlag: The Texas event continues to weigh heavily on a lot of people's minds in terms of risks that may exist out there. First of all, when we talk about outages both for batteries and the five percent for gas, this is a bit of an oversimplification, but I would think of that as five percent of the total capacity of gas resources might be unavailable at any given time. Sometimes it'll be a little bit more, sometimes it'll be a little bit less, and same is true with energy storage. The reality is that these are the middle of a distribution, but I would think of it as a shorthand for the amount of the capacity that are you missing at one time. The Texas event is certainly unique and interesting. It was very different in its consequences and its causes as it was caused not only by performance issues but also fuel security. Fuel security is also a reliability risk that should be considered in a sound planning effort.
  - Comment – RPAC Member: The outage rate doesn't indicate the temporal component. If you are out for a long time, then that can have much larger consequences than just looking at a certain percentage of a resource technology being offline at any time.
  - Response – Nick Schlag: What I will say is these average figures are high level summaries of what is really a distribution of different types of events. If you use these percentages and you use stochastics in a reliability model that factors in different outage lengths and different outage durations, then those factors end up getting rolled up into this overall average that is being presented.
  - Question – RPAC Member: I am curious if the CAISO data includes root cause for the outage whether planned or forced. For example, was it caused by distribution transformers overheating or another root cause that outage.
  - Response – Nick Schlag: I do not think it goes down to that level of detail. There is one subcategory below the level we've shown you here, but the types of information that you might see in that dataset include descriptions such as "plant trouble" or "plant maintenance". It does not include information on the specific element that failed.
  - Comment – RPAC Member: Texas also suffered from poor understanding of the full system. Turning power off to the gas fields wasn't a good move.
  - Question – RPAC Member: I am curious to get your thoughts on the combination of storage, even with these planned and forced outages, with demand response and how demand response helps deliver some interesting results. Do you have any thoughts on that? I think one of the most surprising days was how much was saved on September 5th.

- Response – Nick Schlag: In some respects your evening demand response programs might fill a similar niche in your portfolio as some of the battery storage resources in the sense that it's a resource that you can call on to reduce load for a set window of time, or contribute to meeting load over a set window of time, but the resource becomes unavailable later in the day because either your call on demand response has ended or your storage has been fully discharged. In some respects, demand response and storage are competing for similar shares at the value pie. With that said, I would maybe bring it back to this topic of resource diversity being really important. In the sense that even though they fill similar roles in terms of contributing to the reliability challenge, the nature of their performance risks is quite a bit different. Demand response is not likely to overheat or cause fires the same way that battery storage might in today's planning world. There is some synergistic value in terms of the risk factors that might lead to better or worse performance on those two things and help support the reliability of the system.
- Response – RPAC Member: I think it would be really interesting to explore this further as we continue to get more information on the September event in California because it seems like a lot of customer sited resources delivered some big savings during that week.
- Response – Nick Schlag: I think you are totally right on that. I said battery storage is unequivocally one of things that was different this year from two years ago and the customer response was also quite a bit larger than a couple years ago.
- Question – RPAC Member: Do we know if the gas outage rate went up during peak hours similar to what is being shown on slide 45 with storage?
- Response – Nick Schlag: We do not have all of the data on hand for the gas resources. The data was specific to the energy storage resources.

Matt Lind (1898 & Co./Director of Resource Planning) – 2022 ASRFP Update

- Slide 48 – Remaining Steps
  - Request and receive Best and Final Offer (BAFO) pricing from respondents
    - Timeline: October
  - Identify shorter list for remaining evaluations and contract negotiations
    - Timeline: September to December
  - Execute contracts with selected near-term proposals
    - Timeline: Q1 of 2023
  - Execute contracts with selected long-term proposals
    - Timeline: Q2 of 2023
- Slide 50 – Discussion & Questions
  - Comment – Matt Lind: There is currently a lot on APS' plate as far as remaining steps to get the contracts in the door and signed. Hopefully any curiosities and questions have been met and answered and there are no outstanding questions. If any questions do come up after the meeting, feel free to reach out to the APS team and those will be addressed. Thank you for the discussion today, we had a lot of good material and great presentations, we appreciate the contributions from everyone. The constructive nature of the discussion was good and hopefully it will continue. We will be taking a break in November but will return for an RPAC meeting in December.

- Comment – Todd Komaromy: I just want to say on behalf of APS, I echo everything Matt said. I really want to thank our presenters and thank E3 for their contributions. I hope you found value in this meeting. I know three hours is a long time, but I really appreciate you all and your involvement in the RPAC, so thank you for giving us that time. The December meeting is planned for the 14th at this same time, 9:00 o'clock in the morning. Thank you all!