APS RPAC Meeting

10/26/2022

MEETING AGENDA

Welcome & Meeting Agenda
Matt Lind
1898 & Co.

Arizona Summer 2022 Reliability Recap
Timothy Rusert
Director, Fuel Procurement and Resource Ops

Climate Change Scenario Analysis
Eric Massey and Steve Rose/Erik Smith
APS Sustainability Group / EPRI

IRP Requirements
Mike Eugenis
Manager, Resource Planning

New Technology Risks
Nick Schlag
E3

2022 ASRFP Updates
Matt Lind
1898 & Co.

Next Steps & Discussion

Meeting Guidelines

- RPAC Member engagement is critical. Clarifying questions are welcome at any time. There will be discussion time allotted to each presentation/agenda item, as well as at the end of each meeting.
- We will keep a parking lot for items to be addressed at later meetings.
- Meeting minutes will be posted to the public website along with pending questions and items needing follow up. We will monitor and address questions in a timely fashion.
- Consistent member attendance encouraged; identify proxy attendee for scheduling conflicts.
- Meetings and content are preliminary in nature, and prepared for RPAC discussion purposes. Litigating attorneys are not expected to participate.

Following Up

- Action Items from previous meetings:

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

September Meeting Recap

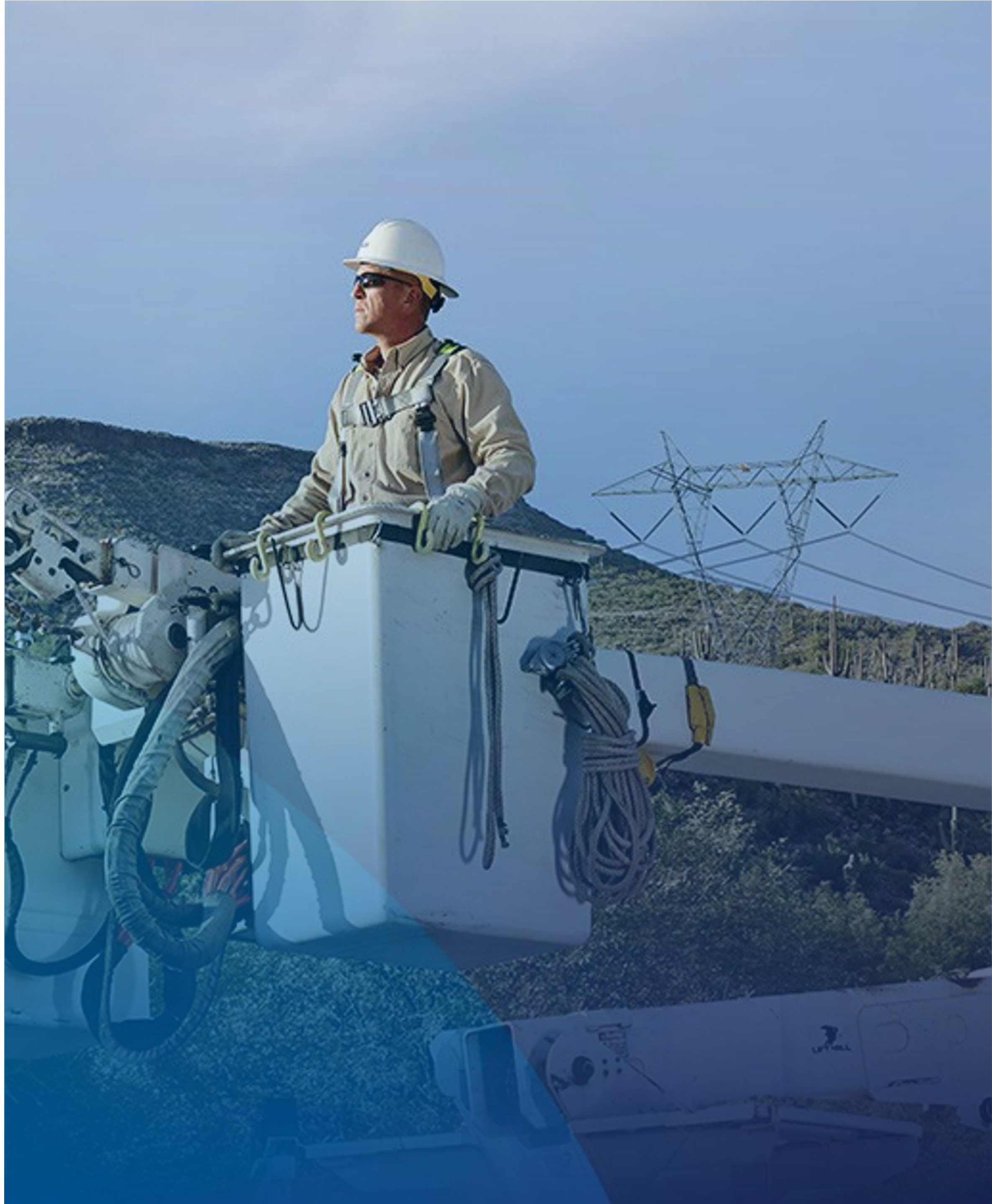
- 2022 All Source RFP update
  - Effective Load Carrying Capability (ELCC)
  - A shortlist has been identified. Actions towards a shorter list are in motion.
- Recent California events
  - Extreme weather results in a close call. Imports from APS played a vital role.
- Load Forecast
  - Load forecast tool will help RPAC members with load assumptions and total energy usage.
- APS will be filing an application with the ACC to update their rate case


Arizona Summer 2022 Reliability
Recap

2022 Summer Reliability Review

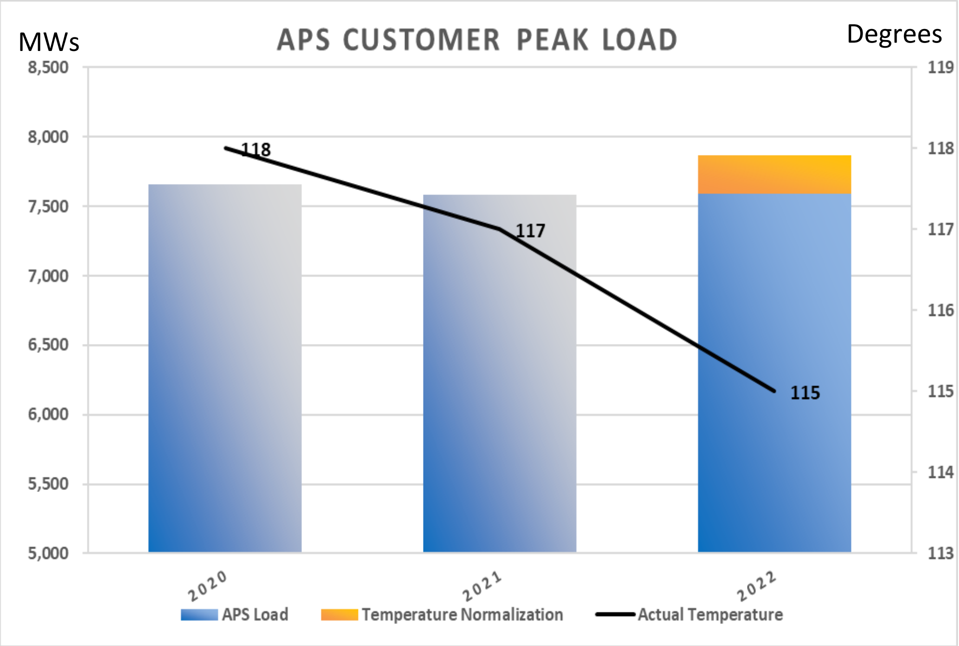
Summer Conditions and Impacts

- Active monsoon season brought 200% of normal rainfall
- 22 days of 110+ degrees vs. 21 normal
- Transmission and distribution replaced 811 poles vs. 290 on average
- Added 110MW New Mexico wind capacity with PPA repowering
- Exceptional thermal generation reliability
  - 95% Summertime EAF



Peak Coverage

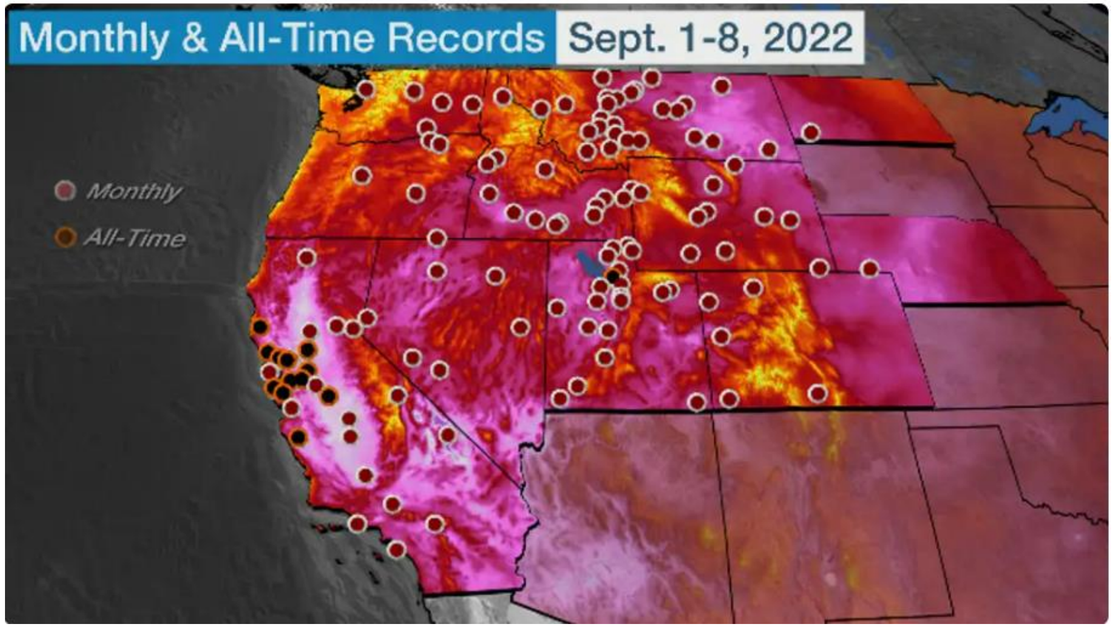
- Peak day – July 11, coincident with peak 2022 temperature (115 degrees)
  - Minimal generation outages
- 2022 peak exceeded 2021 peak while 2 degrees cooler
  - Actual peak load growth exceeding forecast

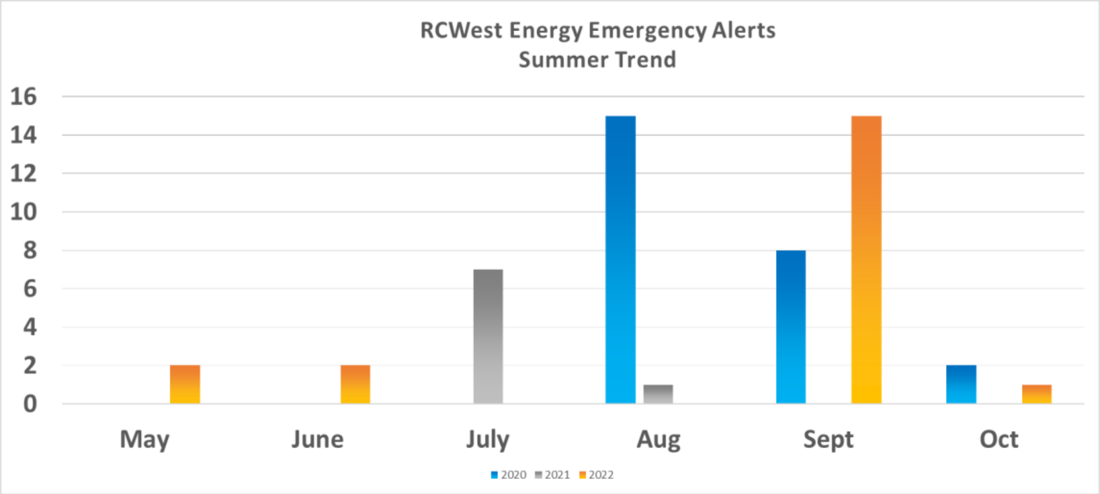


Historic peak load is measured net of EE and DE.

September Regional Heat Wave

- Regional diversity key to avoiding customer outages
- September 2022 had same number of EEA declarations as August 2020
- APS exported substantial energy to assist regional utilities and benefit our customers
- 100% of sales credited to PSA and directly reduce customer costs
- APS energy sales exceeded $74M during this event

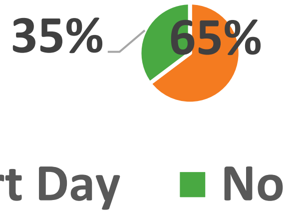




Natural Gas Delivery Challenging

- APS procures natural gas from Permian and San Juan production basins through 2 pipelines
  - Kinder Morgan's El Paso Natural Gas Pipeline (EPNG)
  - Energy Transfer's Transwestern Pipeline
- EPNG capacity reduced ~33% from August 2021 Line 2000 explosion
  - Causing routine scheduled gas cuts
  - Earliest return to service at year end
- Transwestern required maintenance on northern Arizona section
- APS able to consistently procure gas for load coverage while off-system sales were managed to available gas

Transwestern Summer Con Level



2022 Summer Reliability Review

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Discussion & Questions

Climate Change Scenario Analysis

Climate Change Scenario Analysis

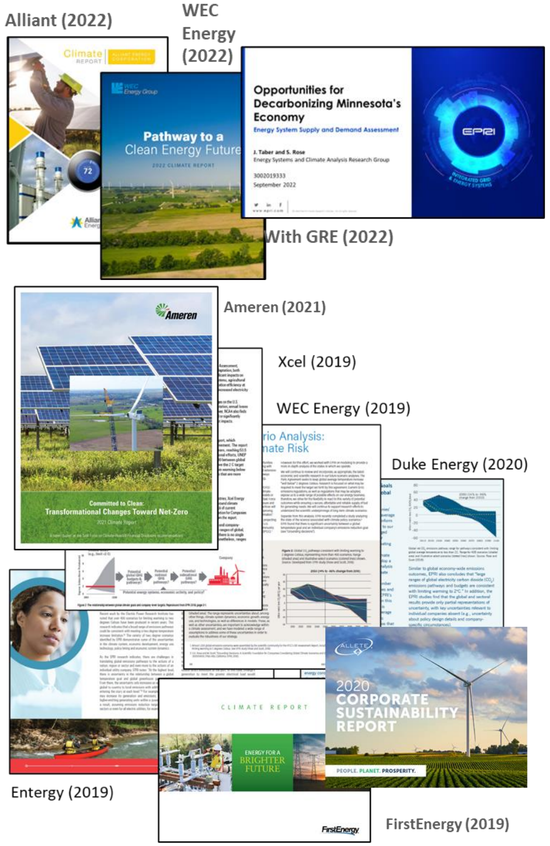
APS Climate Scenarios Project with EPRI

Steven Rose and Erik Smith
Energy Systems and Climate Analysis

APS RPAC
October 26, 2022

About EPRI

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



Securities and Exchange Commission

TCFD TASK FORCE ON CLIMATE-RELATED FINANCIAL DISCLOSURES

MOODY'S

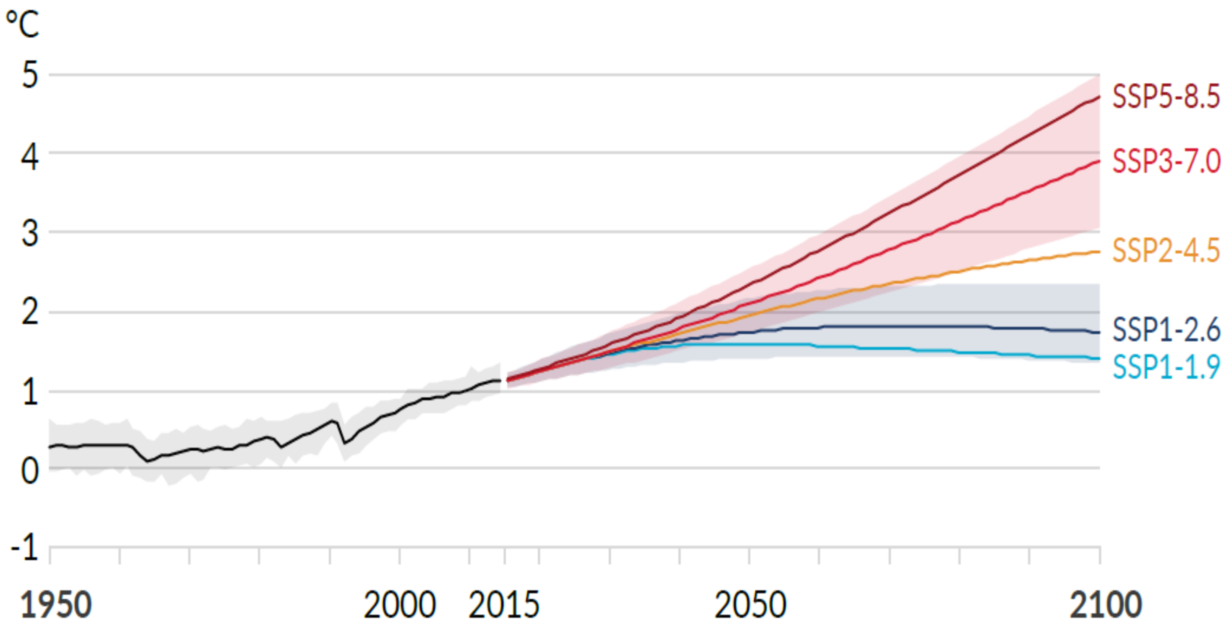
NGFS Central Banks and Supervisors Network for Greening the Financial System

BlackRock.

SCIENCE BASED TARGETS DRIVING AMBITIOUS CORPORATE CLIMATE ACTION

The Climate is Changing – How Much More is Uncertain

Projected global average surface temperature change relative to 1850-1900 (based on multiple lines of evidence, IPCC WG1, 2021)



- Essential to consider different possible future global climates; however, not all are equally plausible.
- From assessing emissions pathways, planning for the possibility of warming greater than 1.5°C and 2°C is prudent (and 4°C and higher unlikely)
  - Rose and Scott (2018, 2020); EPRI (2021) Hausfather & Peters (2020)
- Some level of adaptation inevitable

Climate Change Scenario Analysis: How it Helps

- **Why scenario analysis?**
  - The future is uncertain – planning for one future is risky
  - Scenarios are a way to explore “what ifs” – the implications of different potential conditions. <u>These are not predictions.</u>
  - Scenario analysis valuable for assessing uncertainties, risks, opportunities, and managing risk
- **What is climate change scenario analysis?**
  - Climate change scenario analysis (CCSA) = scenario analysis with climate dimensions
  - This requires considering potential
    - Physical climate changes
    - Low-carbon transition pathways
  - Three categories of uncertainties and potential risks to evaluate:
    - Physical climate conditions – e.g., temperature, drought, lightning, events like low wind & extreme heat
    - Climate policy conditions – e.g., ambition, type, coverage, options
    - Non-policy conditions – e.g., local economy, load, technologies, fuel markets, public perception
- **Valuable to internal and external stakeholders**
  - APS Resource Planning, other internal stakeholders
  - Additional drivers: TCFD, potential SEC disclosure rule, investors, other stakeholders
- **To be meaningful, analysis needs to be customized to reflect local conditions, uncertainties, opportunities**

Climate Change Scenario Analysis: Technical Considerations

- **Having emissions or physical climate change does not imply risk**
  - Risk needs to be explicitly evaluated with proper assessment and metrics
  - Greenhouse Gas (GHG) targets have risks that need to be assessed, managed, communicated
  - Evaluating and communicating risk management strategy robustness and resilience important
- **Company-specific circumstances matter**
  - Each has different contexts, uncertainties, risks, and opportunities
  - Companies will have different cost-effective strategies and pathways
  - There is no one "right" emissions pathway/goal due to uncertainties
  - Company relevant & plausible alternative future climate, climate policy, and non-policy conditions important
  - Global pathways are poor benchmarks or guides for companies

Critical issues for companies

- Uncertainty
- Uniqueness
- Multiple objectives
- Flexibility
- Robust strategies (resilient to different futures)

APS Project

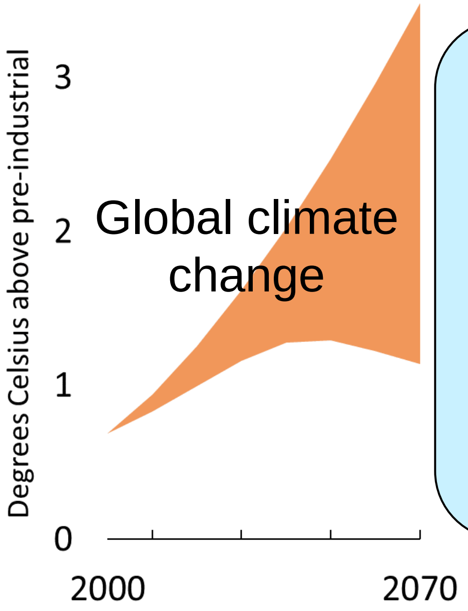
Climate Change Scenario Analysis

Project Overview and Objectives

- Initial Physical Climate Risk Assessment Analytical Foundation
  - Provide an analytical foundation for informed dialogue & additional physical risk analyses aligned with TCFD
    - 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
- 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 their Clean Energy Commitment
  - Provide a scientific basis and grounded insights regarding transition risk in a manner aligned with TCFD
- 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

Full Physical Climate Risk Assessment is a Series of Several Assessments

This requires knowing more than whether the climate is changing – it is a set of assessments that define potential conditions (climates, societies, markets, systems, technologies), risks, and responses



Data Requirements for Risk Assessment Applications?

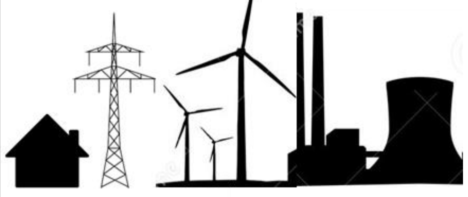
Hazard?
Are local physical conditions changing?

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?

Company & System



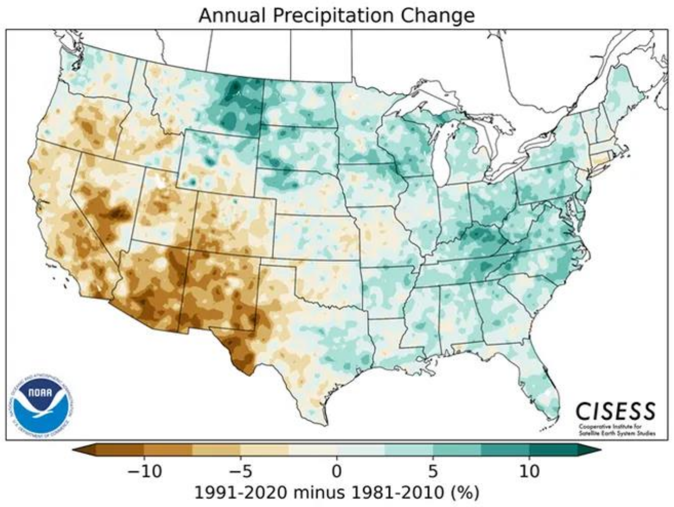
This task develops an initial analytical foundation for education, engagement, and future full physical climate risk assessment

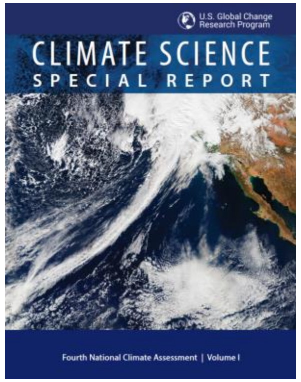
Two Levels of Physical Climate Change Assessment

Regional and Local

Regional Assessment

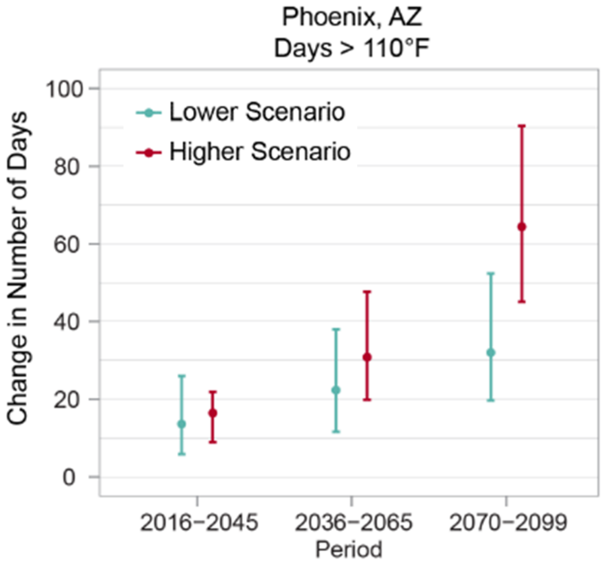
- Assessing information from published studies to characterize regional climate change (historical and projections)
  - Fourth National Climate Assessment – Volumes I and II
  - NOAA National Center for Environmental Information
  - State climate assessments, etc.





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
  - Take into account data availability



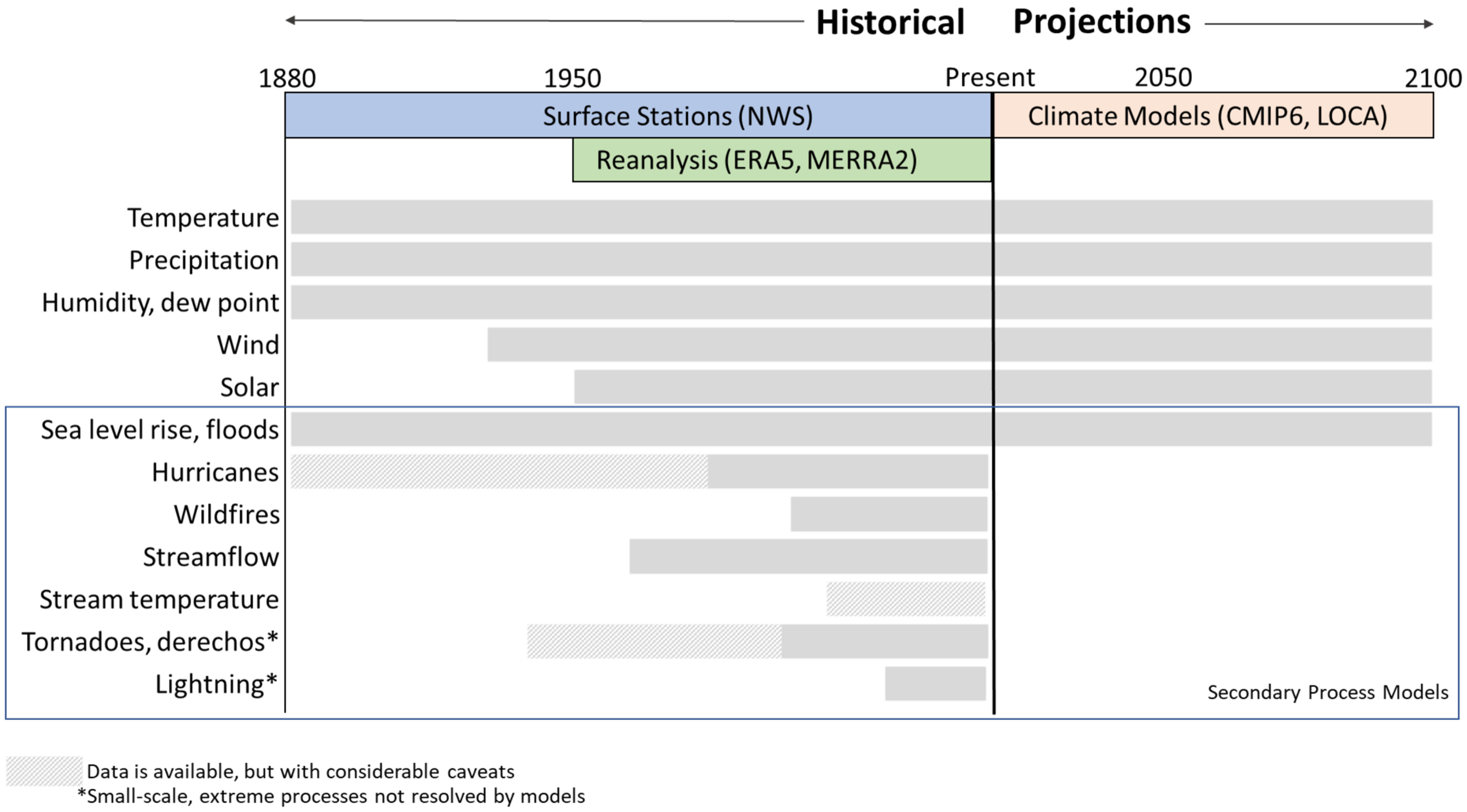
NCA4v2, Chapter 11

Climate Data and Hazards

Physical hazards can consist of a single climate variable or a combination

Increasing complexity

- Extreme heat/cold
- Low wind and/or solar
- Drought
- Lightning
- Streamflow & stream temperature
- Flooding
- Wildfire



Example of Local Climate Change Information
Temperature

Temperature distributions for location X the period of 1950 – 2020 and 2021 – 2060 for a higher climate scenario and historically

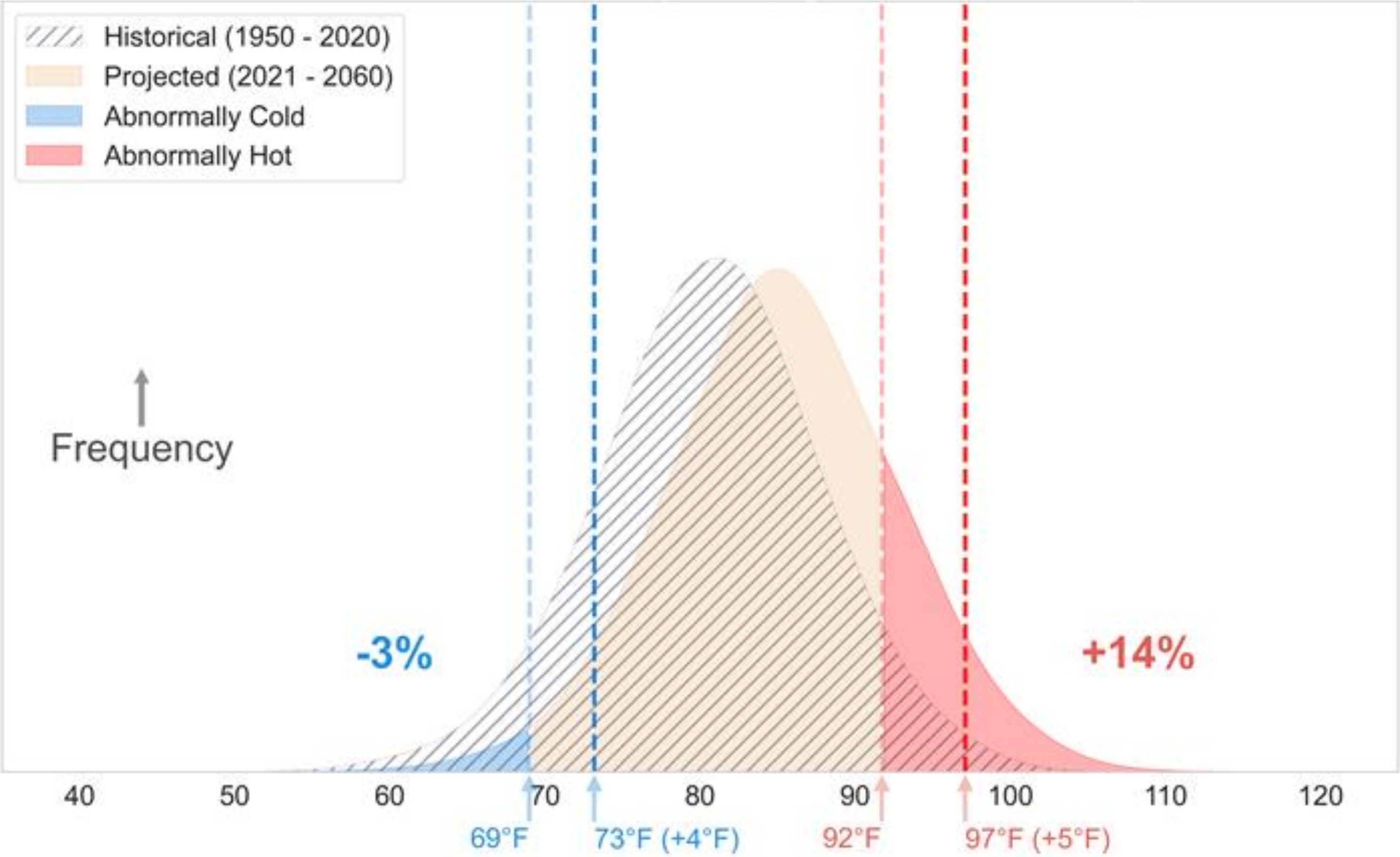


Figure developed by EPRI based on actual data

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
- We look forward to discussing this work with you as it develops

Questions?

RPAC Feedback Request

Eric Massey (APS)

RPAC Feedback Request

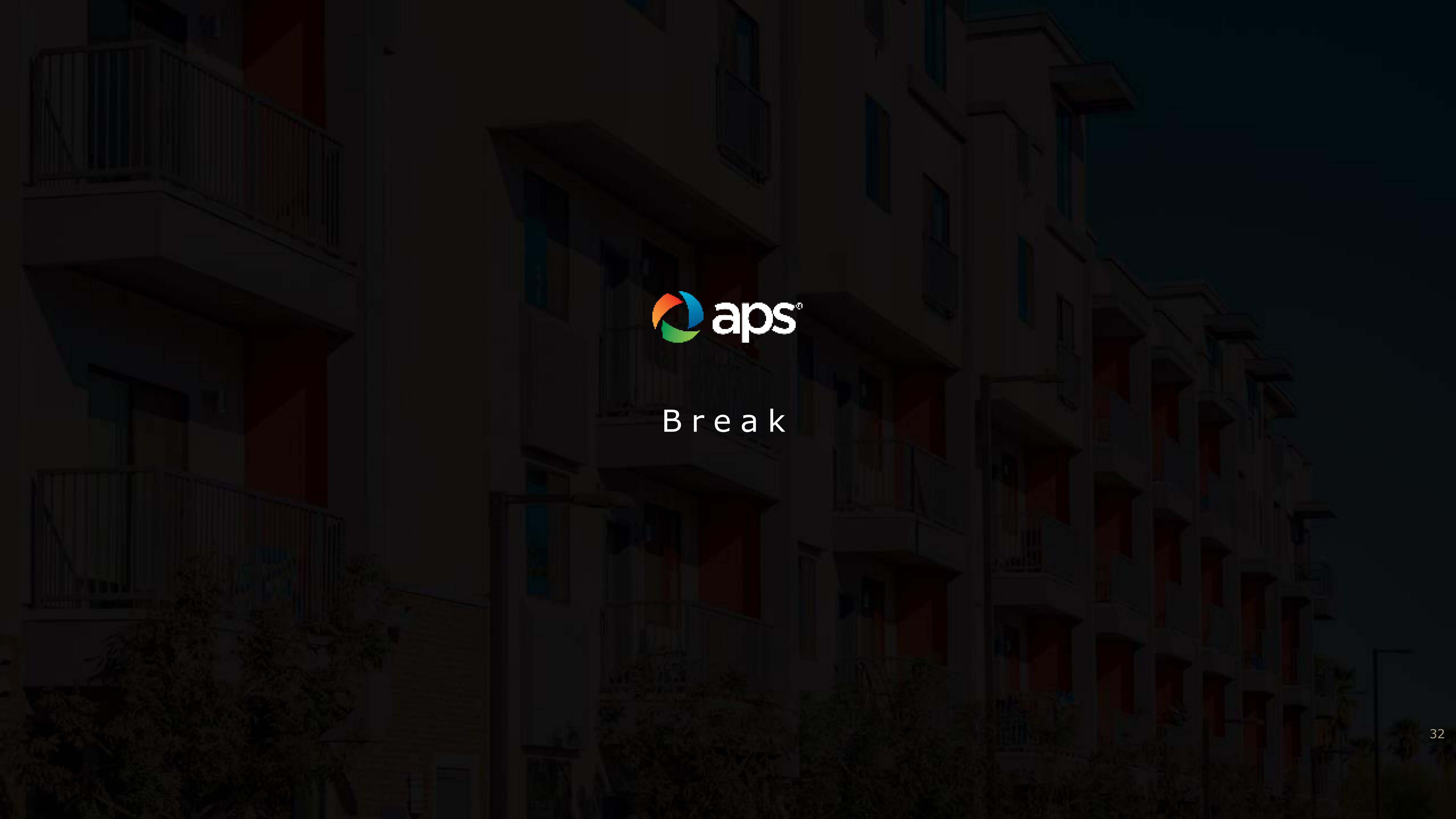
- What do you see as important uncertainties for APS to evaluate for each of the following:
  1. Physical climate condition changes – e.g., with respect to heat, drought, lightning, or events like low wind during extreme heat?
  2. Climate policy conditions – e.g., ambition, type, coverage, options?
  3. Non-policy conditions – e.g., local economy, load, energy supply or demand technologies, markets, public perception?

Together…Shaping the Future of Energy®

Some related EPRI resources

- EPRI, 2022. *Technical Considerations for Climate-Related Risk Disclosure Rules*. EPRI, Palo Alto, CA: 2022. #3002024244.
- EPRI, 2022. *EPRI Public Comments on the SEC's Proposed Climate Risk Disclosure Rule: The Enhancement and Standardization of Climate-Related Disclosures for Investors*. EPRI, Palo Alto, CA: 2022. #3002025101.
- EPRI, 2020. *EPRI Comments on Moody's "Proposed framework to assess carbon transition risks for electric power companies."* EPRI, Palo Alto, CA. #3002020282.
- Rose, S and M Scott, 2020. *Review of 1.5˚C and Other Newer Global Emissions Scenarios: Insights for Company and Financial Climate Low-Carbon Transition Risk Assessment and Greenhouse Gas Goal Setting*. EPRI, Palo Alto, CA: 2020. #3002018053.
- Rose, S and M Scott, 2018. *Grounding Decisions: A Scientific Foundation for Companies Considering Global Climate Scenarios and Greenhouse Gas Goals*. EPRI, Palo Alto, CA: 2018. #3002014510.
- Rose, S and M Scott, 2018b. *A Technical Foundation for Company Climate Scenarios and Emissions Goals*. EPRI, Palo Alto, CA: 2018. #3002014515.
- Scott, M., S. Rose, 2021. *Climate Disclosure and Voluntary Reporting Trends: 2020 Activity Survey Results*. EPRI, Palo Alto, CA: 2021. #3002021876.
- Scott, M and S Rose, 2020. *Climate Disclosure and Voluntary Reporting Trends: 2019 Survey Results*. EPRI, Palo Alto, CA, forthcoming. #3002018052.
- Scott, M and S Rose, 2019. *Climate Disclosure and Voluntary Reporting Trends: 2018 Survey Results*. EPRI, Palo Alto, CA: 2019. #3002016948.
- Taber, J and S Rose, 2022. *Opportunities for Decarbonizing Minnesota's Economy: Energy System Supply and Demand Assessment*. EPRI, Palo Alto, CA: 2022. #3002019333.

Discussion & Questions



Break

IRP Requirements

IRP Requirements

Commission Decision No. 78499

Considerations Informing the 2023 IRP

Commission Decision No. 78499

Portfolio Requirements		
1	**Technology agnostic**	Least-cost method without regard for emissions reduction goal or renewable energy standards.
2	**Coal**	No restrictions on the economic cycling and economic retirement.
3		Eliminate coal units must-run designations.
4	**Energy efficiency**	No limit on the amount of energy efficiency.
5		Achieve an annual minimum of 1.5 percent energy savings
6	**DSM**	Demand-side resource capacity equal to at least 35 percent of 2020 peak demand.
Minimum 10 resource portfolios that are designed to achieve the emissions reductions goals specified in the 2020 IRP		

Considerations Informing the 2023 IRP

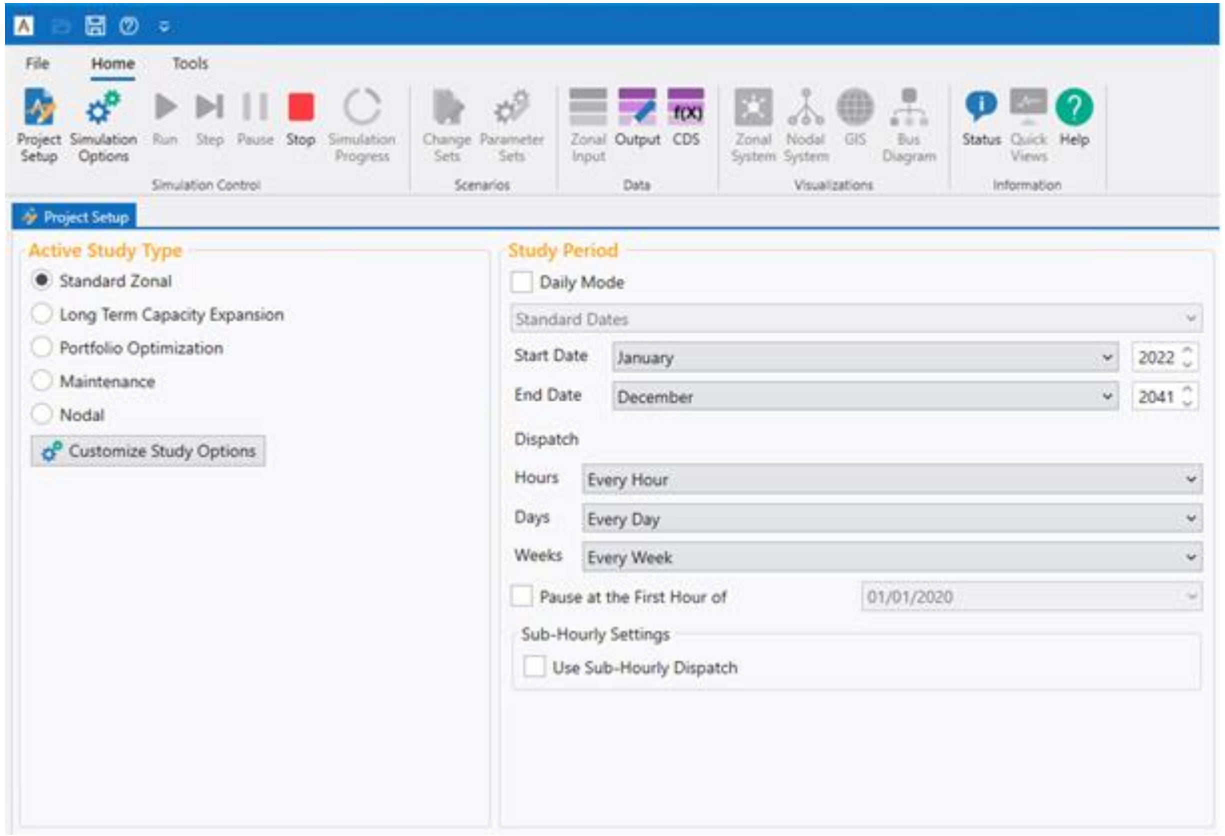
Commission Decision No. 78499

Analysis Requirements		
Power system resiliency	• Extreme weather, correlated risks to both the power and gas systems	
Natural gas price assumptions	▪ Impact on short- and long-term resource procurement decisions.	▪ Implications of declining natural gas usage to achieve emissions reductions.
Regional markets	▪ Effects of participation on near- and long-term resource procurement actions.	
Retirement analyses	▪ Estimated retirement dates.	▪ Economic impact to ratepayers
Grid-connected resources	▪ Value of distribution grid-connected resources as compared to transmission-connected.	
Emissions reduction commitment	▪ Costs and benefits of emissions reduction commitments.	
Resource adequacy	▪ Increasing variability on the bulk electric system.	
Hydrogen	▪ Sources, costs and any associated capital expenditures.	

APS Resource Planning Model

APS will provide

- Licensing to the model
- Training materials
- Dedicated technical workshop



Limited number of licenses available.

Access to modeling software includes proprietary, non-public information. Those who volunteer are required to sign an NDA and will not be permitted to share the information with others.

December Meeting Topics

- APS Load Forecast
- Objective and Metrics
- Base Case key Inputs
- Proposed Scenarios & Sensitivities

Discussion & Questions

New Technology Risks

Key reliability risks as the region's electricity resource portfolio transitions

Today's conversation focuses on risks associated with new technologies

Climate Impacts

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

Battery Performance

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

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

Renewable Variability

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

Fuel Supply

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

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

Timing

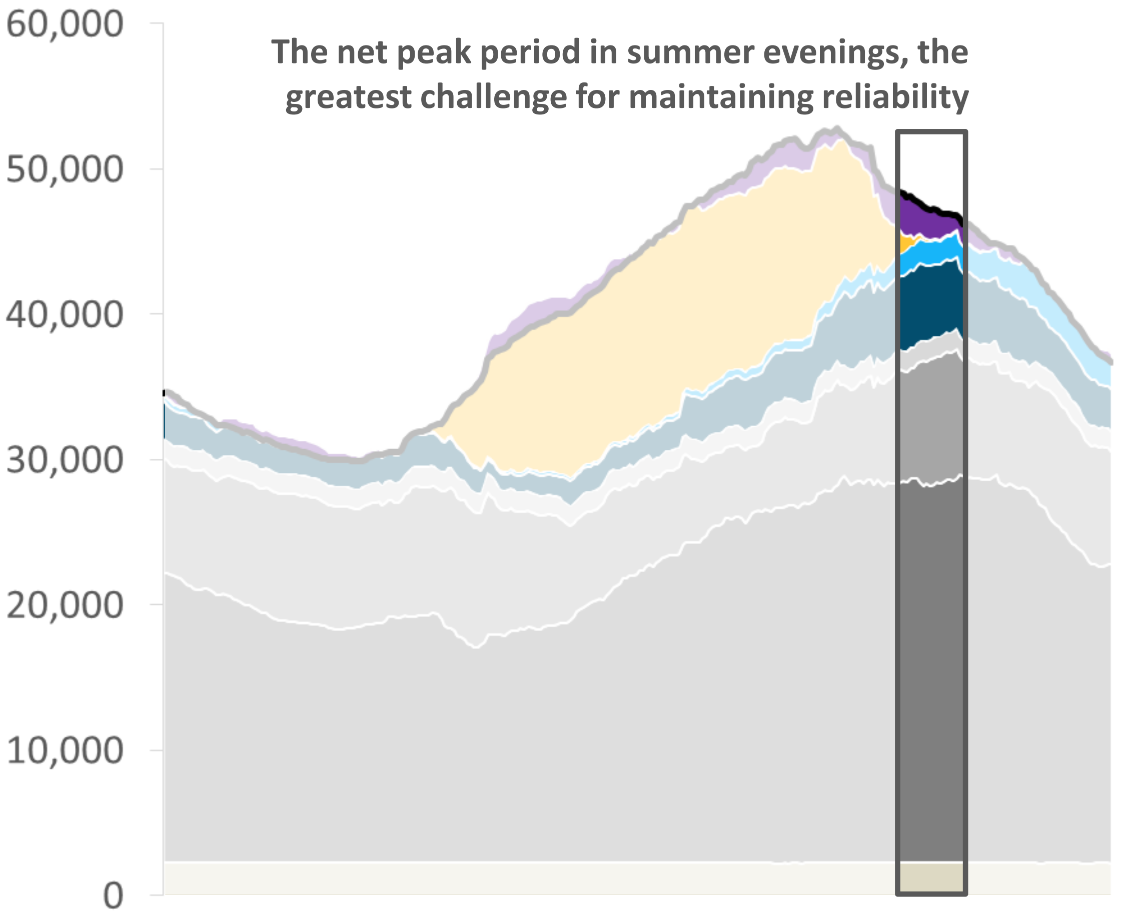
Processes for new resource development typically span multiple years

Project delays or cancellations could result in temporary resource shortfalls

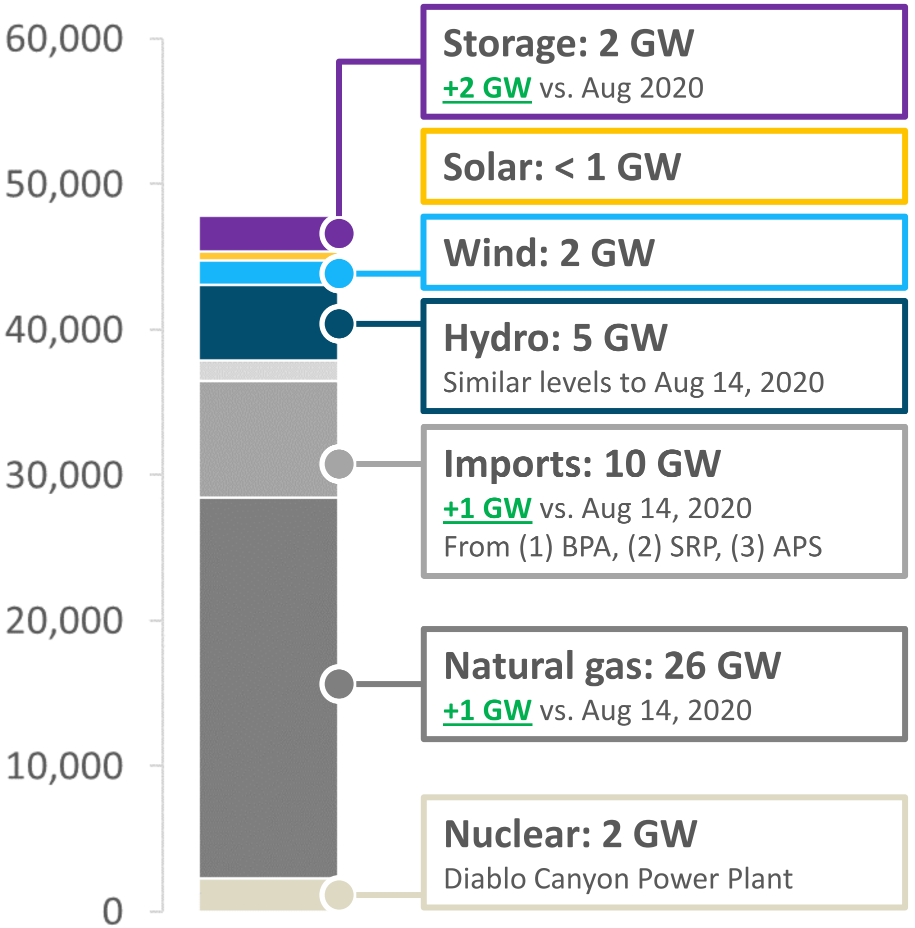
Graphic adapted from E3's Resource Adequacy in the Desert Southwest

Energy storage is poised to play an increasingly important role in supporting reliability

CAISO System Operations on September 6, 2022
(MW)



Generation During Hour of Highest Net Load (7pm)
(MW)



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**
  - Limited outage risks
  - Optimal dispatch during critical periods
- **In the few years that grid-scale battery storage resources have been in operations, newsworthy outages have highlighted several performance vulnerabilities:**
  - Overheating during extreme high temperatures
  - Fires resulting in extended plant outages
- **Planners must consider:**
  - To what extent are these events isolated incidents or part of a pattern of risk?
  - How should that risk be incorporated into future portfolio planning decisions?

DIVE BRIEF

Vistra's 1.2 GWh Moss Landing storage facility remains offline after overheating incident

Published Sept. 7, 2021

Home › Energy Storage › Batteries › Fire reported at PG&E's Elkhorn battery storage facility

Energy Storage | Batteries | News

Fire reported at PG&E's Elkhorn battery storage facility

By Kevin Clark - 9.20.2022

ENERGY

Fire crews tend to massive, smoldering battery in Chandler facility

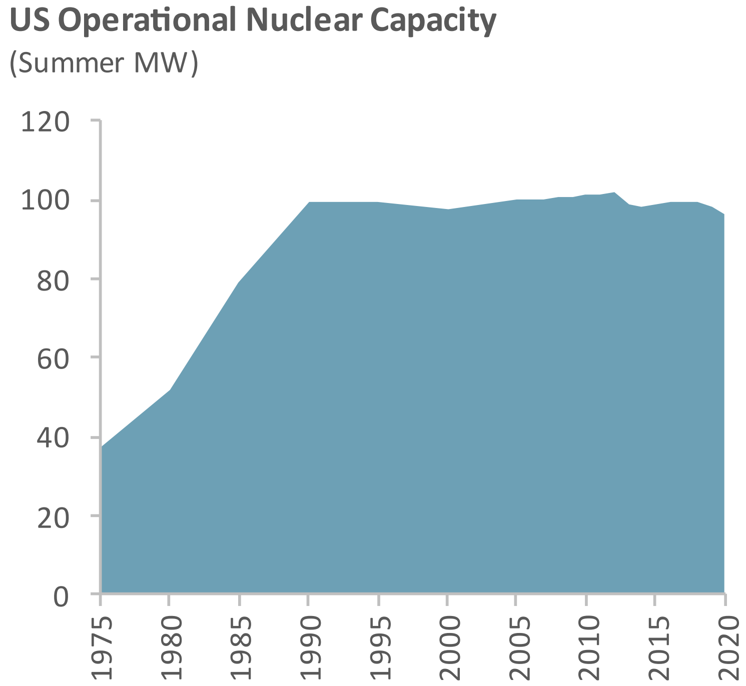
Ryan Randazzo and Perry Vandell Arizona Republic

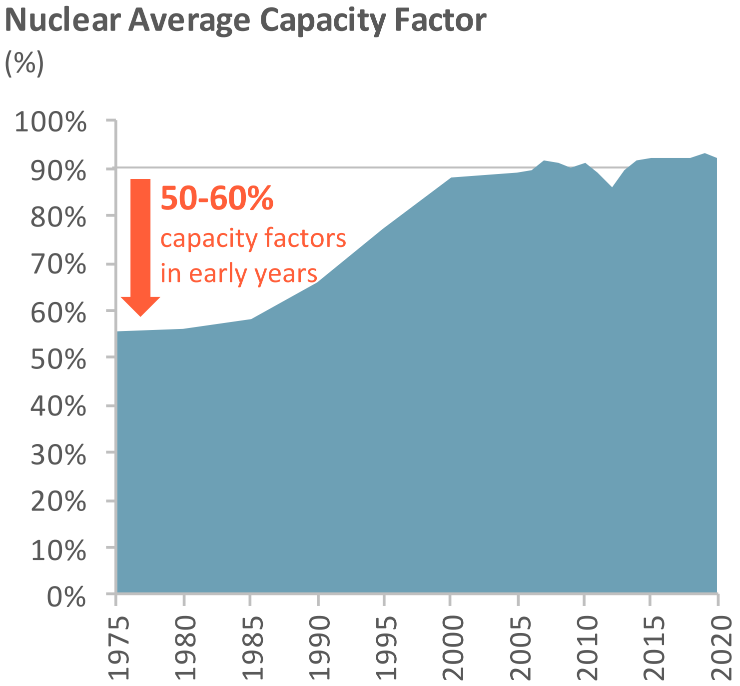
Published 8:45 p.m. MT April 21, 2022

Arizona fire highlights challenges for energy storage

By JONATHAN J. COOPER June 23, 2019

Performance risks in early years of deployment are a normal part of the emerging technology lifecycle





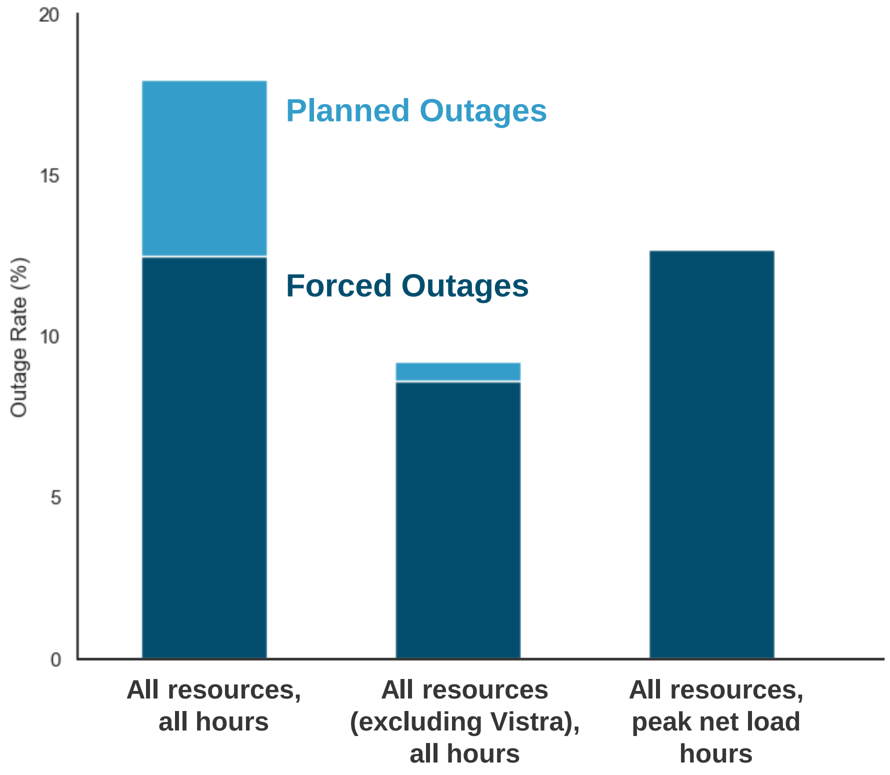
Low capacity factors in early years of nuclear deployment in the US have been linked to planned outages and regulatory inspections (54%) and forced outages (43%)

Source: *Komanoff, Charles. Power Plant Performance: Nuclear and Coal Capacity Factors and Economics. New York and San Francisco: Council on Economic Priorities. 1976.*

Utility-scale battery outage rates in California

- **Over the past year, installed capacity of energy storage on CAISO system has increased from approximately 2 to 4 GW**
  - Daily outage reports published by CAISO provide insight into how often those resources have been available to serve loads
- **Outage data from Oct 1, 2021 - Sept 30, 2022 analyzed under three filters:**
  - **All resources, all hours:** how has the entire CAISO storage fleet performed over the past year?
  - **All resources (excluding Vistra), all hours:** to what extent does the large extended outage at the Vistra facility affect the numbers?
  - **All resources, peak net load hours:** how well have storage resources performed during the most critical periods for reliability?
- **Preliminary takeaways from the data:**
  - Operational data set is still small enough that outliers can significantly skew results
  - Roughly 10% of storage capacity has consistently been offline due to forced outages (excluding Vistra from sample)
  - During the tightest periods on the grid, planned outages are limited, but forced outage rates for storage facilities have approached 15%

Planned and Forced Outage Rates Observed Among CAISO Energy Storage Resources
Oct 1, 2021 – Sept 30, 2022

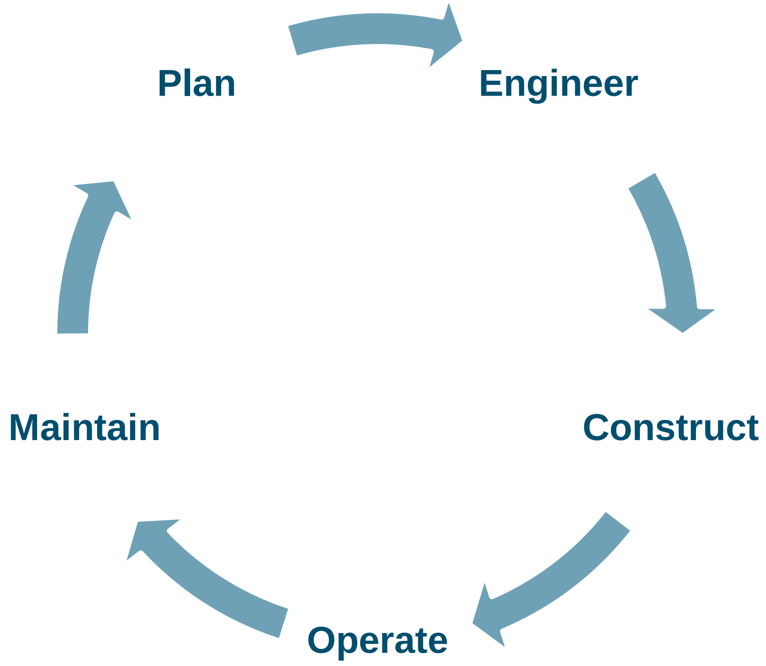


Notes:
Data analyzed based on one-year period from October 1, 2021 to September 30, 2022
"Peak net load hours" defined as the highest four hours of net load on the five days with highest net loads (all occurred in early Sept 2022)

What does this mean for planning and procurement of new technologies?

General lessons for planning for new technologies:

+ For new technologies without a proven history of operations at grid scale, using conservative performance assumptions for reliability planning is justified by historical experience
+ Unexpected operational challenges should not necessarily deter continued development, but provide important opportunities to learn and improve
+ Portfolio diversity can mitigate risks associated with any single new technology



Specific lessons for battery storage

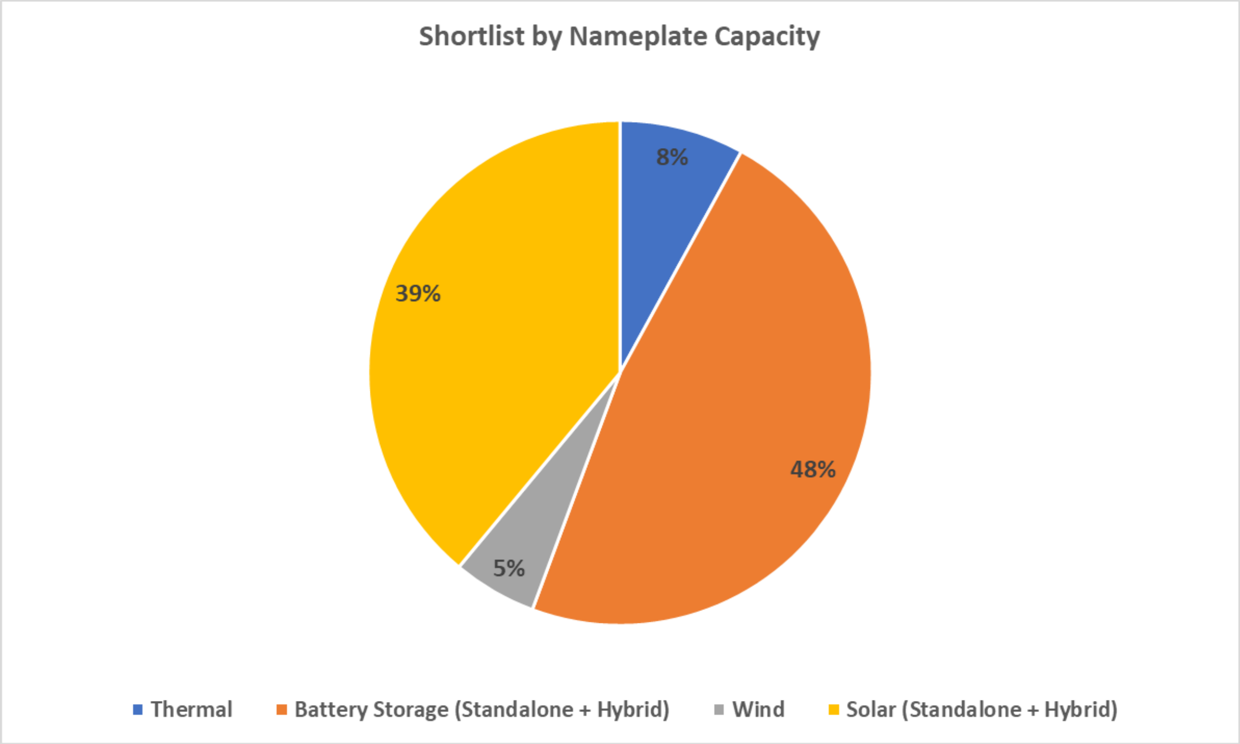
+ Planning for outage rates in the near term between 10-15% is reasonable based on operational history, but improvements are likely over time and should be considered
+ To maximize reliability value, plants must be designed and constructed to withstand stresses of extreme high temperatures

Discussion & Questions

2022 ASRFP Update

Remaining Steps

	Completion Target
• Request and receive 'Best and Final Offer' pricing from Respondents	October
• Identify shorter list for remaining evaluations and contract negotiations	Sept – Dec
• Execute contracts with selected near-term Proposals	Q1 2023
• Execute contracts with selected long-term Proposals	Q2 2023



Discussion & Questions