APS RPAC Meeting

01/18/2023

MEETING AGENDA

Welcome & Meeting Agenda
Matt Lind
1898 & Co.

2023 RPAC Welcome
Ted Geisler
President, Arizona Public Service

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

Load Forecast Update
Ross Mohr
Manager, Energy & Revenue Forecasting

2023 IRP Update
Mike Eugenis
Manager, Resource Planning

Next Steps & Open Discussion
Matt Lind
1898 & Co.

Meeting Guidelines

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

Following Up

- Action Items from previous meetings:

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

December Meeting Recap

- In November, the 2022 DSM Plan was approved and the 2023 DSM Plan and 2023 Transportation Electrification plans were filed with the ACC.
- APS highlighted ongoing developments with Western Markets and its importance for maintaining reliability, integrating clean energy, and increasing customer cost savings.
- E3 elaborated on the timeline of new resource additions and potential factors that can delay power projects.
- APS detailed its 2023 IRP framework and proposed scenarios, sensitivities, and assumptions that it will consider during the modeling process.
- APS shared an overview of gas markets and how fuel prices are forecasted.

2023 RPAC Welcome

CLEAN **ENERGY COMMITMENT**

- 100% clean, carbon-free energy to customers by 2050.
- 2030 target; 65% clean energy using 45% renewables.
- 2031 retire coal-fired generation.

Ted Geisler
President

aps

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Discussion & Questions

Climate Change Scenario Analysis

Climate Change Scenario Analysis

Update and Draft Climate Change Results from APS' Climate Scenarios Project with EPRI

Steven Rose and Erik Smith
Energy Systems and Climate Analysis

APS RPAC
January 18, 2023

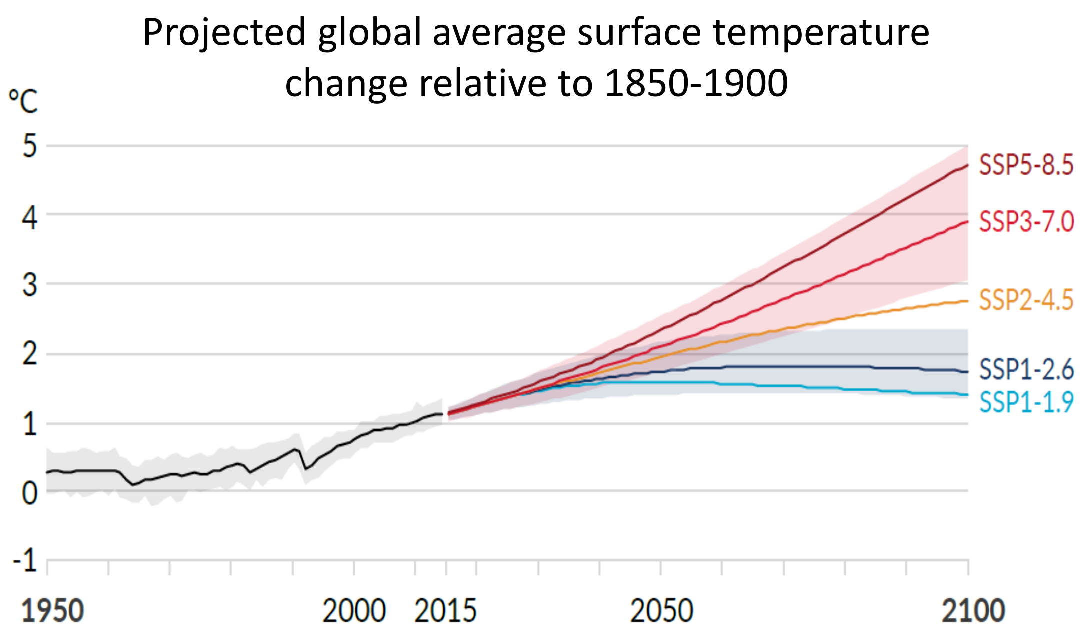
Background

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

This project

- APS initiated this project with EPRI to explore climate and energy system transitions to inform their climate risk management thinking
  1. **Initial Physical Climate Risk Assessment Analytical Foundation (draft results and insights today)**
  2. **Arizona Low-carbon Transition Risk Analysis (launching)**
  3. **Low-Carbon Transition Strategy & GHG Goals Contextualization (launching)**



IPCC WGI (2021)

Critical issues for companies
- Uncertainty
- Uniqueness
- Multiple objectives
- Flexibility
- Robust strategies (resilient to different futures)

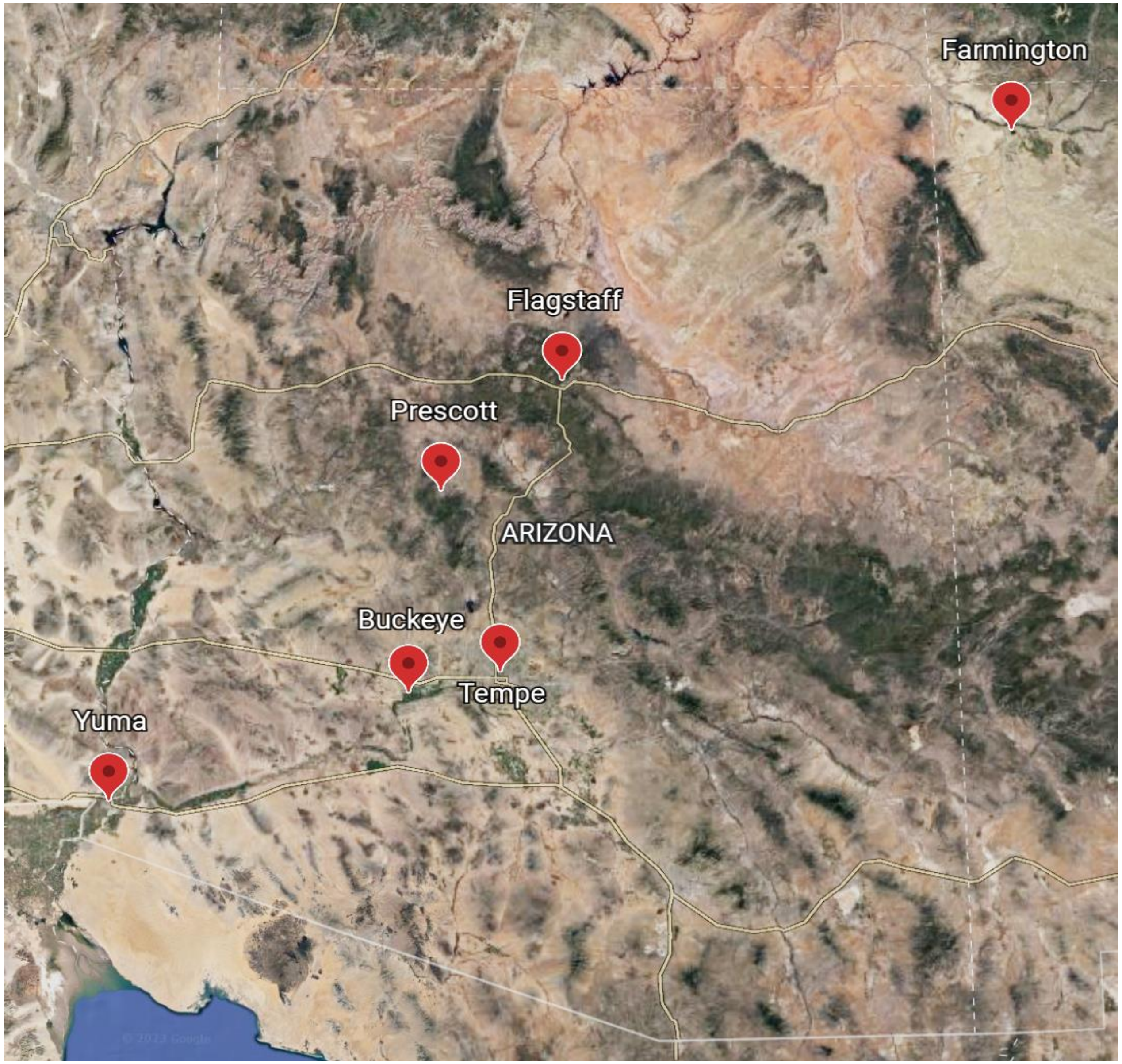
Rose and Scott (2020, 2018)

RPAC’s initial feedback

- Overall, positive RPAC response to APS climate scenario project
- We incorporated specific RPAC feedback
  - Developing capacity building and educational resources
  - Analyzing changes for specific climate variables and metrics of interest, such as related to heat, drought, flooding, and other extremes
  - Evaluating climate change regionally and for multiple individual locations
  - Integrating transition uncertainty and risk analysis suggestions

Assessing physical climate change for the region and select locations

- EPRI worked with APS to identify **six** specific locations for detailed climate change assessment
- Developed dozens of variables and metrics for the region and the six specific locations



Physical climate change – illustration of high-level insights

Draft key insights

- Warming projected in all temperature metrics
  - More extreme heat days
  - Longer and hotter summers – more heat during planned maintenance season
- Extreme cold projected to decrease in frequency and intensity
- Water stress projected to increase across Arizona
- Wind speeds have decreased across the Phoenix metro area, but little change elsewhere
- Projected changes in wind speeds are uncertain

Results sample (additional variables and metrics included in the analysis)

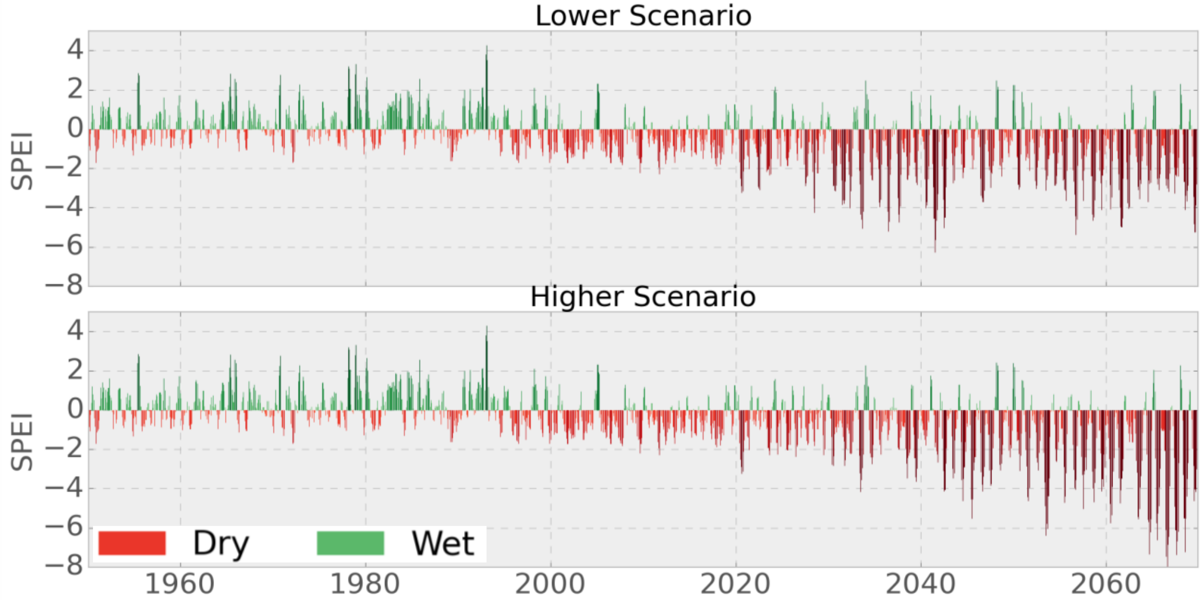
Climate Variable Category	Metric	Projected Change			Confidence In Change
		Tempe	Flagstaff	Regional	
Temperature	Annual Max	↑	↑	↑	High
	Annual Mean	↑	↑	↑	High
	Annual Min	↑	↑	↑	High
Extreme Heat	95th Percentile	↑	↑	↑	High
	Days >= Historical 95th Percentile	↑	↑	↑	High
Extreme Cold	5th Percentile	↓	↓	↓	High
	Days <= Historical 5th Percentile	↓	↓	↓	High
Annual Precipitation	Annual Total - Max	→	→	→	Medium
	Annual Total - Mean	→	→	↓	Medium
	Annual Total - Min	→	→	↓	Medium
Extreme Precipitation, Single-day	100-yr return period	UI	↑	UI	Low
	1,000-yr return period	UI	↑	UI	Low
Annual Snowfall	Annual Total - Max	→	→	→	Medium
	Annual Total - Mean	→	↓	↓	Medium
	Annual Total - Min	→	↓	↓	Medium
Drought	SPEI Index	↑	↑	↑	High
Wind	High Wind Events	UI	UI	UI	Low
	Low Wind Days	↑	→	→	Medium

↑ projected increase, ↓ projected decrease, → no change projected, **UI** = understanding insufficient

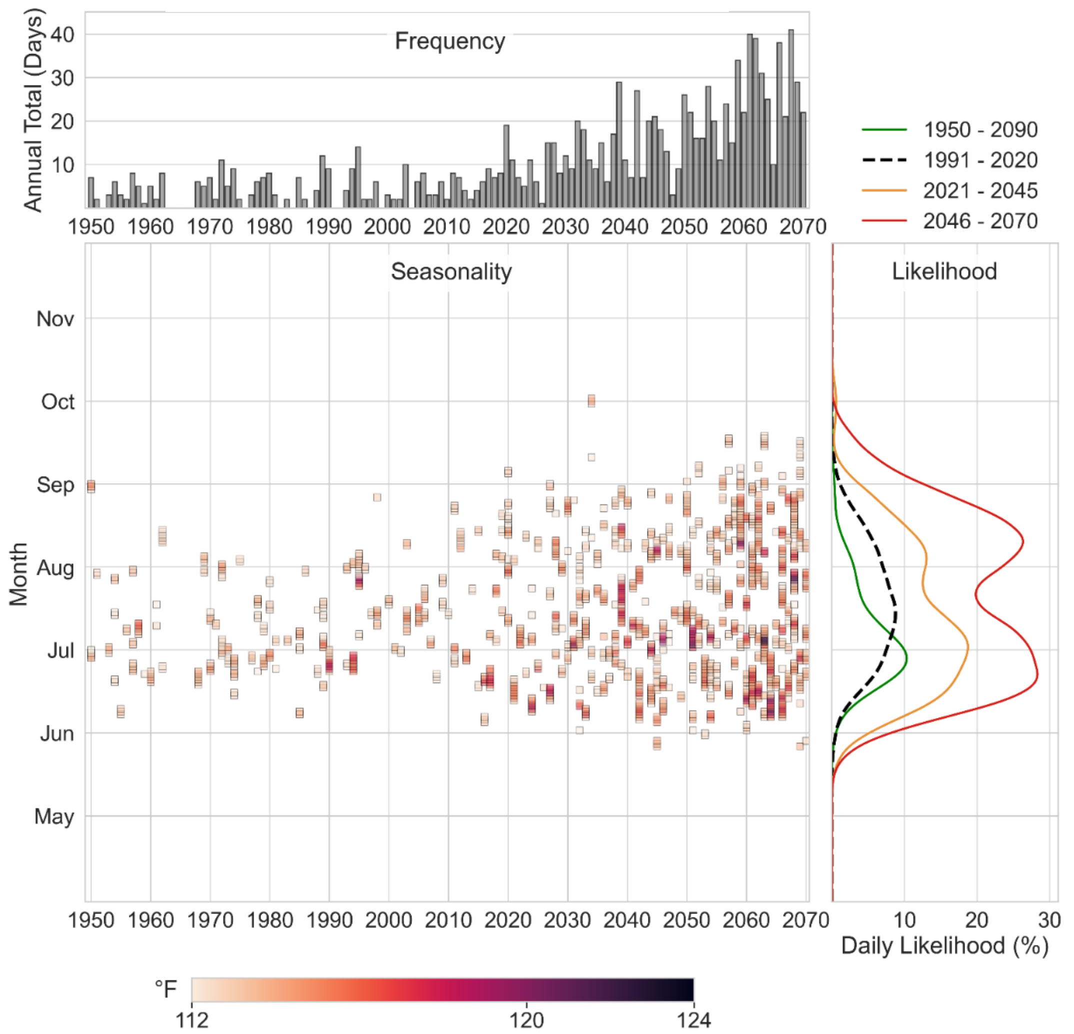
Sample quantitative results: physical climate change

- Extreme heat could become four times more frequent by 2070 and occur earlier and later in the year
- Drought projected to increase in frequency significantly through 2070

Drought (Tempe, AZ)



Extreme Heat (Tempe, AZ)



Other extreme heat thresholds also included in analysis (110F & 115F)

Potential types of impacts and responses

- **System Elements Assessed**
  - Generation
    - Thermal (common impacts)
    - Coal, natural gas (specific impacts)
    - Solar
    - Wind
  - Battery storage
  - Transmission & distribution
    - Lines / conductors
    - Poles & towers
    - Transformers and substations
  - Demand
  - Human health

- **Process**
  - For each system element identify:
    - Relevant climate variables
    - Potential types of impacts (positive or negative)
    - Potential types of adaptation responses
  - Includes identification of potential types of climate change impacts and potential management responses for consideration in a future detailed assessment

Illustrative example: thermal generation

Climate Variable	Potential Impact	Potential Response	Specific Potential Adaptation Response
Thermal generation (common impacts)			
Extreme heat	Reduced efficiency of cooling systems Reduced generation capacity and increased heat rate Changed requirements for plant flexibility and operations due to shifting load profile	Efficiency measures	Improve heat transfer of system components (for example, increase airflow rates, inlet air cooling, improve air distribution through components, apply coatings) Optimize operation of cooling system components Optimize turbine flexibility and asset management and improve flexibility
Extreme precipitation & flooding	Inland flooding—physical damage to power plant infrastructure	Proactive management	Incorporate projections of flood events from climate models into existing processes Management/development of wetlands for flood attenuation Increase inspection of berms, sumps, and drains for flooding and proper lightning grounding for electrical components
		Hardening	Construct or heighten physical barriers to prevent inundation at plants Elevate of backup generators, pumps, and other critical components Secure tanks and other flood-prone equipment to ground
		Communication	Implement water level monitoring systems

Mapping climate variables to system elements

	Average air temp.	Extreme heat	Extreme cold	Air humidity	Average precip.	Extreme precip.	Floods	Surface water temp.	Stream flow	Drought	Average wind speed	Severe wind storms	Severe ice storms	Wildfires	Sea level rise
Thermal power	X	X	X	X		X	X	X	X	X	X	X		X	X
Wind power		X	X								X	X	X	X	
Solar power	X	X				X	X					X		X	X
Hydro power	X	X			X	X	X		X	X		X		X	
Battery storage	X	X	X	X		X	X					X		X	X
Electrolysis		X	X			X	X	X	X	X		X		X	X
Electricity demand	X	X	X	X											
Transmission Towers and Lines	X	X									X	X	X	X	
Transmission Substations		X					X					X	X	X	X
Distribution Substations		X				X	X					X	X	X	X
Distribution Poles & conductors		X		X	X	X	X					X	X	X	X
Distribution Transformers		X		X	X	X	X					X	X	X	X
System Planning & Operation	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

Source: EPRI (2022)

Draft high-level insights: potential types of impacts and responses

- Climate change can impact many system elements of APS's business
- Some climate variables can impact multiple elements simultaneously (extreme heat & severe storms affect nearly all)
- Some system elements could be affected by multiple climate variables simultaneously
- Potential adaptation responses are specific to each combination of climate variable & system element
- Analysis of system element types of impacts and adaptations informs system level assessment
  - Integrated system-level analyses needed to identify additional potential vulnerabilities and adaptation strategies

	Average air temp.	Extreme heat	Extreme cold	Air humidity	Average precip.	Extreme precip.	Floods	Surface water temp.	Stream flow	Drought	Average wind speed	Severe wind storms	Severe ice storms	Wildfires	Sea level rise
Thermal power	x	x	x	x		x	x	x	x	x	x	x		x	x
Wind power		x	x								x	x	x	x	
Solar power	x	x				x	x					x		x	x
Hydro power	x	x			x	x	x		x	x		x		x	
Battery storage	x	x	x	x		x	x					x		x	x
Electrolysis		x	x			x	x	x	x	x		x		x	x
Electricity demand	x	x	x	x											
Transmission Towers and Lines	x	x									x	x	x	x	
Transmission Substations		x					x					x	x	x	x
Distribution Substations		x				x	x					x	x	x	x
Distribution Poles & conductors		x		x	x	x	x					x	x	x	x
Distribution Transformers		x		x	x	x	x					x	x	x	x
System Planning & Operation	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x

EPRI (2022)

Next steps

- **Finalize Initial Physical Climate Risk Assessment Analytical Foundation**
  - Provides an analytical foundation for informed dialogue and additional physical risk analyses aligned with TCFD
    - Provides a physical climate risk assessment conceptual framework
    - Analyzes past, present, and future potential physical climate change
    - Identifies types of potential impacts and responses to climate change to assess
- **Launch Arizona Low-Carbon Transition Risk Analyses**
  - Develop customized, plausible scenarios to evaluate energy system transition uncertainties and risks for APS
  - Identify key risks, signposts and tradeoffs for APS as it continues progress towards its Clean Energy Commitment
  - Provide a scientific basis and grounded insights regarding transition risk in a manner aligned with TCFD
- **Launch Low-Carbon Transition Strategy & GHG Goals Contextualization**
  - Evaluate APS' GHG targets and transition scenarios relative to international climate goals
  - Educate on the relationship between global pathways and companies, including limitations of global pathways as guides for company targets

RPAC Feedback Request

Eric Massey (APS)

RPAC feedback request

- Reactions and feedback on approach, draft insights, etc?

- Anything overlooked?

Together…Shaping the Future of Energy®

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

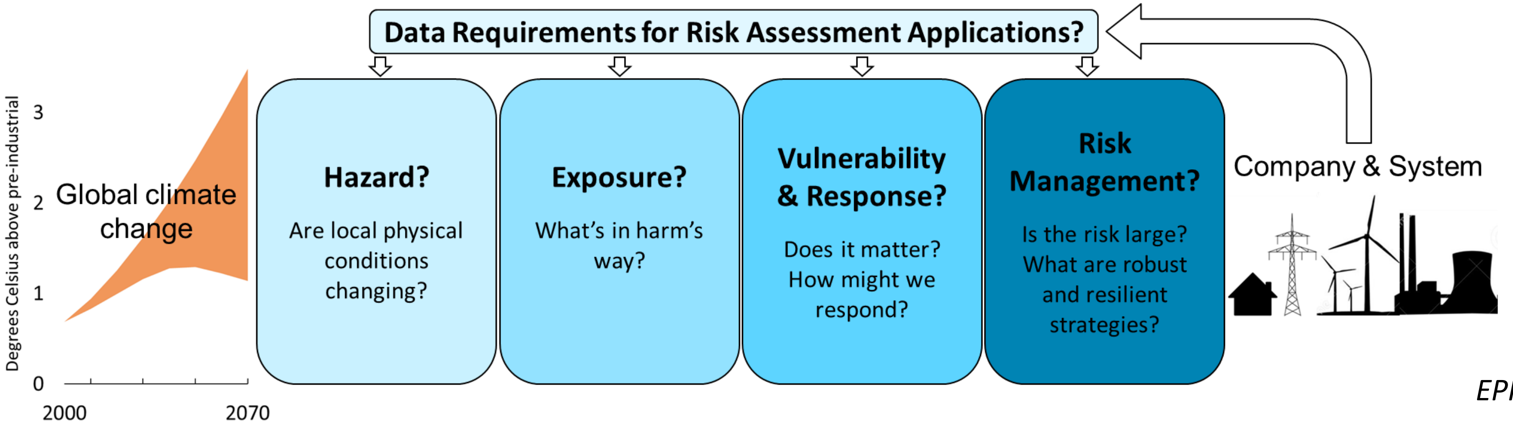
BlackRock.

SCIENCE BASED TARGETS DRIVING AMBITIOUS CORPORATE CLIMATE ACTION

Physical climate risk assessment conceptual framework

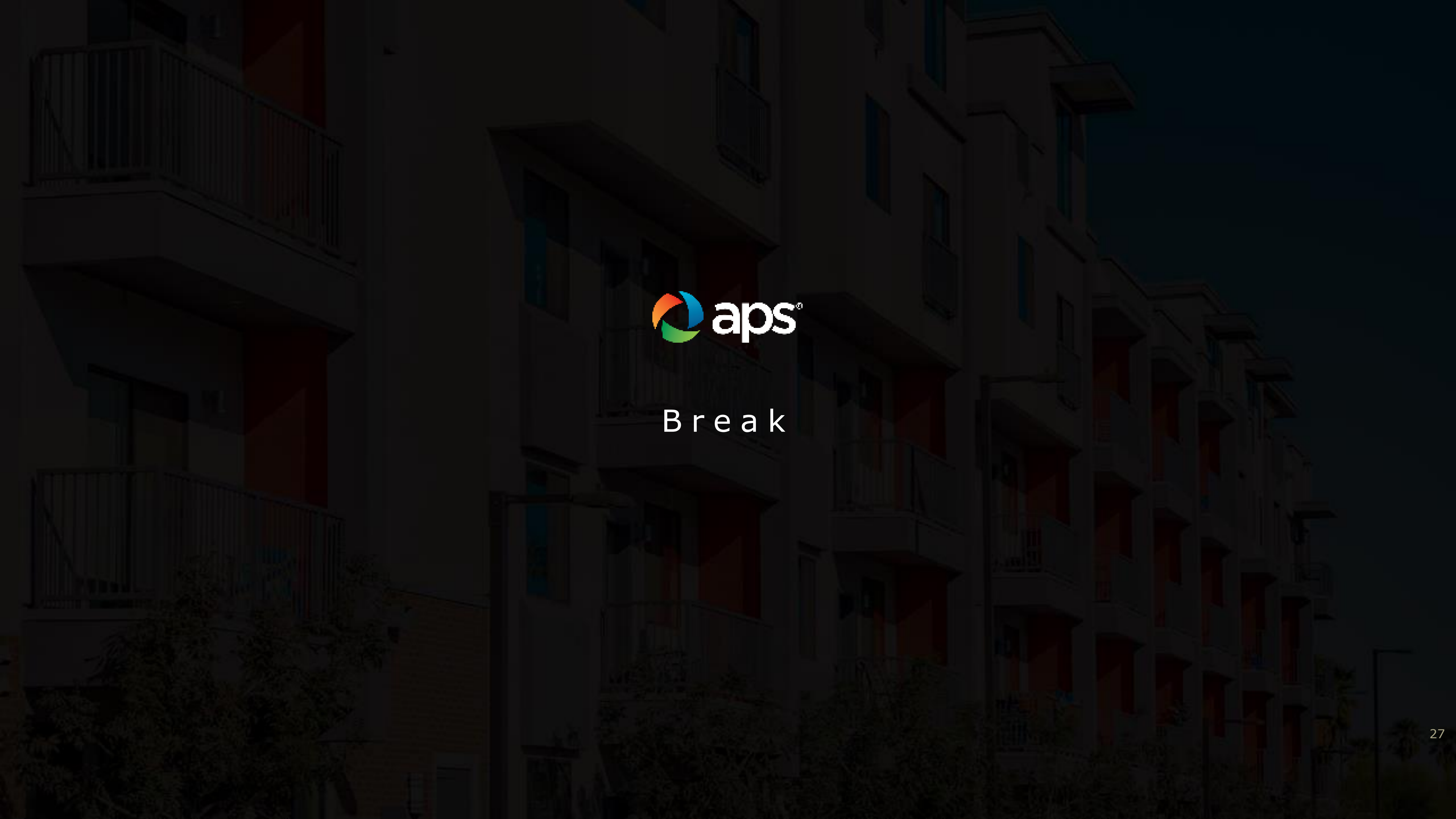
- **Description**
  - Defines physical climate risk assessment
  - Provides a framework, educates, and level sets
  - Characterizes the analytical foundation developed in this project and the opportunities for future analyses to characterize specific risks and risk management options
- **Draft key insights**
  - Physical climate risk assessment requires a set of assessments (see figure)
    - Much more than knowing whether the climate is or could change, or whether something is exposed to weather

- A full physical climate risk assessment for a company is a significant undertaking
- Each assessment has its own analytical needs – historical, current, and projections data & modeling
- Tiers of analyses valuable (e.g., asset, system, service territory)
  - Each identifying potential risks and response options
- Overall assessment begins with defining information requirements to develop metrics fit for purpose
- The next step is assembling and understanding climate change – historical, current, and future



EPRI (2022)

Discussion & Questions



Break

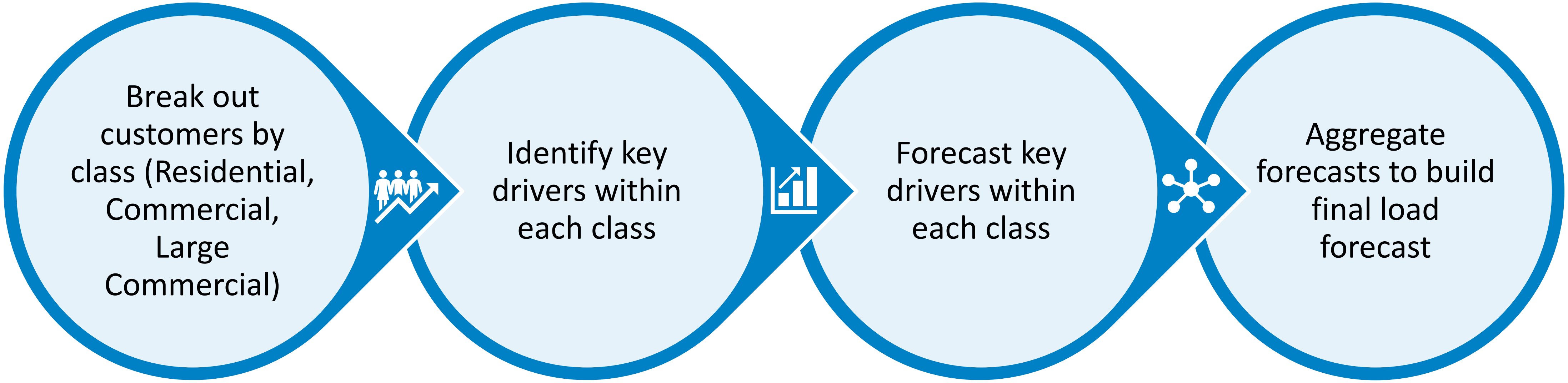
Load Forecast Update

Load Forecast Update

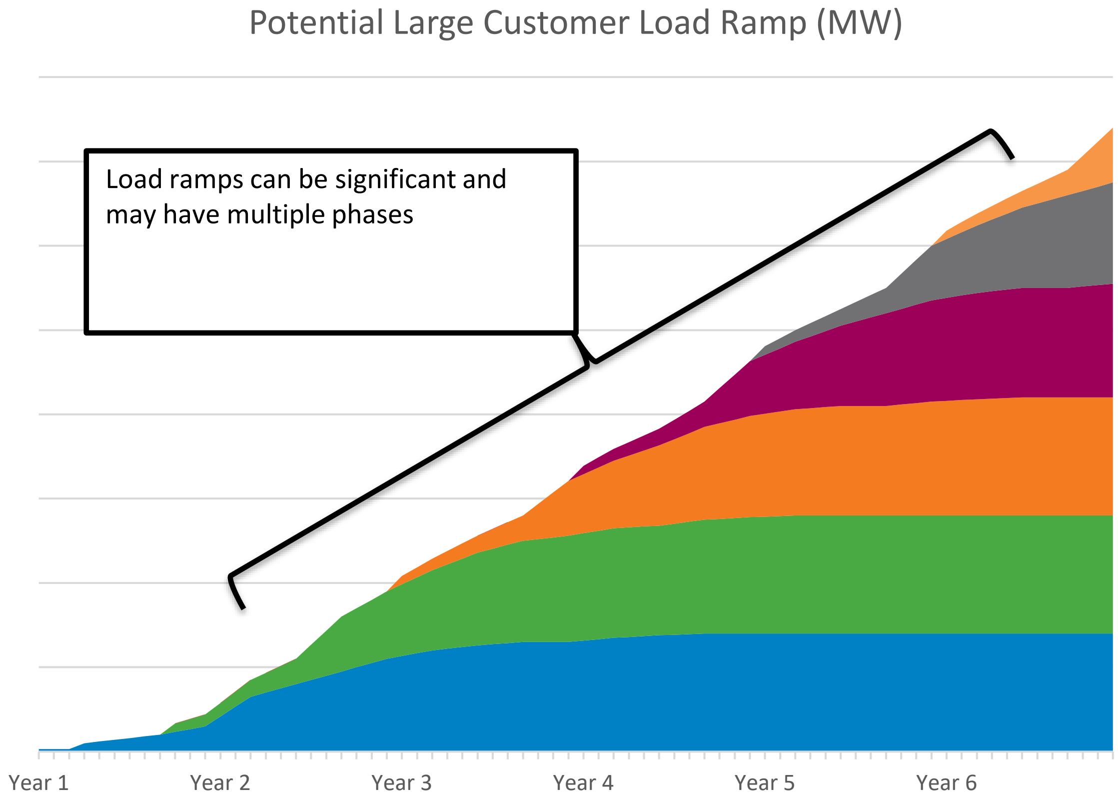
Ross Mohr

January 18, 2023

Load Forecast Approach

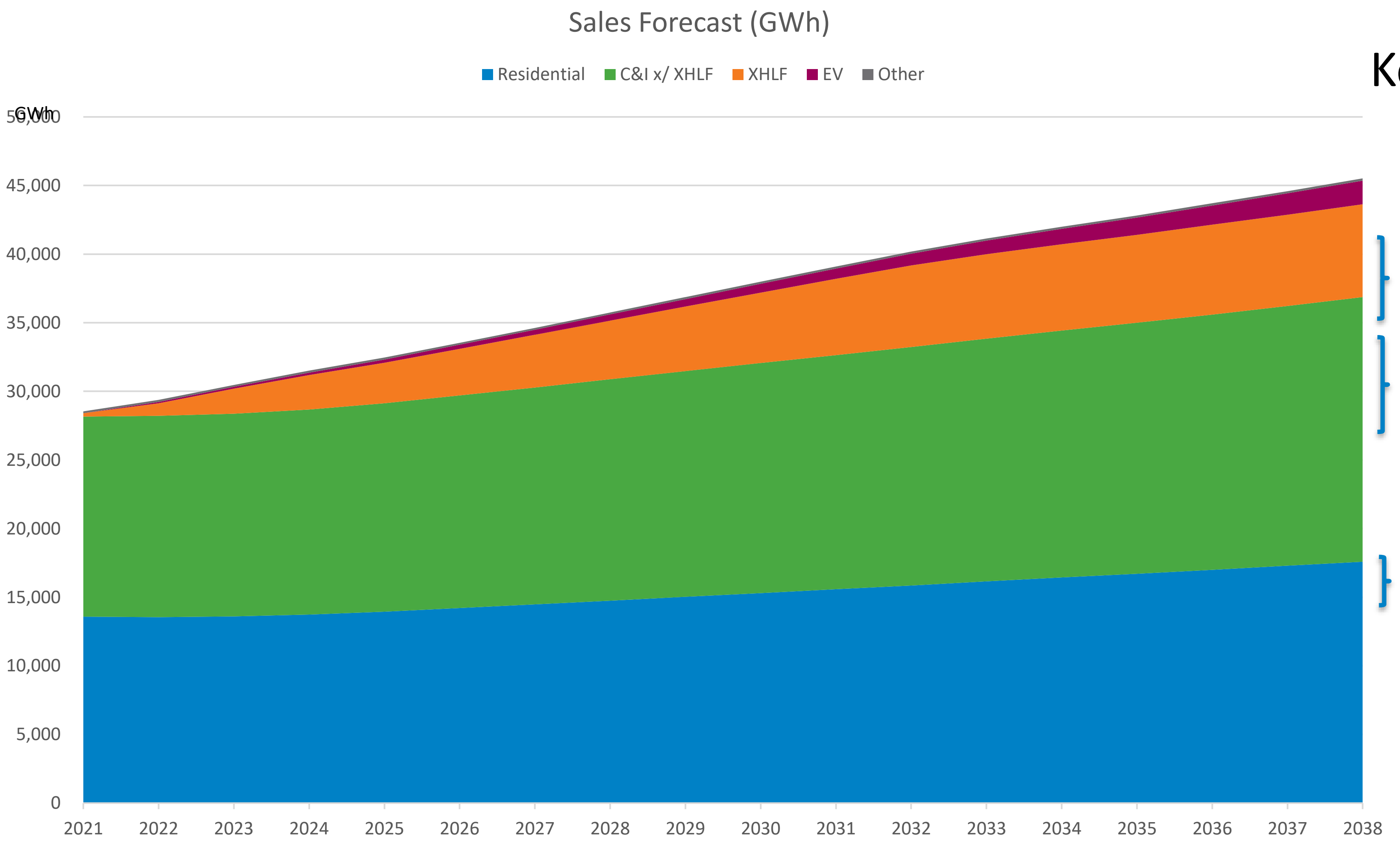


New Manufacturing and Datacenter Loads Add to Resource Needs



- New manufacturing facilities and Datacenters create large resource needs and have limited historical data
- Large loads require careful review and planning to keep the system reliable
  - Customer interaction is relied upon to estimate load additions
- New large customer operations may also bring related supply chain customers

RPAC 2021 Base Case Summary



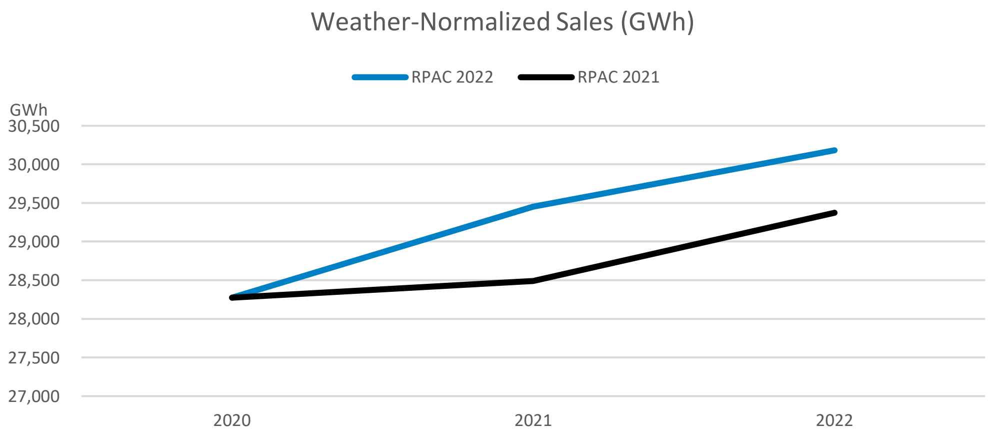
Key Forecast Drivers

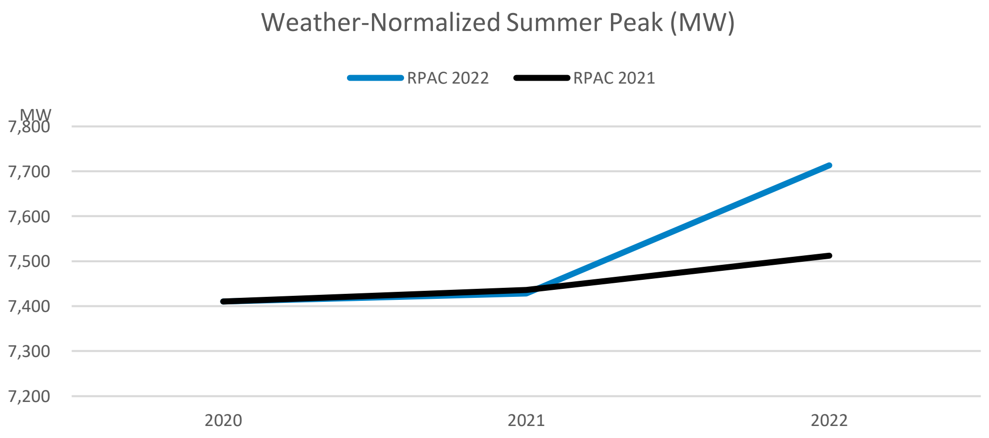
- New large customers are the major source of forecast growth
- C&I: anticipated supply chain for large customers and increased floor space usage
- Residential: increased "other" uses, semi-permanent remote work

2021-2022: Actuals vs RPAC 2021 Forecast

- 2021 sales almost 1000 GWh more than RPAC forecast (strong residential sales)
- 2022 sales almost 900 GWh higher than forecast, despite datacenters ramping slower than forecast (strong residential and small C&I growth)
- 2022 weather-normalized peak 200 MW higher than RPAC forecast
- **RPAC 2021 forecast under-forecast the recovery from COVID**

2022 RPAC forecast starts higher than prior forecast, but has slower load growth in residential and small C&I in later years





Probabilistic Large C&I Customer Forecast

- New forecasting process to include load impacts (sales and peak) of potential large customers (datacenters and large manufacturing – "XHLF")
  - All customers included are at the 100% Locate stage of the Economic Development pipeline
- Probabilistic approach to model the uncertainty of load size and timing
  - Probabilities reflect current status of project study, funding, and construction and reflect possible delays due to recession or supply chain / construction issues

Biden to visit TSMC plant under construction in north Phoenix

Aligned Data Centers of Texas plans big Phoenix expansion

KORE Power poised to break ground on Valley battery manufacturing plant by end of 2022

Behind the deal: Why Nestle picked Arizona for its manufacturing plant

Headlines from the Phoenix Business Journal

Load Forecast Update Summary

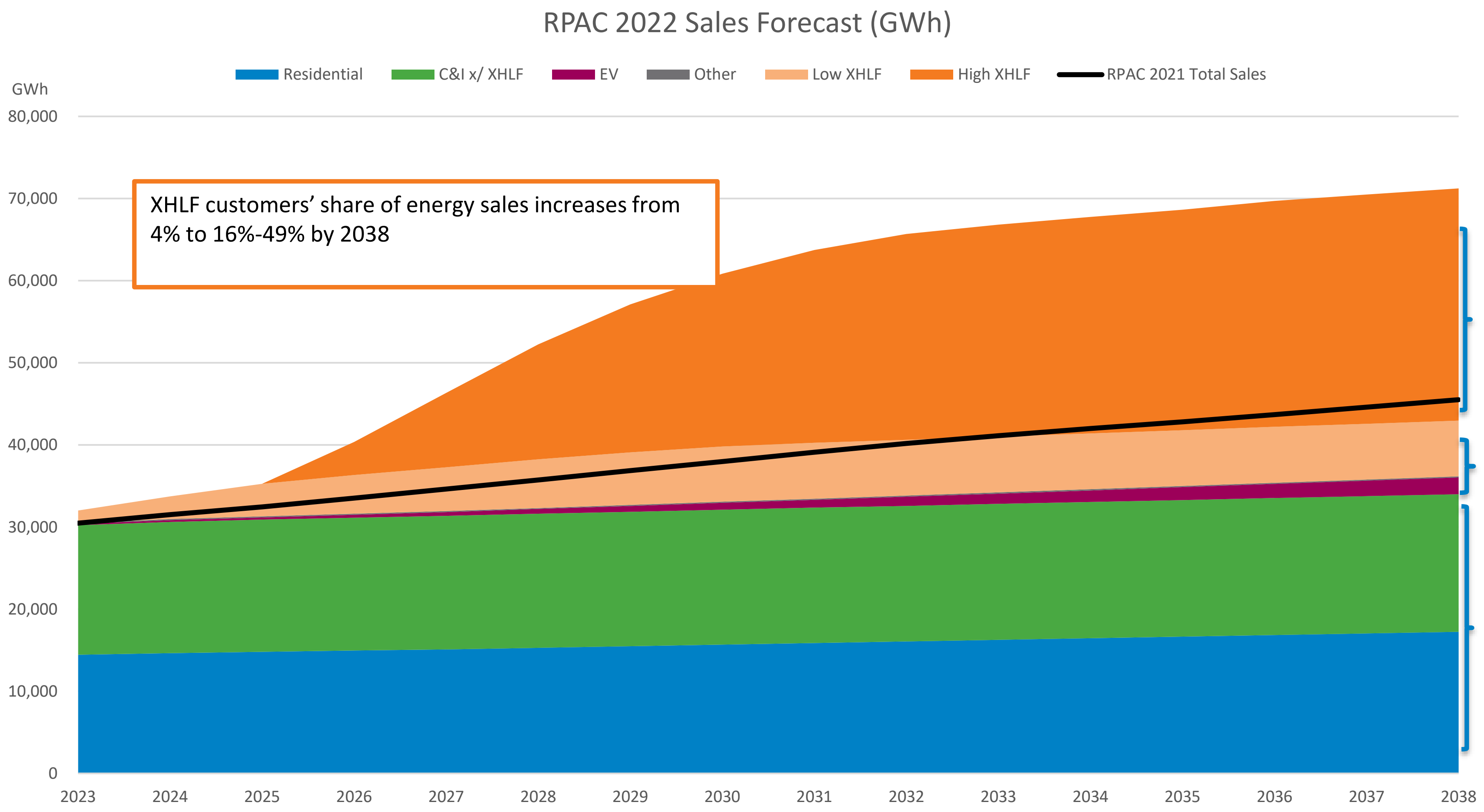
- 2022 RPAC forecast shows slower "core" load growth (residential and non-XHLF C&I customers) due to changes in usage trends post-COVID, increased DSM, and model improvements
  - Minimal change to customer forecast
- Datacenter and large manufacturing customers ("XHLF") are expected to be the major source of load growth, presented here with two scenarios
  - **Low XHLF** is comprised of existing datacenter customers and two announced Fabs of TSMC
  - **High XHLF** includes a probability-weighted forecast for all prospective datacenters and large manufacturing customers that are in various stages of study/funding/construction
  - Datacenters and large manufacturing customers' (XHLF) share of energy sales increases from 4% of sales to 16%-49% of sales from 2023 to 2038
- Slight increase to EV forecast: Guidehouse (2019) "Strong Market Transformation" scenario adopted into load forecast

	2023	2028	2033	2035	2038
PEV Count (light-duty)	53,386	186,395	398,467	496,558	653,815

Forecast updates in progress (all with Guidehouse)

- EV forecast to reflect increased adoption vs current forecast
- DE forecast to reflect increased residential rooftop solar (and battery) adoption
- EE forecast and DR Potential Study

Sales Forecast Update



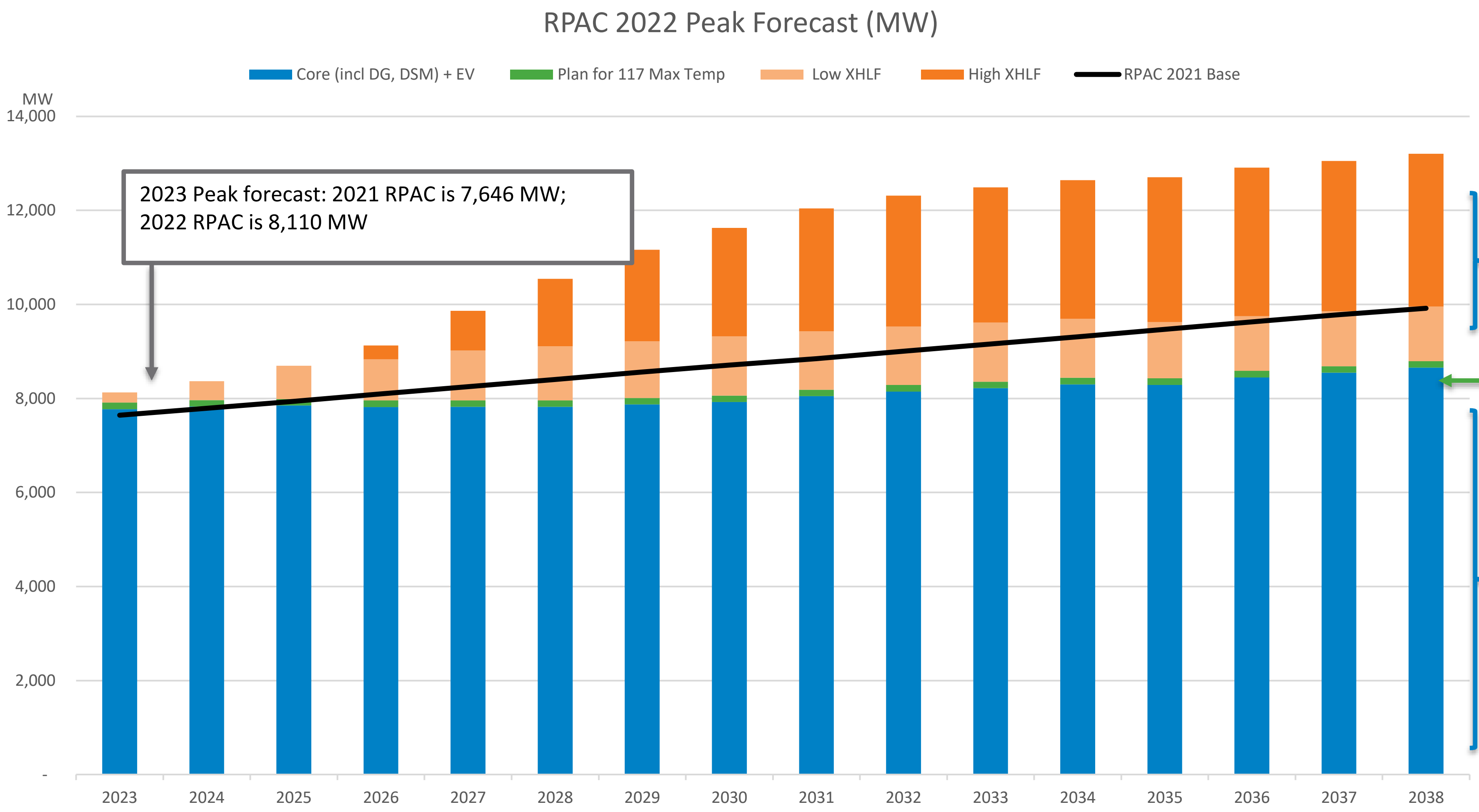
Large projected load increase due to prospective datacenters and large manufacturing

High XHLF: an increase of 28,000 GWh by 2038 vs Low XHLF based on prospective XHLF customers (probabilistic approach)

Low XHLF: close to 2021 RPAC, based largely on existing customers

Slight net decrease among residential and C&I compared to 2021 RPAC forecast

Peak Forecast Update



Peak forecast increases to 9,956 MW (Low) or 13,206 MW (High) vs 9,919 MW (RPAC 2021)

High XHLF: Almost all peak growth compared to 2021 RPAC forecast is due to datacenters and large manufacturing

Planning for **max temps of 117 degrees adds 139 MW** to the peak forecast

Slight net decrease among residential, C&I, and EV compared to 2021 RPAC forecast

Load Forecast Growth Summary

- 2022 RPAC forecast shows slower "core" load growth due to changes in usage trends post-COVID and model improvements
- XHLF customers expected to be the major source of load growth; new probability-weighted forecast

Retail Sales CAGR		2023-2028	2028-2033	2033-2038	2023-2038
RPAC 2021 Base Case	**Total Retail**	**3.2%**	**2.8%**	**2.0%**	**2.7%**
	Total Retail x/ XHLF	1.9%	2.1%	2.1%	2.0%
	Total Retail x/ XHLF, EV	1.7%	1.8%	1.7%	1.8%
RPAC 2022	**Total Retail – High XHLF**	**10.4%**	**5.0%**	**1.3%**	**5.5%**
	Total Retail – Low XHLF	**3.6%**	**1.4%**	**0.9%**	**2.0%**
	Total Retail x/ XHLF	1.2%	1.1%	1.1%	1.1%
	Total Retail x/ XHLF, EV	0.9%	0.7%	0.7%	0.8%

"Core" growth

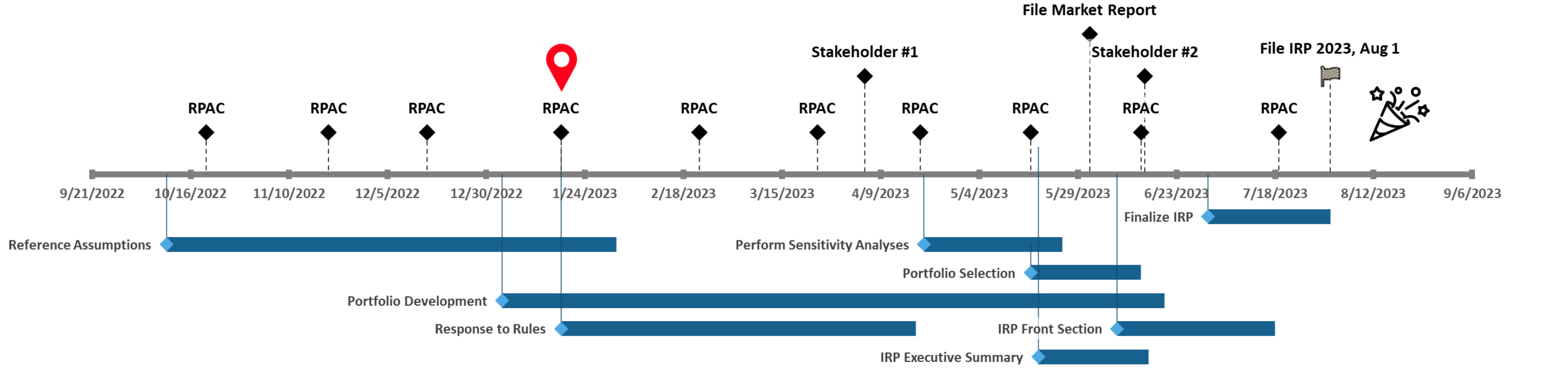
"Core" growth

Peak CAGR	2023-2028	2028-2033	2033-2038	2023-2038
RPAC 2021 – Base Case	1.9%	1.7%	1.6%	**1.8%**
RPAC 2022 – High XHLF	5.4%	3.4%	1.1%	**3.3%**
RPAC 2022 – Low XHLF	2.3%	1.1%	0.7%	**1.4%**

Discussion & Questions

2023 IRP Update

2023 IRP Timeline



Communication Plan

- Tiered approach
  - RPAC to discuss and collaborate
  - Broader stakeholder meetings are to inform others
  - Aurora license holder training forthcoming

February 2023

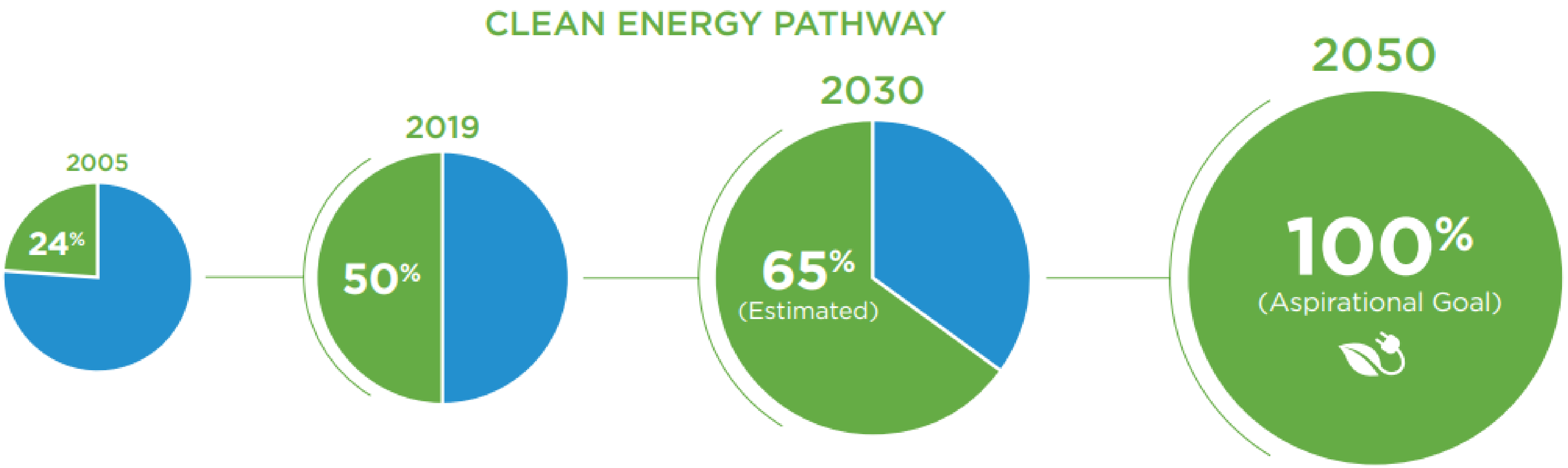
Update on reference assumptions

Additional information on scenarios

Discussion & Questions

Next Steps

APS is celebrating the third anniversary of its Clean Energy Commitment



Commitments:

- 100% clean, carbon free electricity by 2050
- 65% clean energy by 2030 with 45% renewable energy
- Eliminate coal by the end of 2031