2020 IRP Stakeholder Update

June 11, 2020

Welcome

Jeff Burke - APS

Agenda

Welcome

Jeff Burke - APS

Clean Energy Commitment

Eric Massey - APS

Load Forecast Review

Mark Quan - Itron

Renewable Integration Study

Chuck Fan – Energy Exemplar

Reserve Margin Review

Ed Downing - APS

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Derek Seaman - APS

APS Portfolio Review

Laura Herman - APS

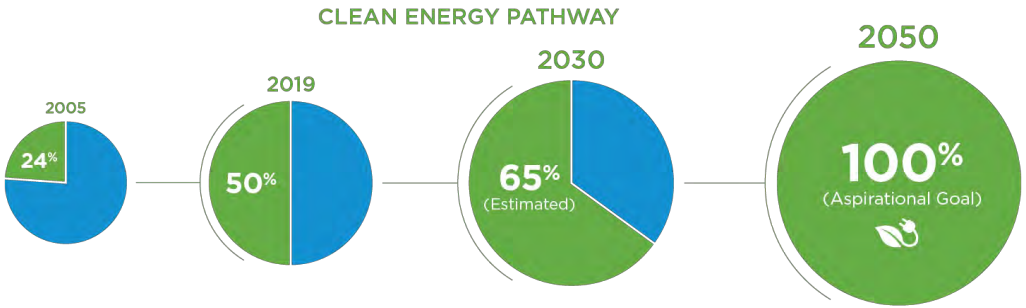
Next Steps

Jeff Burke - APS

Clean Energy Commitment

Eric Massey - APS

APS Clean Energy Commitment



Clean energy commitments

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

A clean economic future

- Meet our responsibility to power a low-carbon economy in Arizona
- Guided by sound science to advance a healthy environment
- Market-driven energy innovation and a strong Arizona economy are critical
- Starting from an energy mix that is 50% clean, including energy efficiency and carbon-free and clean energy from Palo Verde Generating Station

Pathways to 100% Clean

Policy decisions	Support policy decisions that leverage market-based technology and innovation to attract investment in Arizona
Existing power sources	Near-term use of natural gas until technological advances are available to maintain reliable service at reasonable prices
Evolving market-based solutions	Participation in the Energy Imbalance Market provides access to clean energy resources while saving customers money
Electrification	Electrification will drive a cleaner environment and more energy-efficient operations throughout the economy
Modernization of the electric grid	Continue to advance infrastructure that is responsive and resilient while providing customers more choice and control
Energy storage solutions	Storage creates opportunity to take advantage of midday solar generation and better respond to peak demand

Next Steps: Collaboration, alignment and innovation

- Reliability and affordability are foundational
- Collaborate with customers, stakeholders and regulators
- Promote economy-wide electrification of industry, transportation and buildings
- Support innovation, research and development of new technology

aps.com/cleanenergy

aps

Questions?

Load Forecast Review

Mark Quan – Itron

APS MODEL REVIEW

February 7, 2020

MARK QUAN
MARK.QUAN@ITRON.COM

AGENDA

- Project Work Scope
- Principal Conclusions
- Residential Forecast
- C&I Forecast
- Data Center Forecast
- Peak Forecast

WORK SCOPE

- Itron will review four components of APS's forecast.
  - Residential Model
  - Commercial and Industrial Model
  - Data Center Forecast
  - System Peak Model
- Final Report
- On-Site Presentation (2)
  - February 7, 2020
  - Future Stakeholder Meeting

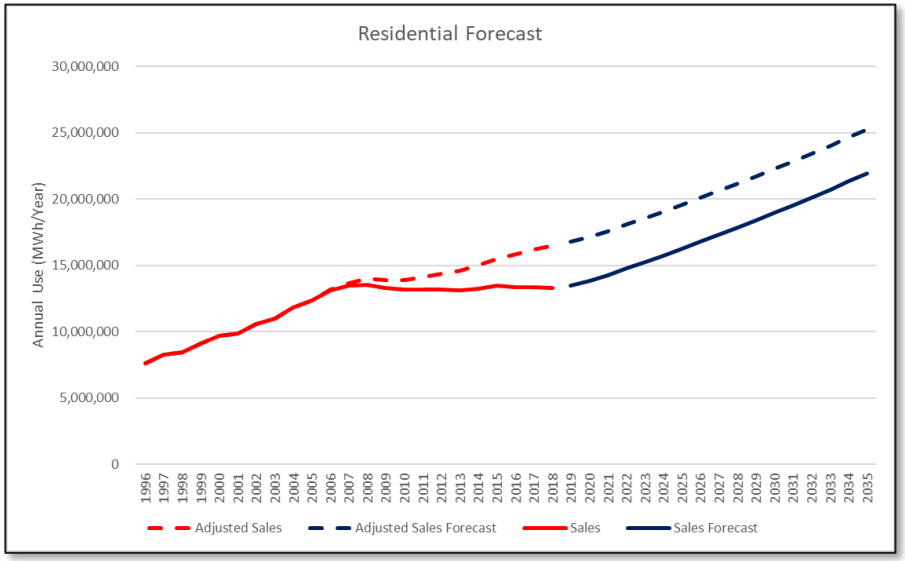
Key Assumptions and Disclaimer:

- Itron's review considers forecasting technique and model reasonableness. Itron did not review specific input assumptions such as historic data for sales, customers, weather, DSM, DG, and economic forecasts.
- Itron reviewed APS's 2019 Q3 Load Forecast, not the IRP forecast (2020 Q1 forecast).
- Itron recognizes that there are multiple ways to develop forecast models. Itron's support of APS's methods does not imply that APS's methods are the only way to develop a reasonable forecast. Different models will generate different forecasts.

PRINCIPAL CONCLUSIONS

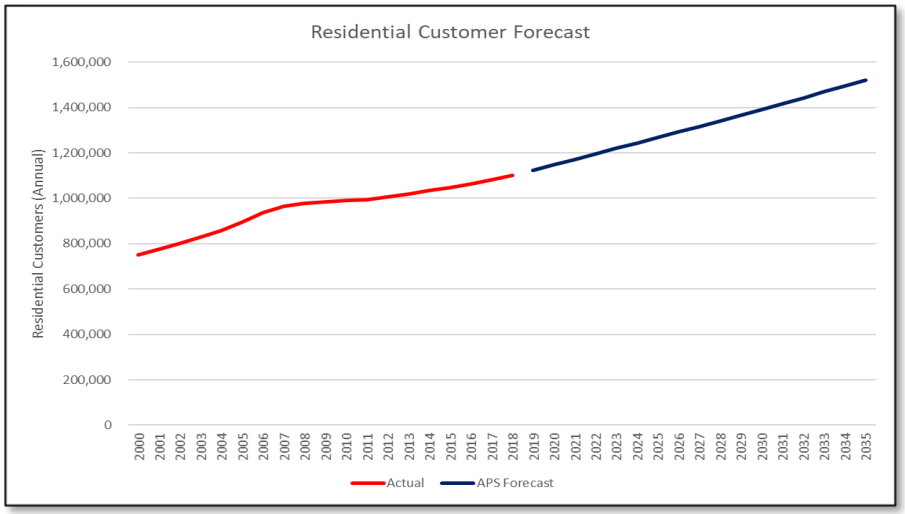
- Methods are consistent with industry practices and produce reasonable results given the input assumptions.
- The primary drivers are:
  - Residential Customers: Households
  - Residential Average Use: Real Personal Income
  - Commercial and Industrial Use: Occupied Square Footage
  - Data Centers: Customer Knowledge
  - Peak: Summer Adjusted Energy
- Itron finds that the modelling approaches for residential customers, C&I usage, data centers, and peak are reasonable.
- Itron recommends that APS revisit the residential average use model assumptions to remove the apparent inconsistencies.
- Since this review, APS has revised their residential model considering this project's recommendation.

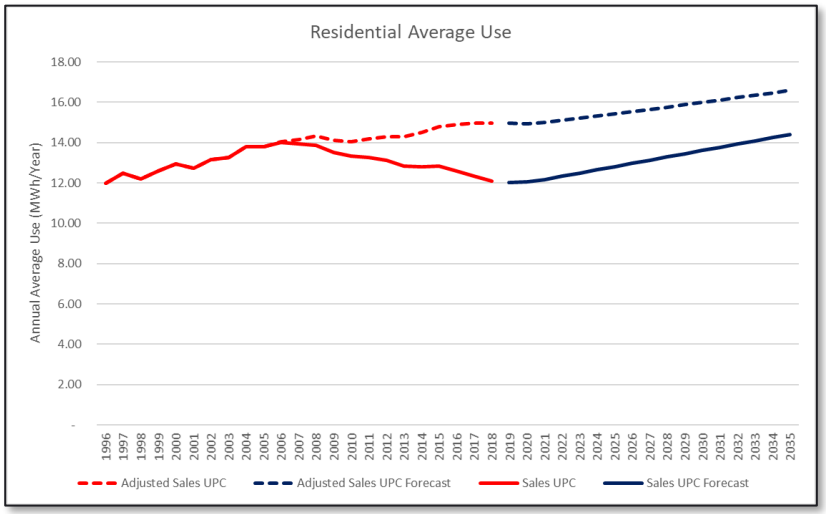
RESIDENTIAL FORECAST



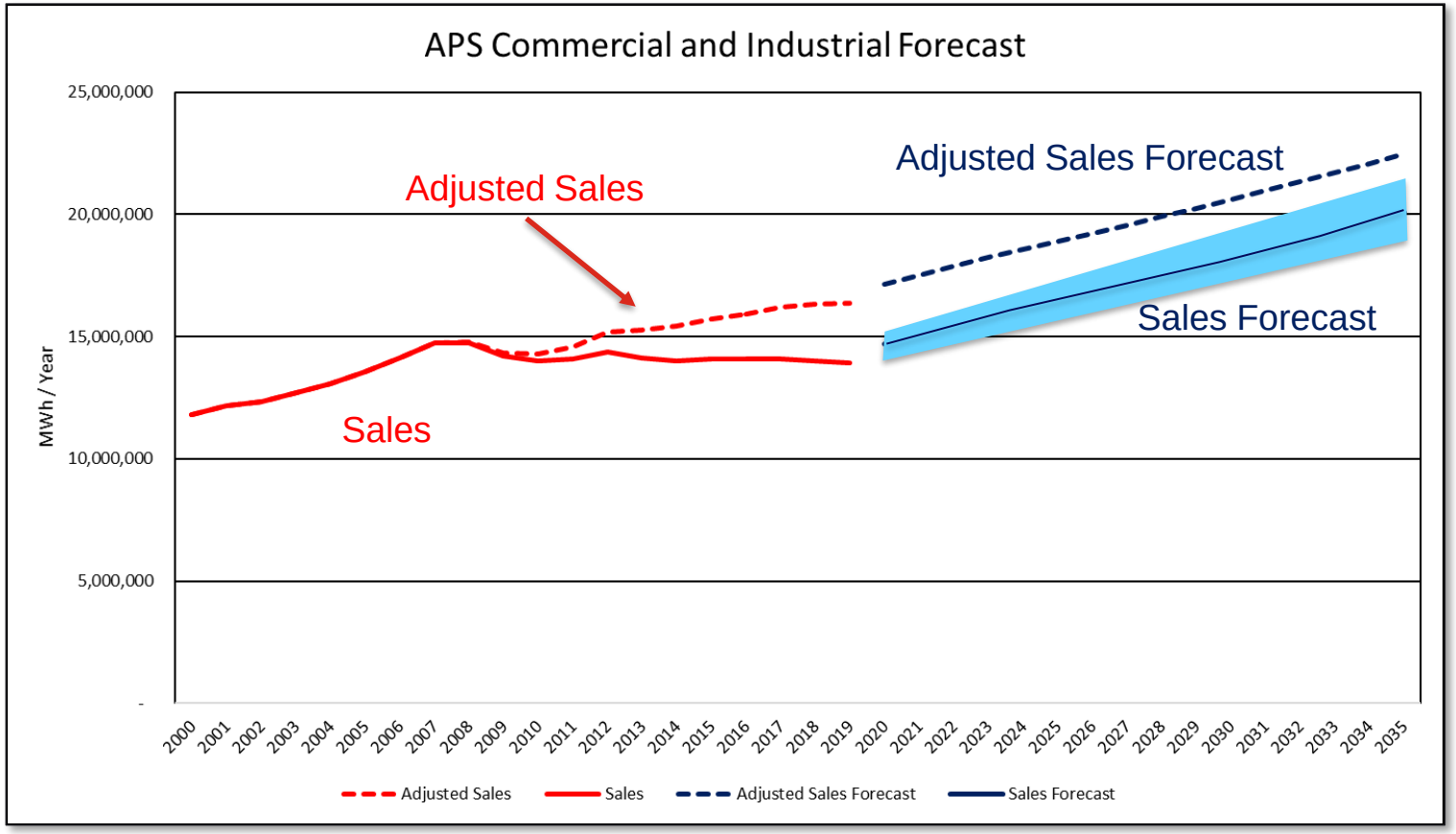
Sales = Customer Counts x UPC

- Customer Counts is a judgmental model based on household forecast.
- UPC (Average Use) is an econometric model on adjusted UPC based on real per capita personal income.
- Modelling shows some instability which has been addressed in the IRP.
- Forecast in the range of possibilities





C&I ENERGY FORECAST



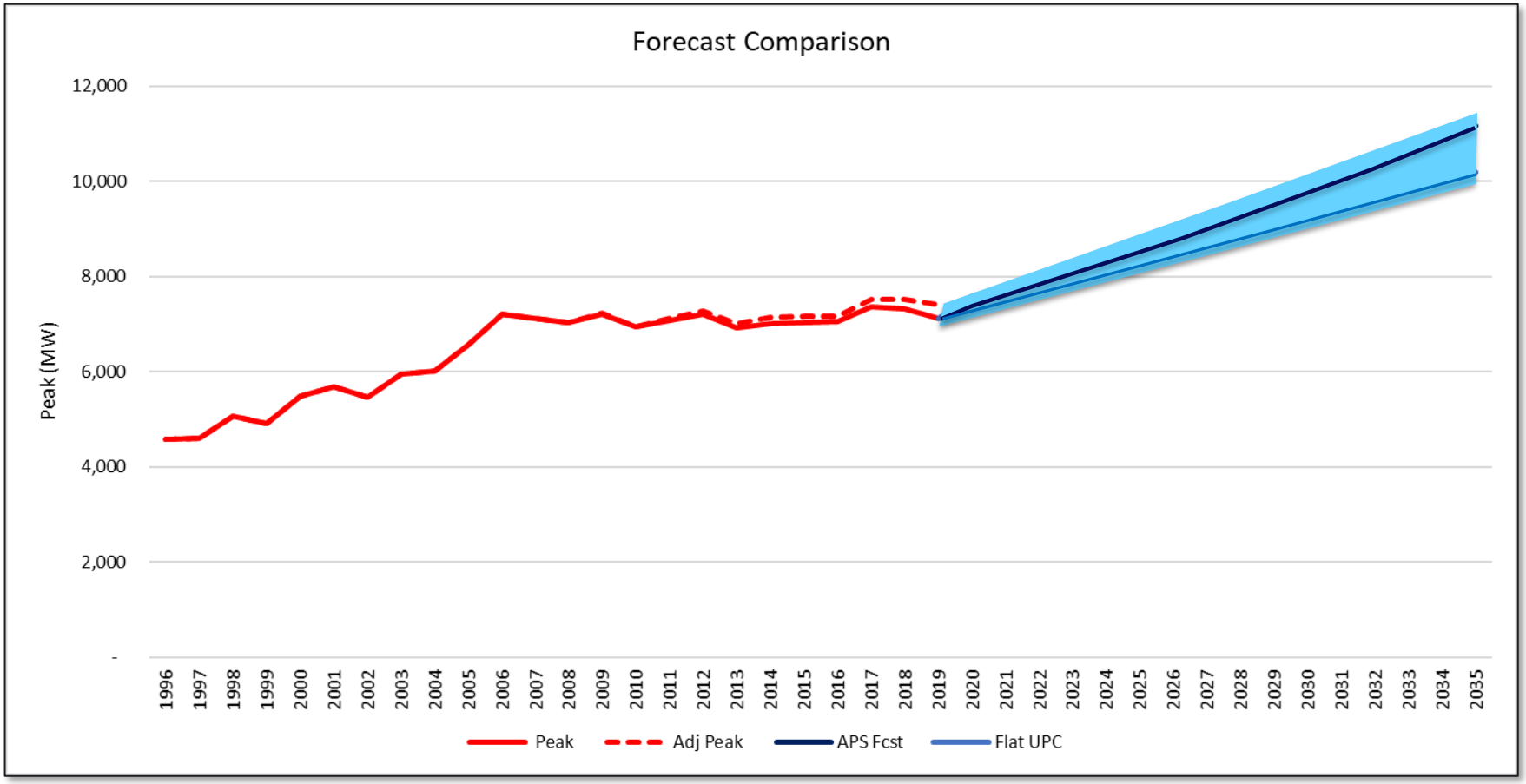
- Econometric model on adjusted sales (Add Back Method)
- Primary growth driver is occupied commercial building square footage
- Forecast in the range of possibilities

DATA CENTER FORECAST

- Data centers should be forecast separately from classes.

- Data centers should rely on APS customer specific knowledge.

PEAK FORECAST



- Peak Model uses a load factor method.
- Flat UPC Scenario assumes customer growth only and APS actor forecast.
- Peak forecast in the range of possibilities.

SUMMARY OF REVIEW

Forecast Area	Key Driver	Conclusion
Residential Energy Forecast		
Residential Customer Forecast	Households	
Residential Average Use Forecast		
Statistical Forecast	RPI	
End-Use Forecasts	Various	
Base load Forecasts	Residual	
Commercial Energy Forecast	Occupied Square Footage	
Data Center Energy and Peak Forecast	Customer Knowledge	
System Peak Forecast	Summer Sales	

 Itron support APS's forecast approach and results.

 Itron recommends APS revisit the forecast assumptions to improve the approach and results.

THANK YOU

SAN DIEGO

Mark Quan

mark.quan@itron.com

858.724.2649

www.linkedin.com/in/markquan/

http://blogs.itron.com/forecasting/

www.itron.com

Questions?

Renewable Integration Study

Chuck Fan - Energy Exemplar

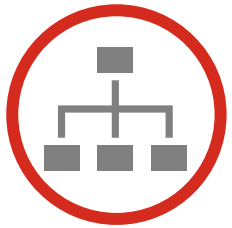
Energy Exemplar

APS Operational Cost of Renewable Integration

PLEXOS AURORA

Energy Exemplar Overview

Global organization founded in 1999 with headquarters in Adelaide, Australia.



More than 100 employees across eight locations in North America, South American, Europe and Australia.

Serving 1,500 users in 52 countries at more than 300 sites.

In 2017, the Riverside Company became the majority stakeholder with a focus on growing the business into new markets.

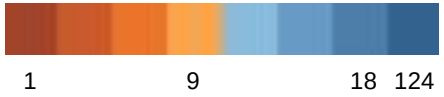
Acquired EPIS in 2018, developers of a leading electricity forecasting and analysis tool with clients in North America and Europe.

Proven power market simulation tool that is a leader in modelling flexibility, efficiency, simulation alternatives and advanced analysis.

Energy Exemplar

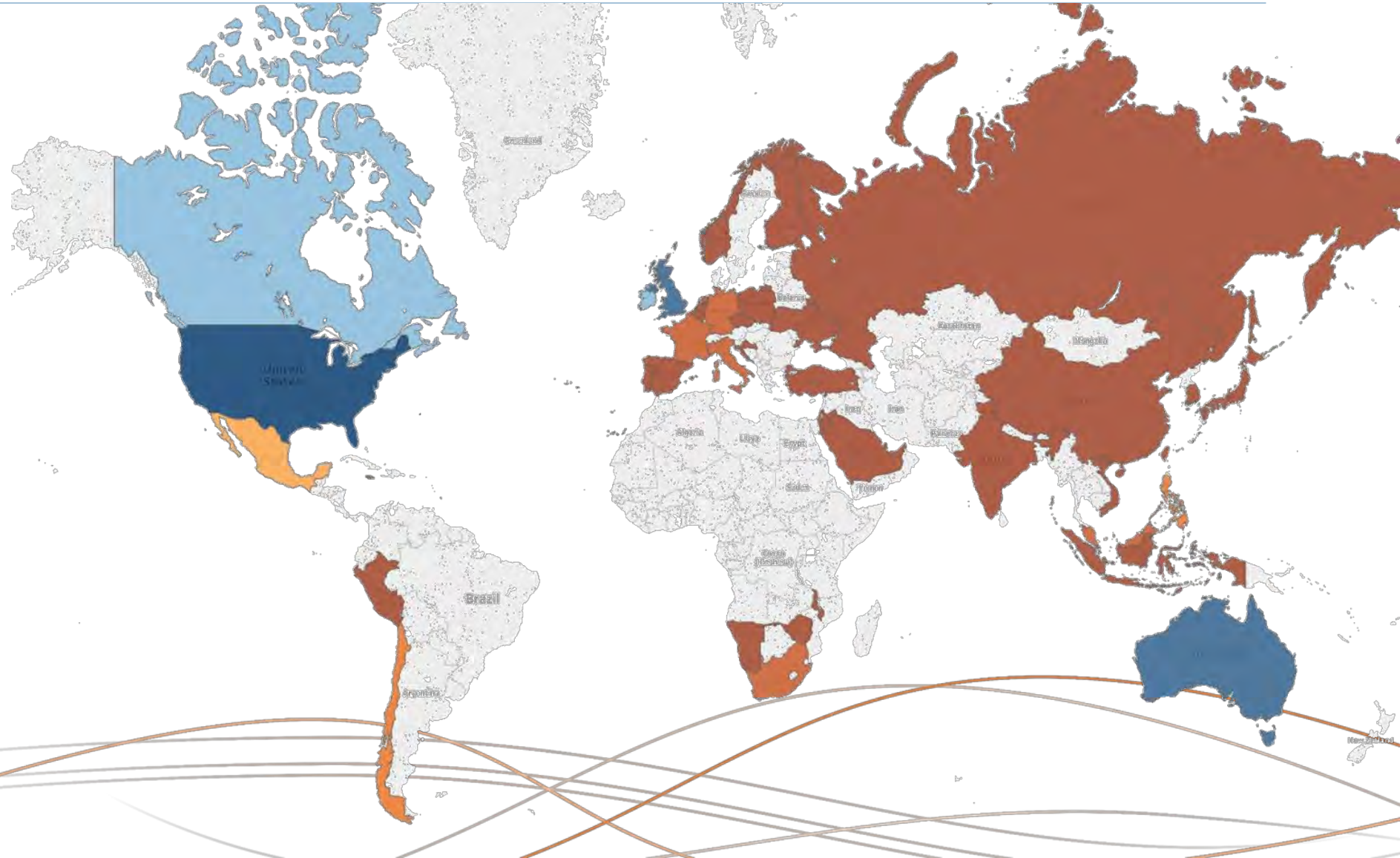
Client Portfolio

Clients by Region:



Clients by Segment:

Utility:	97
Consultant:	44
Power Producer:	39
Researcher:	28
Regulator:	21
TSO:	14
ISO:	13
Trader:	5
Energy Analyst:	4
International Institute:	3



Energy Exemplar

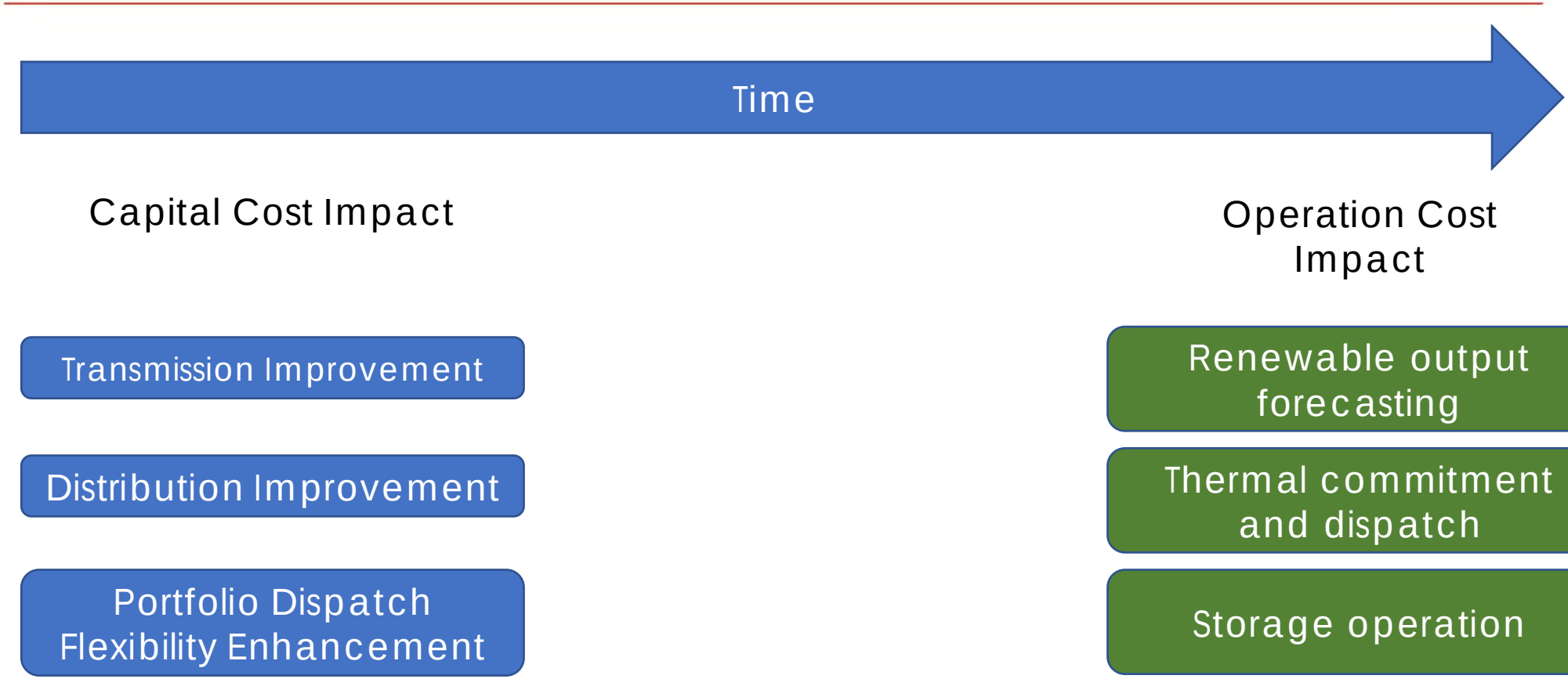
How is AURORA Used?

Generation Planning/ Budgeting	• Integrated resource planning • Budget projections • Detailed generator analysis • Assess RPS and environmental policies
Market Assessment/ Strategy	• Zonal & nodal price forecasting (hourly &/or sub-hourly) • Scenario based and probabilistic • Risk & portfolio analysis • Market design and policy analysis
Transmission Planning	• Frequency and value of constraints • Production cost impacts • Infrastructure studies
Portfolio Optimization	• Short term analysis (often nodal) • Highly optimal operational decision making • Highly automated (e.g. data feeds)

Study Objective

- Assess the Impact of Renewables on Generation Operation:
  - How does limited real-time adjustability of renewable impact Day-ahead and Real-time generation operation?
  - Does APS's projected dispatchable portfolio for 2030 and 2035 have the capability to compensate for renewable generation's limited real-time adjustability?
  - What is the excess generation operation cost of compensating for limited real-time adjustability of renewables?

Study Scope


Time
Capital Cost Impact
Operation Cost Impact
Transmission Improvement
Distribution Improvement
Portfolio Dispatch Flexibility Enhancement
Renewable output forecasting
Thermal commitment and dispatch
Storage operation

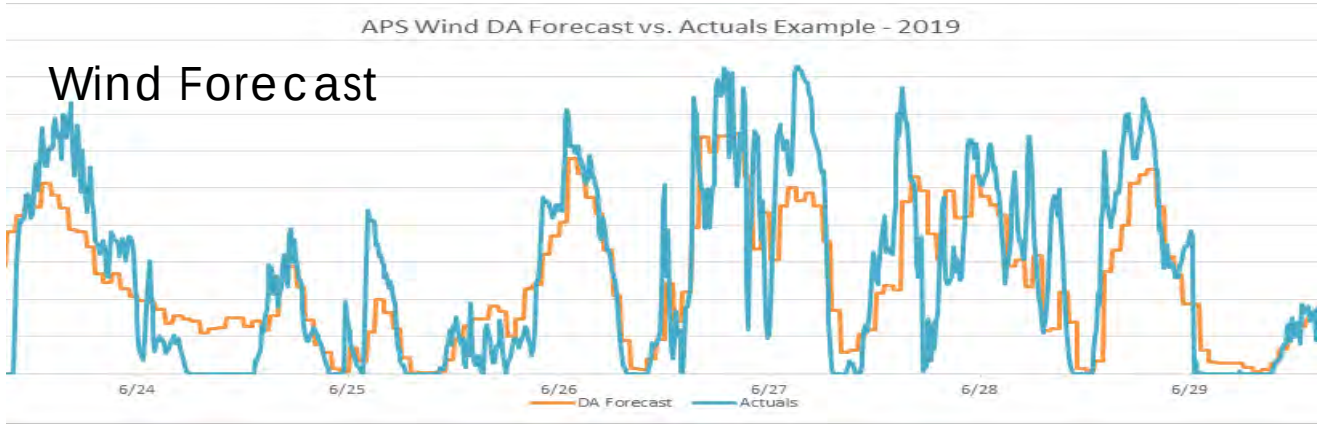
Study Assumptions

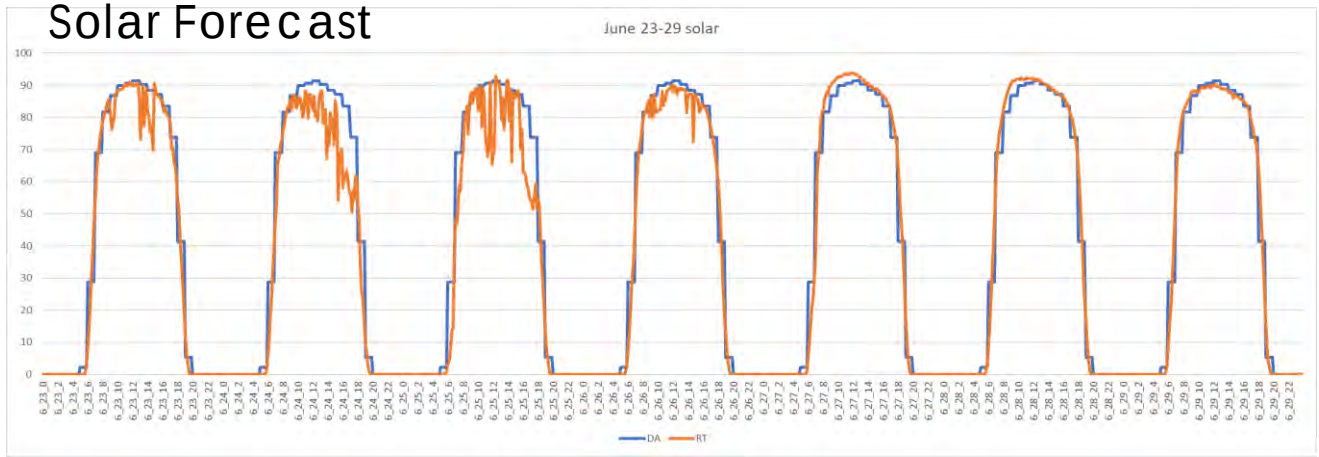
- APS will handle renewable operational impact without socializing the cost to neighboring regions
- APS will commit and dispatch its own resources to serve its demands
- There is no binding transmission constraint within APS territory
- Impact of forced outage, dispatchable deviation and load deviations are separate and not modeled.

PLEXOS AURORA

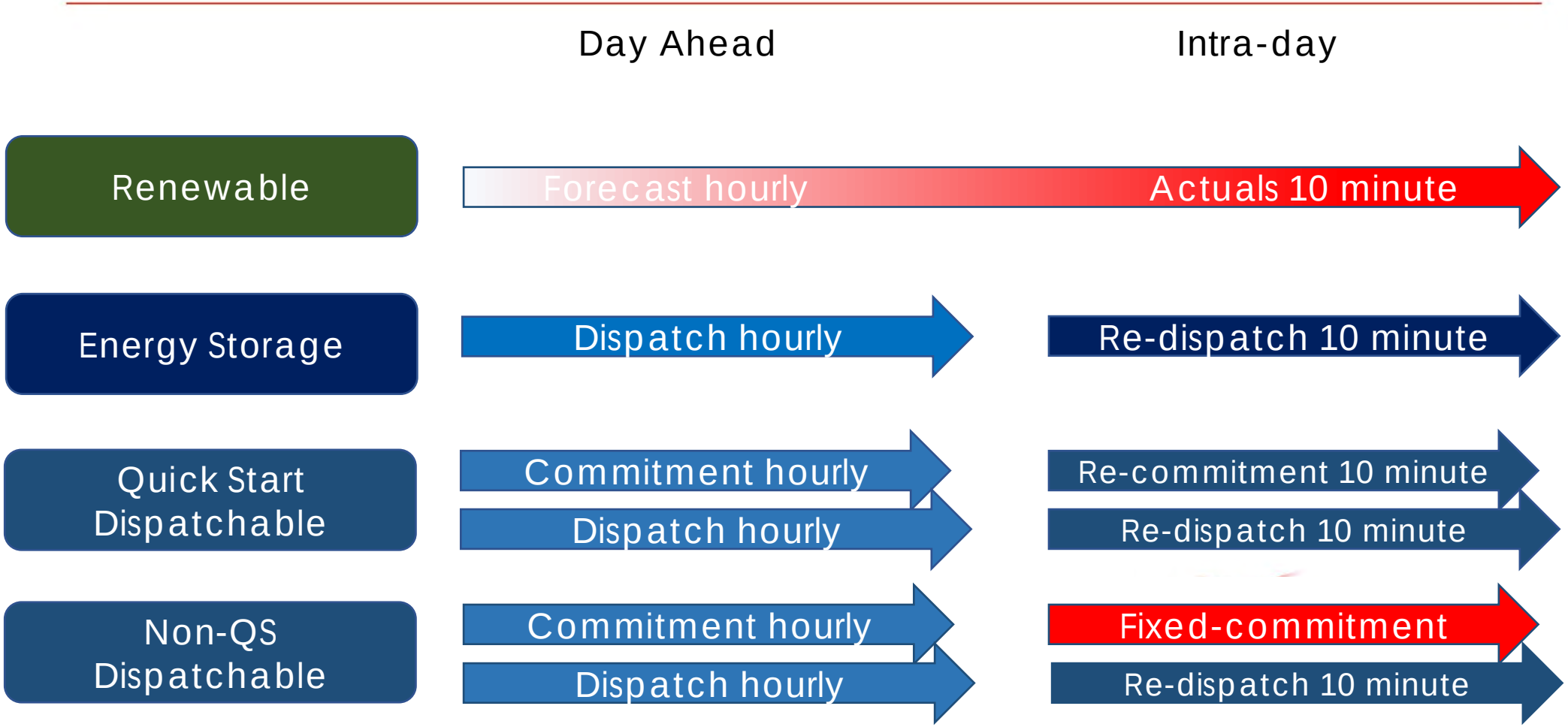
Modeling Forecast

- Portfolio level Forecast
- Day-ahead Forecast
  - Hourly renewable portfolio output expectation = avg of % of portfolio name plate capacity realized during comparable hour for 3 recent years
  - Comparable hour is the same hour during each month
- Real-time Actuals
  - Actual renewable portfolio output = % of portfolio name plate capacity realized each 10 minutes during a recent historic year





Aurora Operational Impact Modeling



Study Results

- Quick starting thermal resources are instrumental to providing sufficient flexibility to meet operational integration needs of APS's 2030 and 2035 renewable portfolios
- APS' currently projected portfolios for 2030 and 2035 have sufficient flexibility to meet solar and wind operational integration needs
- Holding operational reserves has little impact on operational integration cost.

Operational Integration Cost		
Resource Type	2030	2035
Solar	$1.28/MWh	$1.79/MWh
Wind	$2.89/MWh	$3.11/MWh

Additional Consideration

- Correlation between wind and solar volatility
- Correlation between load and renewable volatility
- Optimizing scheduled maintenance around integration needs
- Localized integration constraints and costs

Questions?

Reserve Margin Review

Ed Downing - APS

Overview

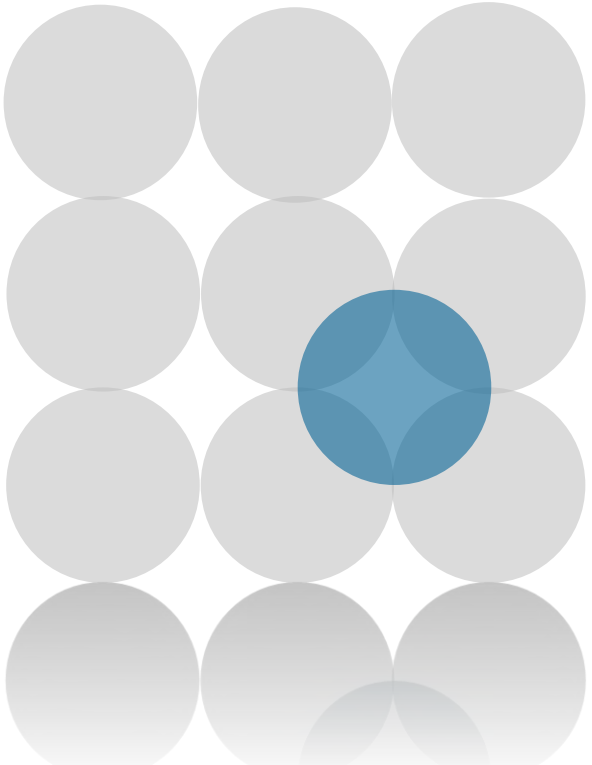
- APS proposed evaluating reserves used to provide system reliability in prior stakeholder meeting
- APS reserve margin calculations updated to reflect current and projected generation resources through 2024
- Study utilized Loss of Load Hours (LOLH) metric and determined that 15% reserve margin is appropriate for now; however updates to the study are required as we change the mix of resources on the system

Reliability Metric Definitions

- Reliability Event: Period of time in which resources fall short of serving customer demand
- LOLH: Loss of Load Hours is the expected number of hours in a year that resource capability is insufficient to meet demand
- LOLH target: 24 hours of outage in ten years or 2.4 hours of outage annually
- Forced Outage Rate: metric used to express generation unit unavailability to serve load

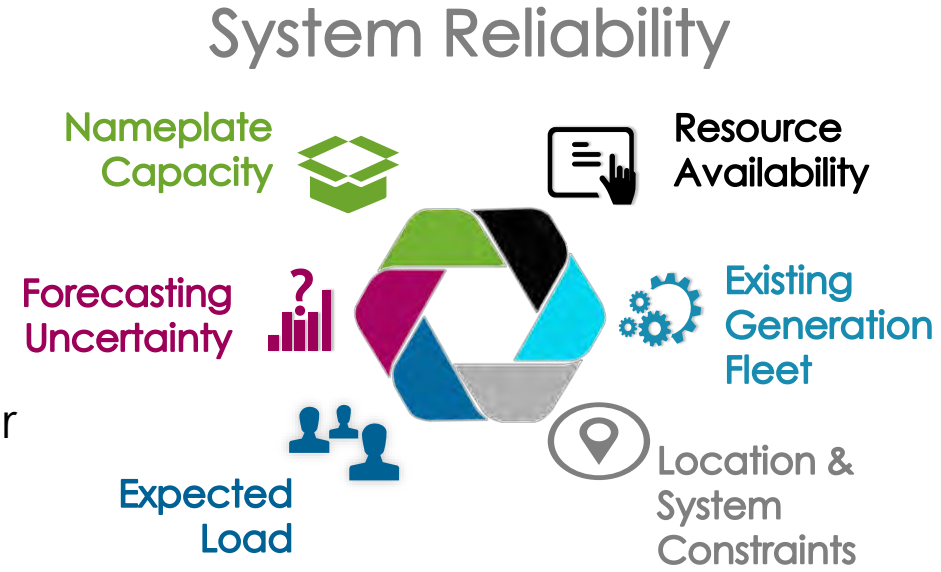
Modeling Resources and Methodology

- AURORA, Production Cost Model
- Utilize Risk Analysis Functionality in AURORA
  - Random forced outages for conventional resources
  - Uncertainty introduced for variable resources
  - Solar production simulations correlated to load

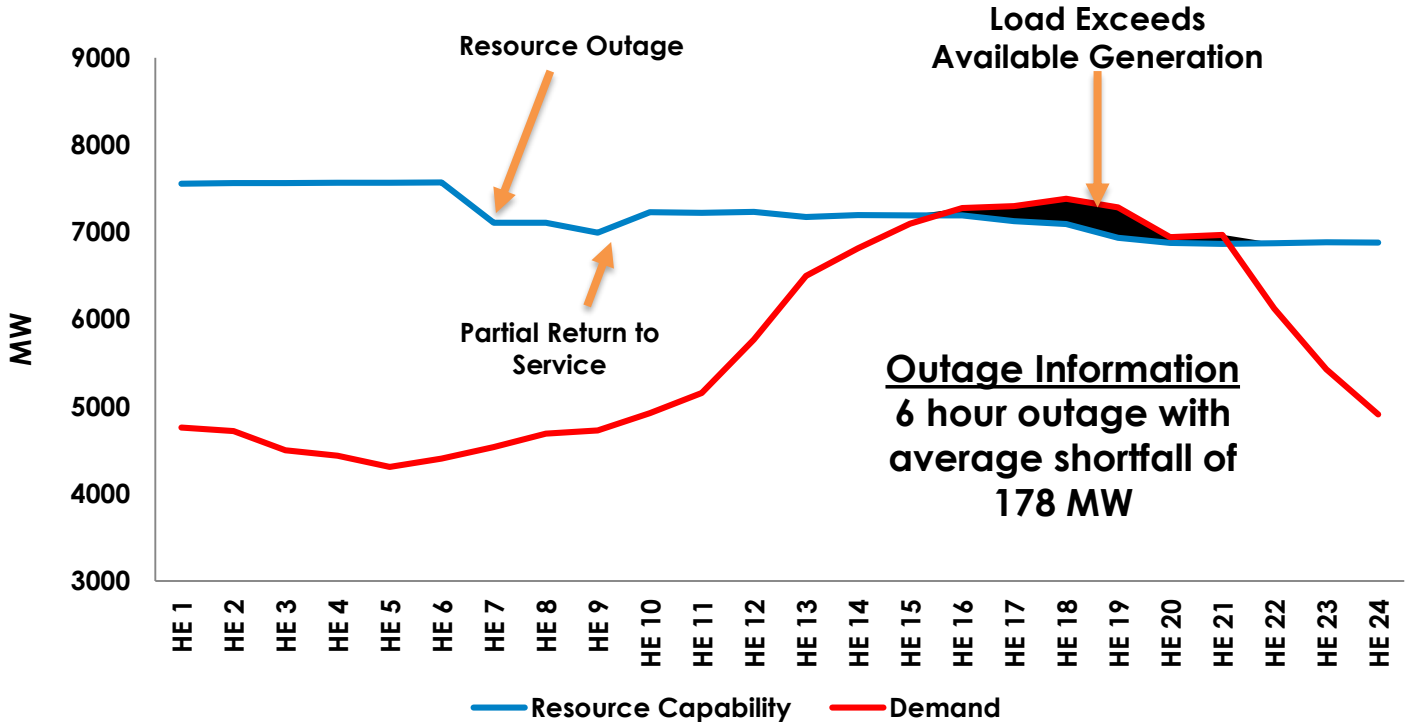


Study Design

- Run multiple iterations of resource plan in Aurora
- AURORA outputs hourly resource and demand data
  - System load
  - Resources available
  - Resource random outage information
- Post-modeling analysis
  - Calculate MWs necessary to maintain target of 2.4 LOLH per year to determine required reserve margin

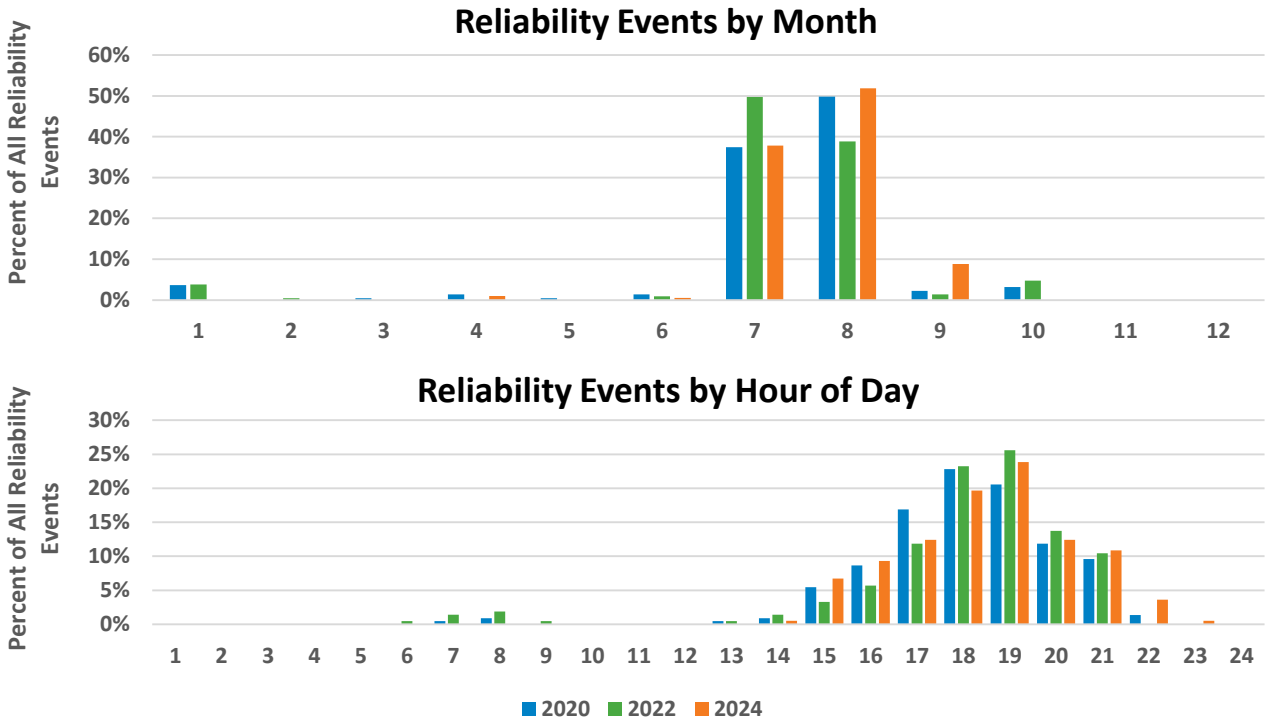


Resource Capability Example



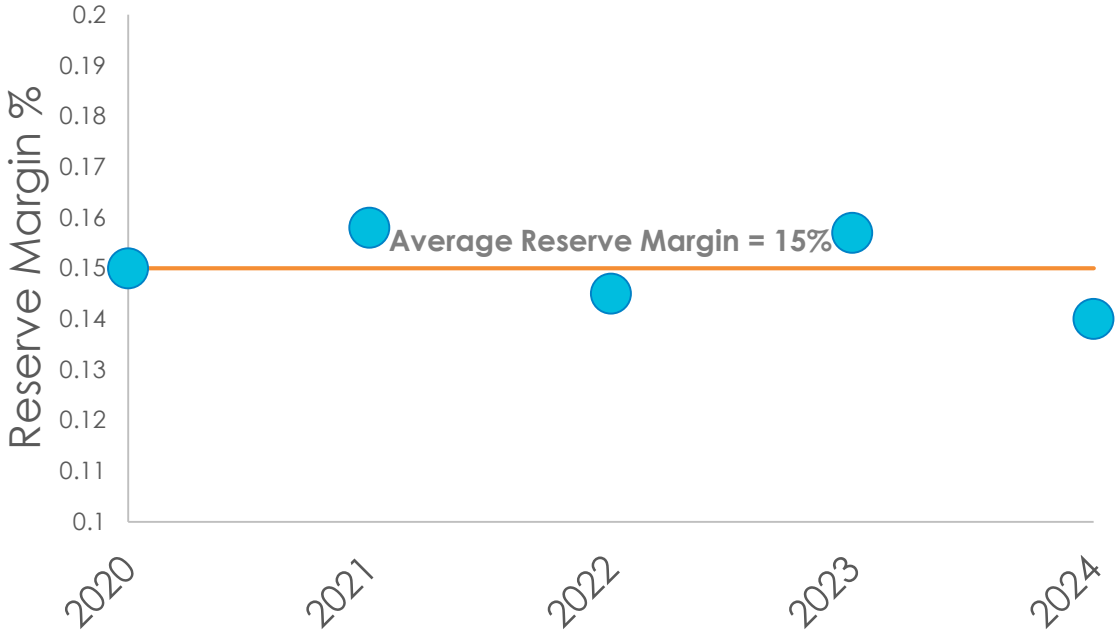
Periods when load exceeds available generation result in loss of load hours (LOLH)

Reliability Events Distribution



High load hours during the evening in the summer months have the largest potential to create reliability events

Reserve Margin Results



- APS plans to a 15% reserve margin, but allows short-term purchases to meet near-term fluctuations in projected needs
- Reduction in excess regional capacity may influence the level of short-term purchase going forward

Going Forward

- APS will continue to evaluate and update reserve margin studies on an ongoing basis
- Results of future reserve margin studies will be dependent on different resource/technology selections
  - Potential to increase or decrease the reserve margin
  - Heavily dependent on the availability of different resource types

Questions?

IRP Overview

Derek Seaman - APS

Base Assumptions

- Load growth
  - Assumes pre-COVID forecast (will amend our plan in the future)
- Coal
  - All cases and discussion assume Cholla (2025) and FC (2031) retirements
- Energy Storage
  - Are significant part of our future
  - We will ensure future technologies are safe and affordable prior to proceeding but are committed to a minimum of 850MW by 2025
- Renewables
  - All final portfolios will meet 45% by 2030 as discussed in APS CEC
- Carbon
  - Declining carbon trajectory must create a path to achieve 2050 goals

Load Forecast

Through the Action Plan window (2020-2024) we expect:

- Annual **Customer additions** of 20,000-22,000 annually
- Annual **peak demand** growth of approximately 150 MW
- **AZ business climate** continues to flourish and bring new manufacturing and data center development
- **Electric vehicles** program developed and growing
- **Customer programs** focused on peak reduction and bill savings

Through the planning period of 2035 we expect:

- **Population** to grow at an average of 1.5% annually
- Annual **peak demand** growth of 2.1%
- Annual **energy** growth of 2.7%
- Positive **economic activity** to drive C&I energy growth at an average of 2% annually
- **Data centers** to add 640 MW of capacity needs
- Approximately 320,000 additional **electric vehicles**
- **Customer Programs** focus grows as we continue to work with stakeholders to identify new opportunities

IRP Sensitivities Considered

Load Forecast*

- Customer Growth
- Energy Usage

Natural Gas Prices*

- Market
- Forecasts

CO2 Prices

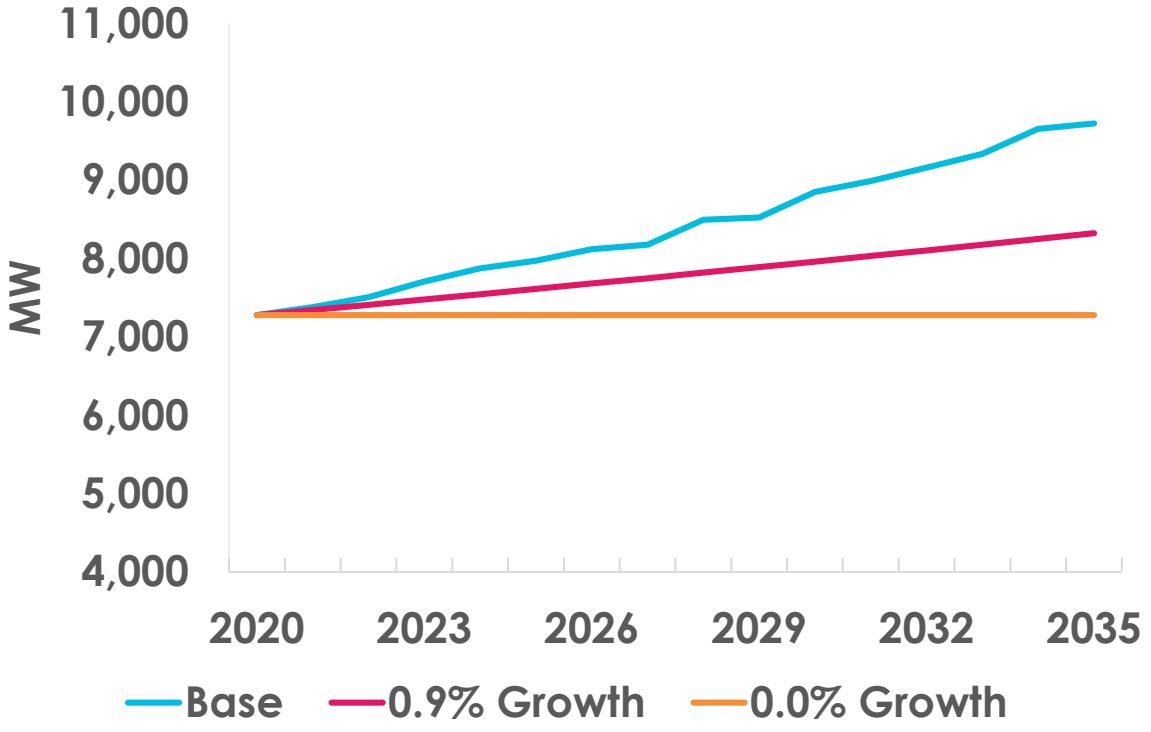
- Market
- Regulations

At least one portfolio*

- 1,000 MW energy storage
- Fossil fuel < 20% of additions
- At least 50% clean
- 20% DSM minimum
- 25 MW of biomass

*ACC required

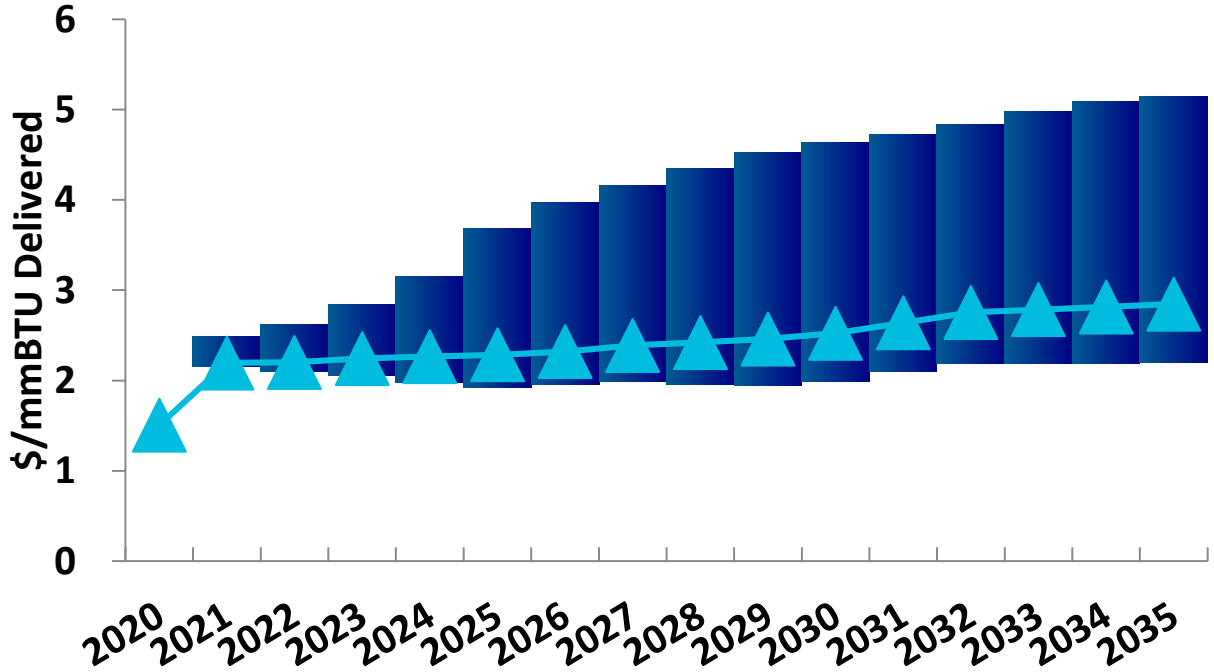
Load Forecast Sensitivity



- Base forecast projects load additions of approximately 2,600 MW
- 0.9% forecast projects load additions of approximately 1,000 MW

APS base forecast and ACC required sensitivities

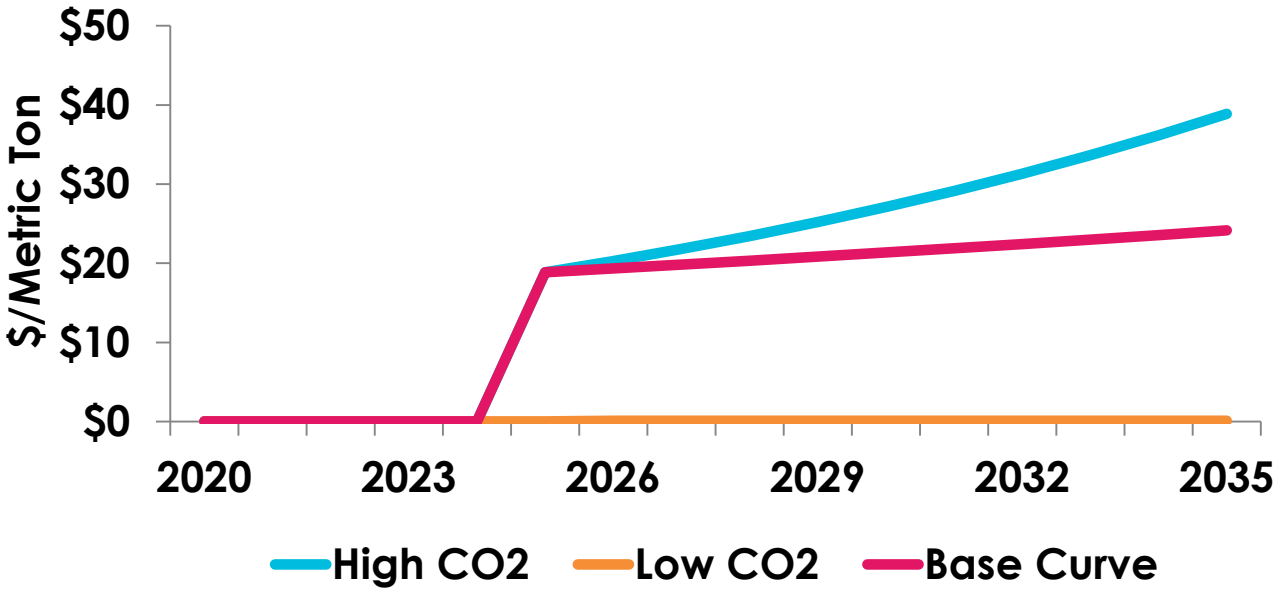
Natural Gas Price Sensitivity



- Natural gas prices are forecast to remain low over the planning period
- High gas case approximately 75% higher than base case

Natural gas prices represent the 2020 Annual Energy Outlook high and low cases, adjusted for the APS hedge

Carbon Price Sensitivity



- Carbon pricing is evaluated at three levels beginning in 2025
- Carbon Prices up to $40/metric ton during planning period

Assumes carbon legislation becoming effective in 2025

Planning for Future Needs

- We will **adapt** to new and future technology
  - Energy storage, hydrogen, carbon capture…
  - Long duration storage solutions will become essential to reliability with high renewable additions
- Technology will be needed to achieve 100% **clean** while maintaining **affordability**
- Many **future technologies** emerging are not yet commercial
- We see our path forward only made possible by working with our **stakeholders** in the best interest of our **customers**

Questions?

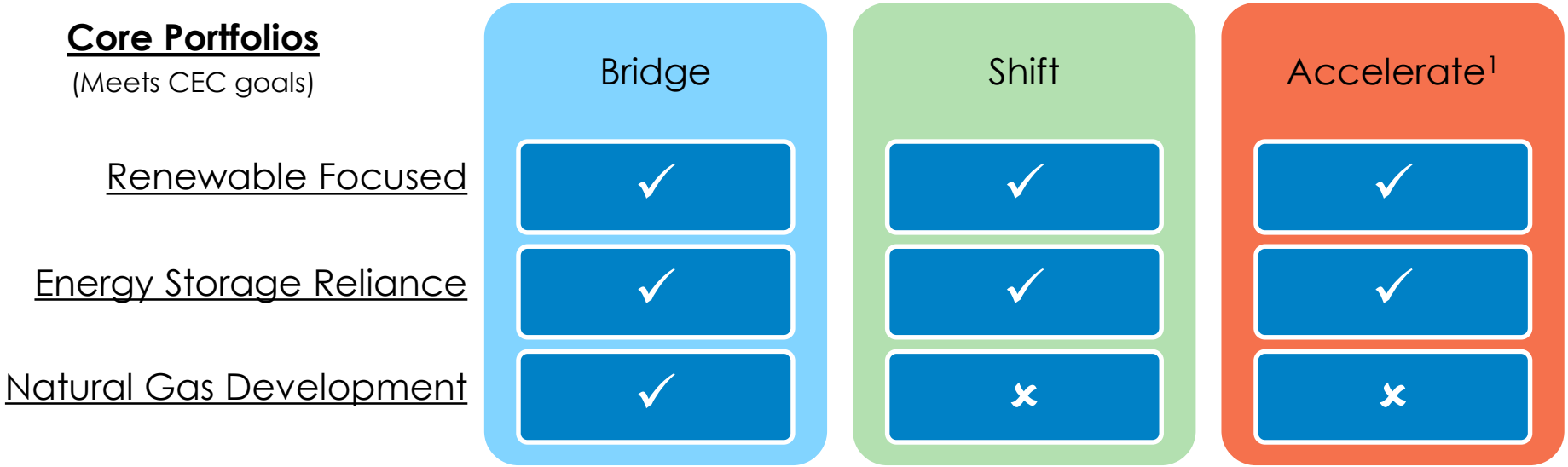
APS Portfolio Review

Laura Herman - APS

Portfolio Perspectives*

APS will offer multiple portfolios and sensitivities but will not selected a preferred portfolio

Core Portfolios
(Meets CEC goals)

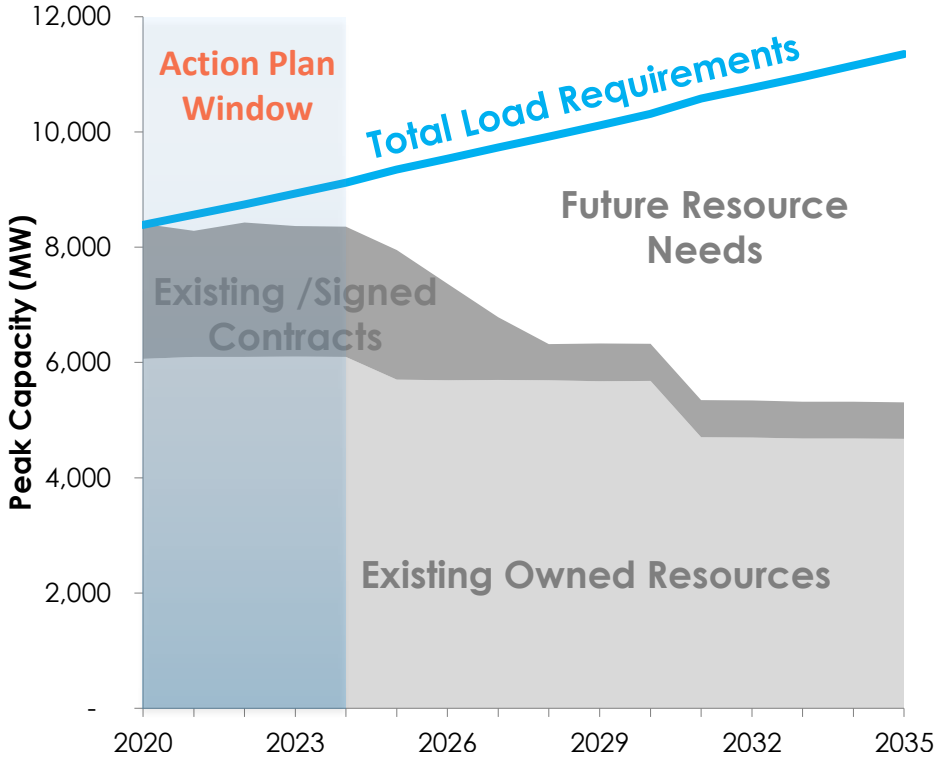


[1]The ACC requires at least one plan include 25 MW of biomass

*Technology agnostic plan was created for reference only

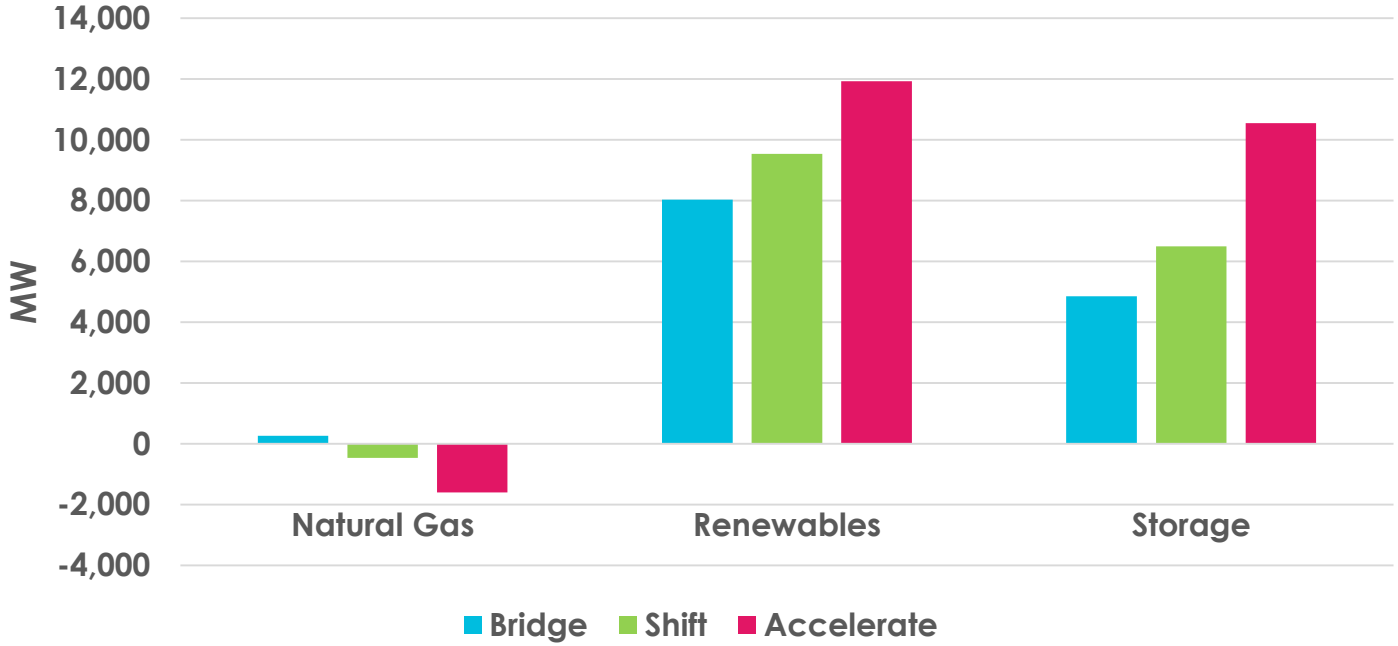
Determining Peak Resource Needs

- Resource needs are driven by:
  - Increasing load
  - Unit retirements
  - Contract expirations
- Action Plan window identifies decisions that must be made
  - All three portfolios require same near-term resources
- 15 year planning window view allows for strategy development to achieve a carbon free future
  - Identifies pace of renewable and storage additions



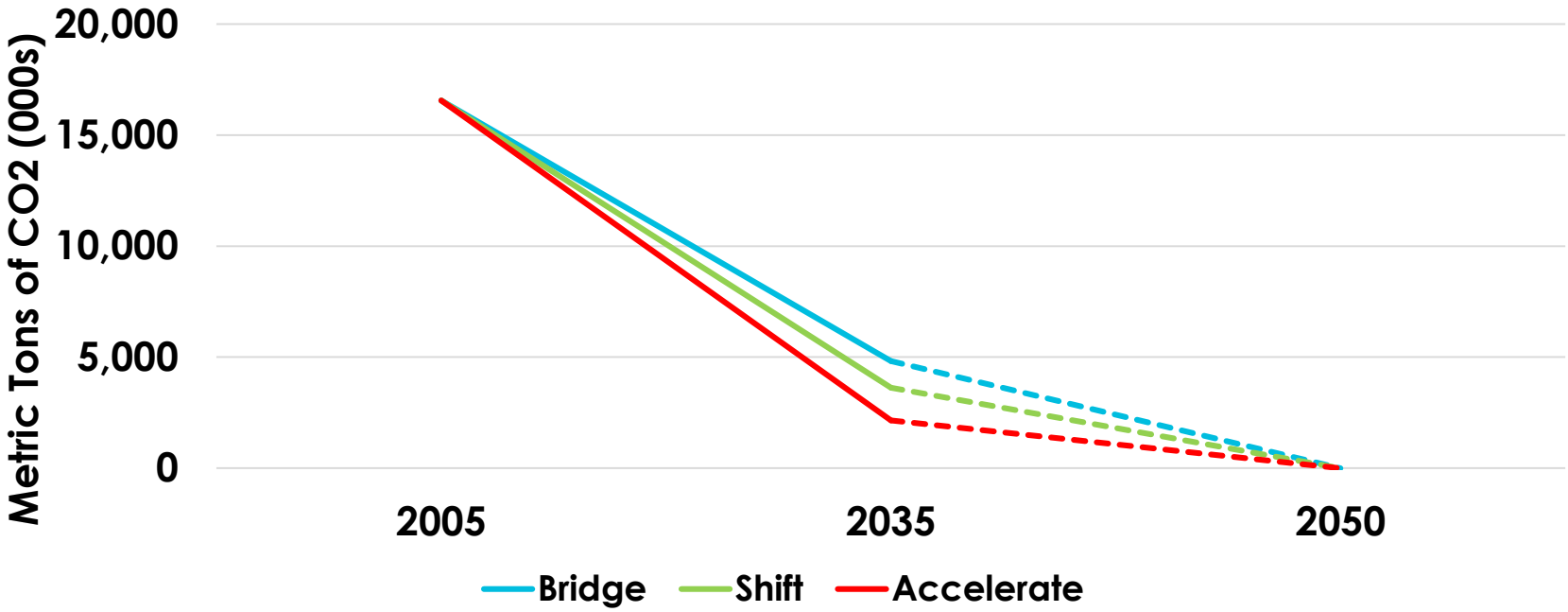
Net Portfolio Resource Additions by 2035

Compared to existing portfolio



Large renewable and storage resources needed in every portfolio

Carbon Reduction Path

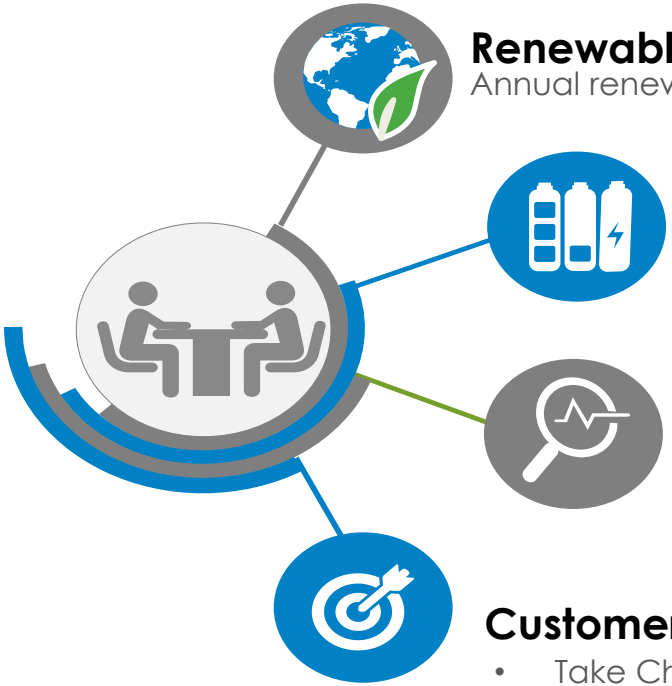


Questions?

Next Steps

Jeff Burke - APS

Action Plan Update

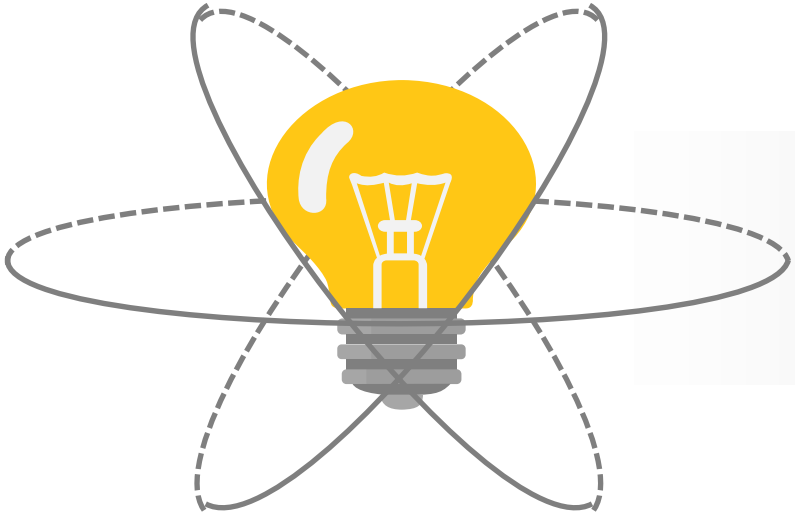


Renewable Timing
Annual renewable additions of 300-400 MW through 2024

Storage Timing
Annual energy storage additions of 200-300 MW, beginning in 2022

RFP Update & Approach
- Update current RFP status
- Utilize Action Plan to announce upcoming RFPs, consider multiple years at once

Customer Programs and Updates
- Take Charge AZ
- DSM Implementation Plan
- APS Rewards Programs



REMINDER: IRP will be filed June 26

THANK YOU!