



**SRP Integrated System Plan
Advisory Group Meeting #10
ISP Preliminary Results**

March 10th, 2023

Welcome

Kelly Barr

AGM Chief Strategy Corp Services & Sustainability, SRP

Welcome SRP Board and Council Observers



John Hoopes
SRP Association Vice
President



Chris Dobson
SRP District Vice President



Anda McAfee
SRP Board Member



Jack White
SRP Board Member



Larry Rovey
SRP Board Member



Krista O'Brien
SRP Board Member



Suzanne Naylor
SRP Council Member



Rocky Shelton
SRP Council Member

Safety & Sustainability Minute

SRP Updates

Meeting Objectives:

- Debrief the Technical Working Session: Inverter-Based Resources
- Share and discuss preliminary ISP long-term capacity expansion results

Agenda

Time		Topics	Discussion Lead
8:30-9:00	30 min	Breakfast & Networking	
9:00-9:20	20 min	Welcome, Opening Remarks and Meeting Orientation	Kelly Barr (SRP) Bobby Olsen (SRP) Joan Isaacson (K&W)
9:20-9:30	10 min	Recap of Jan. 27 th ISP Advisory Group Meeting: Continuing Forward	Angie Bond-Simpson (SRP)
9:30-10:00	30 min	Technical Working Session: Inverter-Based Resources Debrief, Roundtable Discussion and Takeaways for Planning	Arne Olson (E3) Angie Bond-Simpson (SRP)
10:00-10:30	30 min	ISP Study Plan Context for Preliminary Results	Kyle Heckel (SRP)
10:30- 10:45	15 min	Coffee Break	
10:45-12:30	105 min	Preliminary ISP Long-Term Capacity Expansion Results — Select Cases	Joe Hooker (E3)
12:30-1:30	60 min	Working Lunch/Wrap Up	Angie Bond-Simpson (SRP)
1:30-2:30	60 min	Technical Q&A Opportunity	Facilitated by Joan Isaacson (K&W)

Guides for Productive Meetings

- Actively participate
- Stand up name tent to indicate wanting to provide input, ask a question, etc.
- Encourage and seek multiple perspectives, including use of multiple engagement methods
- When introducing technical subjects, begin with straightforward definitions and avoid acronyms; create comfortable environment for questions and understanding
- Stay concise so that everyone has time to participate
- Maintain one representative per Advisory Group member organization in meeting discussions
- Enjoy the meeting!

Recap of Jan. 27th ISP Advisory Group Meeting: Continuing Forward

Angie Bond-Simpson

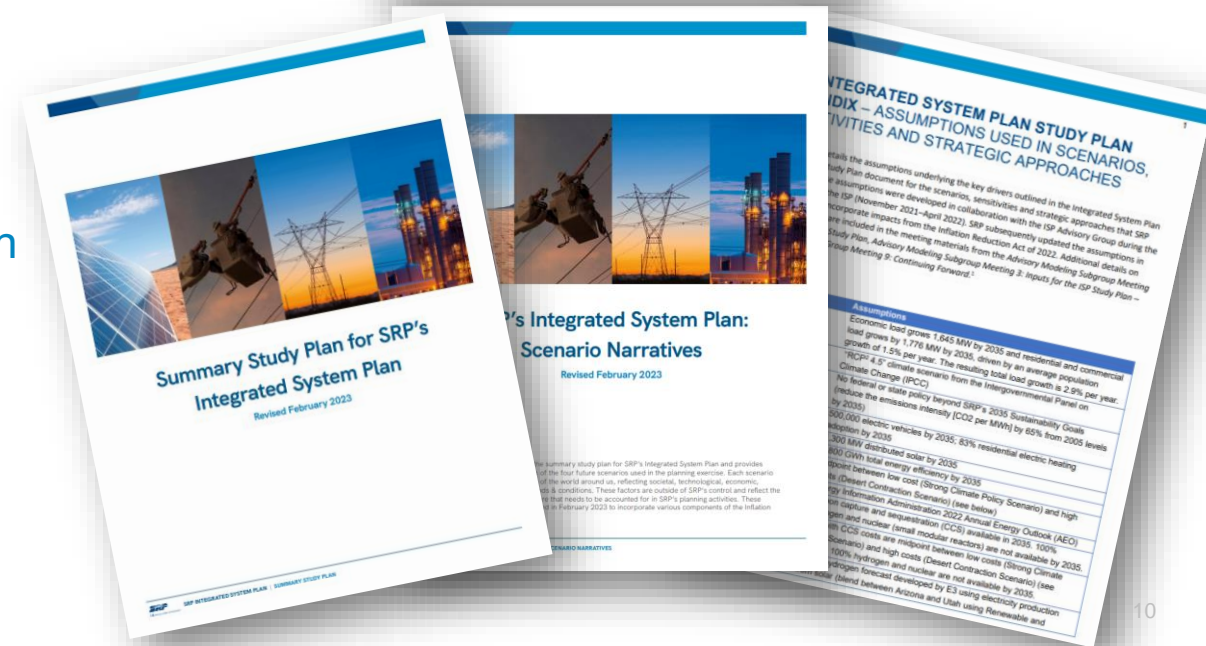
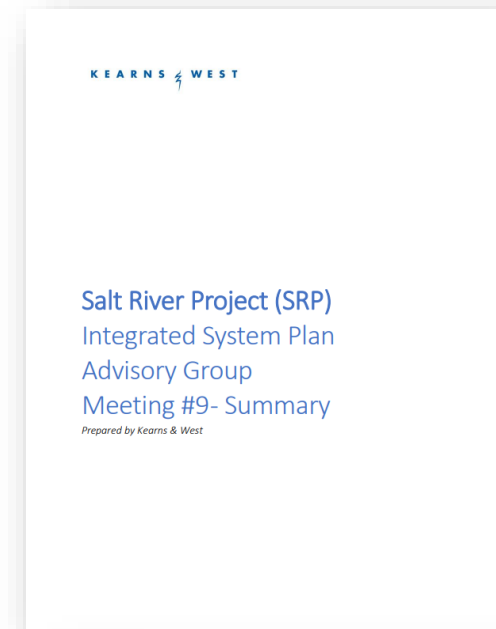
Director, Integrated System Planning & Support, SRP

Jan. 27th Discussion Themes

- Final Guiding ISP Principles
- ISP analysis validation work discussion
- Debrief the Technical Working Session: Inflation Reduction Act (IRA)
- Integrating IRA impacts into technology costs for all ISP scenarios

Since January 27th

- Updated SRP's ISP Study Plan Summary and companion document deliverables to reflect IRA impacts discussed during the Jan. 27th meeting
- Deliverables now available on the ISP Portal



Technical Working Session: Inverter-Based Resources Debrief

Arne Olson
Senior Partner, E3

E3 Summary of Presentations



Moderator- Tess Williams, PhD

**Co-Founder & Principal
Sound Grid Partners**



Nick Miller

**Principal
HickoryLedge LLC**

Future Opportunity and Challenges with High Levels of Inverter-Based Resources (IBRs)

- IBRs bring challenges to power system operations at different timescales with different levels of penetration
- Batteries, synchronous condensers, grid-forming inverters offer opportunities to operate a system reliably with high IBR penetration



Ryan Quint

**Director of Engineering and Security
Integration
North American Electric Reliability
Corporation (NERC)**

Reliability Perspectives: Rapid Integration of Increasing Levels of IBRs

- The industry is still building up knowledge of IBR reliability risks, as demonstrated by the recent disturbance events in Odessa, TX
- NERC's risk management framework and IBR strategy strive to continually improve standards/industry guidelines and mitigate risk



Guillermo Alderete Bautista

**Director, Market Analysis & Forecasting
California ISO (CAISO)**

Market Operations with Increasing IBRs

- Forecasting challenges for renewables result in uncertainty in market and system operations in CAISO
- Numerous solutions for demand- and supply-side flexibility and enhanced market operation are needed to mitigate challenges

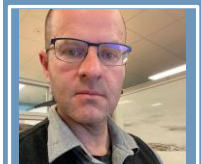


Mahesh Morjaria

**EVP, Plant Operational Technology
Terabase Energy**

Lessons Learned on IBR Dispatch

- Solar photovoltaic (PV) systems have demonstrated capability to provide essential reliability services and flexible dispatch and to operate as firm capacity when paired with battery storage



Keith Parks

**Senior Data Scientist
Xcel Energy**

Utility Perspective: Experience in Managing Increasing IBRs

- Xcel Energy has been a leader in IBR integration on its Colorado system and has worked to address challenges through strategies such as dynamic operation of renewable resources, improved renewable forecasting and large-scale transmission to access diverse renewable resources

E3 takeaways from panel discussion

Inverter-Based Resources (IBRs) are playing an **increasingly large role** on the grid

- IBRs are starting to impact system operational patterns and instantaneously provide very high shares of total generation

IBRs offer **opportunities** to bolster grid reliability and stability

- IBRs can provide essential reliability services with faster response and higher accuracy than thermal generators
- IBRs can be dispatched economically
- Advancements in understanding, regulation and market constructs are needed to provide the right incentives to unlock the potential of IBRs

Many **challenges** will need to be addressed for successful IBR integration

- Forecasting error for renewable resources
- Large-scale outage events due to tripping
- Inadequate standards and knowledge of emerging IBR risks and needs
- Information access and communication challenges for fast-response distributed energy resources (DER)

Numerous **solutions** can be leveraged to mitigate the uncertainty and risks of IBRs

- New system operation schemes and reserve products considering IBR uncertainty & capabilities
- Flexible dispatch and loads (including DERs)
- Diversity of resources and aggregation of resources across larger areas/markets

Roundtable Discussion:

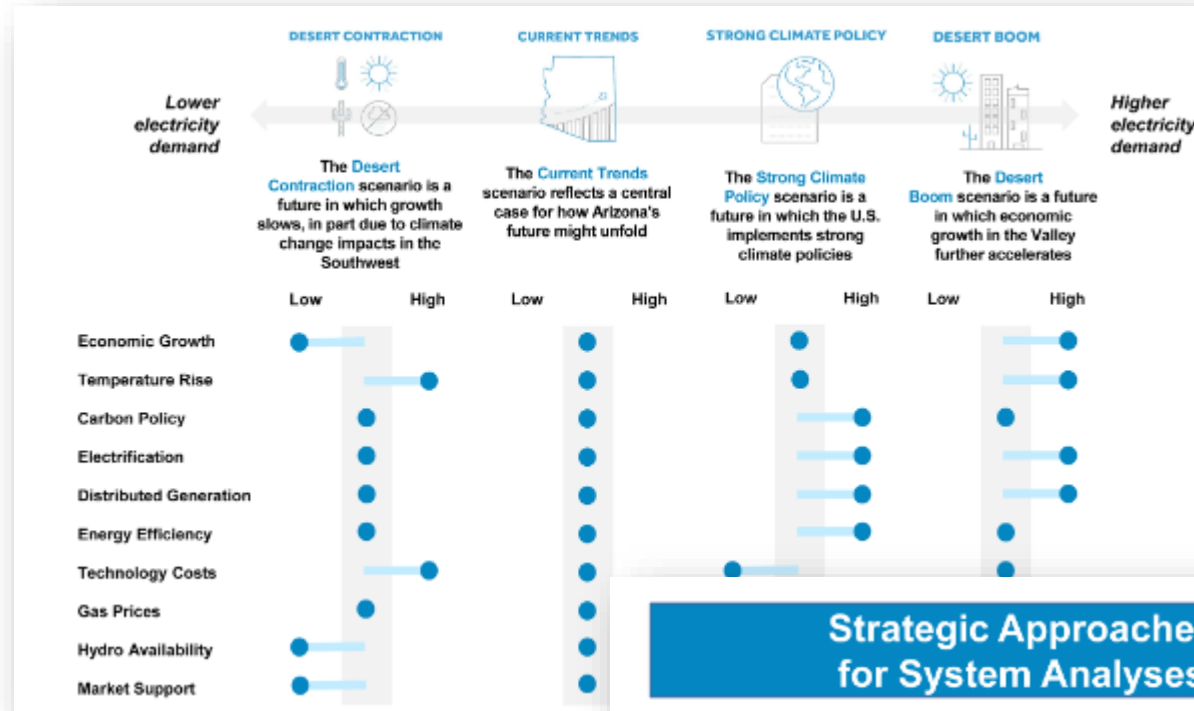
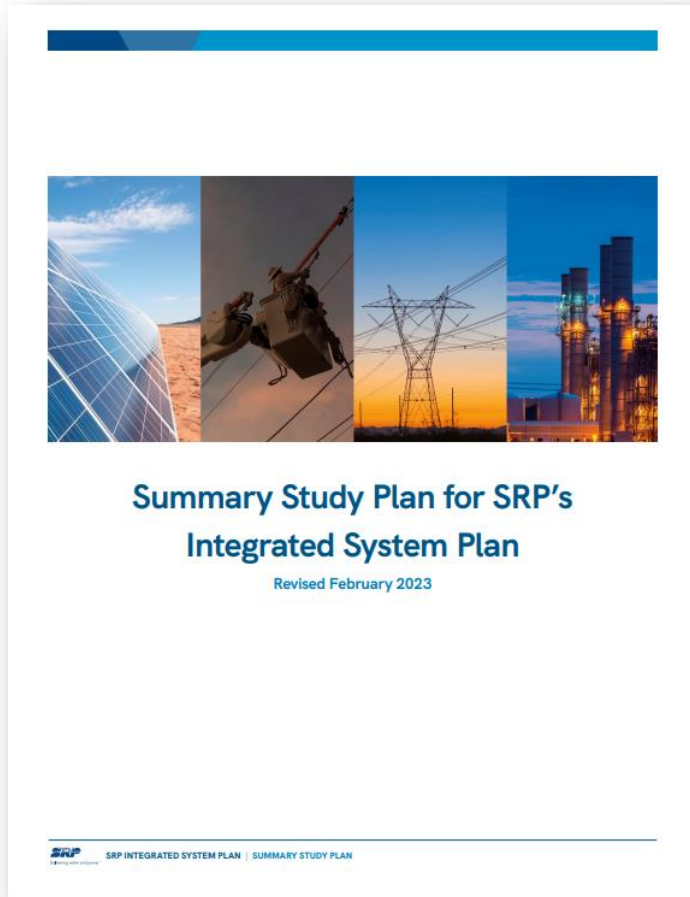
How does your organization plan for transformational change?

ISP Study Plan Context for Preliminary Results

Kyle Heckel

Sr. Engineer, Integrated System Planning & Support, SRP

ISP Study Plan



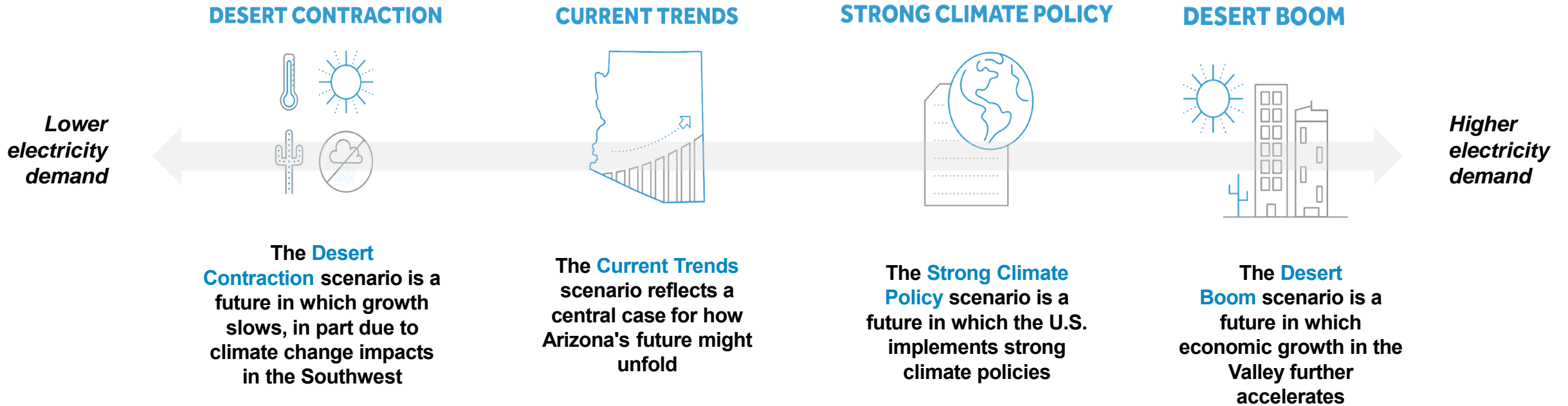
Strategic Approaches for System Analyses

Technology Neutral

No New Fossil

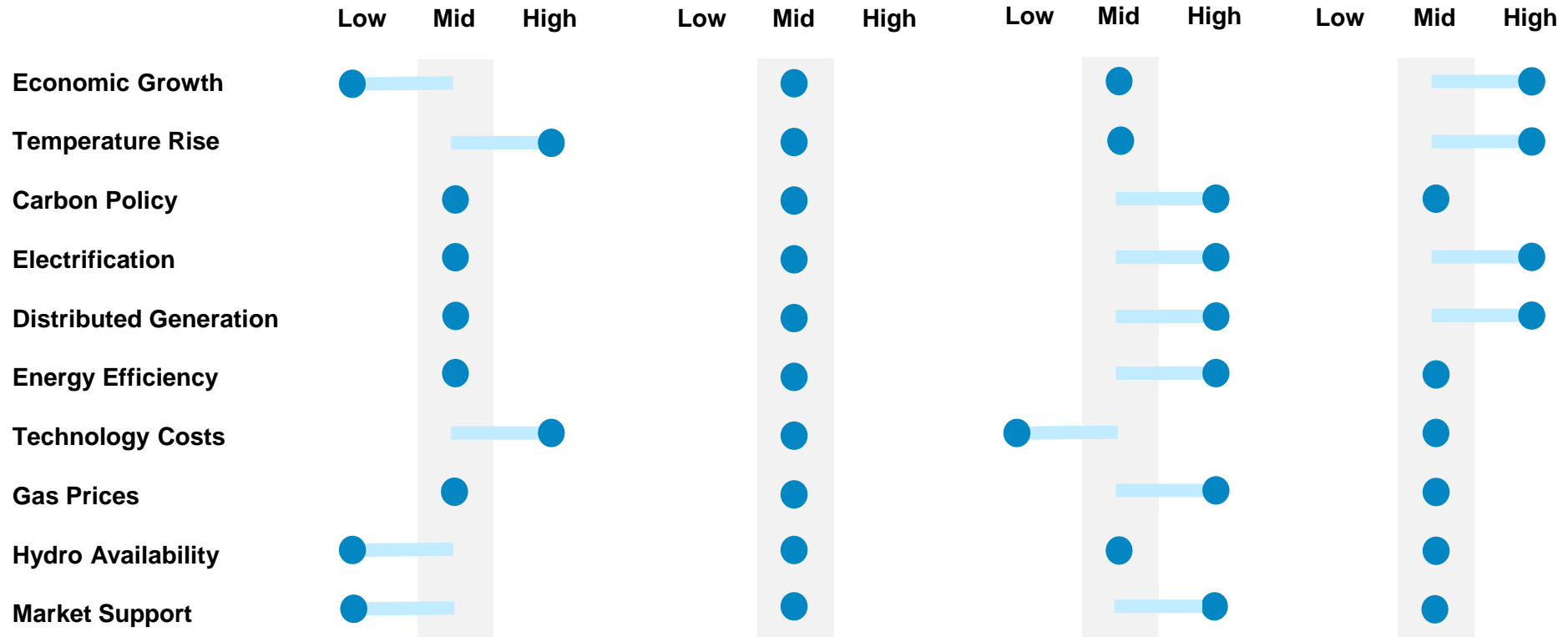
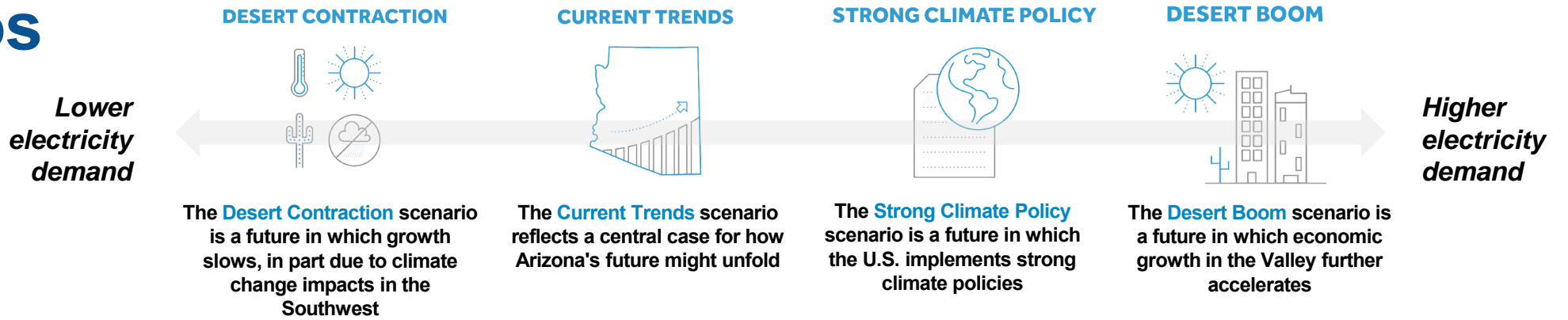
Minimum Coal

The Scenarios in the Integrated System Plan



These scenarios are designed to test how future power systems perform across a range of plausible futures. SRP will not be picking one of these scenarios as a result of the ISP.

Scenarios



Sensitivities Added in Response to Advisory Group Discussions

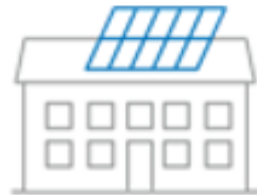
High Demand Response



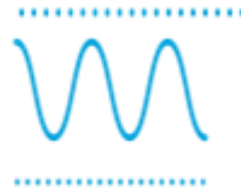
High Energy Efficiency



High Distributed Generation Adoption



Increased Load Management



High, Low & Volatile Gas Prices



High & Low Technology Costs



Regional Diversity



The Strategic Approaches in the Integrated System Plan

Strategic Approaches for System Analyses

Technology Neutral



SRP takes a **least-cost** approach to building the future power system

No New Fossil



SRP avoids investment in new natural gas capacity, **meeting future needs with carbon-free resources**

Minimum Coal



SRP **reduces power generation from coal** and analyzes the system-wide impacts while maintaining reliability

Study Plan Matrix

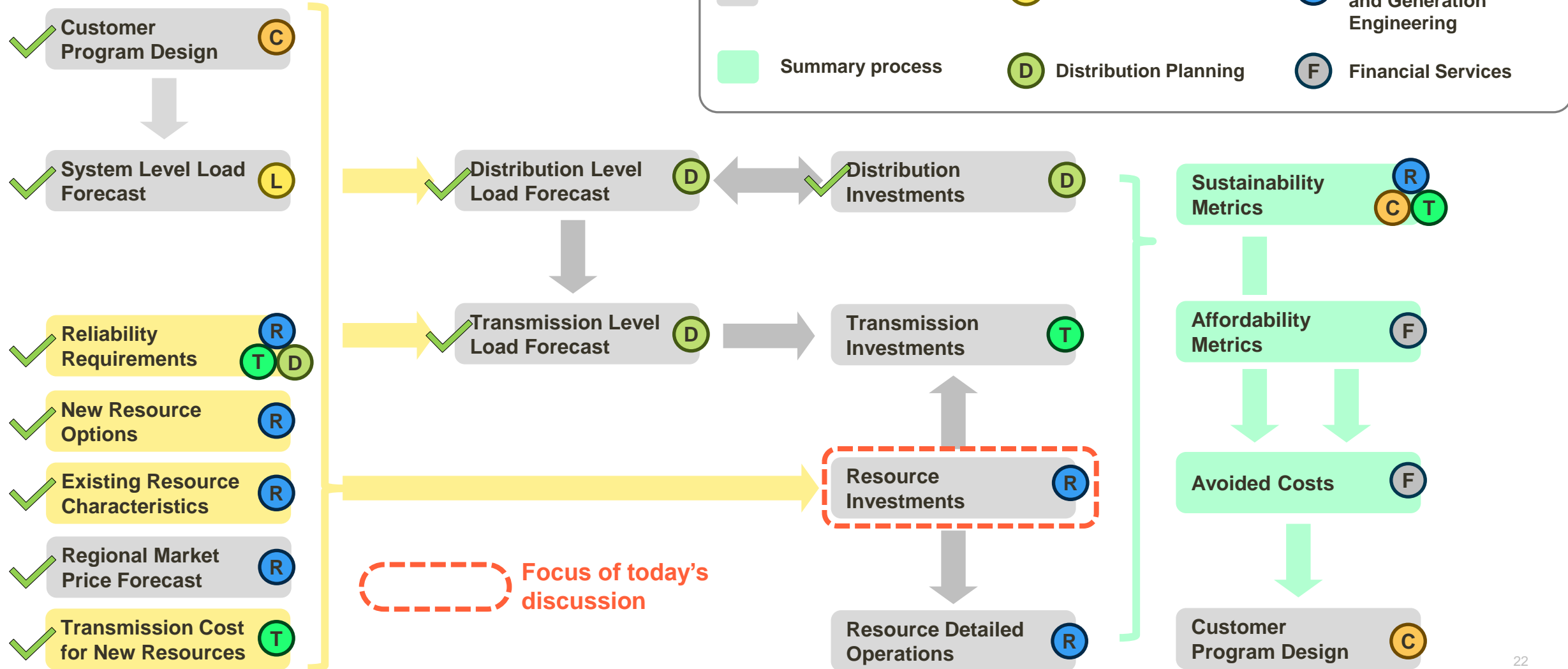
Strategic Approaches

		Technology Neutral	No New Fossil	Min. Coal
Sensitivities	Current Trends	●	●	●
	<i>High, Low, & Volatile Gas Prices</i>	● ● ●	● ● ●	● ● ●
	<i>High & Low Technology Costs</i>	● ●	● ●	● ●
	<i>High Demand Response</i>	●	●	●
	<i>High Energy Efficiency</i>	●	●	●
	<i>High DER Adoption</i>	●	●	●
	<i>Increased Load Management</i>	●	●	●
	<i>Regional Diversity</i>	●	●	●
Scenarios	Desert Contraction	●	●	●
	Desert Boom	●	●	●
	Strong Climate Policy	●	●	●

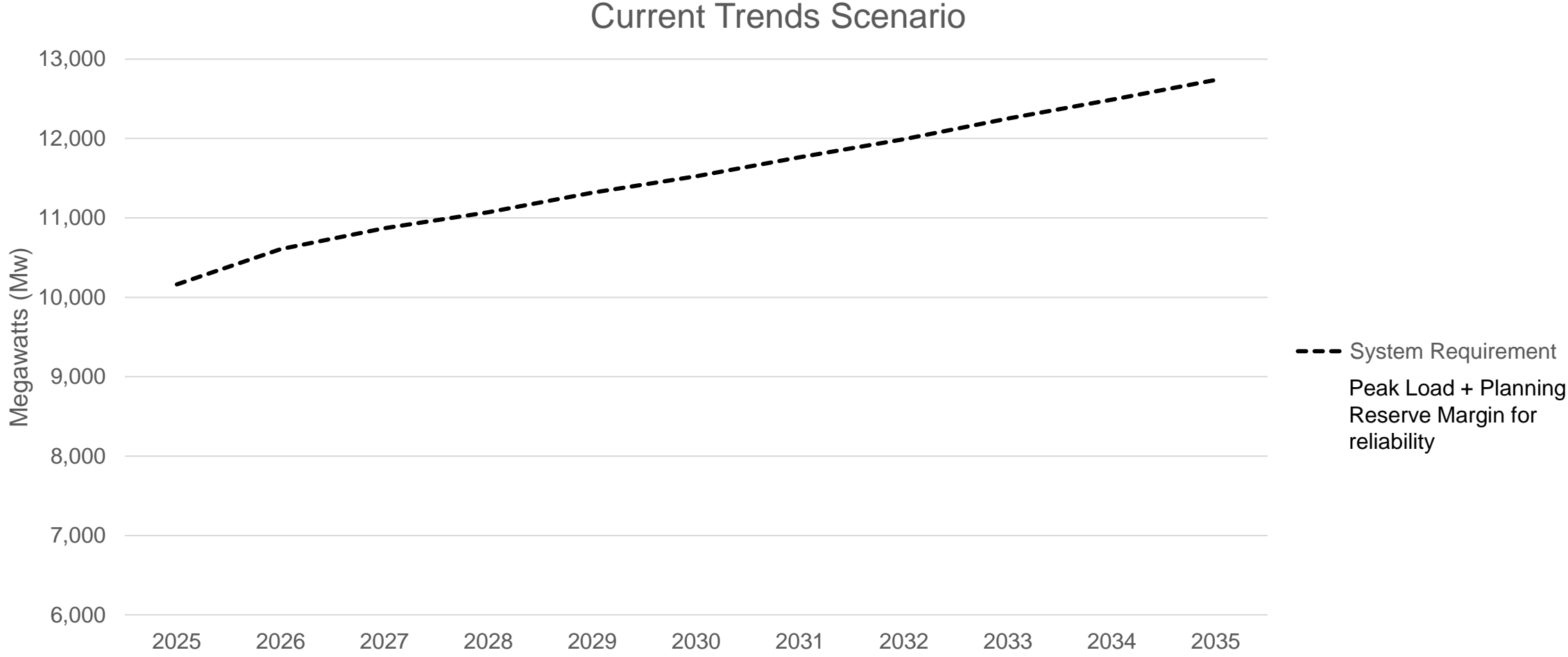


Focus of today's discussion

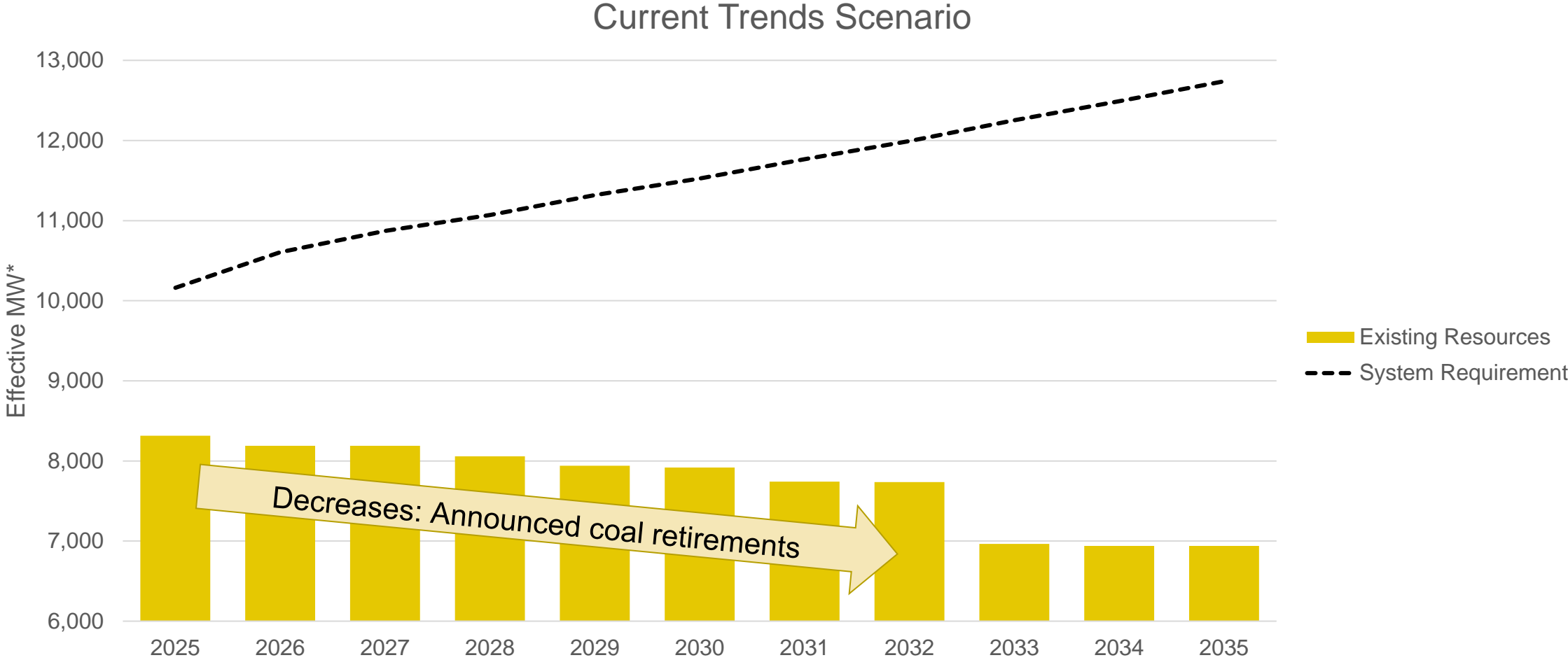
Modeling Framework



Future Resource Needs (2025-2035)



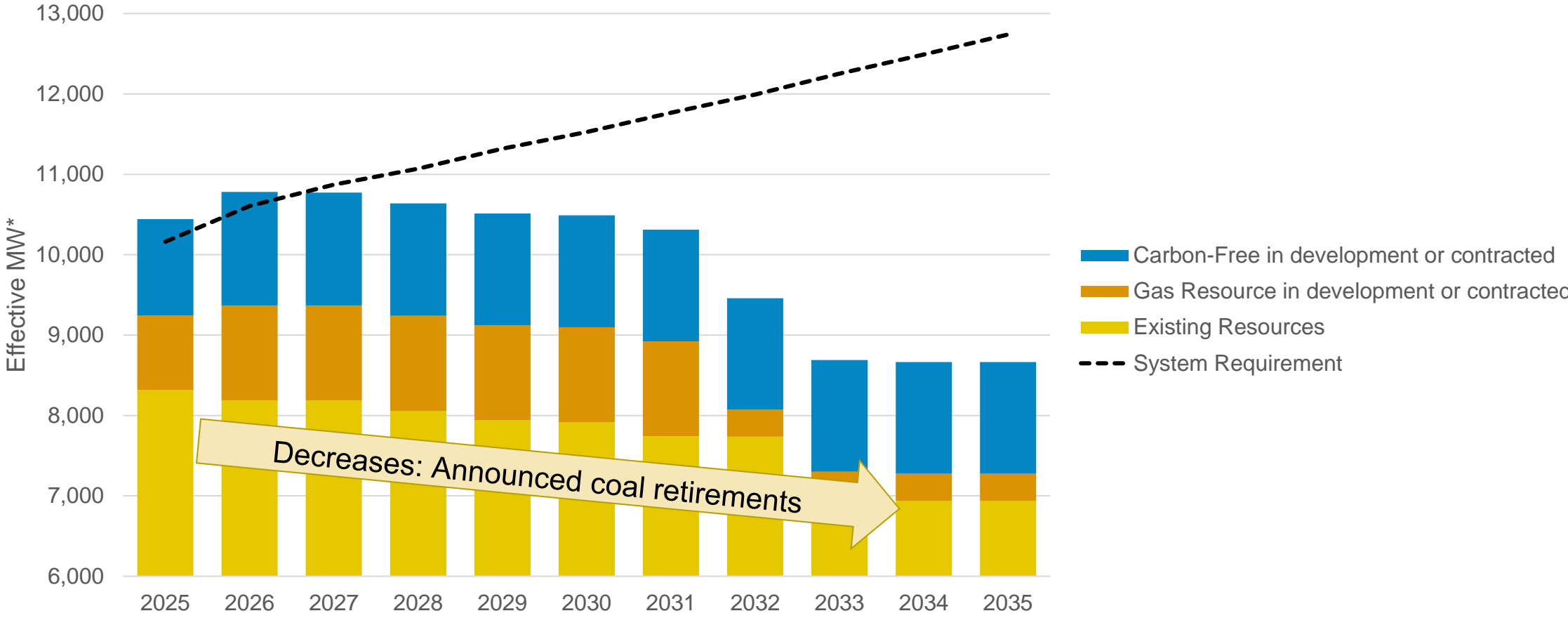
Future Resource Needs (2025-2035)



*Effective MW represents how each resource serves SRP's reliability needs, which is usually less than nameplate MW.

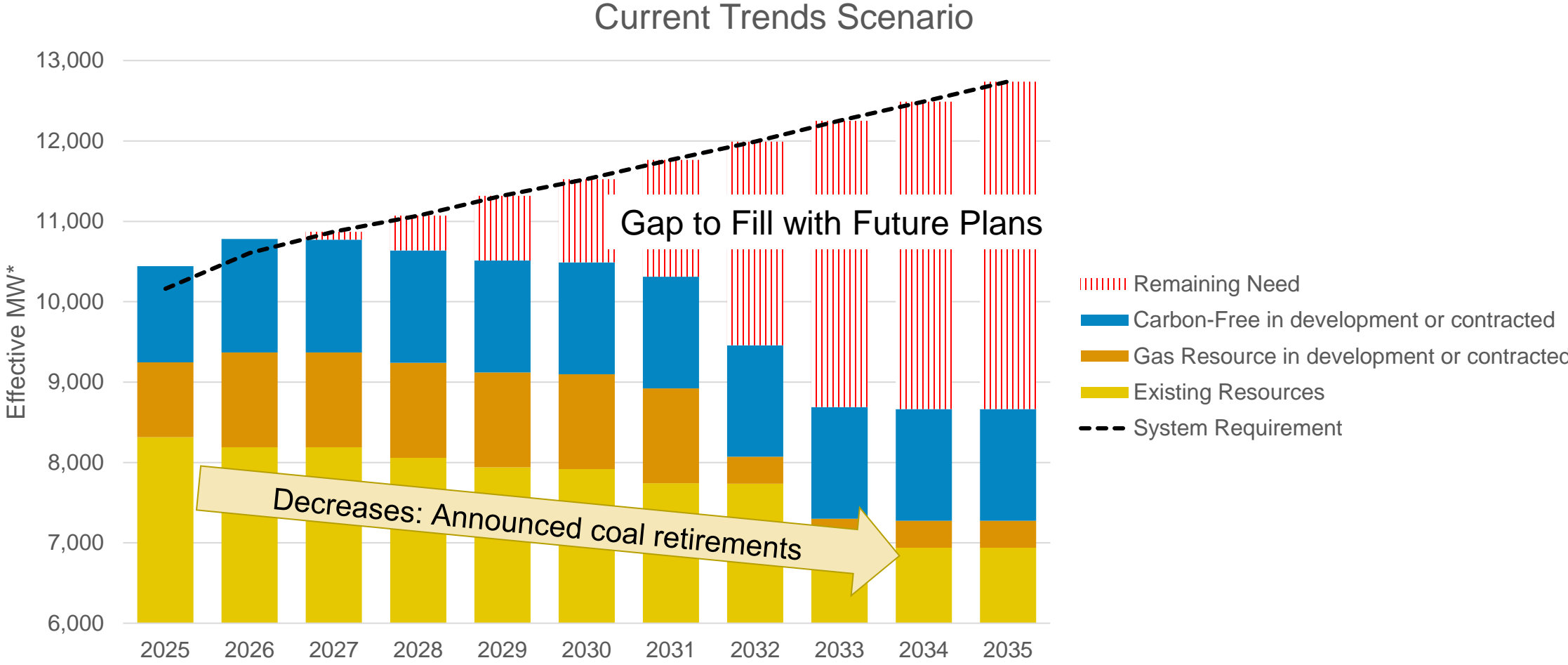
Future Resource Needs (2025-2035)

Current Trends Scenario



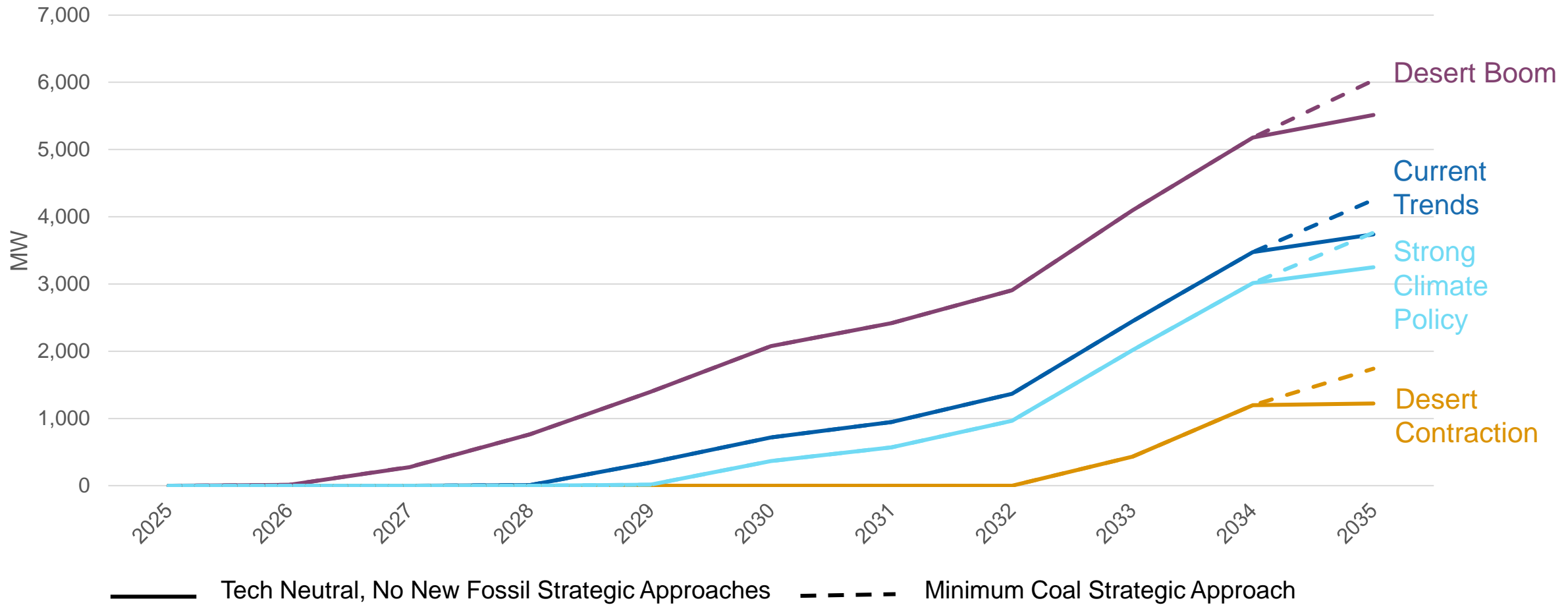
*Effective MW represents how each resource serves SRP's reliability needs, which is usually less than nameplate MW.

Future Resource Needs (2025-2035)



*Effective MW represents how each resource serves SRP's reliability needs, which is usually less than nameplate MW.

Resource Needs by ISP Scenario



Questions

Coffee Break

Preliminary ISP Long-Term Capacity Expansion Results — Select Cases

Joe Hooker

Associate Director, E3

Overview of Section

- Establish foundation by reviewing current system and near-term additions
- Review installed capacity and energy mix results for two cases in 2025/2030/2035
- Compare installed capacity and other metrics across all six cases analyzed to date

Study Plan Matrix

Strategic Approaches

		Technology Neutral	No New Fossil	Min. Coal
Sensitivities	Current Trends	●	●	●
	<i>High, Low, & Volatile Gas Prices</i>	● ● ●	● ● ●	● ● ●
	<i>High & Low Technology Costs</i>	● ●	● ●	● ●
	<i>High Demand Response</i>	●	●	●
	<i>High Energy Efficiency</i>	●	●	●
	<i>High DER Adoption</i>	●	●	●
	<i>Increased Load Management</i>	●	●	●
	<i>Regional Diversity</i>	●	●	●
Scenarios	Desert Contraction	●	●	●
	Desert Boom	●	●	●
	Strong Climate Policy	●	●	●

Today, we will discuss long-term capacity expansion results for six cases.

These six cases were selected to share initially because they span a wide range of planning assumptions.

Resource Definitions

Resource Name*	Description	Inverter-Based Resource	Carbon-Free Energy
Demand Response	Flexible loads that can reduce or shift consumption on demand		✓
Market Purchases	Electricity imports into SRP's service area		
Pumped Hydro	Energy storage using water (pump uphill, release to generate)		
Battery Storage	Energy storage using lithium-ion batteries	✓	
Solar	Solar photovoltaic panels	✓	✓
Wind	Wind turbines	✓	✓
Hydrogen	Power plant fueled by 100% green hydrogen fuel — produced from renewable energy via electrolysis		✓
Hydro	Conventional hydroelectric power		✓
Biomass with CCS	Power plant fueled by biomass that captures carbon dioxide and sequesters it underground. CCS = carbon capture and sequestration		✓
Biomass	Power plant fueled by biomass		✓
Geothermal	Power plant powered by underground geothermal heat		✓
Nuclear	Power plant fueled by uranium; Palo Verde (existing) and small modular reactors (candidate resource option)		✓
Natural Gas	Power plant fueled by natural gas; combined cycle plants or gas peakers		
Coal	Power plant fueled by coal		

* The order in this table aligns with the order in the legend for charts in this section of the presentation.

Overview of Select Metrics

Installed capacity in megawatts (MW) (“capacity”) — This is the amount of power plant capacity when generating at maximum output. Oftentimes, power plants do not operate at their maximum output. As a basis of comparison, SRP’s current installed capacity is greater than 8,800 MW.

Why it matters:

- Capacity additions represent projects that SRP or contractors would construct.
- SRP must build enough capacity to ensure reliability.

Annual generation in gigawatt-hours (GWh) (“energy”) — This is the amount of energy generated by power plants over the course of a year. As a basis of comparison, SRP’s total annual energy demand is on the order of 33,000 GWh today.

Why it matters:

- For some generating technologies, generation results in emissions (e.g., CO₂) and/or water usage.
- SRP has 2035 Sustainability Goals for carbon emissions reduction and water resiliency.

Study Plan Matrix

Strategic Approaches

		Technology Neutral	No New Fossil	Min. Coal
Sensitivities	Current Trends	●	●	●
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	<i>High & Low Technology Costs</i>	● ●	● ●	● ●
	<i>High Demand Response</i>	●	●	●
	<i>High Energy Efficiency</i>	●	●	●
	<i>High DER Adoption</i>	●	●	●
	<i>Increased Load Management</i>	●	●	●
	<i>Regional Diversity</i>	●	●	●
Scenarios	Desert Contraction	●	●	●
	Desert Boom	●	●	●
	Strong Climate Policy	●	●	●

The **Technology Neutral** strategic approach aims to develop future system plans on a technology-neutral basis.

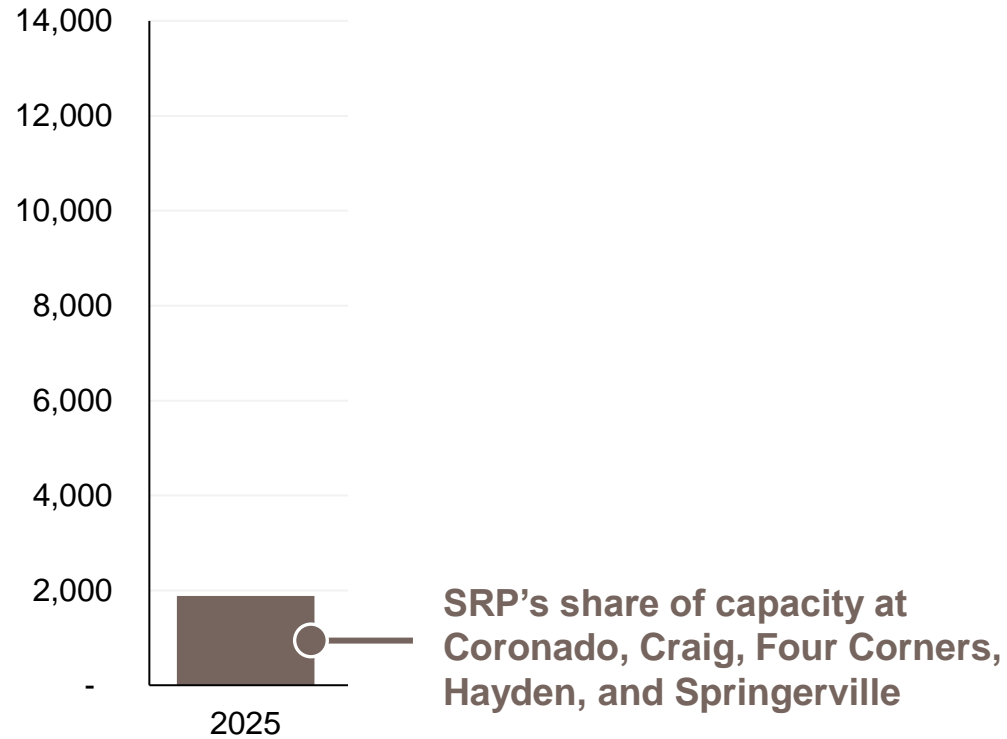
The **Current Trends** scenario reflects a central case for how Arizona's future might unfold.

Technology Neutral, Current Trends

Technology-neutral approach – current trends continue for external factors

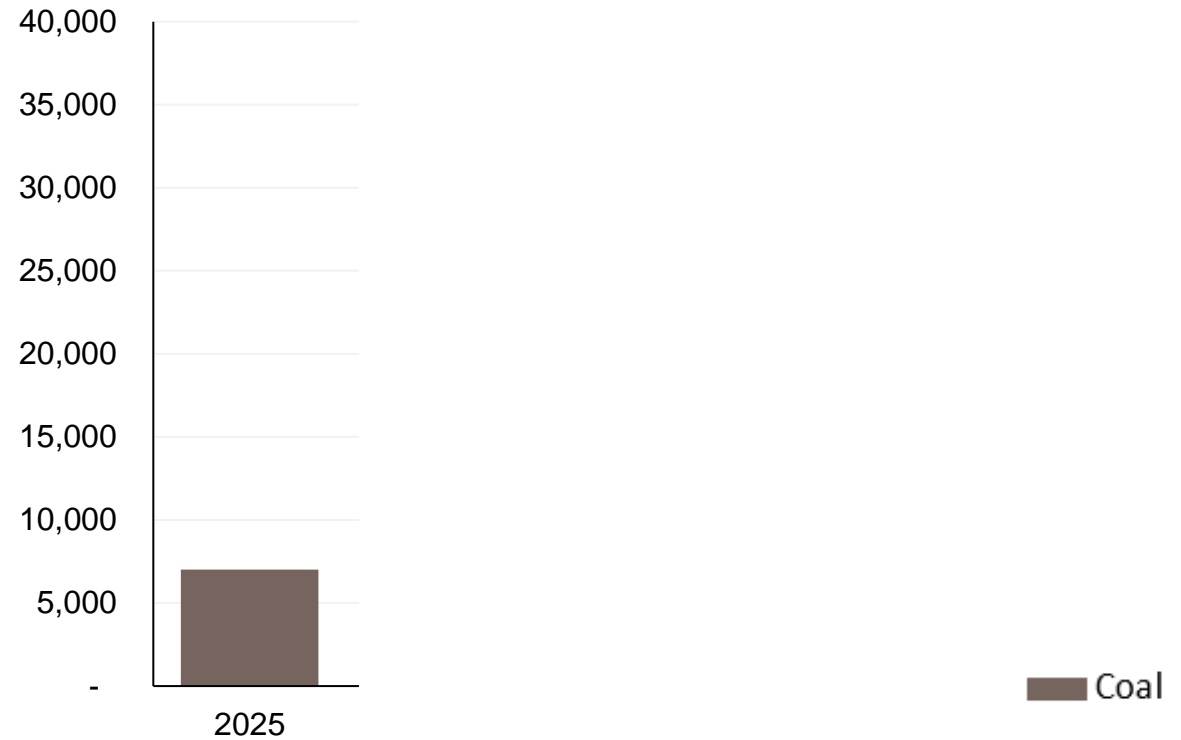
Total Installed Capacity

(MW)



Annual Generation (Preliminary Energy Mix*)

(GWh)



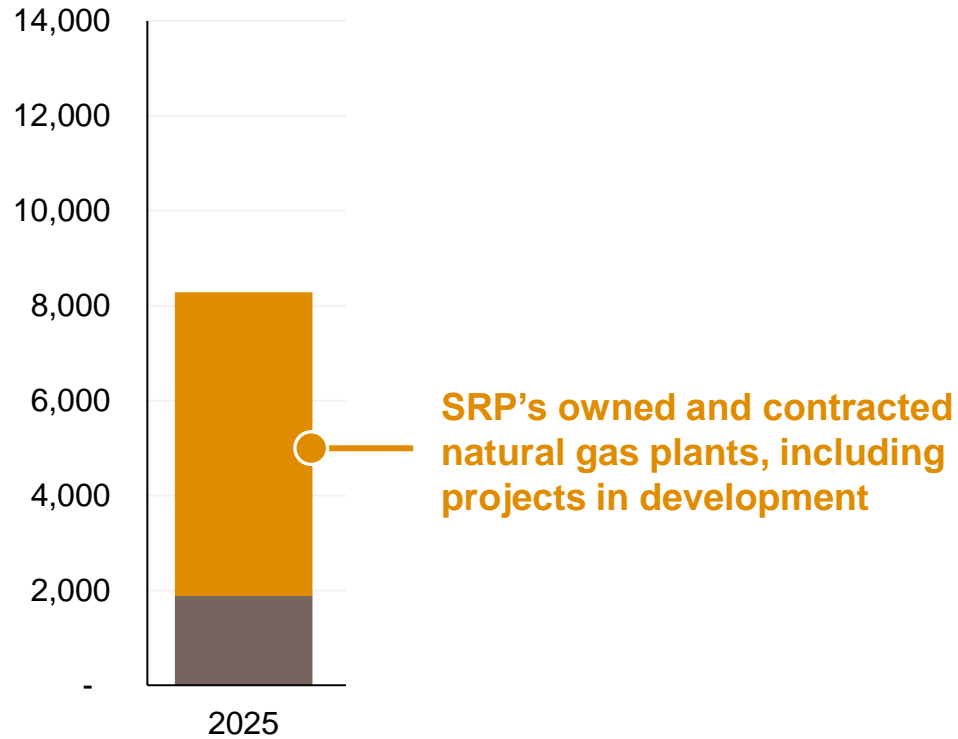
* This is the energy mix based on capacity expansion modeling. Detailed operational analysis through production cost modeling will follow and set the basis for the final energy mix.

Technology Neutral, Current Trends

Technology-neutral approach, current trends continue for external factors

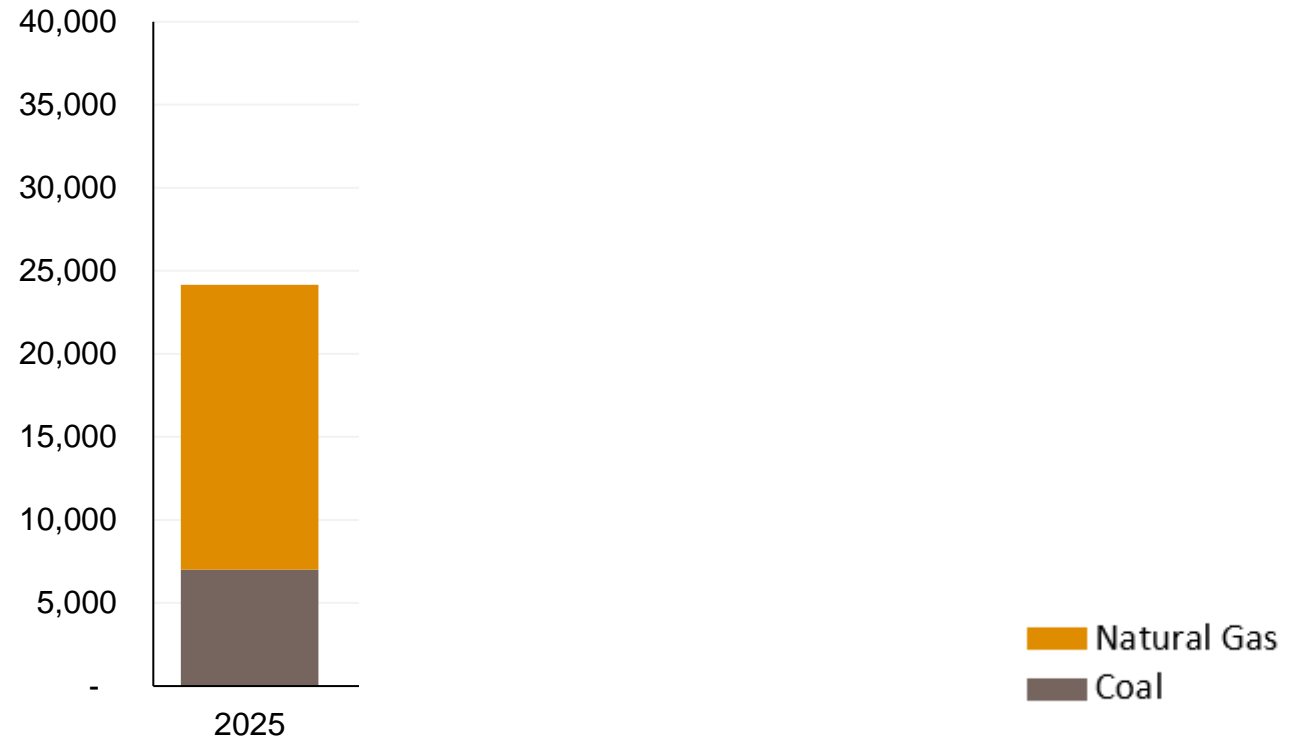
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Annual Generation (Preliminary Energy Mix*)

(GWh)



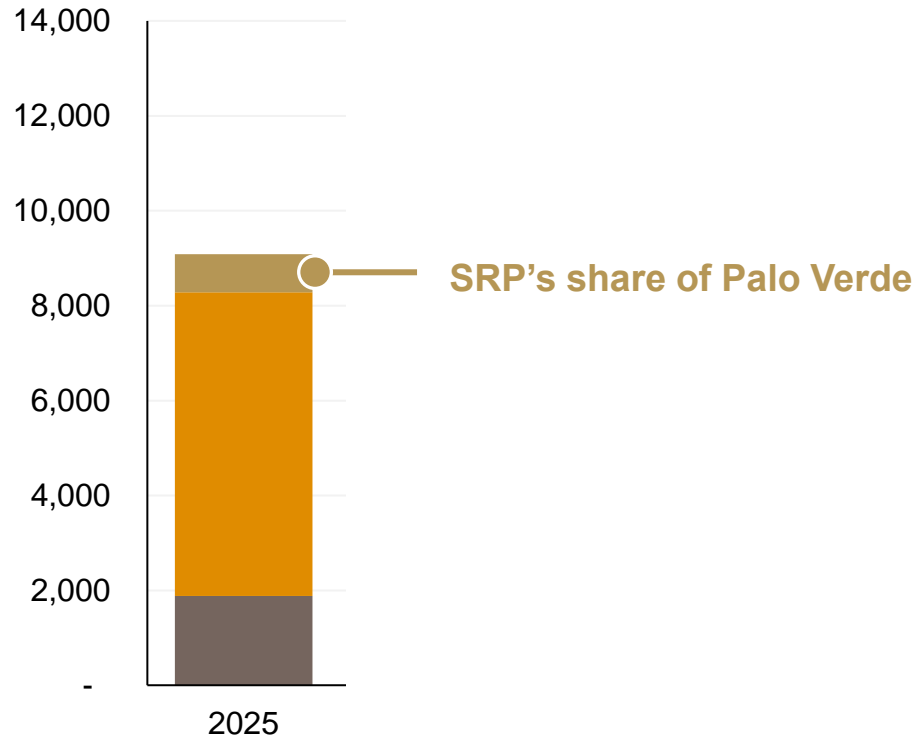
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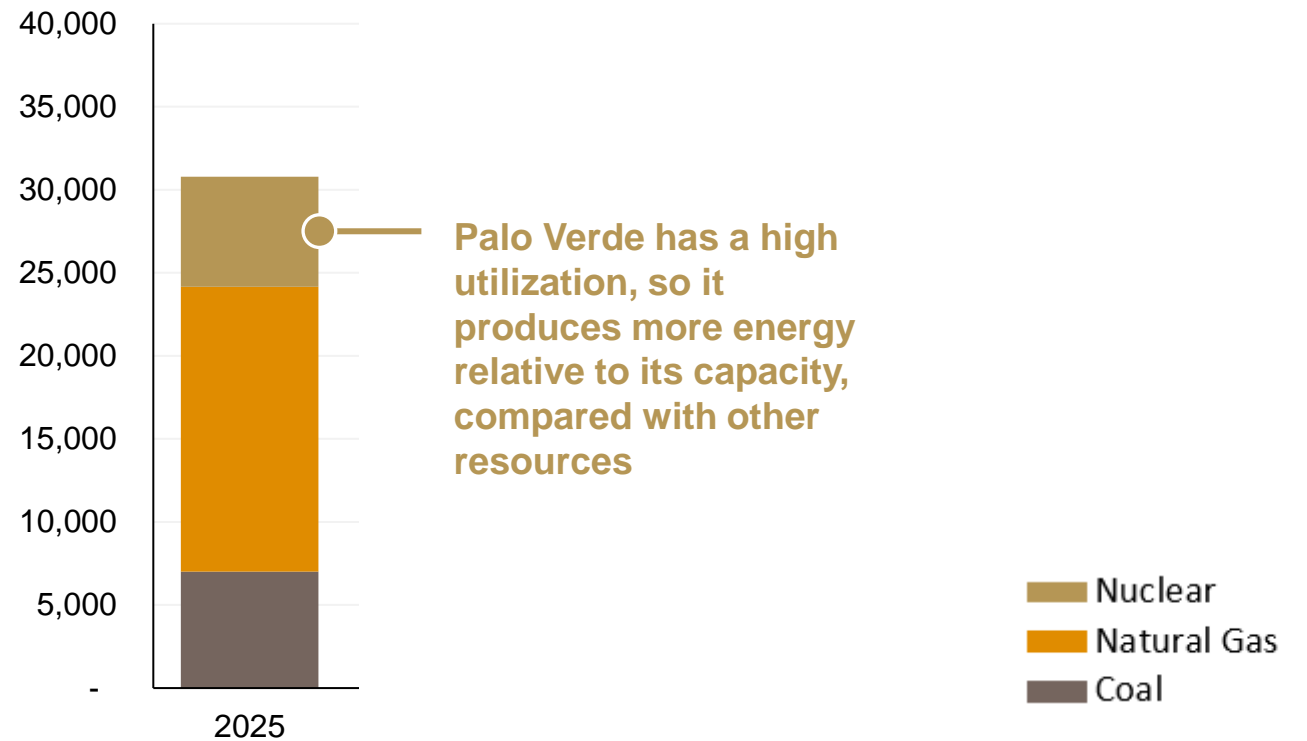
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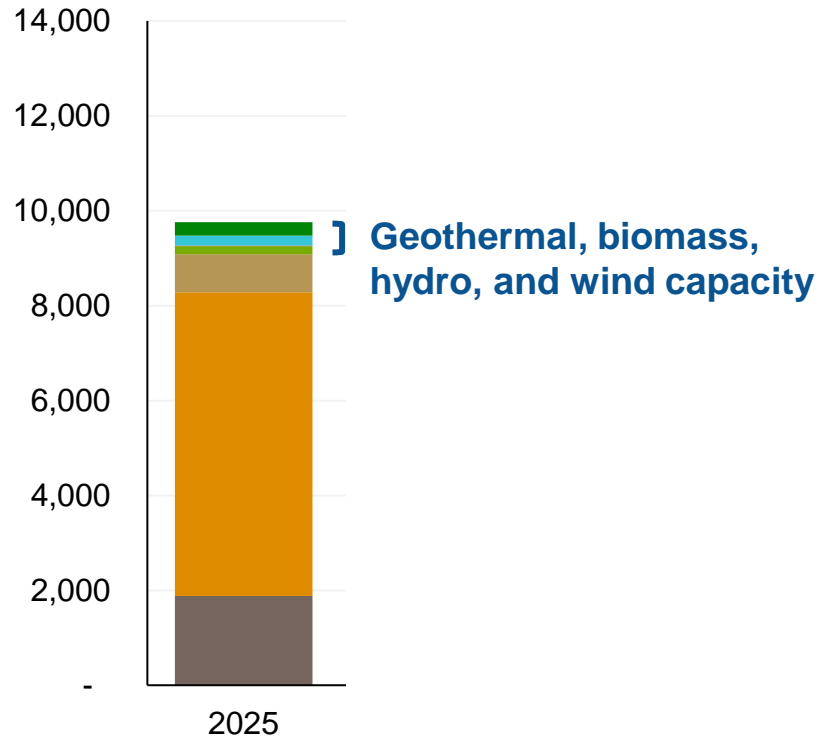
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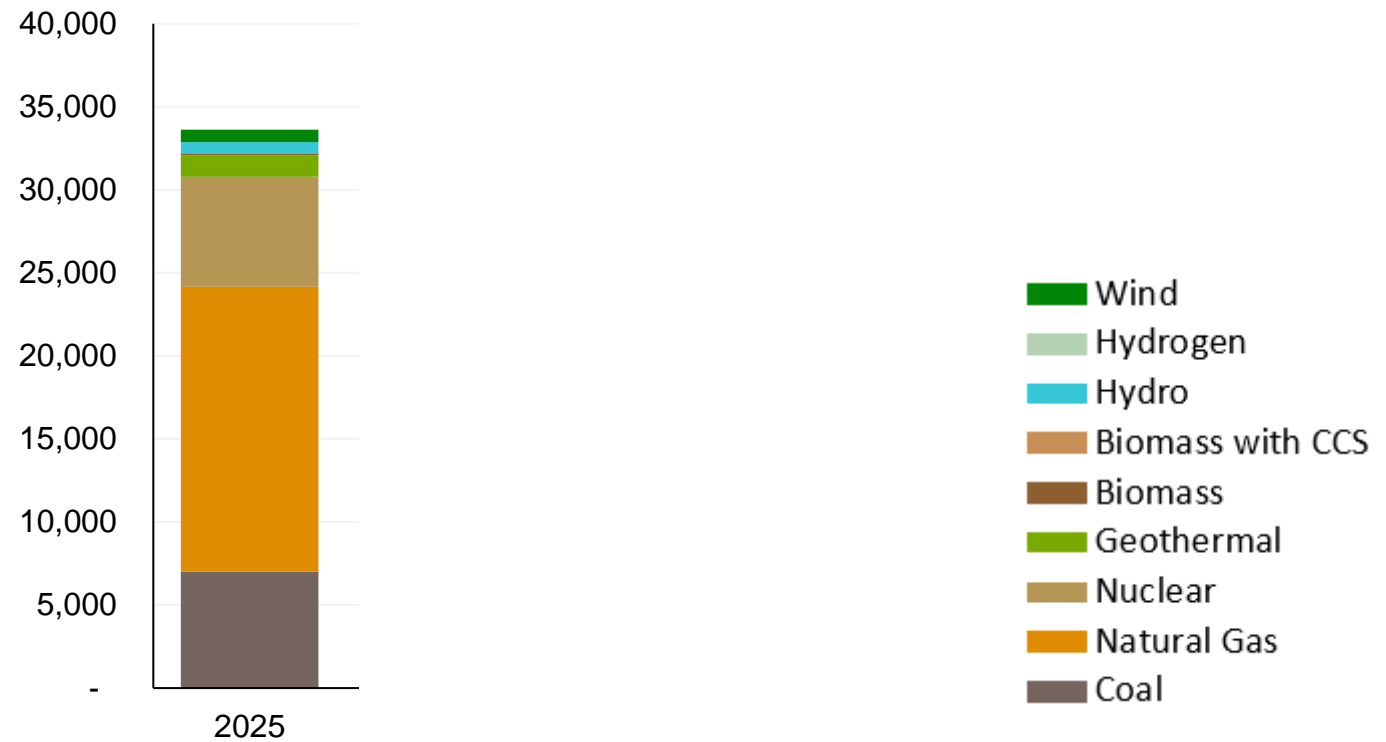
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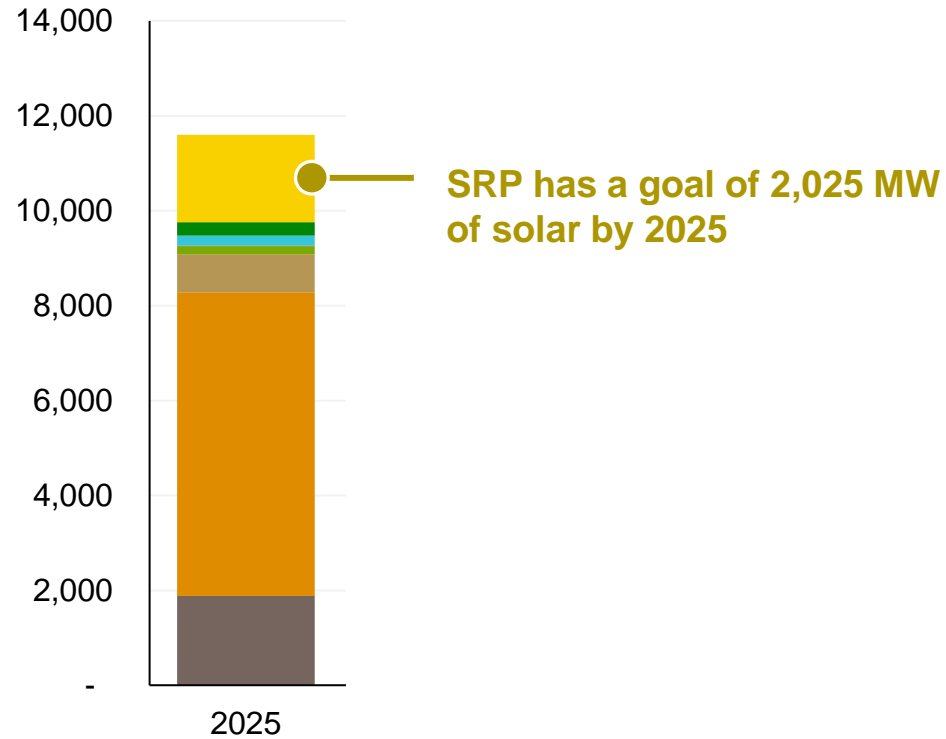
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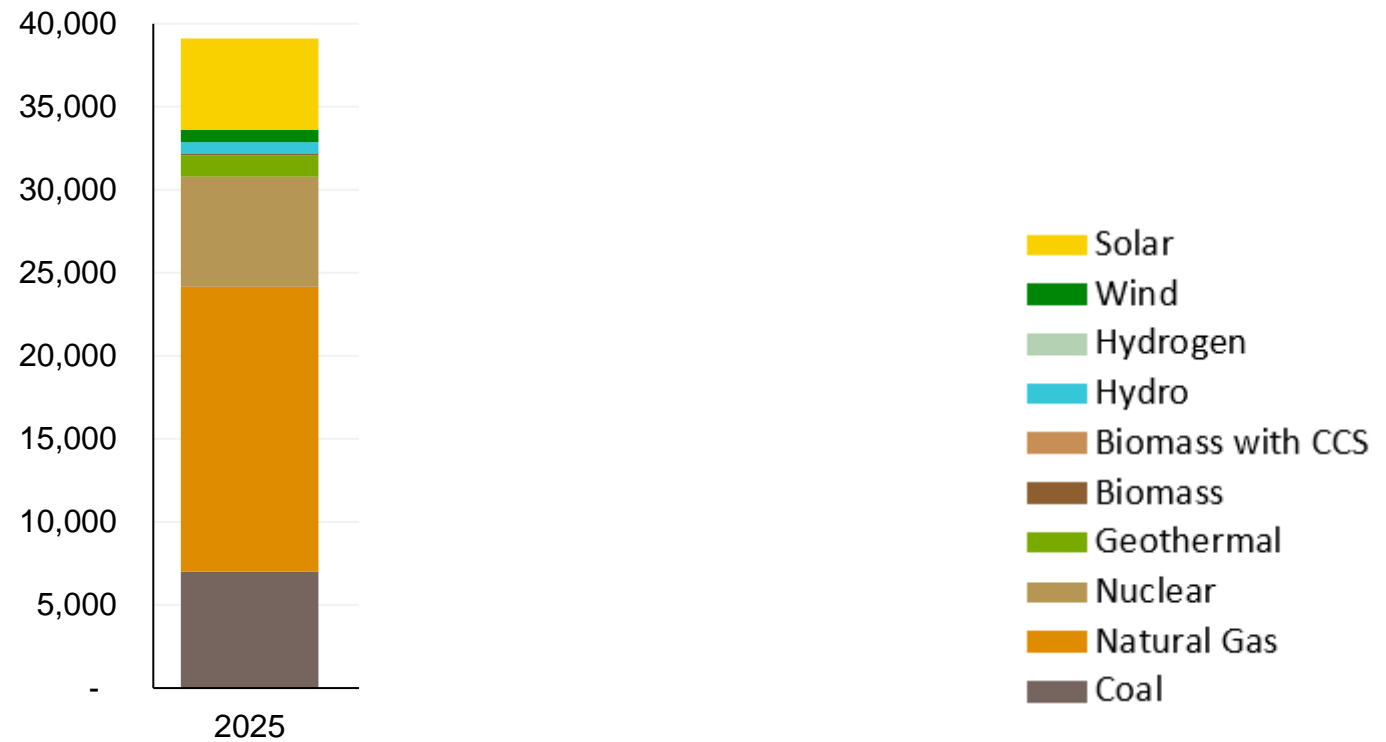
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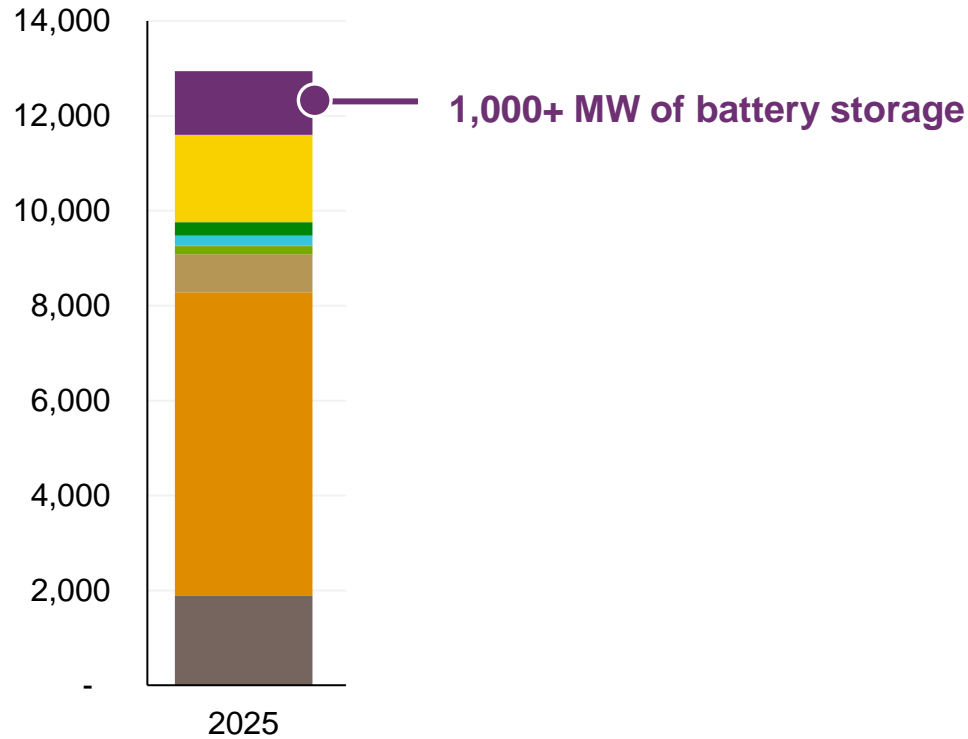
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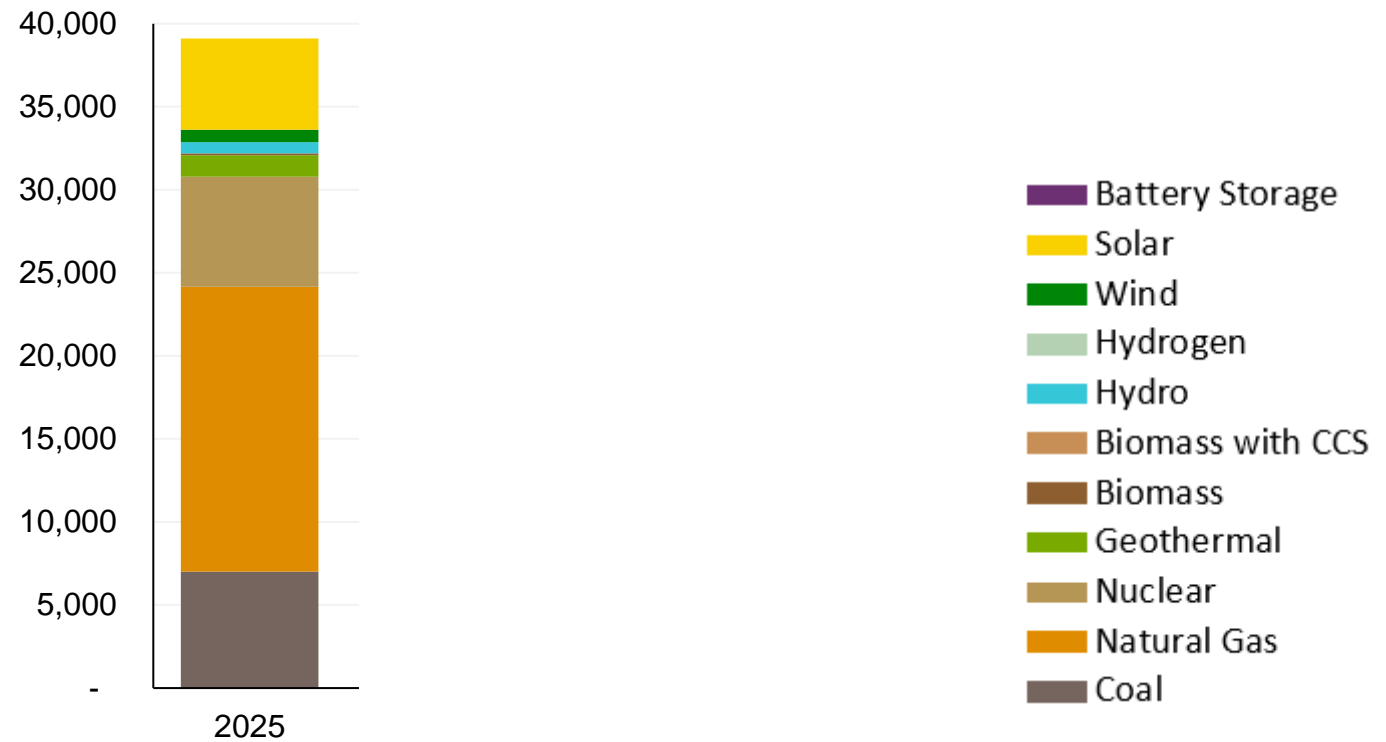
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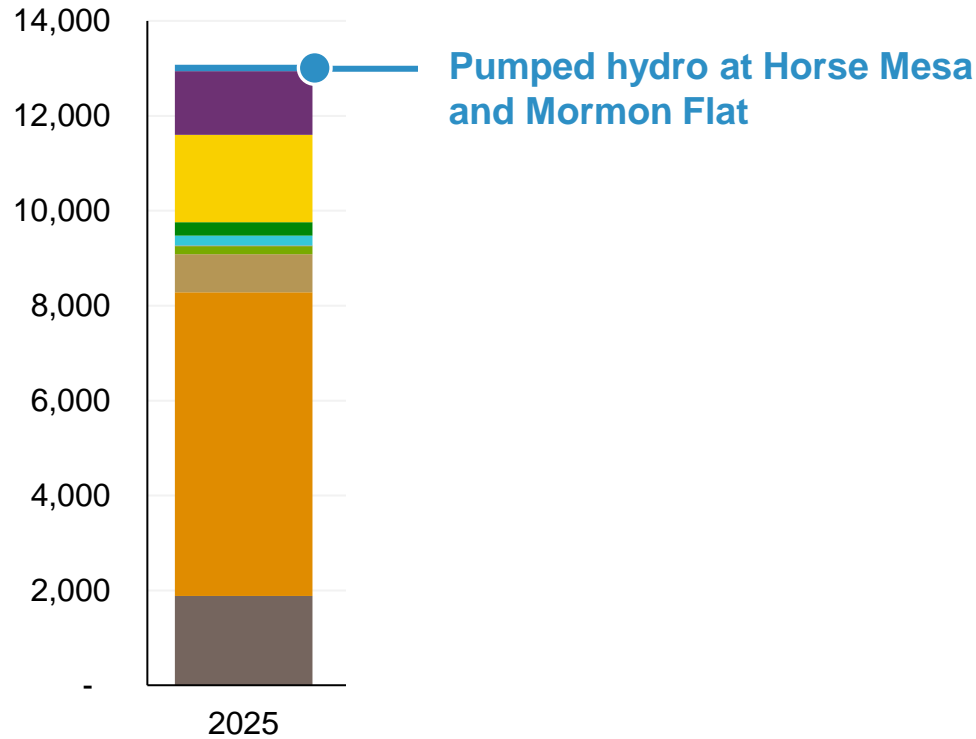
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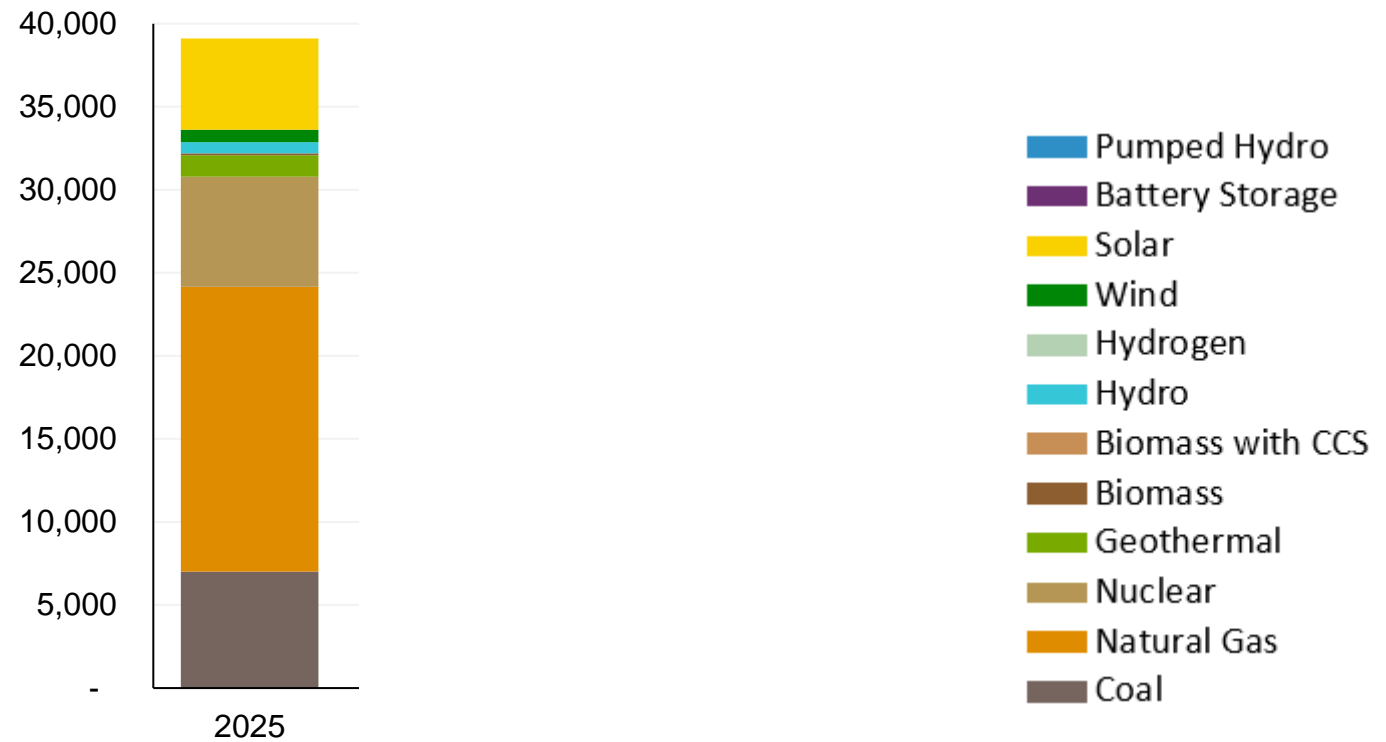
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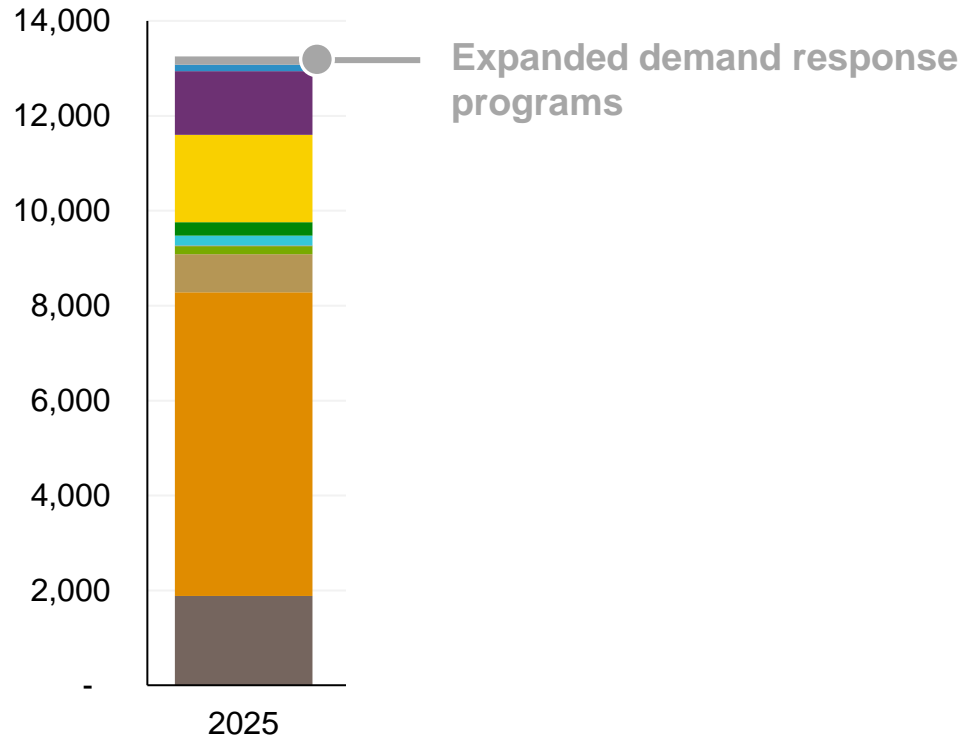
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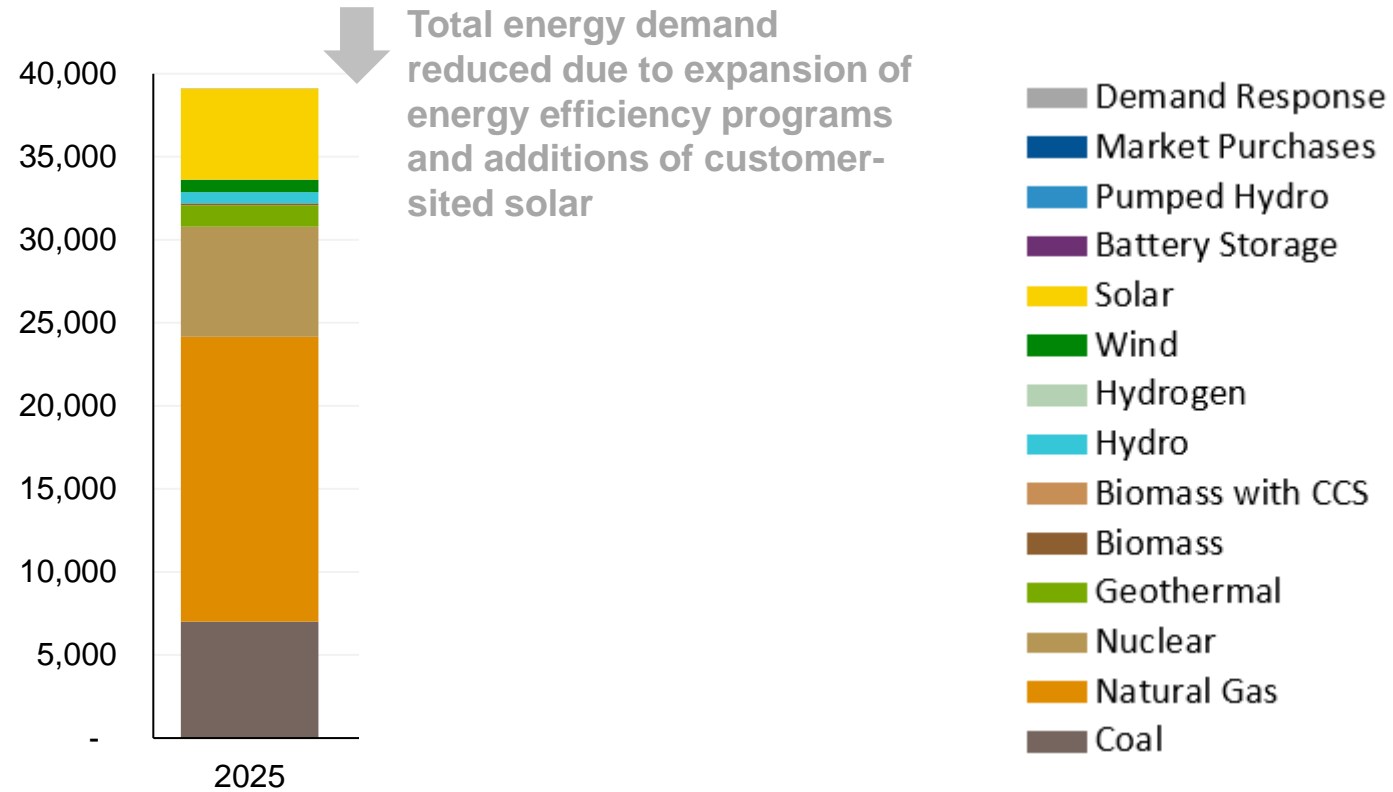
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Annual Generation (Preliminary Energy Mix*)

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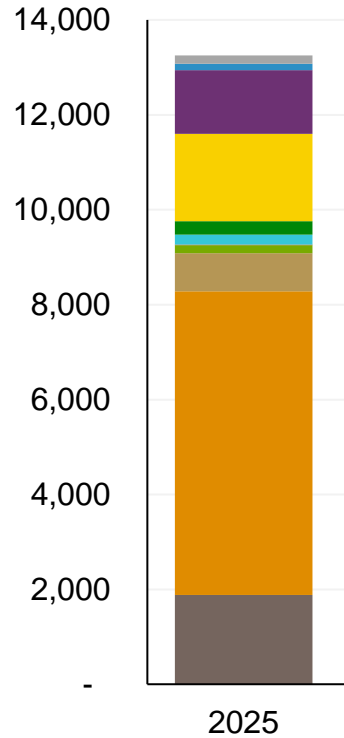
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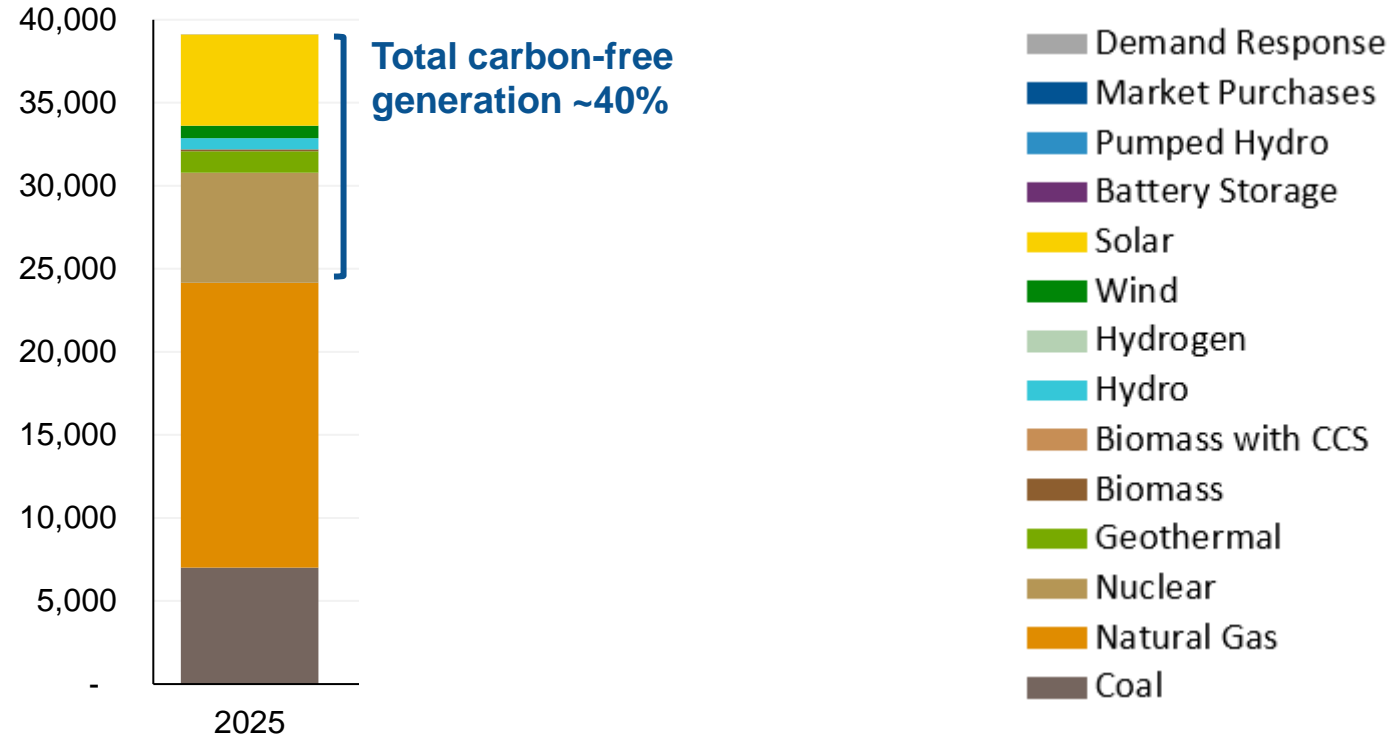
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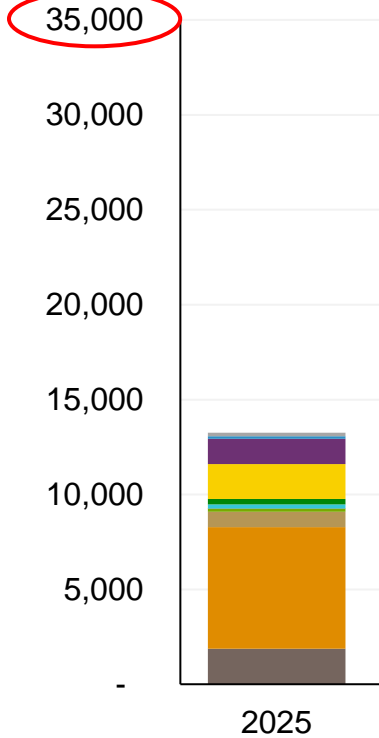
Technology Neutral, Current Trends

Technology-neutral approach, current trends continue for external factors

Total Installed Capacity

(MW)

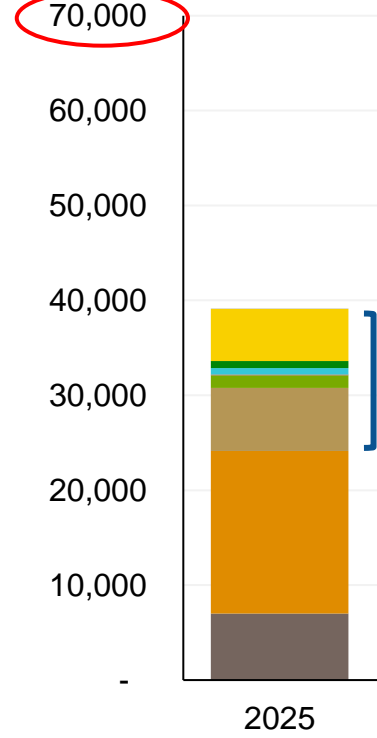
Note change in scale



Annual Generation (Preliminary Energy Mix*)

(GWh)

Note change in scale



Total carbon-free generation ~40%

- Demand Response
- Market Purchases
- Pumped Hydro
- Battery Storage
- Solar
- Wind
- Hydrogen
- Hydro
- Biomass with CCS
- Biomass
- Geothermal
- Nuclear
- Natural Gas
- Coal

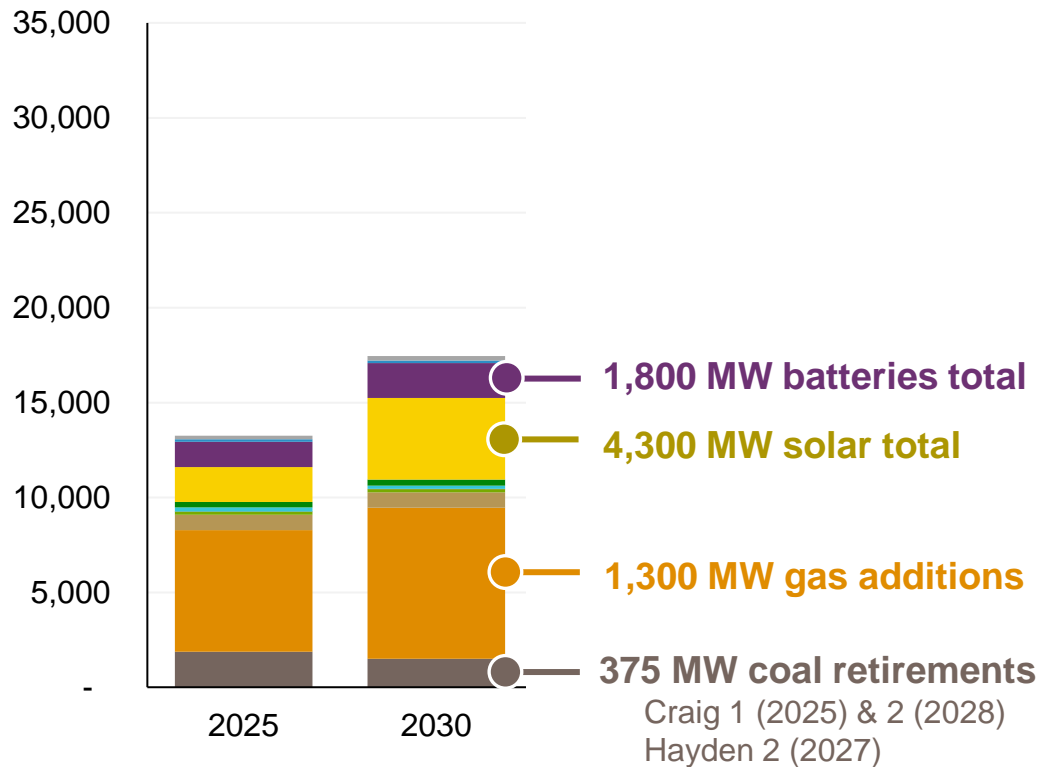
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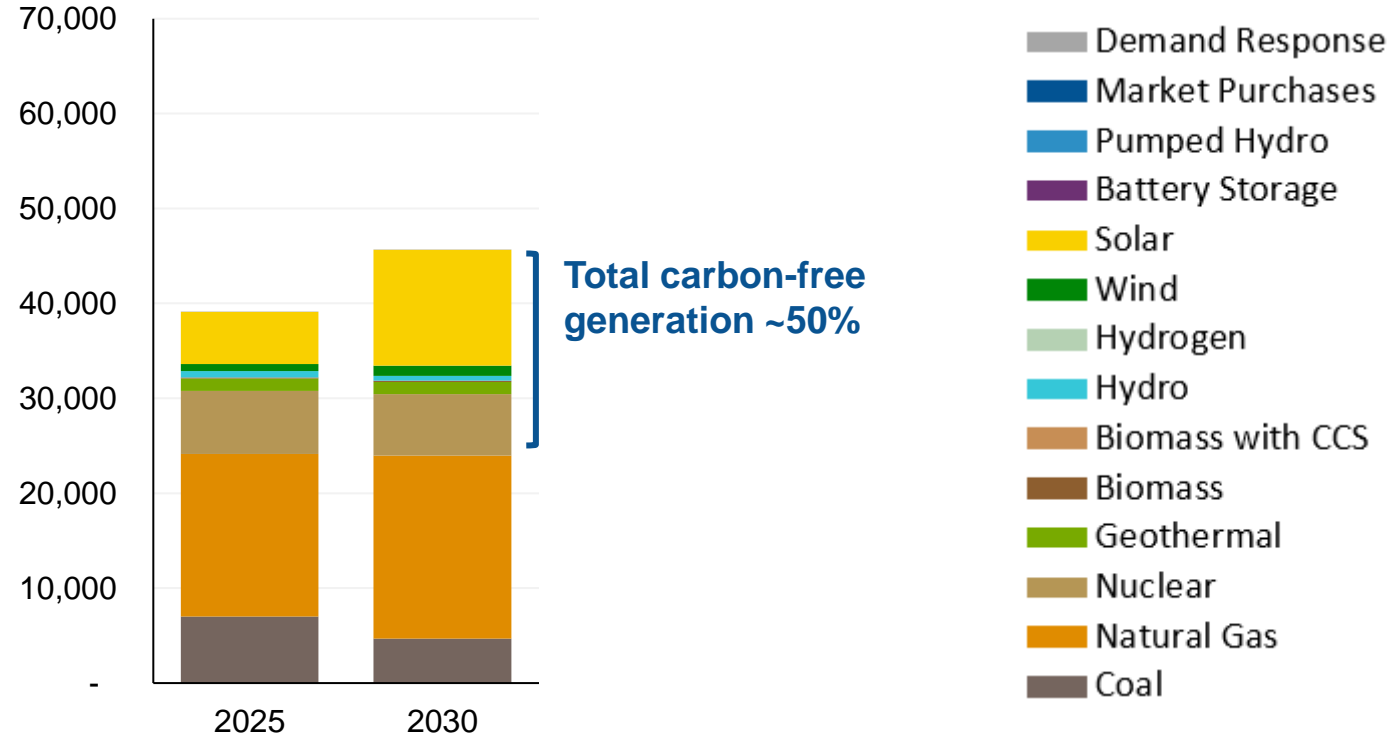
Total Installed Capacity

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Annual Generation (Preliminary Energy Mix*)

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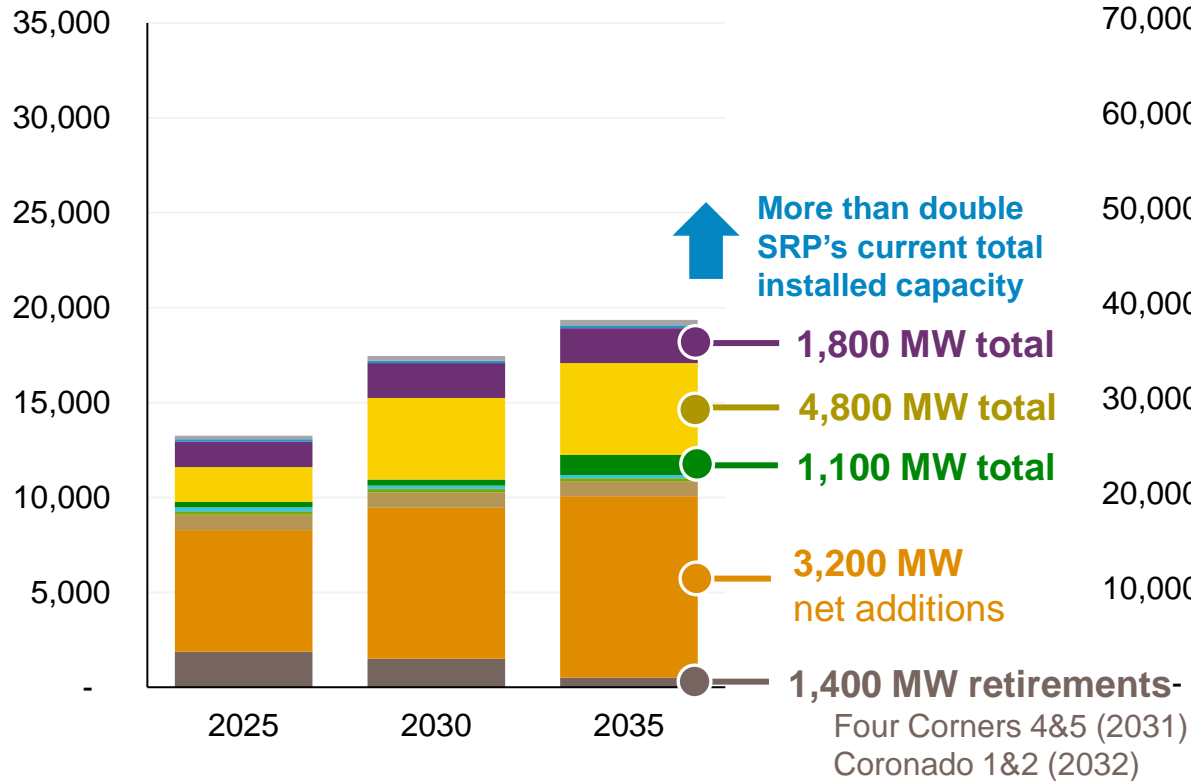
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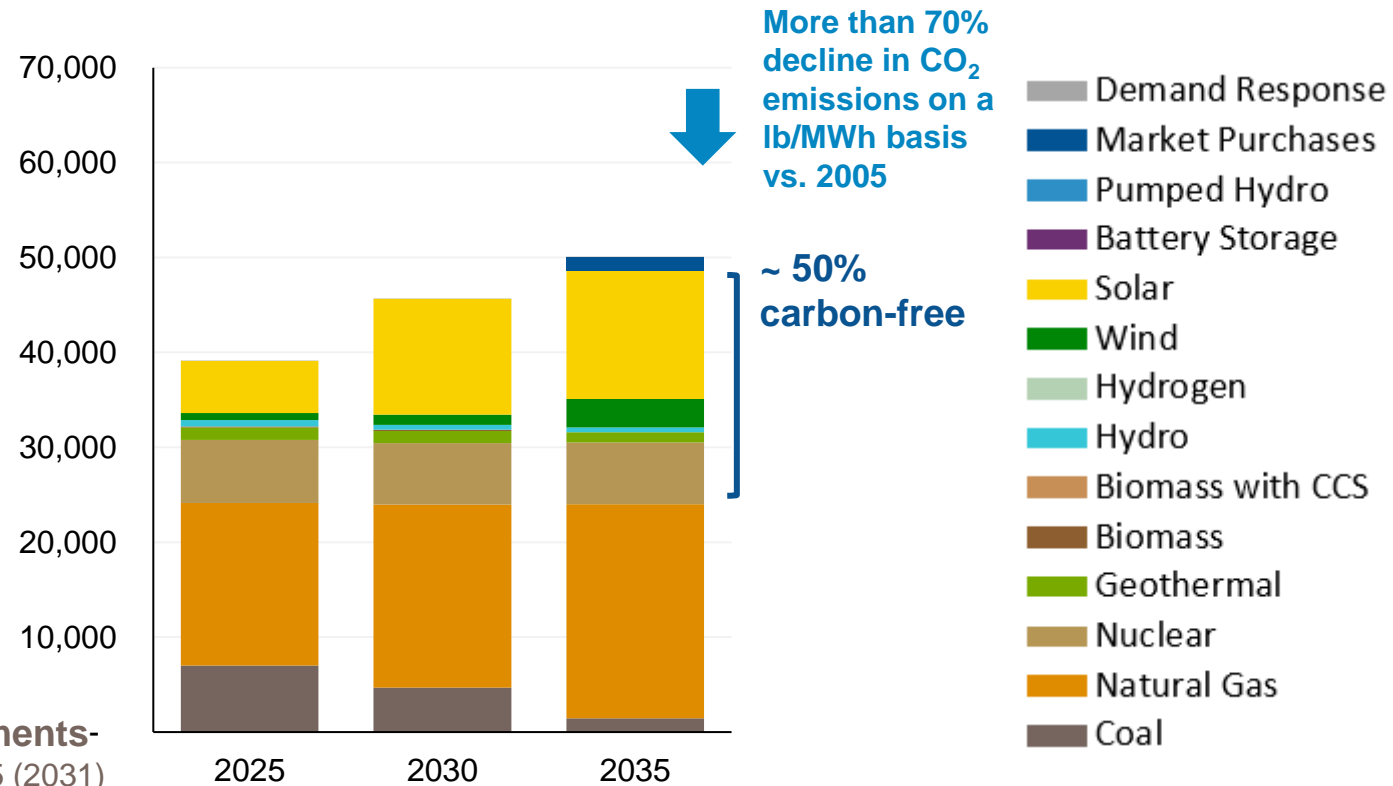
Total Installed Capacity

(MW)



Annual Generation (Preliminary Energy Mix*)

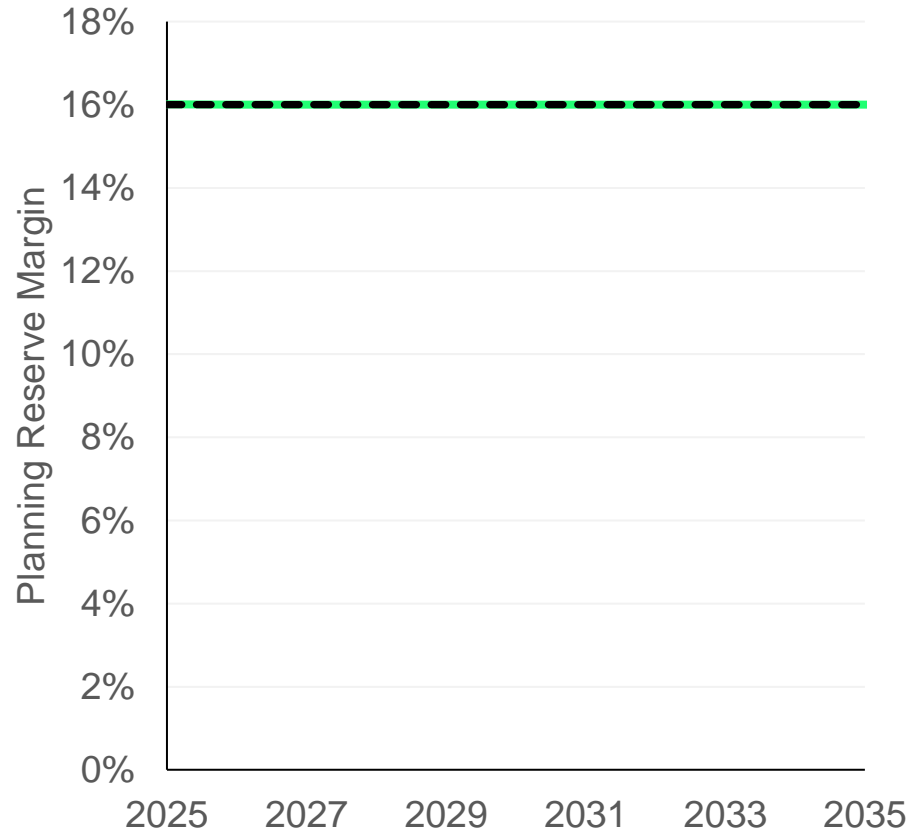
(GWh)



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Technology Neutral, Current Trends

Technology-neutral approach, current trends continue for external factors



The target planning reserve margin is 16%

Margin above expected maximum energy demand to account for higher-than-expected energy demand, extreme weather and the need to have resources on standby to respond to fluctuations

The resulting reserve margin meets SRP's reliability planning target in all years



Turn and Talk/ First Q&A Check-in

Study Plan Matrix

Strategic Approaches

		Technology Neutral	No New Fossil	Min. Coal
Sensitivities	Current Trends	●	●	●
	<i>High, Low, & Volatile Gas Prices</i>	● ● ●	● ● ●	● ● ●
	<i>High & Low Technology Costs</i>	● ●	● ●	● ●
	<i>High Demand Response</i>	●	●	●
	<i>High Energy Efficiency</i>	●	●	●
	<i>High DER Adoption</i>	●	●	●
	<i>Increased Load Management</i>	●	●	●
	<i>Regional Diversity</i>	●	●	●
	Scenarios	Desert Contraction	●	●
Desert Boom		●	●	●
Strong Climate Policy		●	●	●

The **Minimum Coal** strategic approach aims to reduce power generation from coal in SRP's system by testing operational changes to SRP's coal resources, including seasonal operations and SRP coal exit by the end of the study period.

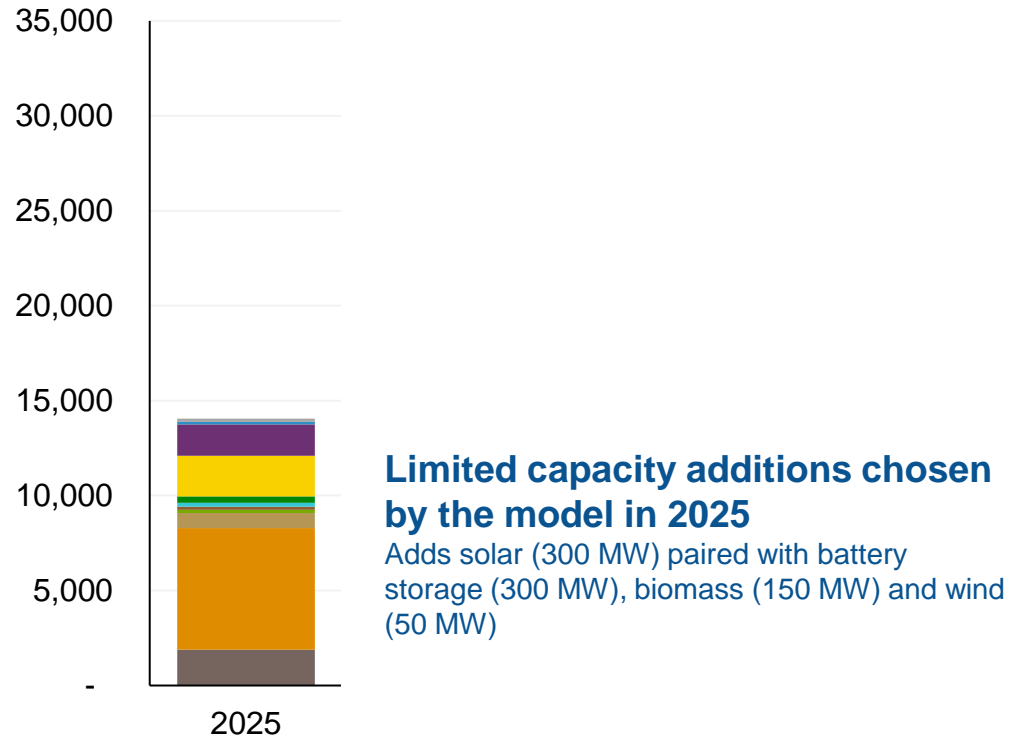
The **Desert Boom** scenario is a future in which economic growth in the Valley further accelerates.

Minimum Coal, Desert Boom

No new fossil, seasonal coal operations and coal exit by 2035, accelerated economic growth

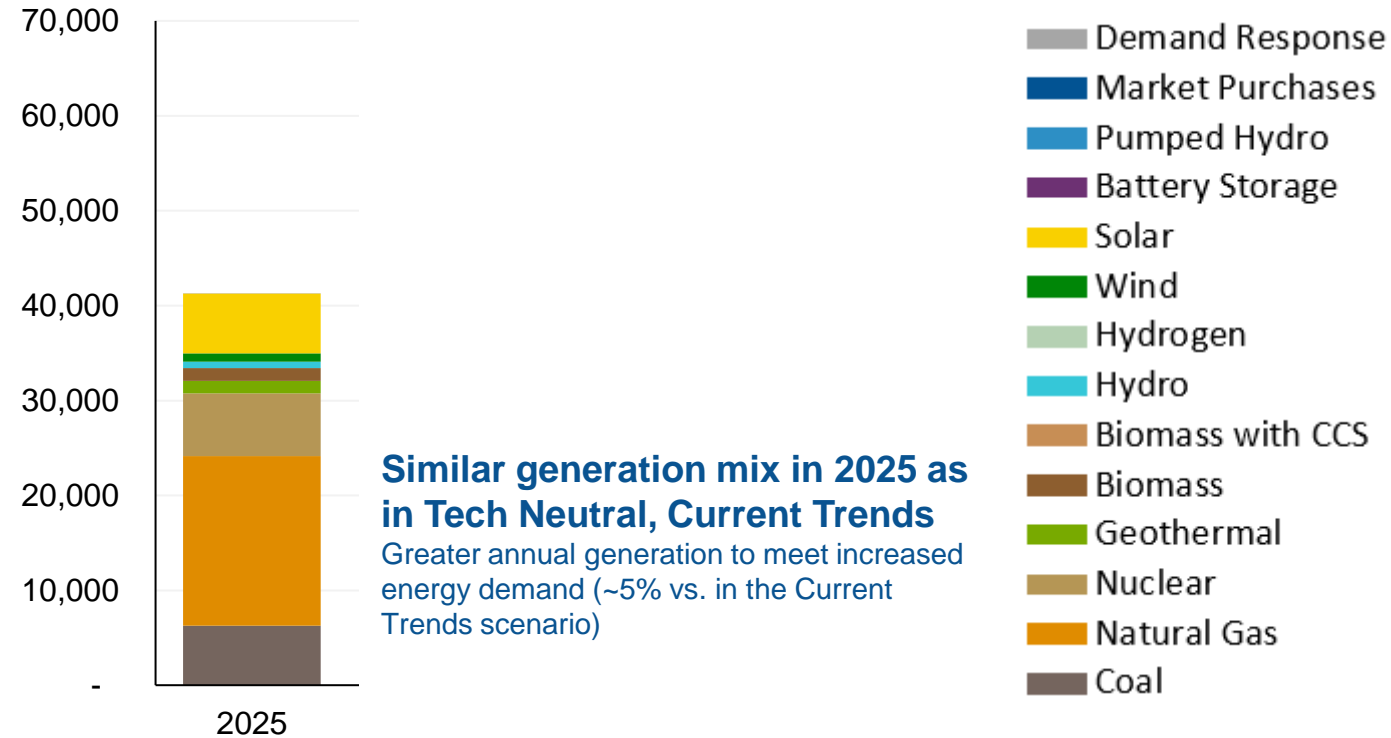
Total Installed Capacity

(MW)



Annual Generation (Preliminary Energy Mix*)

(GWh)



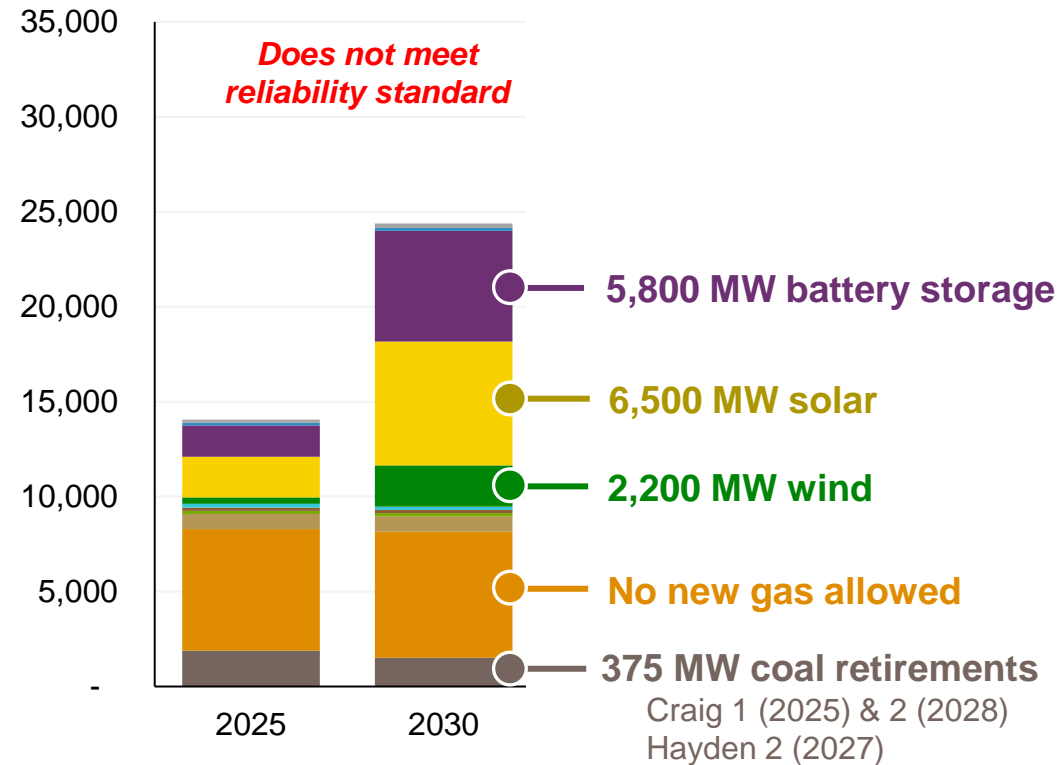
* This is the energy mix based on capacity expansion modeling. Detailed operational analysis through production cost modeling will follow and set the basis for the final energy mix.

Minimum Coal, Desert Boom

No new fossil, seasonal coal operations and coal exit by 2035, accelerated economic growth

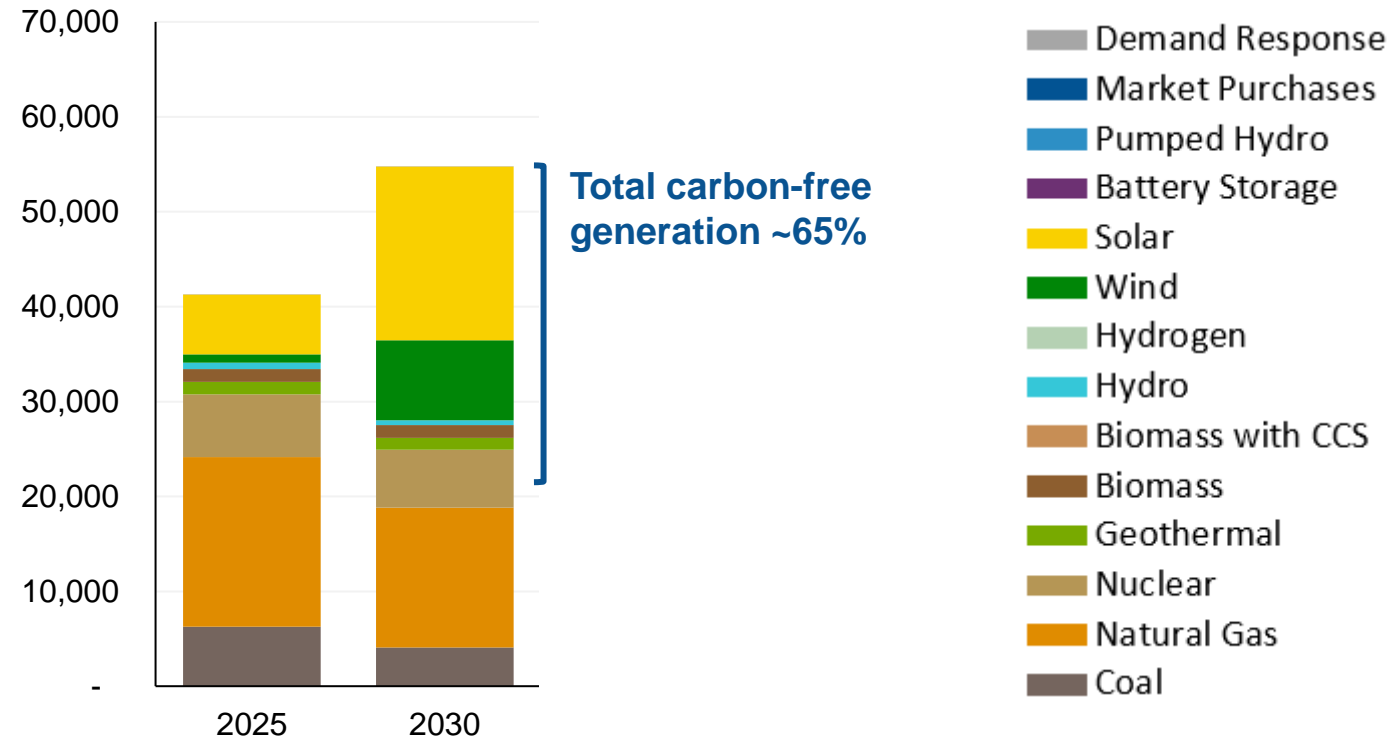
Total Installed Capacity

(MW)



Annual Generation (Preliminary Energy Mix*)

(GWh)

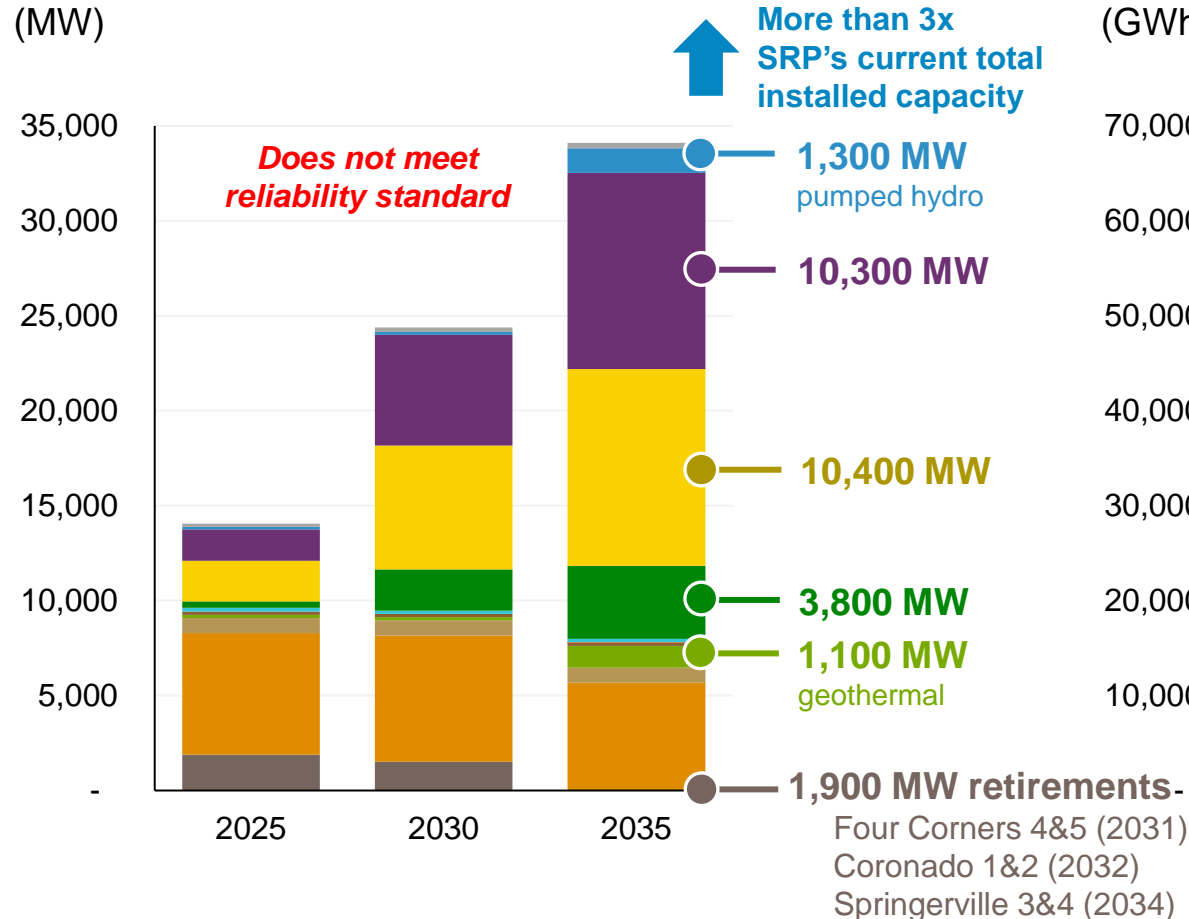


* This is the energy mix based on capacity expansion modeling. Detailed operational analysis through production cost modeling will follow and set the basis for the final energy mix.

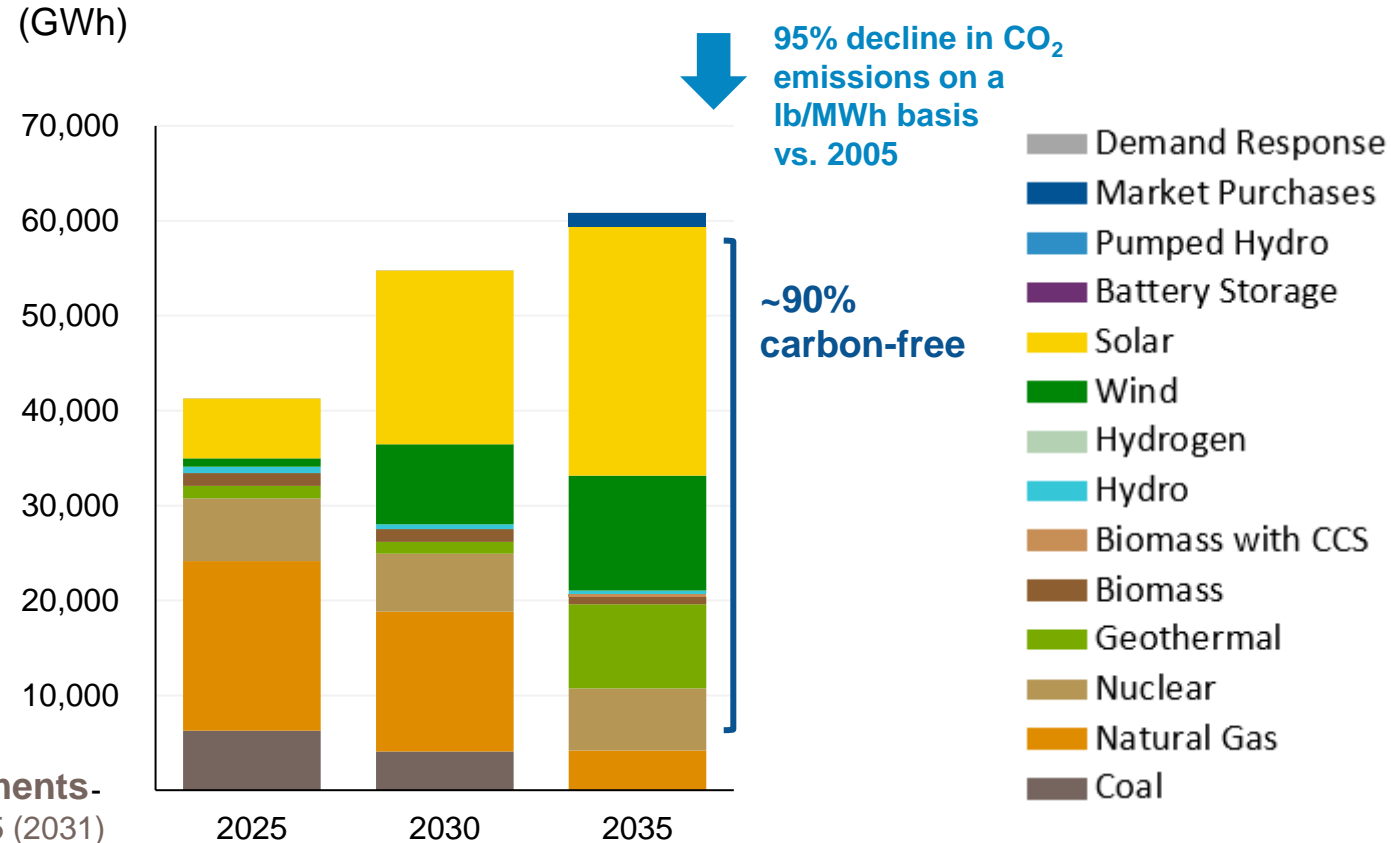
Minimum Coal, Desert Boom

No new fossil, seasonal coal operations and coal exit by 2035, accelerated economic growth

Total Installed Capacity (MW)



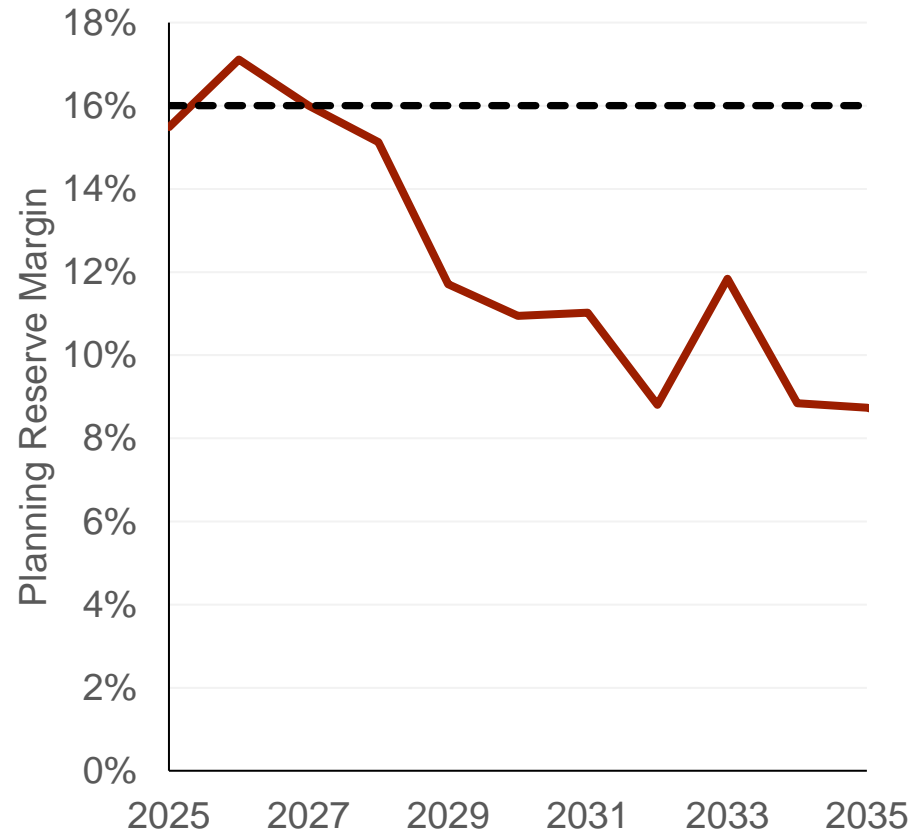
Annual Generation (Preliminary Energy Mix*) (GWh)



* This is the energy mix based on capacity expansion modeling. Detailed operational analysis through production cost modeling will follow and set the basis for the final energy mix.

Minimum Coal, Desert Boom

No new fossil, seasonal coal operations and coal exit by 2035, accelerated economic growth



The target planning reserve margin is 16%

Margin above expected maximum energy demand to account for higher-than-expected energy demand, extreme weather and the need to have resources on standby to respond to fluctuations

The resulting reserve margin falls short of the target

This means that this system does not meet SRP's standard for reliability. Customer outages due to insufficient resources would be more frequent. In 2035, the system needs several hundred megawatts of reliable capacity to close the gap.

Study Plan Matrix

Strategic Approaches

Scenarios

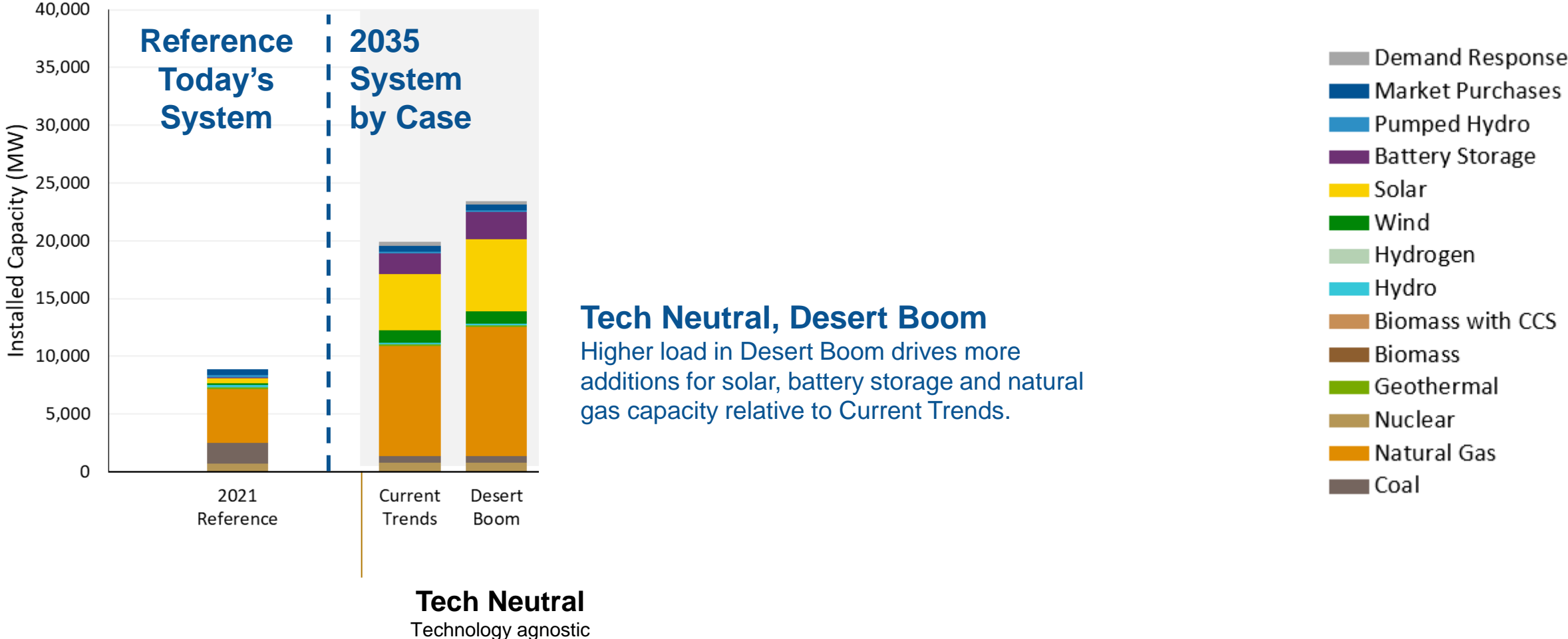
	Technology Neutral	No New Fossil	Min. Coal
Current Trends	●	●	●
<i>High, Low, & Volatile Gas Prices</i>	● ● ●	● ● ●	● ● ●
<i>High & Low Technology Costs</i>	● ●	● ●	● ●
<i>High Demand Response</i>	●	●	●
<i>High Energy Efficiency</i>	●	●	●
<i>High DER Adoption</i>	●	●	●
<i>Increased Load Management</i>	●	●	●
<i>Regional Diversity</i>	●	●	●
Desert Contraction	●	●	●
Desert Boom	●	●	●
Strong Climate Policy	●	●	●

Preliminary cases

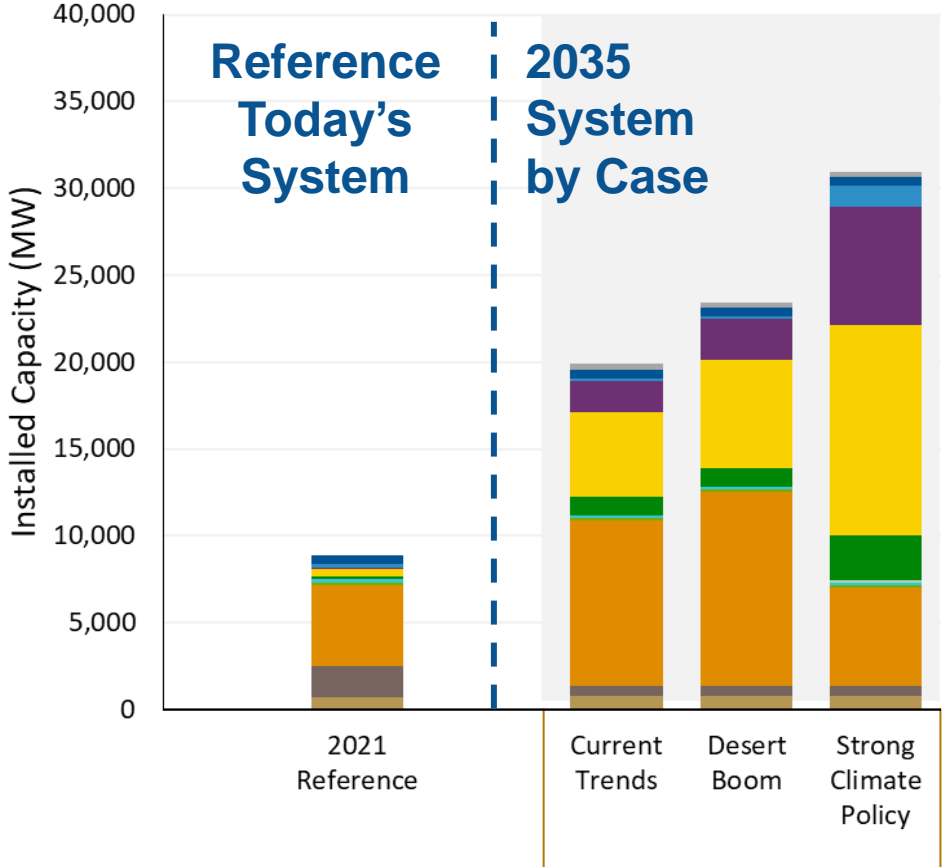
Comparison Between Cases: 2035 Installed Capacity



Comparison Between Cases: 2035 Installed Capacity



Comparison Between Cases: 2035 Installed Capacity



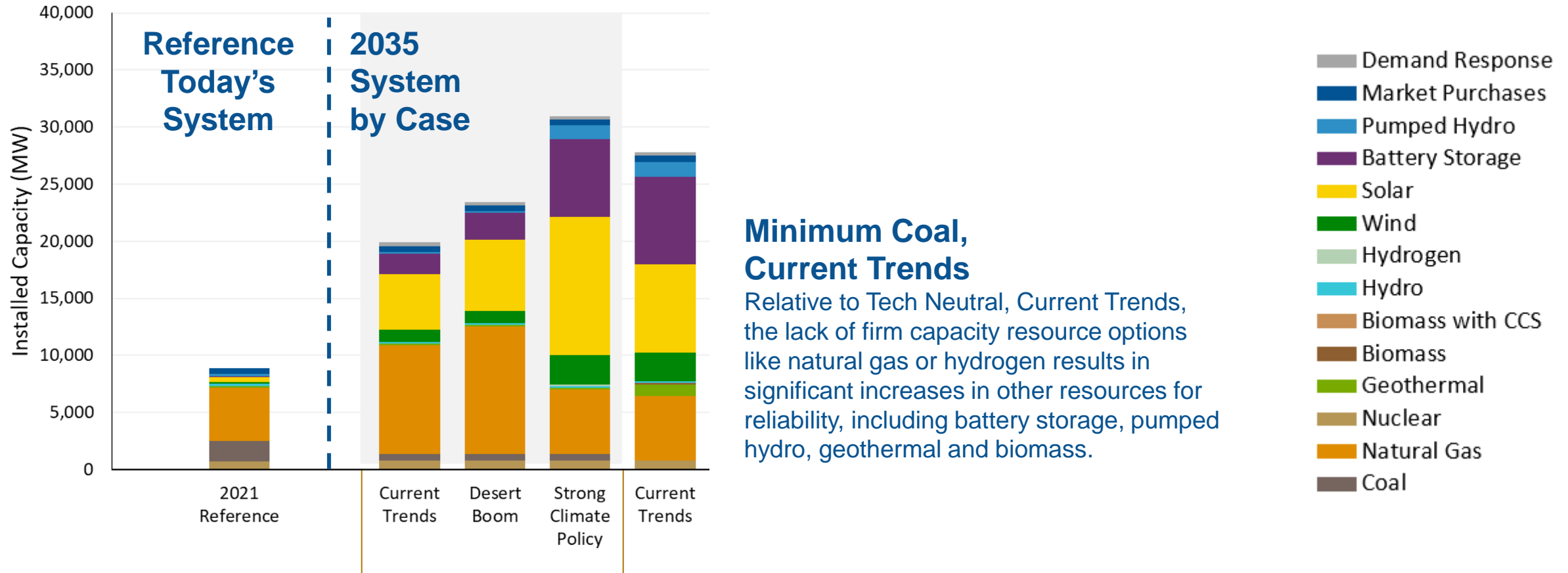
Tech Neutral
Technology agnostic

Tech Neutral, Strong Climate Policy

A stringent federal emissions policy (85% reduction by 2035) drives much larger additions for solar, wind, battery storage, and pumped hydro. Hydrogen capacity is also selected.

- Demand Response
- Market Purchases
- Pumped Hydro
- Battery Storage
- Solar
- Wind
- Hydrogen
- Hydro
- Biomass with CCS
- Biomass
- Geothermal
- Nuclear
- Natural Gas
- Coal

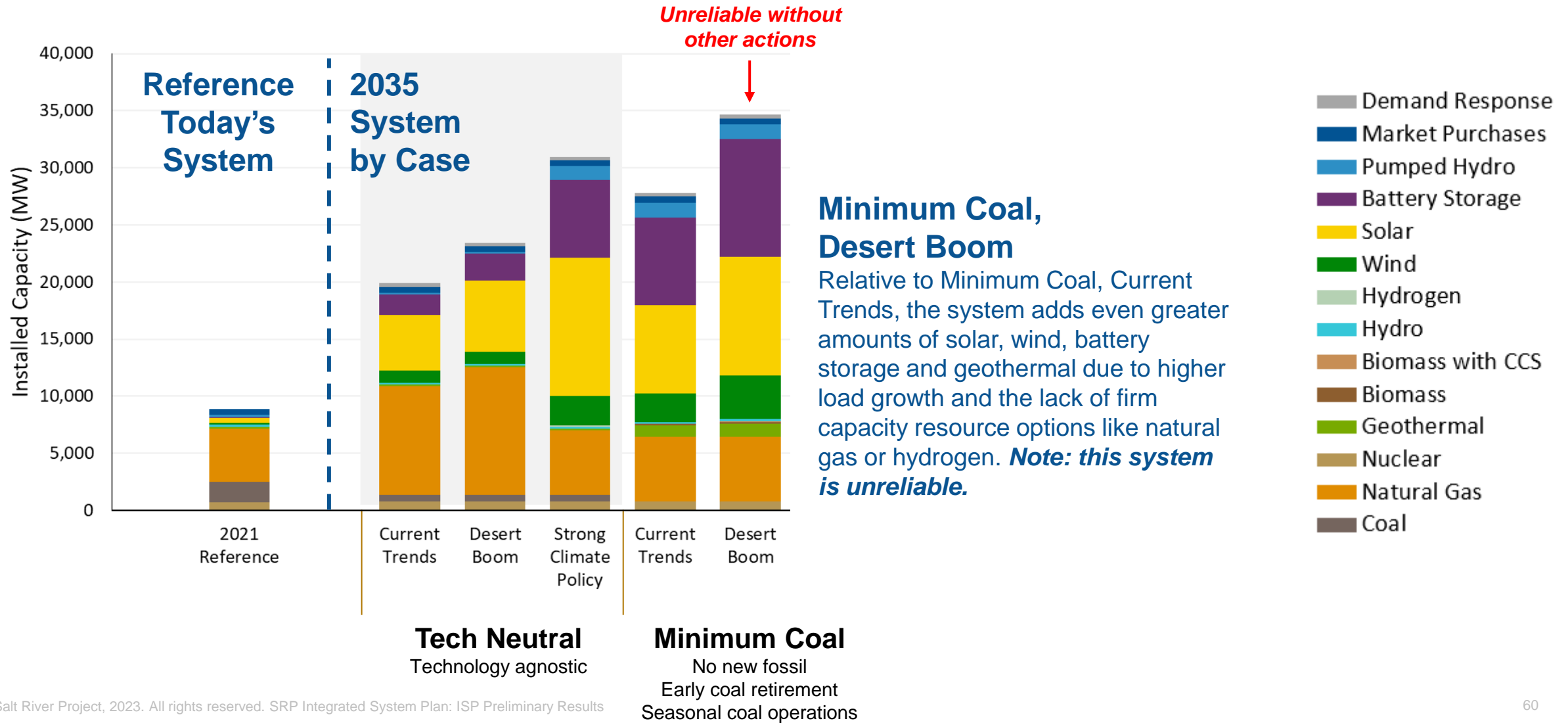
Comparison Between Cases: 2035 Installed Capacity



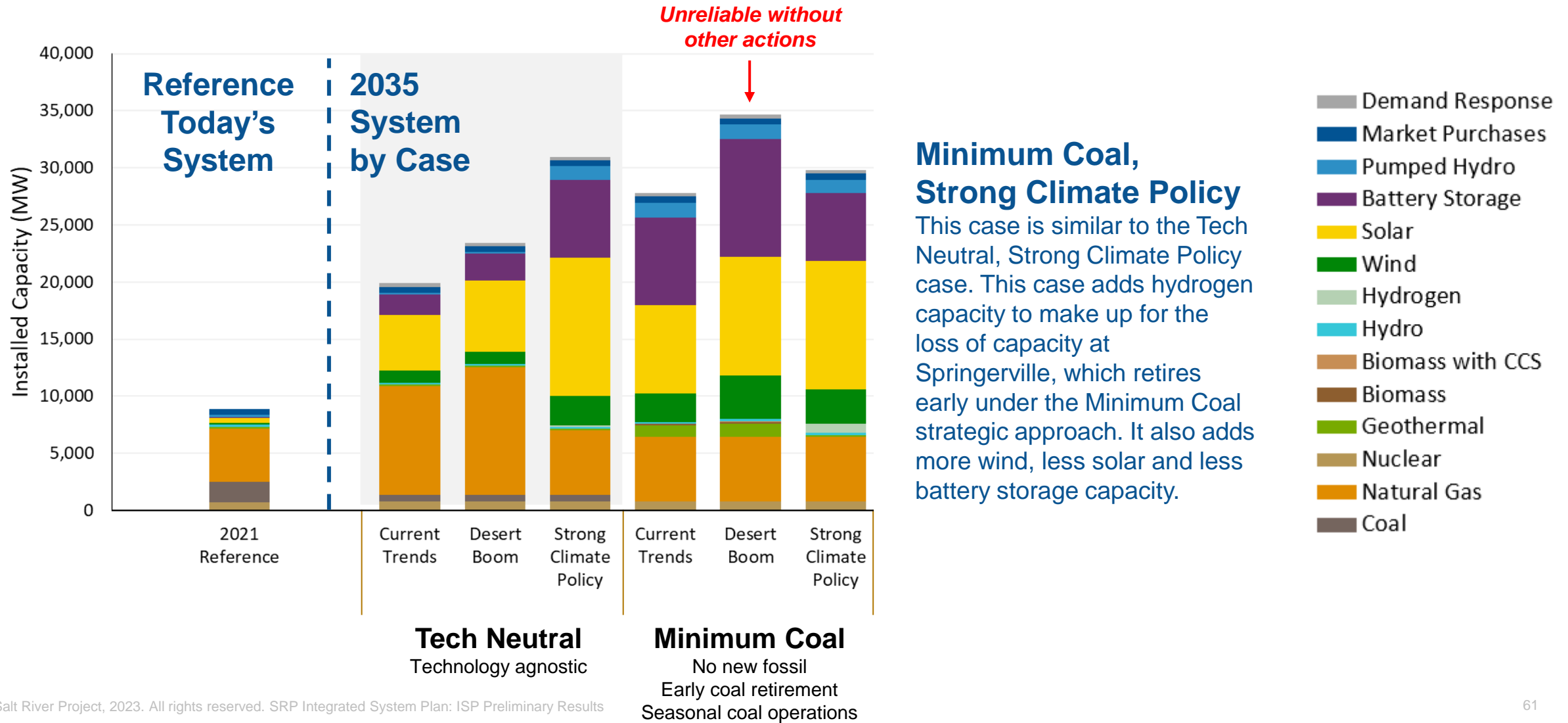
Tech Neutral
 Technology agnostic

Minimum Coal
 No new fossil
 Early coal retirement
 Seasonal coal operations

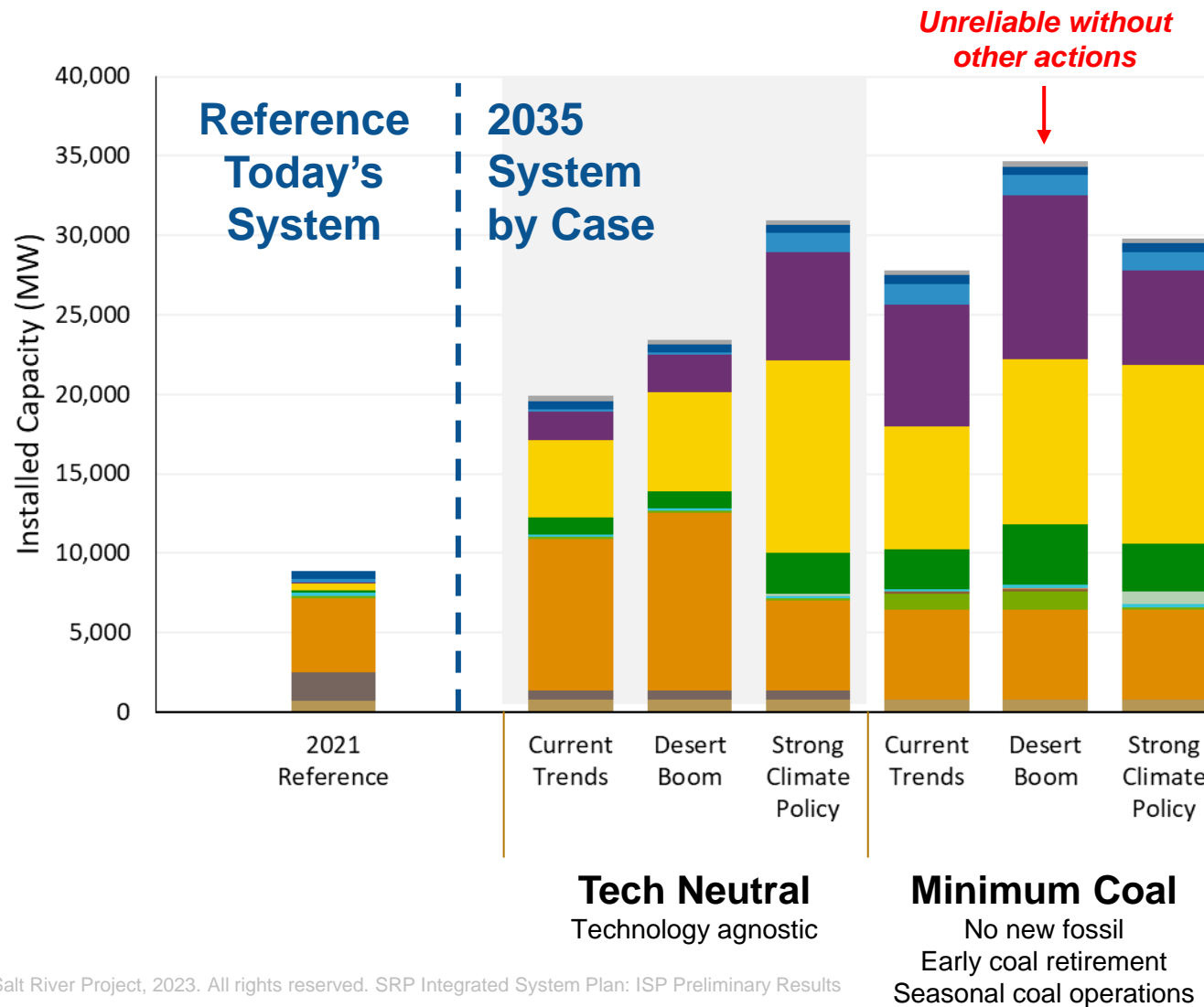
Comparison Between Cases: 2035 Installed Capacity



Comparison Between Cases: 2035 Installed Capacity

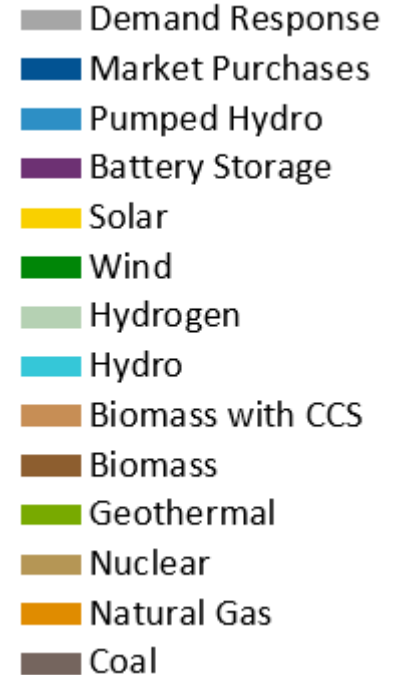


Comparison Between Cases: 2035 Installed Capacity

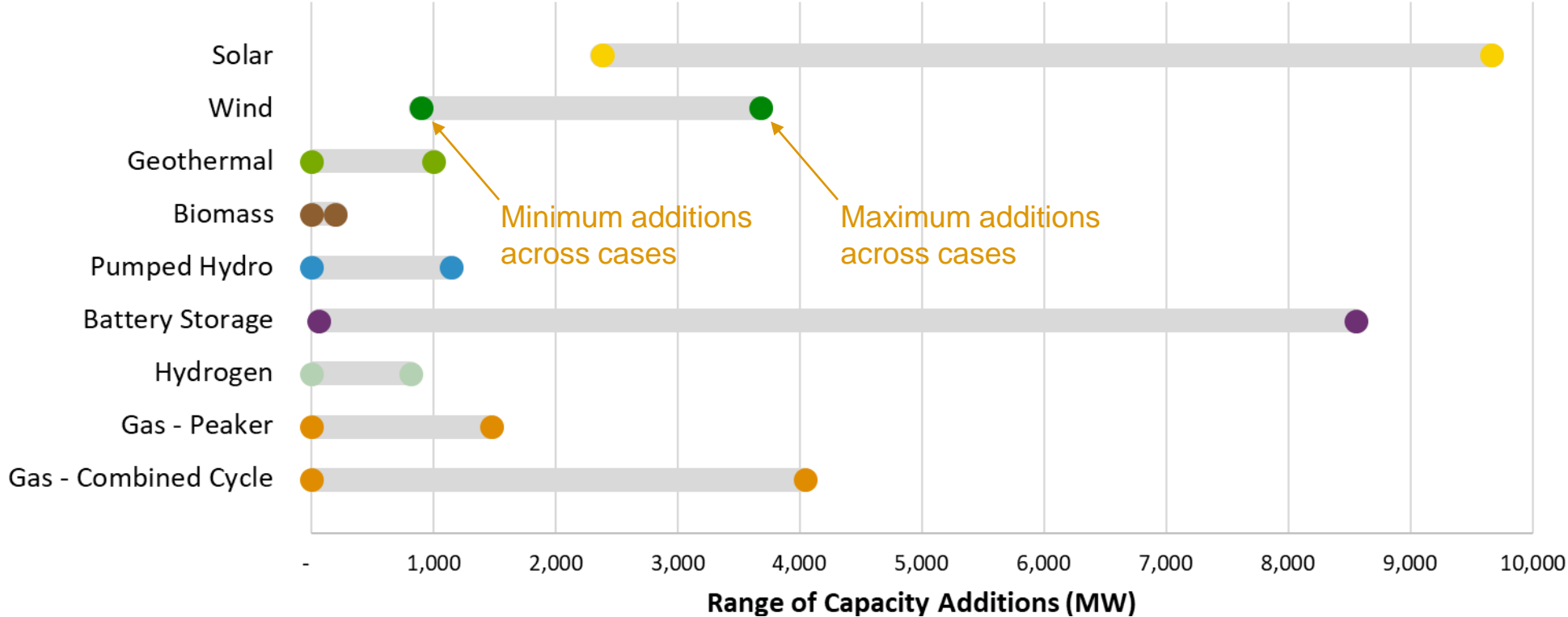


Early findings

- In every case, the system adds significant amounts of inverter-based resources.
- Without a firm capacity option like natural gas or hydrogen, the system adds significantly more capacity (Minimum Coal, Current Trends/Desert Boom) and is unreliable if load growth is high (Minimum Coal, Desert Boom).
- Under a more stringent federal carbon target (Strong Climate Policy), the system adds a lot of renewables and storage, as well as firm hydrogen capacity.



Range of Modeled Capacity Additions (2025-2035)



Notes

- The bar represents a range of modeled capacity additions across scenarios and strategic approaches. The bottom of the bar reflects the minimum additions across all six cases, and a larger bar reflects greater variations across cases.
- Modeled capacity additions displayed here do not include SRP’s capacity additions already planned to come online.
- Additional technologies (Small Modular Reactors and Carbon Capture and Storage) that were candidate resources in the modeling are not shown here because no capacity was added by 2035 in the modeling across the preliminary cases.

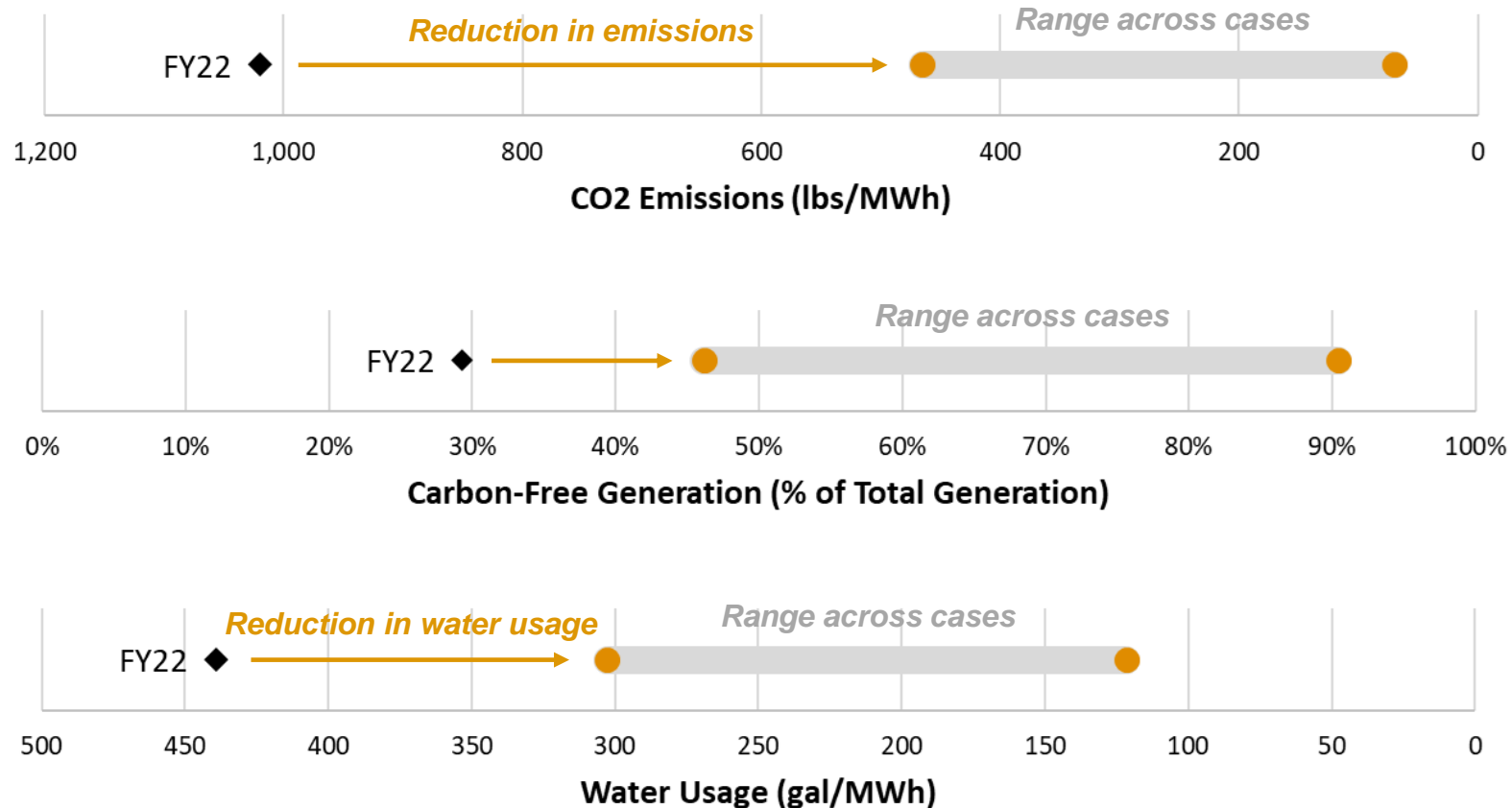
Overview of Select Sustainability Metrics

CO2 emissions in pounds per megawatt-hour (lb/MWh) — This is the amount of carbon dioxide emissions (in pounds) from emitting power plants, expressed relative to the amount of total generation (in megawatt-hours) across all power plants. SRP has established a goal of reducing carbon emissions intensity (lb/MWh) by 65% by 2035 and by 90% by 2050, relative to 2005 levels. In 2005, SRP's emissions rate was 1,576 lb/MWh.

Carbon-free generation (%) — This is the amount of generation from resources that emit no carbon dioxide, expressed relative to the amount of total generation. As a basis of comparison, in 2021, SRP's share of carbon-free generation was 28%.

Water consumption per megawatt-hour (gal/MWh) — This is the amount of water consumption (in gallons) from power plants, expressed relative to the amount of total generation (in megawatt-hours). SRP has established a goal of achieving a 20% reduction in generation-related water use intensity across all water types by 2035 relative to 2005 levels.

Range of Metrics in 2035 for Preliminary Cases*



Early findings

- All system plans result in significant improvements in carbon emissions and water usage relative to today's system.
- Total system cost metrics are in development, which will be used to understand tradeoffs across various metrics.

Next Steps

- Complete capacity expansion modeling for the remaining cases
- Perform detailed operational analysis to refine generation mix, emissions, water usage and cost metrics
- Complete transmission system analysis
- Quantify sustainability, affordability and avoided cost metrics

Small Group Activity:

What questions do you have about the preliminary results presented?

Please write your questions on index cards and share them with your table. The project team will then collect the cards.

Coffee Break

Question & Answer Session

Working Lunch

Roundtable Discussion:

Minimum Coal, Desert Boom is the first case from the ISP study plan that does not meet minimum criteria – in this case reliability.

How can we use the ISP Guiding Principles to discuss possible outcomes?

Options for Addressing the Reliability Shortfall

Minimum Coal, Desert Boom case

Option A: Add in additional firm resource options to the case to try to achieve the planning reserve margin requirement

Option B: Remove the case from consideration for further analysis in the ISP and use as a learning for the Minimum Coal strategic approach.

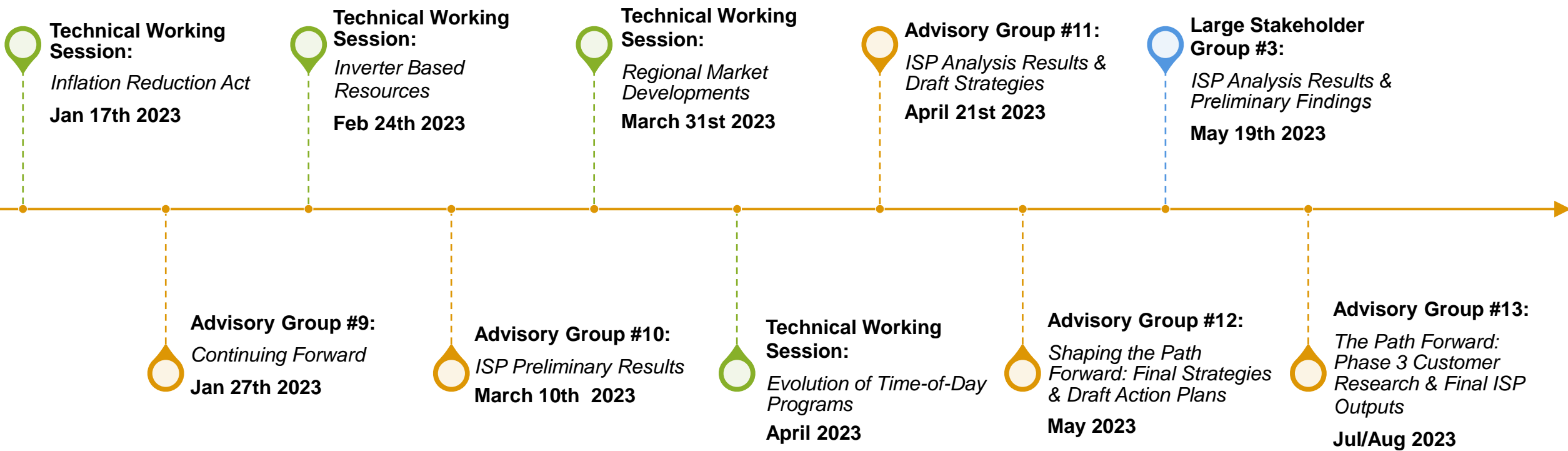
Option C: Other suggestions?

Wrap Up and Next Steps

Angie Bond-Simpson

Director, Integrated System Planning & Support

2023 Engagement Calendar



Next Steps

Advisory Group

- Regional Market Developments Technical Working Session (March 31st)
- Advisory Group Meeting (April 21st)
- Evolution of Time-of-Day Programs Technical Working Session (April)

SRP Team

- Complete ISP Analysis
- Send invitation for Evolution of Time-of-Day Programs Technical Working Session (April)



Stakeholder Communication Email:
IntSysPlan@srpnet.com

Integrated System Plan: Informational Portal
<https://srpnet.com/about/integrated-system-plan.aspx>

Technical Q&A Opportunity

Facilitated by Joan Isaacson (K&W)

thank you!