2023 – Integrated Resource Plan (IRP)

September 29, 2023

https://www.tep.com/2023-irp/

TEP Tucson Electric Power | UniSourceEnergy SERVICES

Agenda (RPAC)

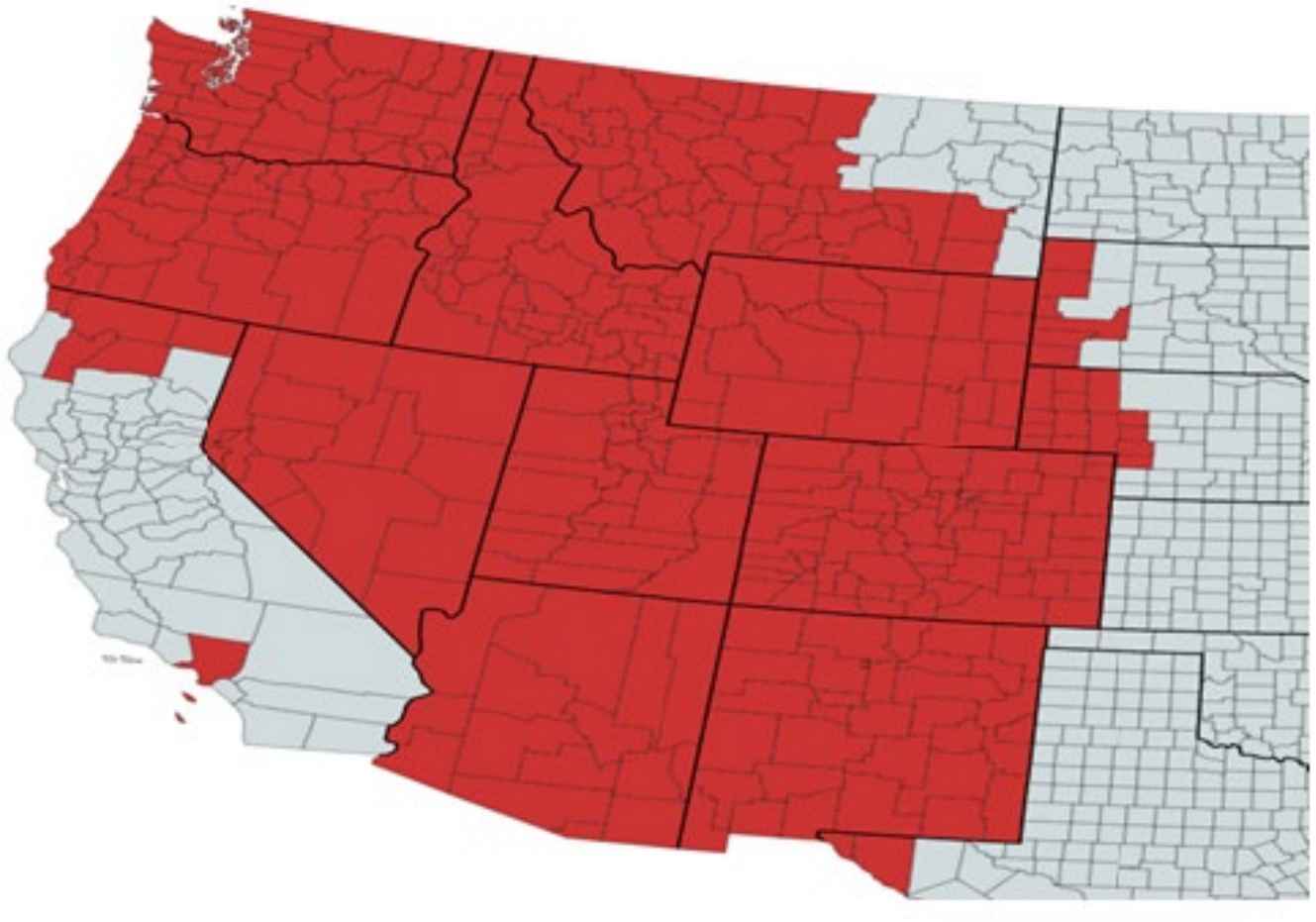
- Introduction
- Market Update
- Key Input Overview
- Inflation Reduction Act (IRA)
- Resource Adequacy
- Portfolios
- Results
- Open Discussion

Western Market Exploratory Group (WMEG) Production Cost Study Results Summary

Goals of Market Participation

- Reliability
- Customer Cost Savings
- Clean Energy Integration

WMEG Participation



APS	Puget Sound
SRP	Xcel
TEP	Avista
AEPCO	BANC
PNM	BPA
Black Hills	Chelan
LADWP	El Paso
Portland	Grant
Seattle	Northwestern
Platte River	Tacoma
NV Energy	Tri-State
PacifiCorp	WAPA
Idaho	

Note: Map boundaries are approximate and for illustrative purposes only

Purpose of Study

This study assessed production costs only (generation dispatch) in various market footprints and scenarios

- Main report is limited to WECC-wide results and does not include individual company results
- Each entity has individual results (TEP results are shown here)

Study Results Consideration

- The results demonstrate the potential production cost savings for different market scenarios and footprints

- These production cost results are only one part of the overall assessment of market participation and are expected to be only a portion of the overall savings of a combined resource adequacy and day-ahead market scenario

Market Footprints and Seams Treatment

CBS looked at various footprints as part of the **Core CBS Study**.

The Main Split footprint is uses as the base footprint in all Core Study modeling.

A subset of members opted for modeling extra market cases of **additional footprints**

Figures provided by Greg MacDonald from PSE

Main Report Results (WECC Wide)

- Results with a CAISO WECC-wide footprint (compared to BAU* case):
  - WMEG entities show an overall cost increase of $20M
  - Non-WMEG (mainly CA) entities show an overall cost decrease of $80M
  - Overall cost decrease of $60M (0.6%) WECC-wide
- Results with split footprints (compared to BAU case):
  - WMEG entities show a cost decrease of $26M
  - Non-WMEG (mainly CA) entities show a cost increase of $247M
  - Overall cost increase of $220M (2.3%) WECC-wide

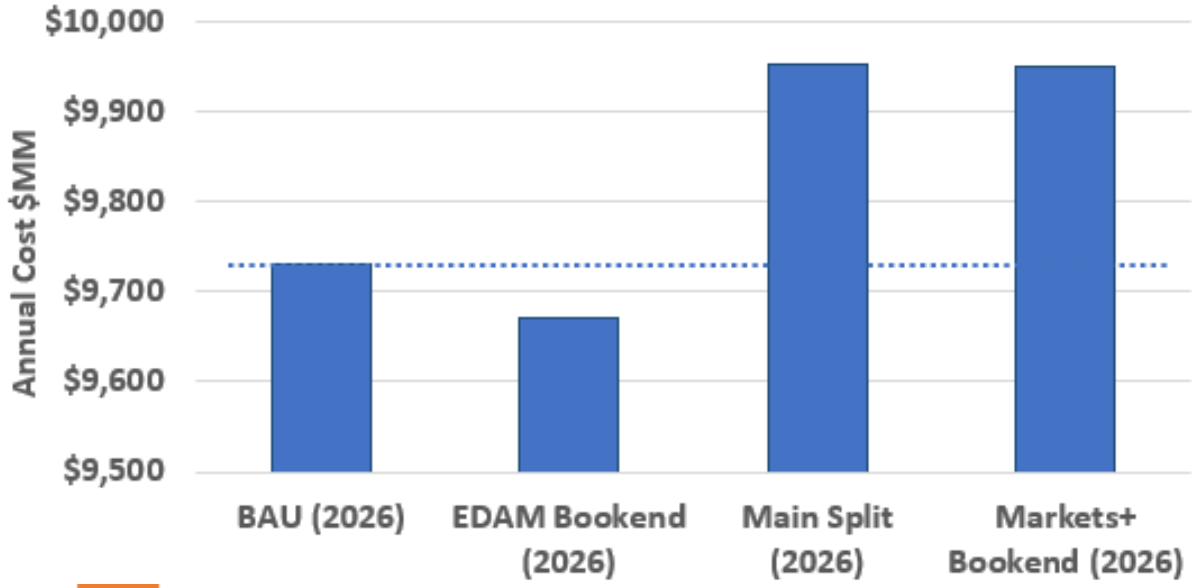
*Note that BAU means current participation in real time markets in both CAISO and SPP
**For context, the WECC total production costs are projected to be $9.732 Billion in 2026 in BAU Case

Overall Take-Away from Study Results

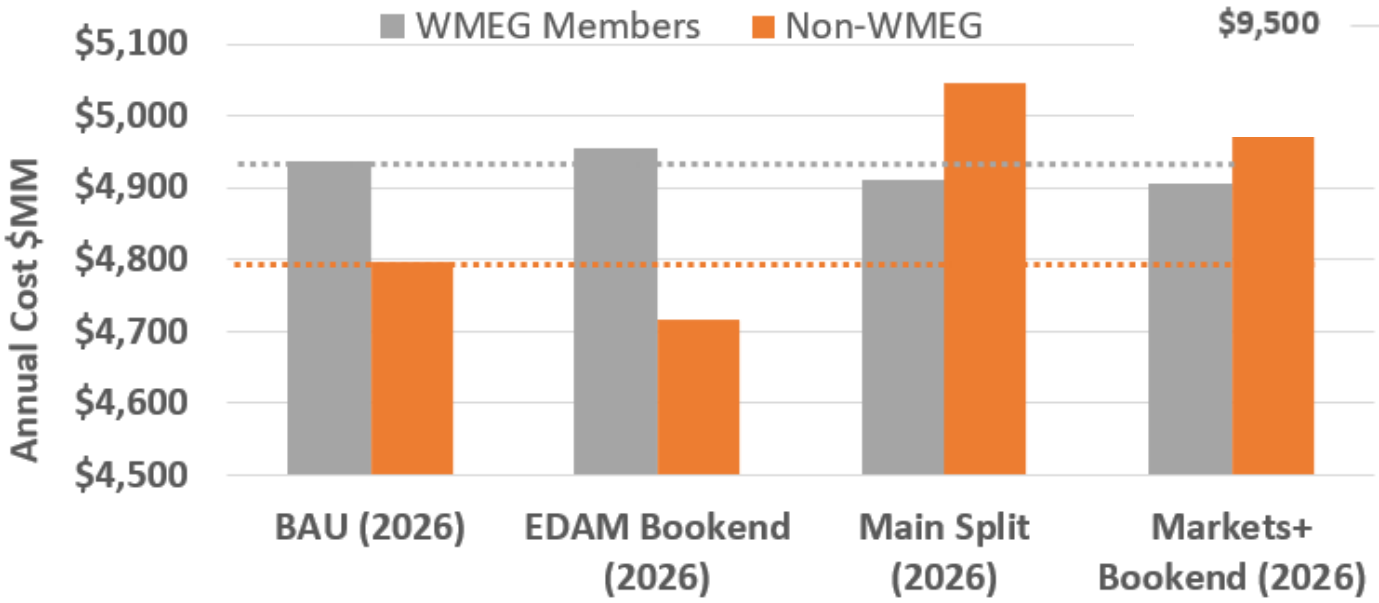
- APS, SRP, and TEP are assessing both CAISO and SPP market options
- SPP is a viable and potentially superior option from a cost production standpoint.
- APS, SRP, TEP continue to pursue the build-out of the SPP market option to ensure the best market outcome.
- Overall production cost differences between footprints are modest

Main Report Results

WECC Wide



WMEG vs Non-WMEG



TEP Cost-Benefit Study Results

- TEP shows the most savings when TEP is in the Southwest Power Pool Markets + cases versus CAISO Extended Day Ahead Market (EDAM)
- TEP shows between $6M - $17M in savings in all cases

Case	Net Cost ($Millions)	% Savings*
BAU (2026)	223.3	N/A
EDAM Bookend (2026)	217.8	2.5%
Markets Bookend (2026)	210.4	5.8%
Main Split (2026)	210.0	5.9%
Alt Split 1 (2026)	213.6	4.3%
Alt Split 2 (2026)	211.4	5.3%
Alt Split 3 (2026)	214.9	3.7%
Alt Split 4 (2026)	206.4	7.6%

TEP Cost-Benefit Study Results – 2026 Case

Preliminary 2023 IRP Results – September 2023

Case Studied: BAU | TEP in Markets + | TEP in EDAM

TEP Cost-Benefit Study Results – Results and Take-Aways for TEP

- APS, SRP, and TEP see benefits in day ahead market participation from a production cost standpoint
  - This holds true in a single market and multiple market footprint scenarios
  - It is important for AZ entities to be aligned in our decision to maximize benefits
  - There is a risk in not joining a day ahead market if others do

- Governance and Resource Adequacy
  - TEP's experience with SPP as Reliability Coordinator
  - Flex Alerts and transmission curtailments in the west

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2023 Integrated Resource Plan (IRP)

https://www.tep.com/2023-irp/

2023 Integrated Resource Planning Strategy

Resource Planning Strategic Framework

- **Reliability** – Capacity needed for summer peak demand and future load growth
- **Affordability** – Targeting lower cost, lower risk, high value portfolios
- **Sustainability** – Accelerate clean energy investments in comparison to the 2020 IRP
- **Diversity** – Resource diversity needed on a longer-term basis

Updates from the 2020 Integrated Resource Plan

The 2023 IRP improves upon the 2020 resource plan in several ways:

- Incorporation of the Inflation Reduction Act of 2022, which offers large incentives for electrification and tax credits that reduce the cost of renewables and energy storage resources
- Consideration of project development issues that have arisen since 2020, such as supply chain disruptions, increasingly-lengthy interconnection studies results and delays on acquisition of new equipment
- A deeper dive into emerging clean-energy technologies and the reliability challenges they pose as they displace more traditional fossil generation technologies and become an increasing larger portion of our resource portfolio in the near-term
- Reduction in wholesale power market options and the need to focus more on resource adequacy

2020 TEP and UNSE IRP Action Plan Initiatives

Major initiatives executed on as part of our 2020 IRP Action Plans

- Commissioned 480 MW of new wind and solar plus storage projects in 2021 and 2022
- Joined the real-time Western Energy Imbalance Market in May 2022
- Retired 170 MW of coal capacity at the San Juan Generating Station in June 2022
- Transitioned to seasonal operations at the Springerville Generating Station in 2023
- TEP has reduced its direct (Scope 1) CO_2 emissions by 32% since 2020

Resources executed on as part of our 2022 ASRFP

- Issued the Company's first All-Source Request for Proposal for new energy and capacity resources in April 2022
- Planned acquisition of 600 to 800 MW of new solar plus storage resources that are expected to be in service by the summer of 2026

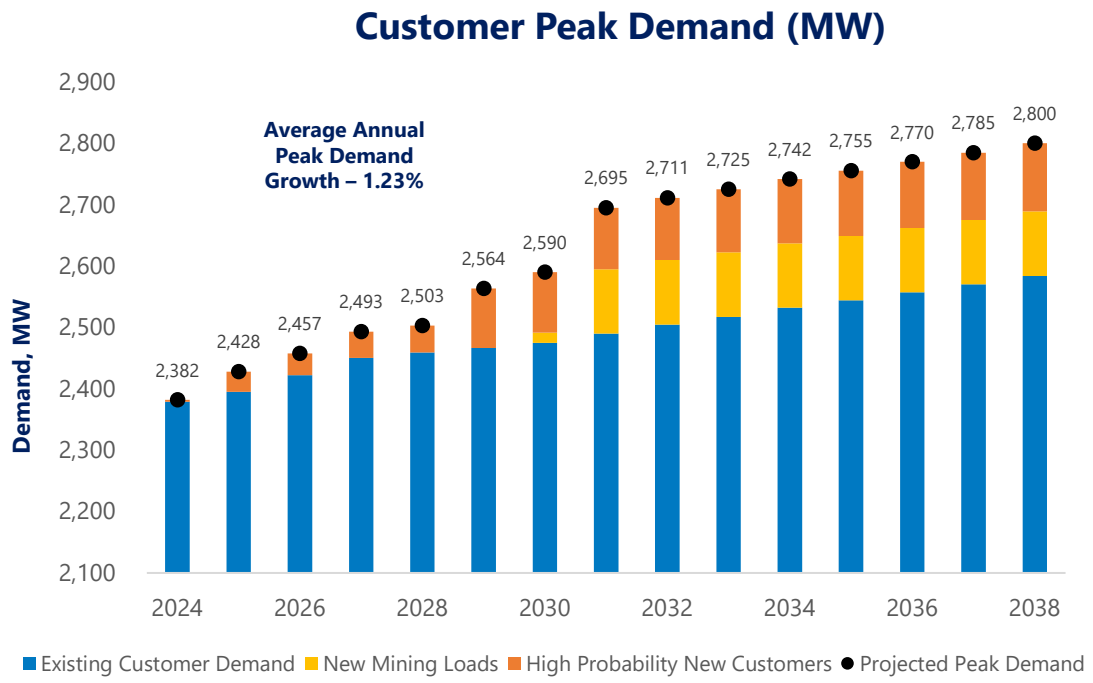
Base Plan Assumptions

- Load growth assumptions include new economic development and mining load customer expansions
- Coal Unit Retirements[1]
  - Springerville Unit 1 retires in the fall of 2027
  - Four Corners retires in July 2031
  - Springerville Unit 2 retires in the fall of 2032
- Sundt Unit 3 will retire in 2032 and Sundt Unit 4 will operate through the duration of the 15-year forecast
- All portfolios achieve 80% reductions in water usage, CO_2 and NO_X emissions by 2035
- All existing and future resources will be modeled to comply with the EPA's Regional Haze program, EPA's Good Neighbor Plan and EPA's recently proposed Greenhouse Gas Standards and Guidelines for Fossil Fuel-Fired Power Plants
- All portfolios target a minimum 16.5% planning reserve margin

Notes:
1. The 2023 coal unit retirements are based on the commitments made in the 2020 TEP Integrated Resource Plan. Moreover, Springerville Units 1 & 2 are limited to seasonal operations under all scenarios.

Customer Demand Forecast

Summer Peak Demands, MW



Customer Demand MW				
Year	Existing Customer Demand	High Probability New Customers	New Mining Loads	Projected Peak Demand
2024	2,379	3	0	2,382
2025	2,395	33	0	2,428
2026	2,422	35	0	2,457
2027	2,450	43	0	2,493
2028	2,459	43	0	2,503
2029	2,467	97	0	2,564
2030	2,475	99	17	2,590
2031	2,490	100	105	2,695
2032	2,505	102	105	2,711
2033	2,517	103	105	2,725
2034	2,532	105	105	2,742
2035	2,544	106	105	2,755
2036	2,557	108	105	2,770
2037	2,570	109	105	2,785
2038	2,584	111	105	2,800

Customer Load Assumptions:

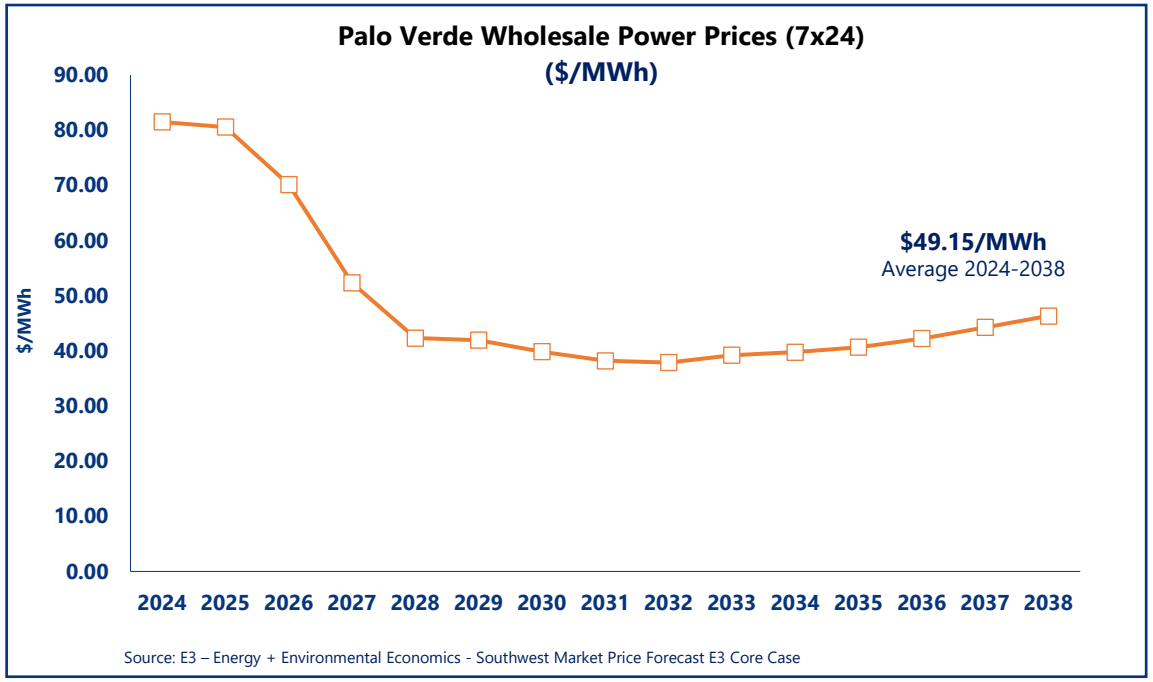
- Existing customer demand is expected to grow at 0.73% over the next five years.
- TEP's peak demand grows by 1.23% per year over the 15-year timeframe.

New Customer Load Growth Assumptions:

- New high probability customers are based on current economic development discussions with large customers.
- New mining load is based on estimated production levels for Hudbay's Copper World Complex that starts in 2030 and ramps up to 105 MW by 2031.
- New customer assumptions based on data as of September 2023.

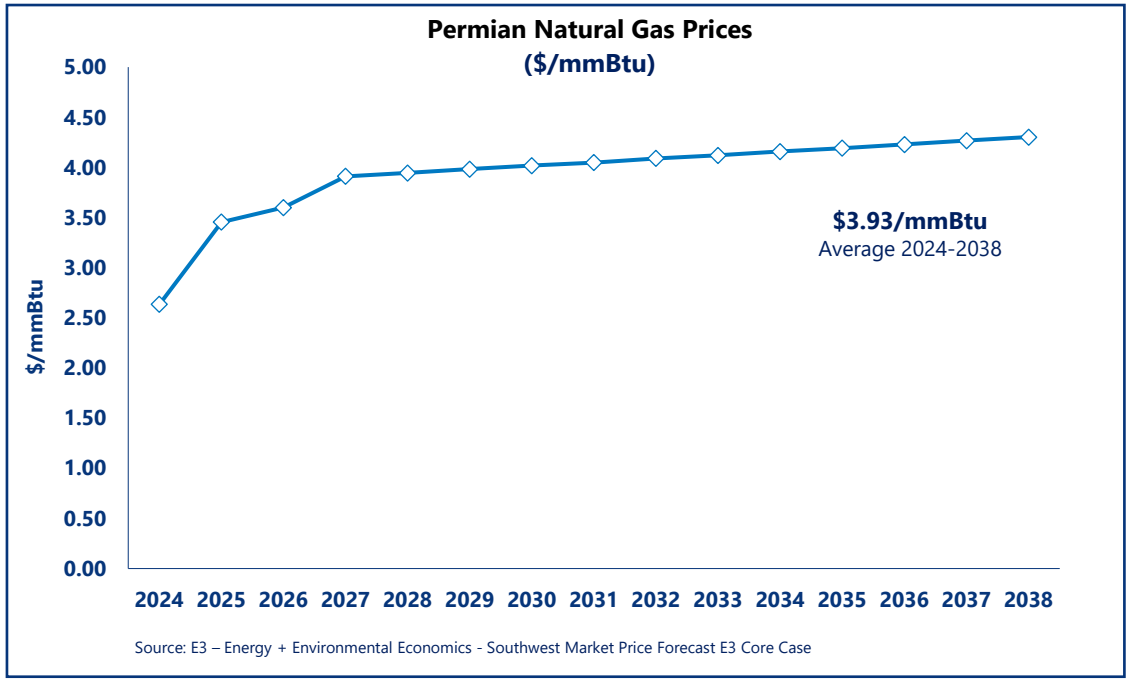
Forward Market Conditions

Wholesale Power & Natural Gas



Source: E3 – Energy + Environmental Economics - Southwest Market Price Forecast E3 Core Case

Wholesale Power Price Assumptions:
- The 2023 IRP forecast assumes that average wholesale power prices decline as solar generation increases in the Desert Southwest region.
- Excess solar generation increases daily curtailments of solar resources which results in more negative prices during some hours of day.
- Price forecast derived Q1 2023.



Source: E3 – Energy + Environmental Economics - Southwest Market Price Forecast E3 Core Case

Natural Gas Market Price Assumptions:
- Gas prices derived from monthly forwards in the near term and the 2022 Energy Information Administration (EIA) Annual Energy Outlook for the long term.
- Monthly SNL forwards for Permian used through 2026. Beyond 2026, the Desert Southwest Natural Gas forecast trends to EIA longer-term forecasts.
- Price forecast derived Q1 2023.

Inflation Reduction Act (Investment Tax Credit – ITC)

- **All energy storage projects are assumed to qualify for the 30% investment tax credit**

Future storage and renewable resources are assumed they will meet the prevailing wage and apprenticeship requirements under the IRA.

			Start of Construction						
			2006 to 2019	2020 to 2021	2022	2023 to 2033	The later of 2034 (or two years after applicable year[a])	The later of 2035 (or three years after applicable year[a])	The later of 2036 (or four years after applicable year[a])
ITC	**Full rate** (if project meets labor requirements[b])	Base Credit	30%	26%	30%	30%	22.5%	15%	0%
		Domestic Content Bonus				10%	7.5%	5%	0%
		Energy Community Bonus				10%	7.5%	5%	0%
	Base rate (if project does not meet labor requirements[b])	Base Credit	30%	26%	6%	6%	4.5%	3%	0%
		Domestic Content Bonus				2%	1.5%	1%	0%
		Energy Community Bonus				2%	1.5%	1%	0%
	Low-income bonus (1.8 GW/yr cap)	<5 MW projects in LMI communities or Indian land				10%	10%	10%	10%
		Qualified low-income residential building project / Qualified low-income economic benefit project				20%	20%	20%	20%

Inflation Reduction Act (Production Tax Credit – PTC)

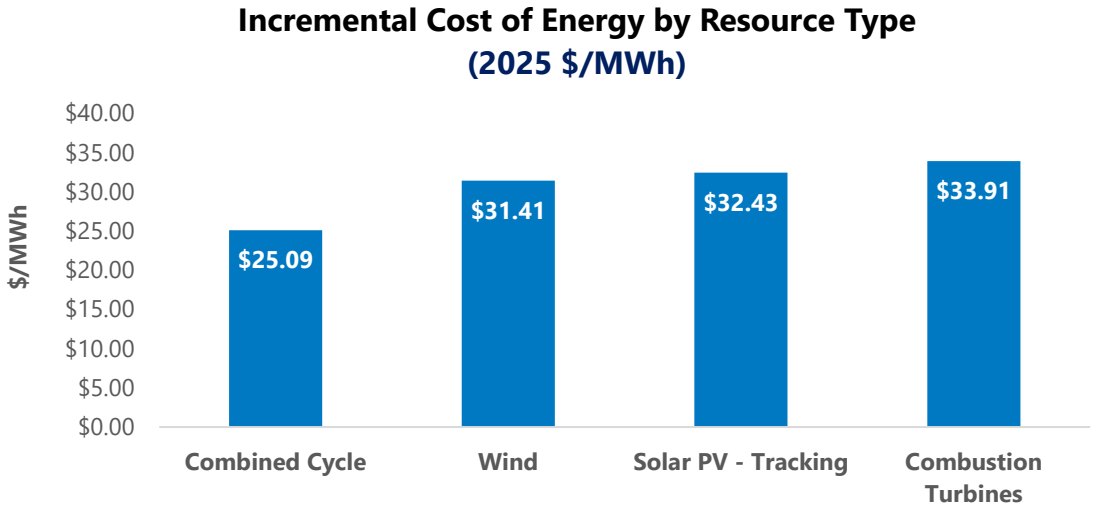
- **All wind and solar projects are assumed to qualify for $2.75¢/kWh production tax credits**

Future storage and renewable resources are assumed they will meet the prevailing wage and apprenticeship requirements under the IRA.

			Start of Construction						
			2006 to 2019	2020 to 2021	2022	2023 to 2033	The later of 2034 (or two years after applicable year[a])	The later of 2035 (or three years after applicable year[a])	The later of 2036 (or four years after applicable year[a])
PTC for 10 years ($2022)	**Full rate** (if project meets labor requirements[b])	Base Credit			2.75 ¢	2.75 ¢	2.0 ¢	1.3 ¢	0.0 ¢
		Domestic Content Bonus				0.3 ¢	0.2 ¢	0.1 ¢	0.0 ¢
		Energy Community Bonus				0.3 ¢	0.2 ¢	0.1 ¢	0.0 ¢
	Base rate (if project does not meet labor requirements[b])	Base Credit			0.55 ¢	0.55 ¢	0.4 ¢	0.3 ¢	0.0 ¢
		Domestic Content Bonus				0.1 ¢	0.0 ¢	0.0 ¢	0.0 ¢
		Energy Community Bonus				0.1 ¢	0.0 ¢	0.1 ¢	0.0 ¢

Incremental Energy Costs

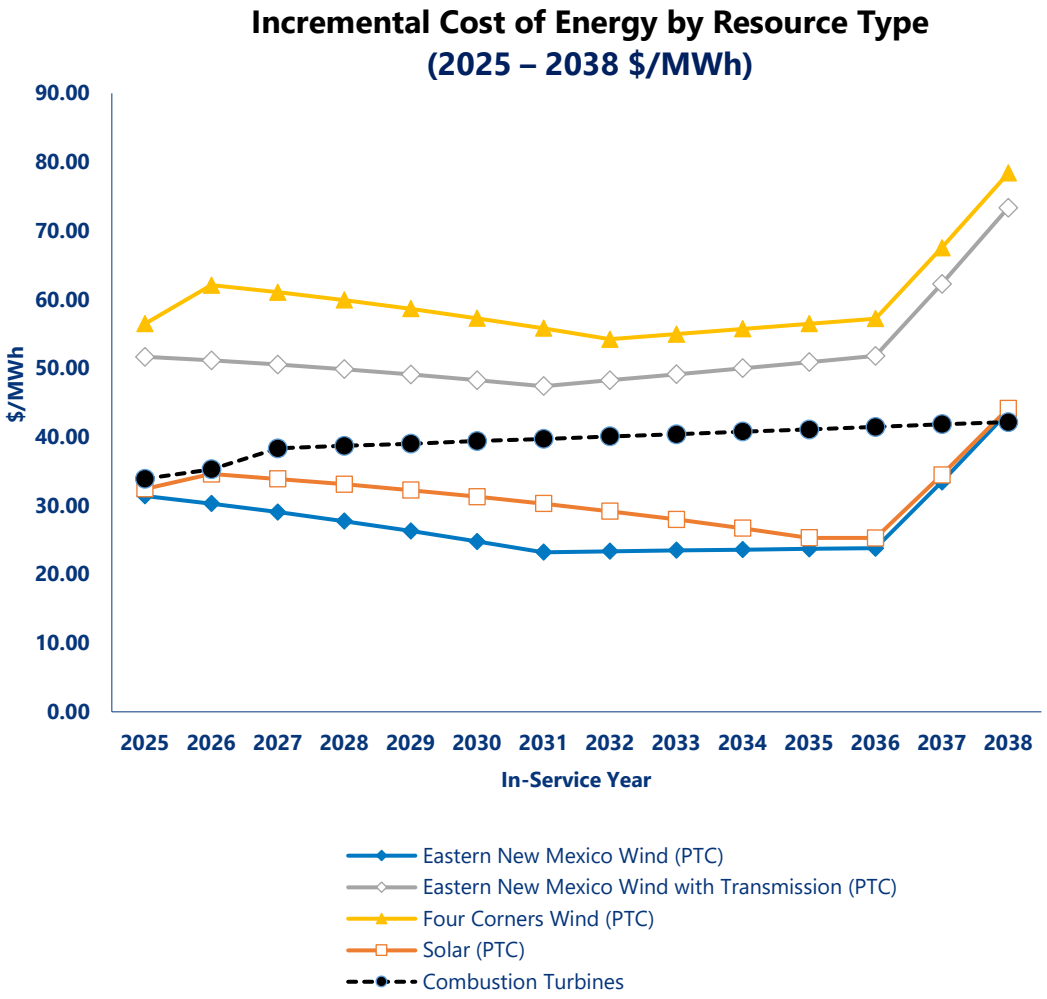
The Cost of Energy



Resource Technologies	Combined Cycle	Wind	Solar PV - Tracking	Combustion Turbines
Project Cost, $/kW	**$1,388**	**$1,591**	**$1,273**	**$1,186**
Installed Capacity, MW	100	100	100	100
Capacity Factor, %	50.0%	43.9%	31.0%	20.0%
Heat Rate, Btu/KWh	7,250			9,800
Natural Gas, $/mmBtu	$3.46			$3.46
Energy Cost, $/MWh	**$25.09**	**$31.41**	**$32.43**	**$33.91**

Incremental Cost of Energy:

- Future storage and renewable resources are assumed they will meet the prevailing wage and apprenticeship requirements under the IRA. See base credit details on slides 1&2
- All energy storage projects are assumed to qualify for the investment tax credit (See Slide 14).
- All wind and solar projects are assumed to qualify for $2¢/kWh production tax credits (See Slide 15).
- Natural gas prices are based on the 2025 average forward market price of $3.46/mmBtu (Permian Basin).



Levelized Cost of Operations by Resource Type

Solar plus storage is more expensive than natural gas capacity

Levelized Cost of Operations by Resource Type

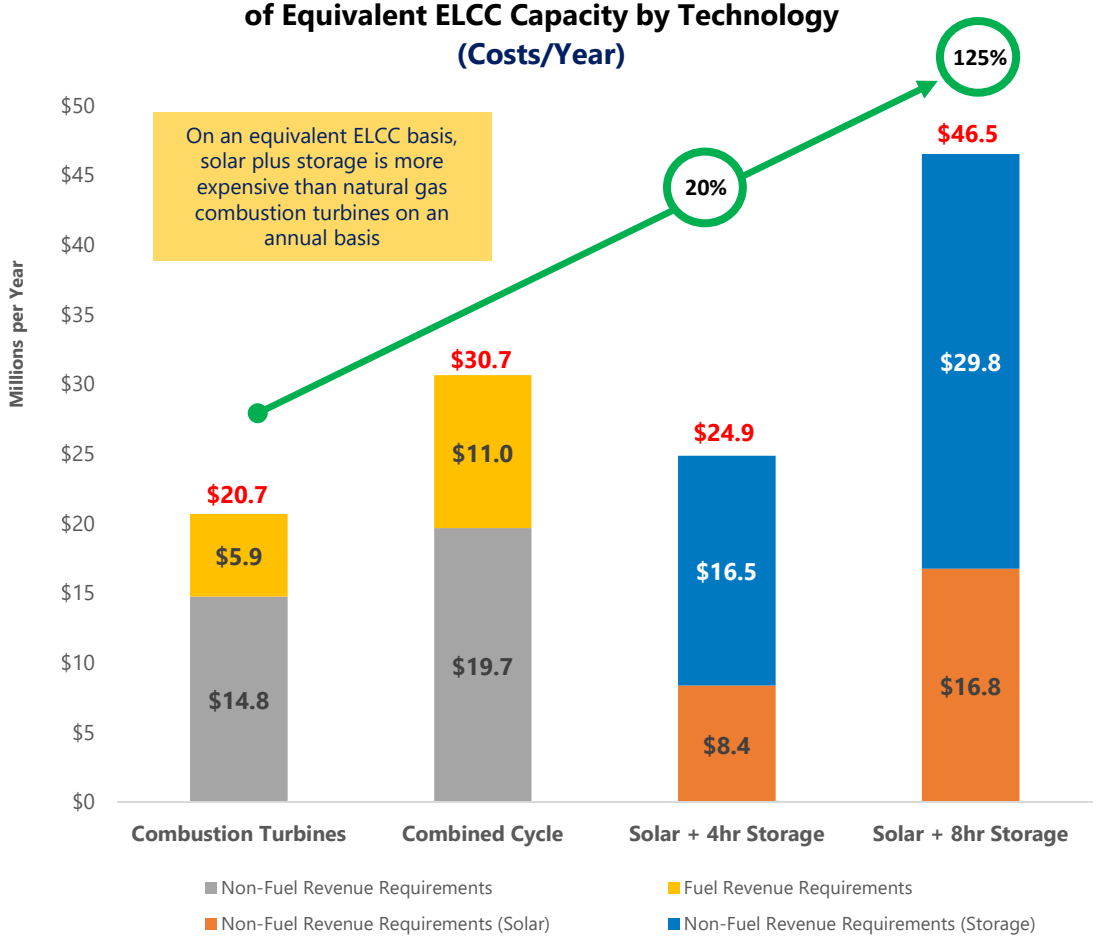
(2025 $/kW Costs Based on Equivalent ELCC Contributions)

Resource Technologies	Combustion Turbines	Combined Cycle	Solar + 4hr Storage	Solar + 8hr Storage
Project Cost, $/kW ($2025)	$1,186	$1,388	$1,485	$2,801
Capital Investment, $000	**$118,600**	**$138,800**	**$297,000**	**$560,100**
Hours of Daily Dispatch Capacity, Hours	**24**	**24**	**4**	**8**
Capacity Factor, %	20%	50%	31%	33%
Heat Rate, Btu/KWh	9,800	7,250		
Natural Gas, $/mmBtu	$3.46	$3.46		
ELCC Contribution, %	**100%**	**100%**	**50%**	**50%**
Equivalent Capacity Needed	**100**	**100**	**200**	**200**
Fuel Revenue Requirements, $000	$5,941	$10,987		
Non-Fuel Revenue Requirements, $000	$14,752	$19,675	$24,877	$46,537
Annual Revenue Requirements, $000	**$20,692**	**$30,662**	**$24,877**	**$46,537**

Effective Load Carrying Capability (ELCC) :

- Effective Load Carrying Capability (ELCC) is recognized by the industry as a methodology for measuring the resource adequacy contribution of resources.
- The ELCC is a technology-neutral measurement of the equivalent or 'perfect' capacity of intermittent and energy-storage limited resources.
- Based on work conducted by E3 Energy + Environmental Economics, the combination of solar plus 4-hour storage has an average ELCC of 50% on TEP's system.
- Fuel Revenue Requirements are based on the 2025 average natural gas price of $3.46/mmBtu (Permian Basin) using the capacity factors listed in the table above.
- Non-Fuel Revenue Requirements are based on capital less any tax incentives, plus on-going operations and maintenance costs.

Levelized Cost of Operations for 100 MW of Equivalent ELCC Capacity by Technology (Costs/Year)



Levelized Cost of Operations:

- The "Levelized Cost of Operations" applies revenue requirements approach to evaluating each resource technology based on its ELCC capacity value.
- This methodology captures the upper limit on the annual revenue requirements (fuel & non-fuel) for a given capacity resource.
- In the example above, 200 megawatts of solar plus 4-hour storage would be needed to achieve a similar peak reliability standard as a 100-megawatts from a dispatchable natural gas combined-cycle or combustion turbine resource.

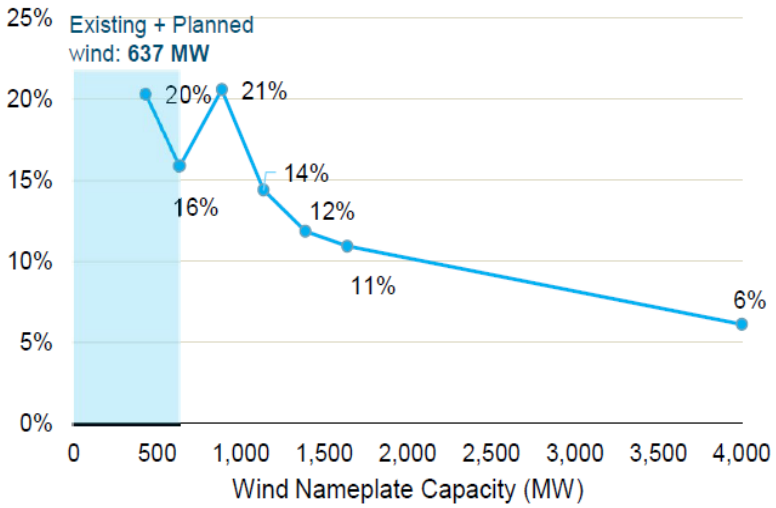
Resource Adequacy

Two step process for ensuring each portfolio is resource adequate

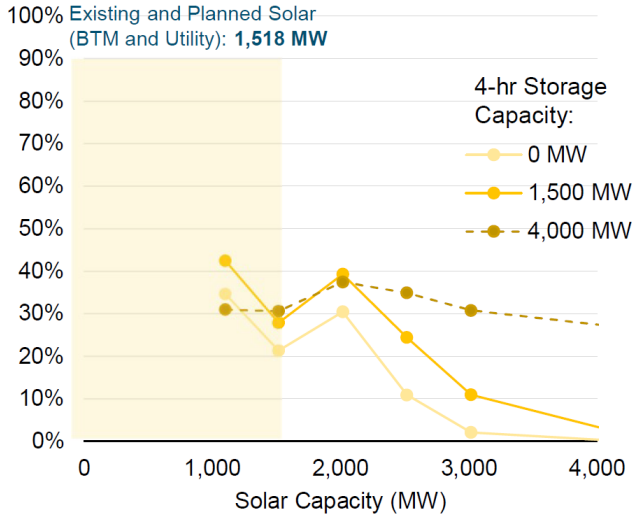
Step 1: Planning reserve margin of at least 16.5% each year

- Accounts for higher-than-average loads, operating reserves, and thermal outages
- Up from 15% typically used in prior IRPs
- Uses of a “loss of load probability” method (ELCC) to determine the capacity value of solar, wind, and 4h storage

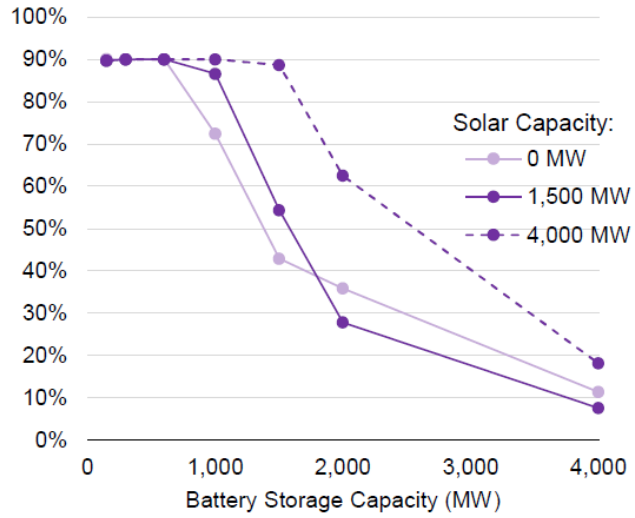
Incremental Wind ELCC



Incremental Solar ELCC



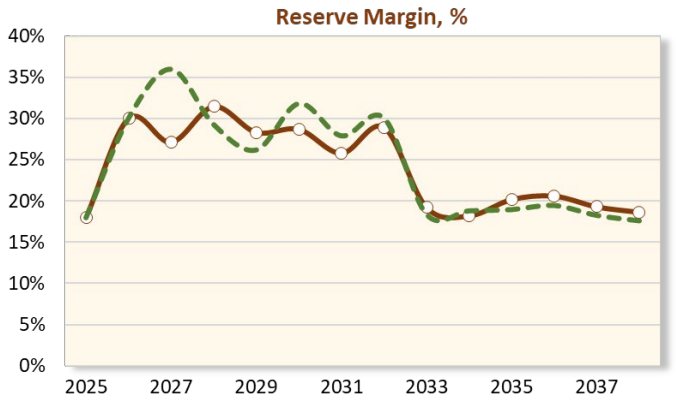
4h Storage ELCC



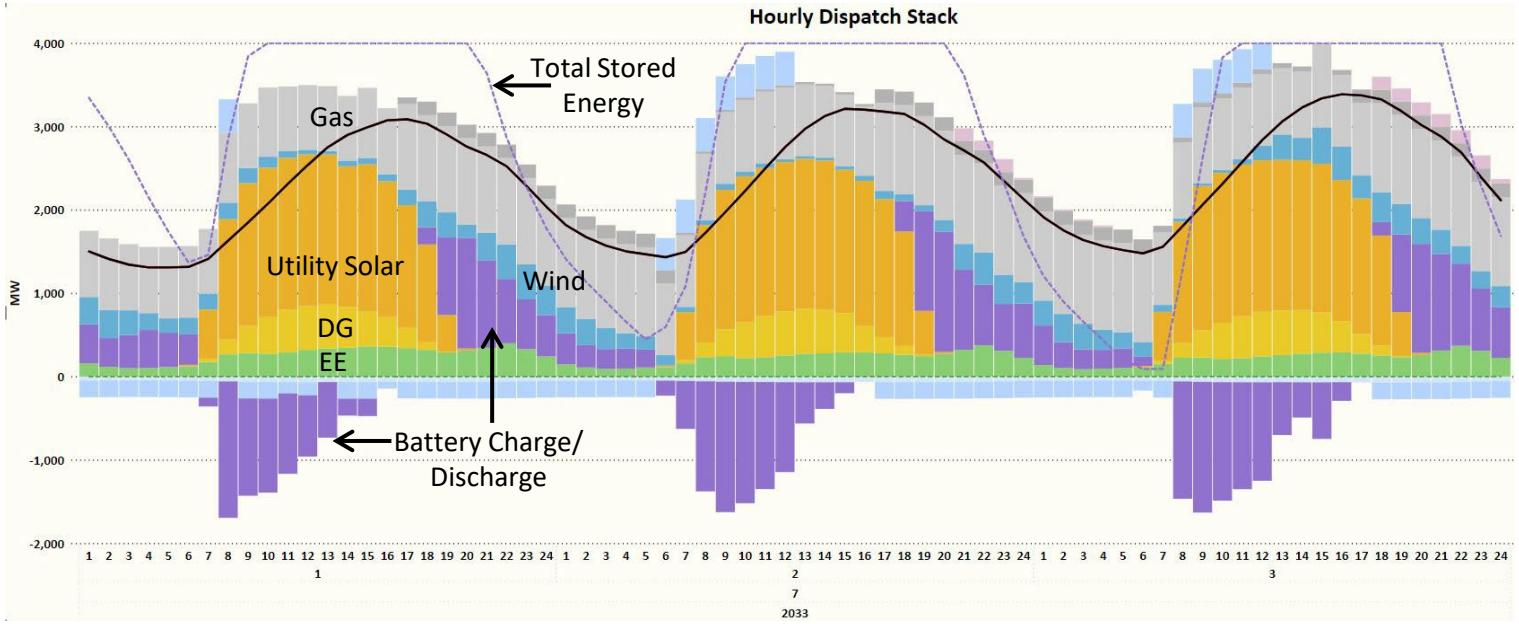
Resource Adequacy

Step 2: 15-year hourly stress test

- Demand increased 16.5% (ensures model accounts for high loads, reserves, and outages)
- No market access is permitted during summer afternoons and evenings



Simulated Dispatch, July 1-3, 2033



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Preliminary Portfolio Results

Three pathways emerge for TEP as potential resource portfolio outcomes…

Solar + Storage Portfolio

- 2,440 MW Renewables
- 2,180 MW Storage

4,620 MW
New Generating & Storage Resources

Balanced Portfolio

- 1,890 MW Renewables
- 1,330 MW Storage
- 400 MW Natural Gas

3,620 MW
New Generating & Storage Resources

Coal Extension Portfolio

- 2,440 MW Renewables
- 2,180 MW Storage

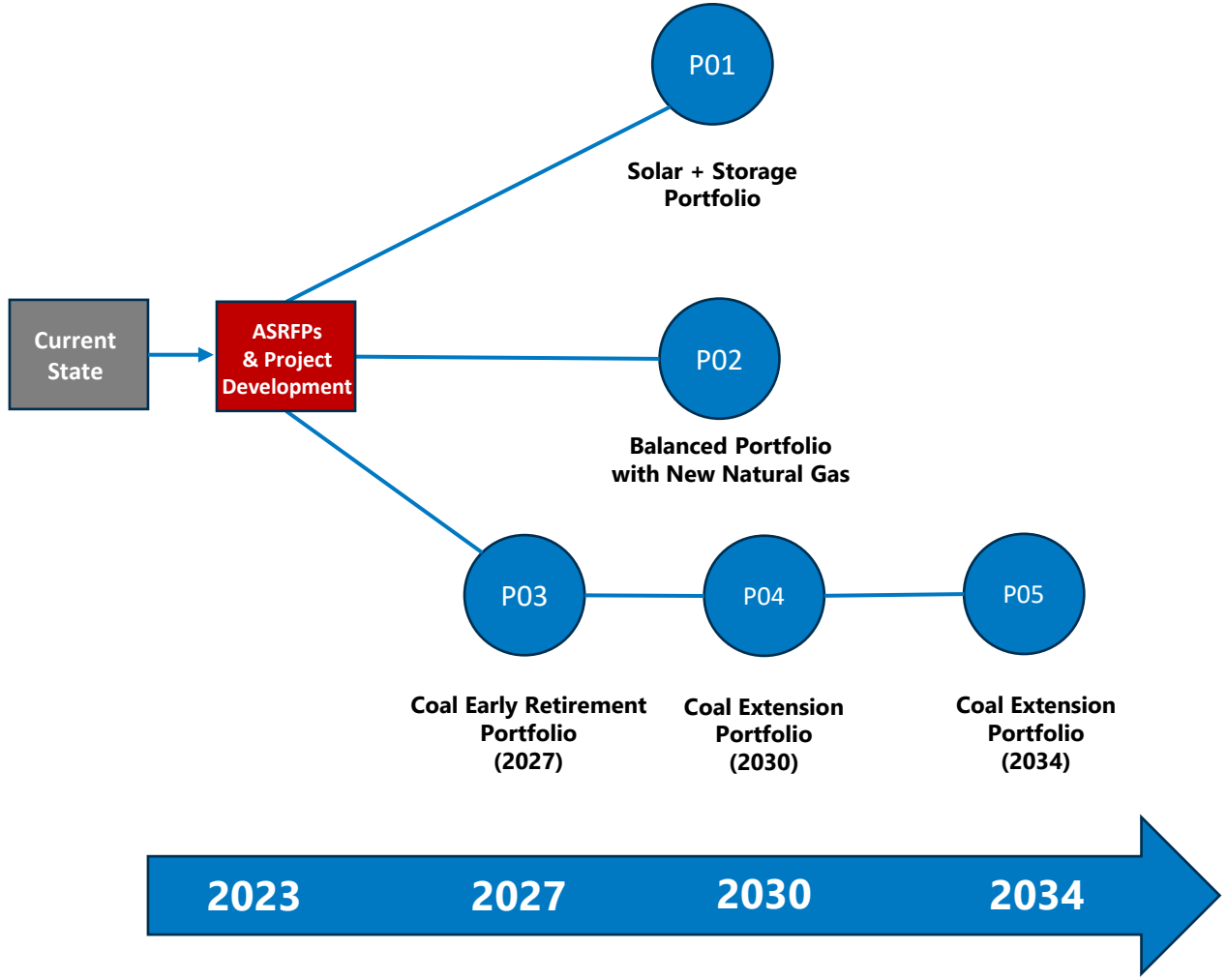
4,620 MW
New Generating & Storage Resources

Resource Contingency Planning

- **Regional market scarcity along with new economic development driving demand for near term firm capacity resources**

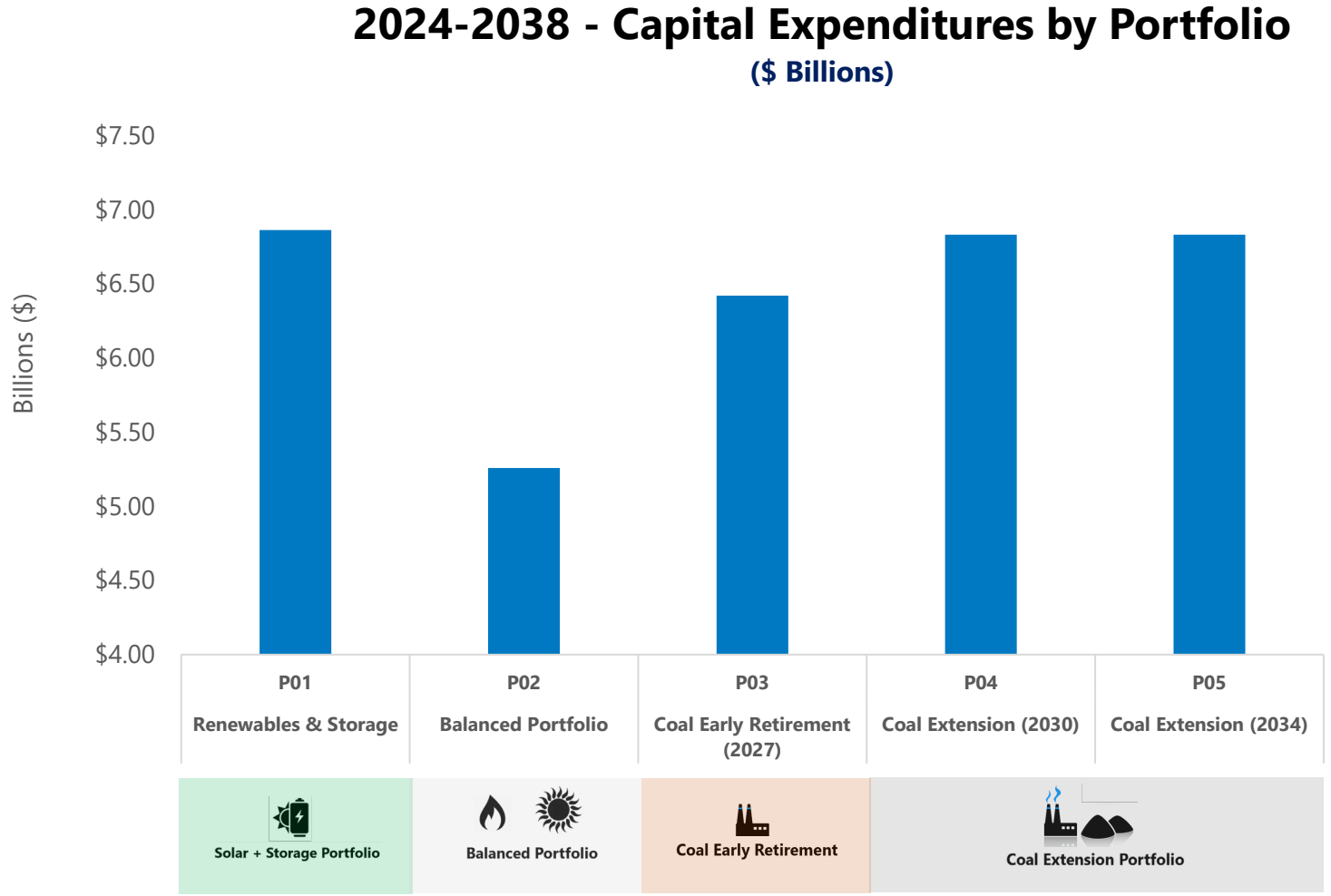
- **Planning with Uncertainty**
  - Generation interconnection study bottlenecks (FERC Order 2023)
  - Project denials (i.e., environmental, regulatory or zoning)
  - Limited natural gas pipeline transportation in Arizona
  - Lack of existing transmission capacity available throughout the region
  - Supply-chain and workforce constraints

- **All resource options need to be considered**

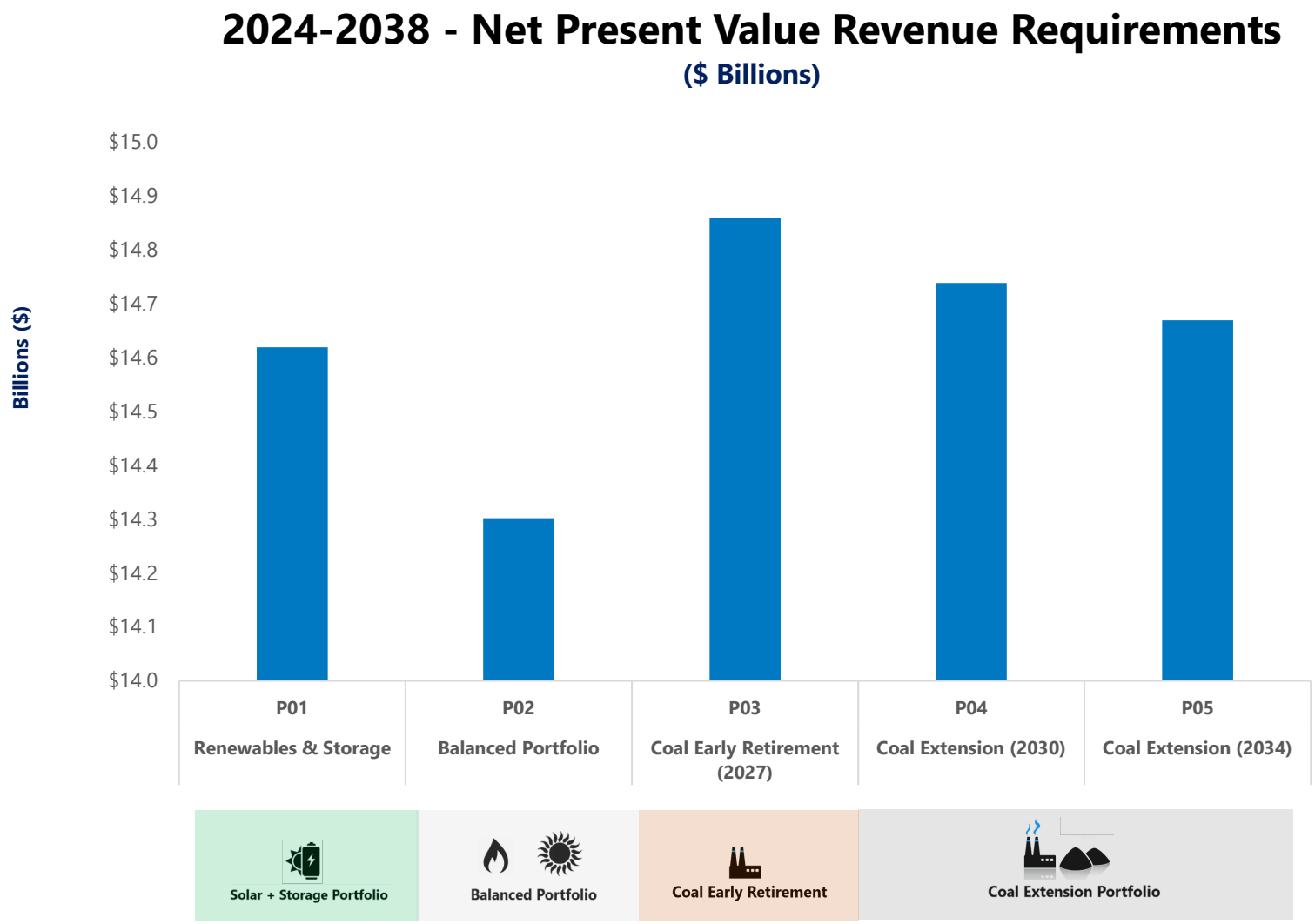


Notes:
- Future All-Source Requests for Proposals (ASRFP) along with successful project development will determine ultimate portfolio expansion plan.

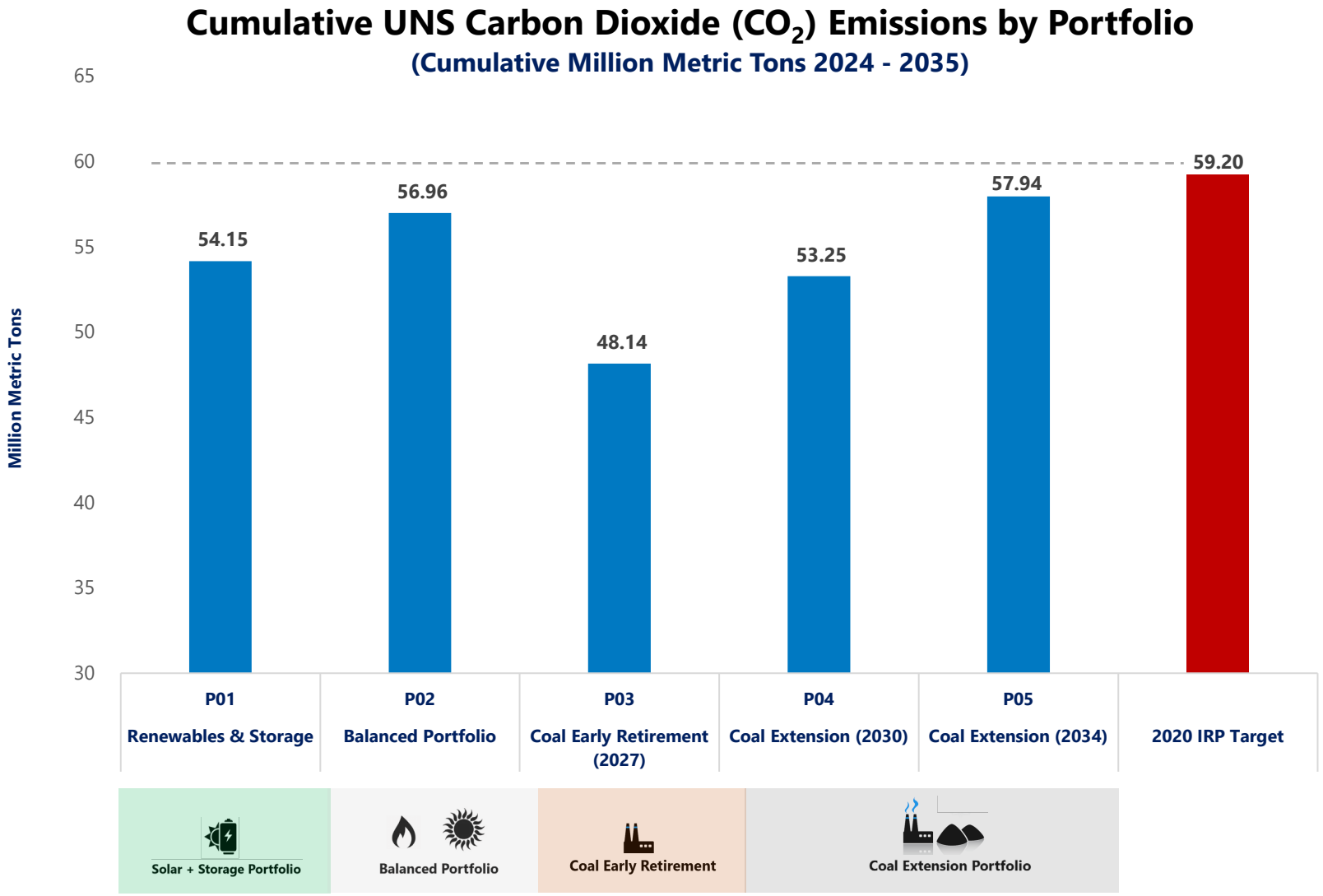
Portfolio Capital Expenditures ($ Billion)



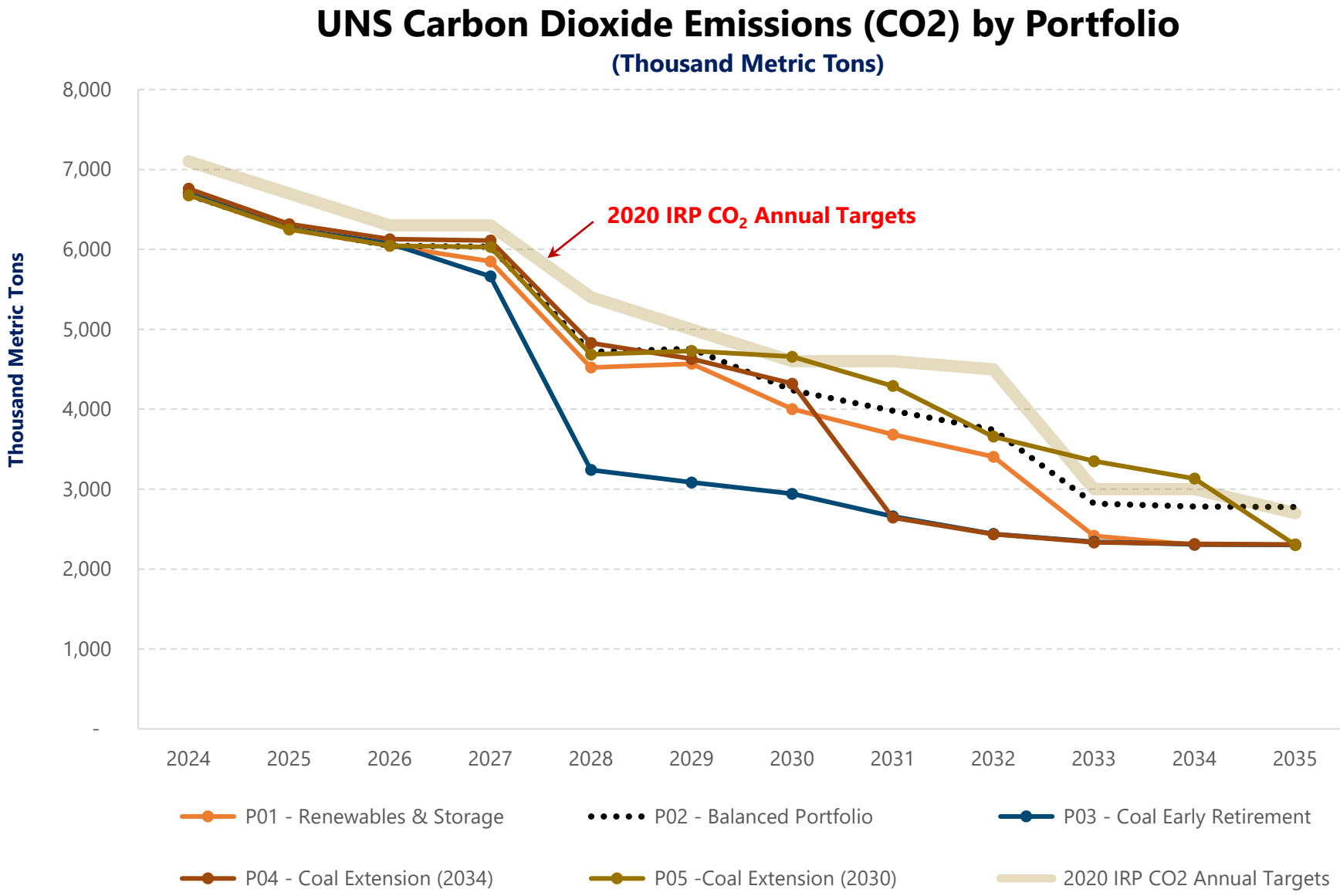
Portfolio Net Present Value Revenue Requirements ($ Billion)



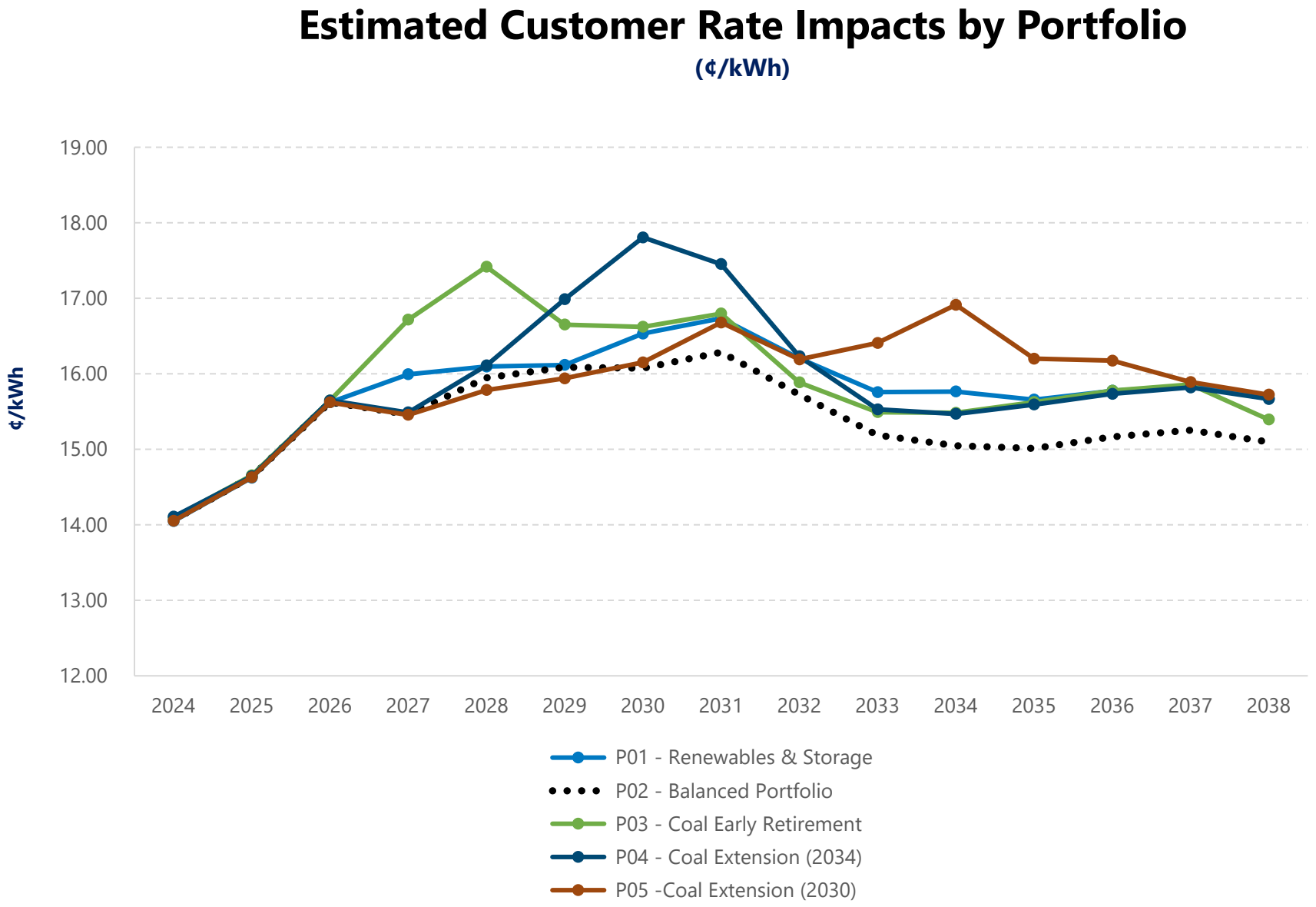
Cumulative UNS CO2 Emissions 2024-2035 (Million Metric Tons)



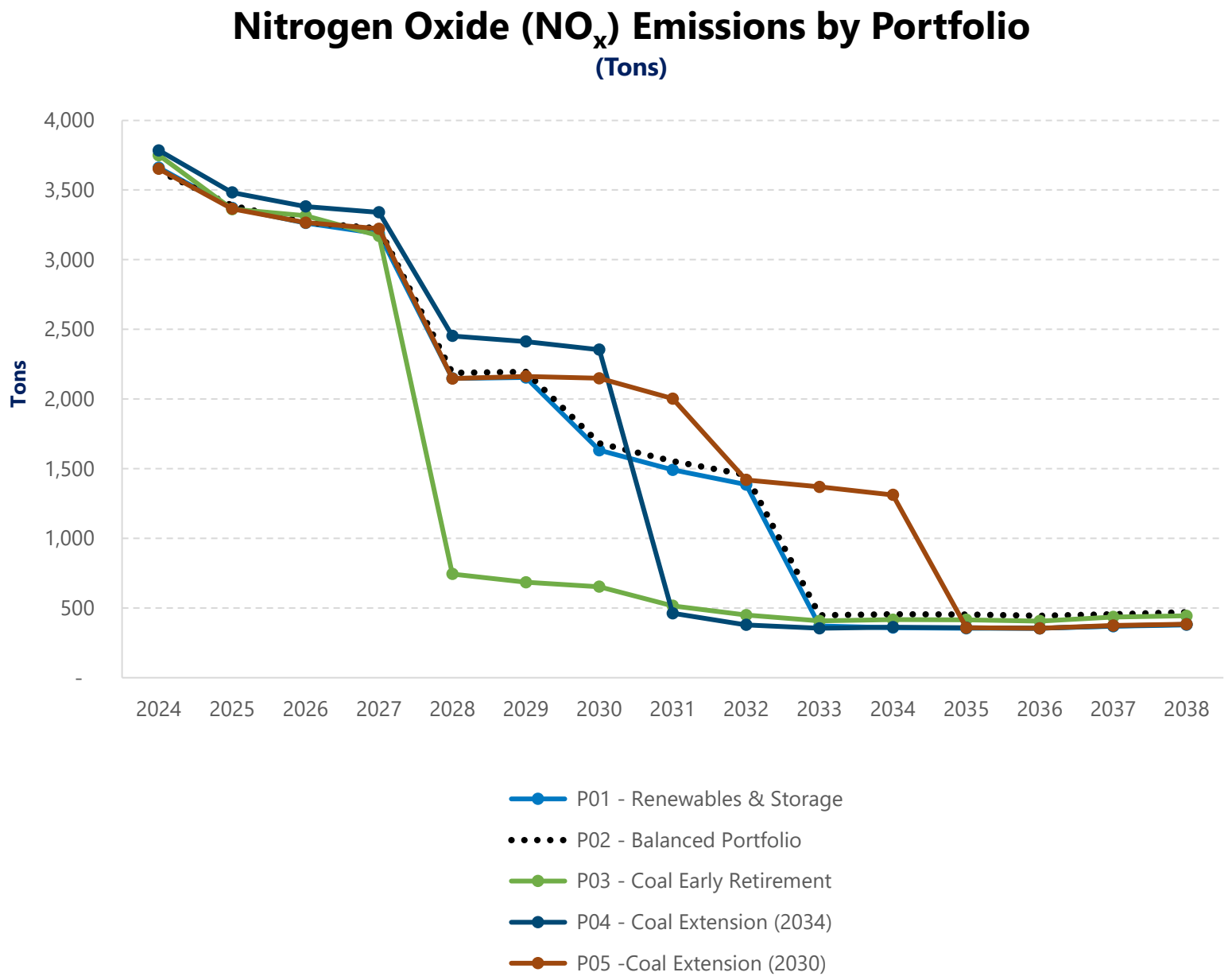
UNS CO_2 Emissions by Portfolio (Thousand Metric Tons)



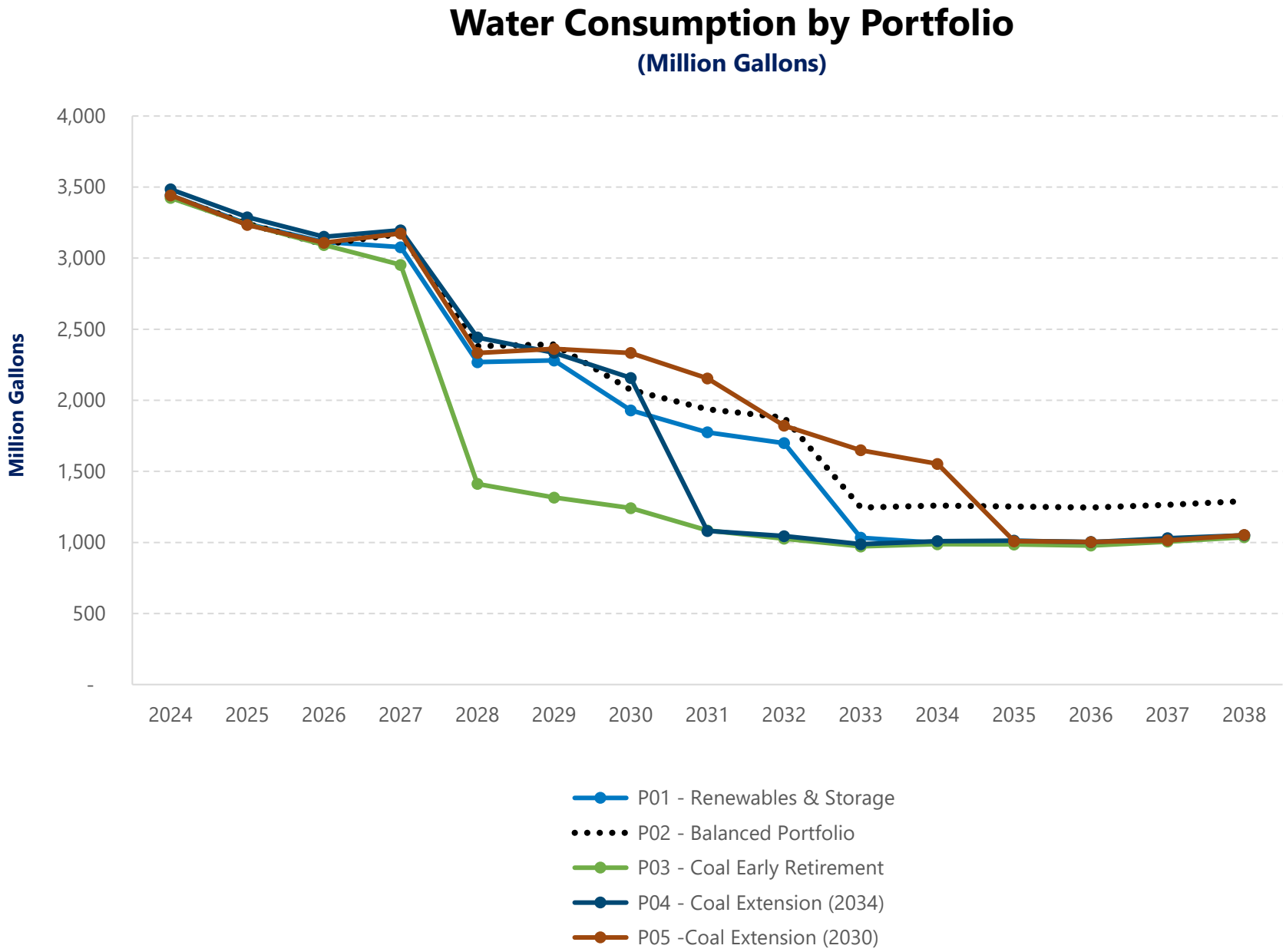
Estimated Customer Rate Impacts by Portfolio (¢/kWh)



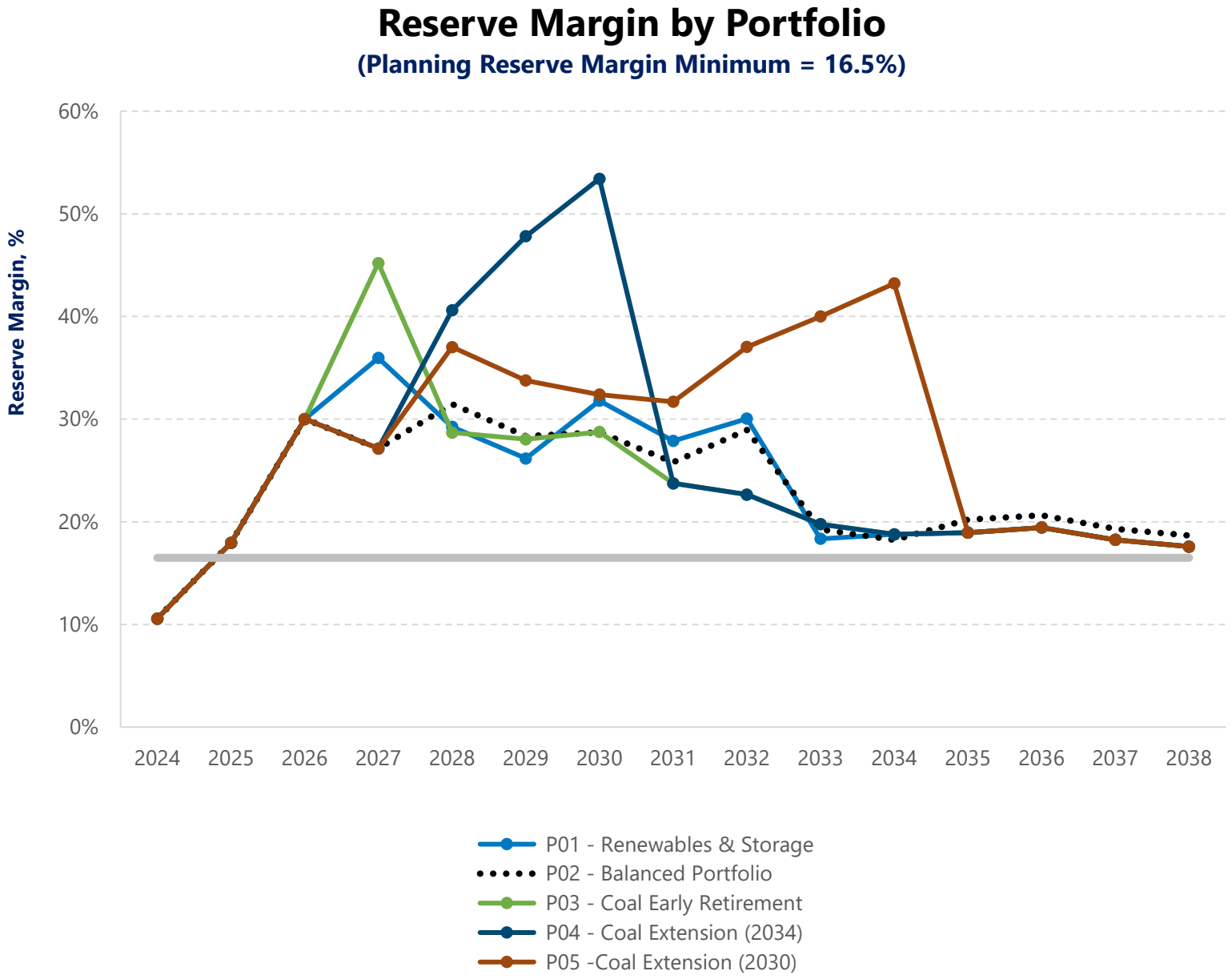
TEP NO_x Emissions by Portfolio (Tons)



TEP Water Consumption by Portfolio (Million Gallons)

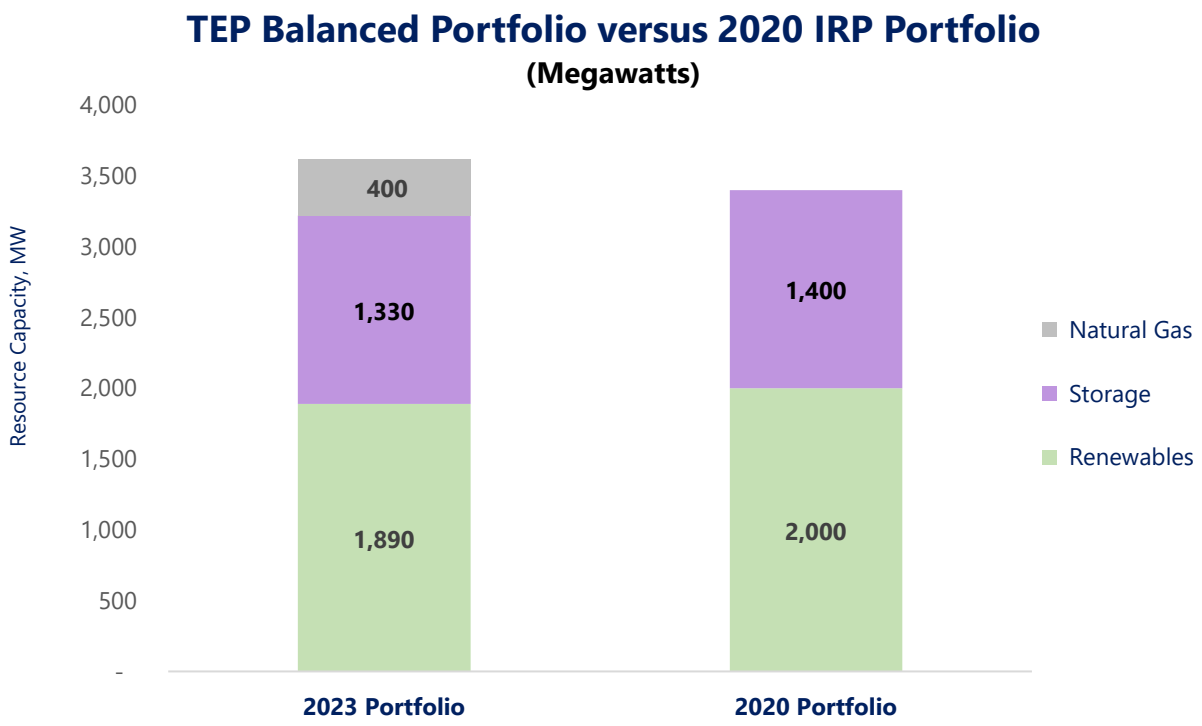


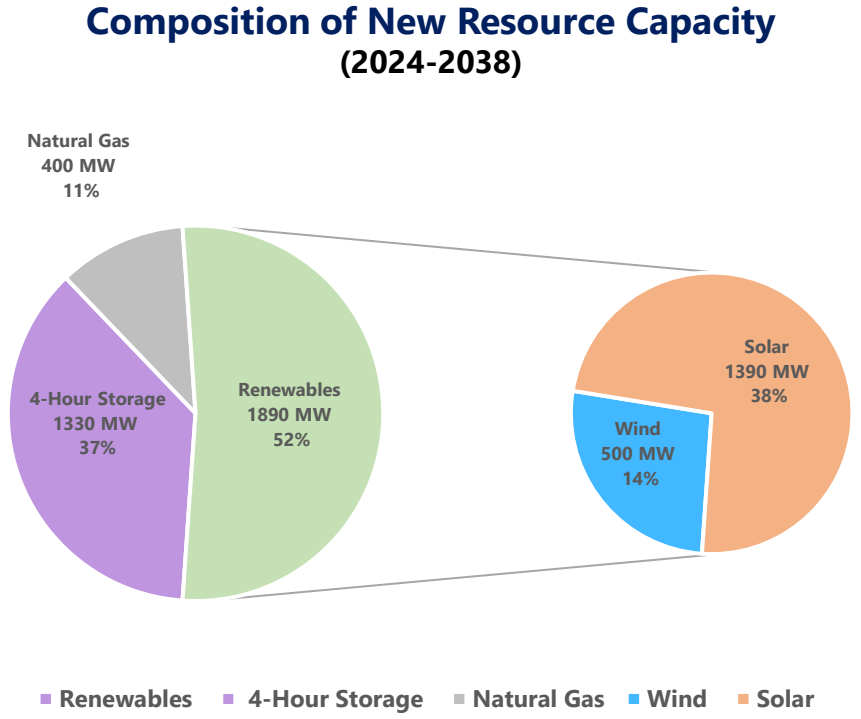
System Reliability by Portfolio (Reserve Margins)



TEP Balanced Portfolio

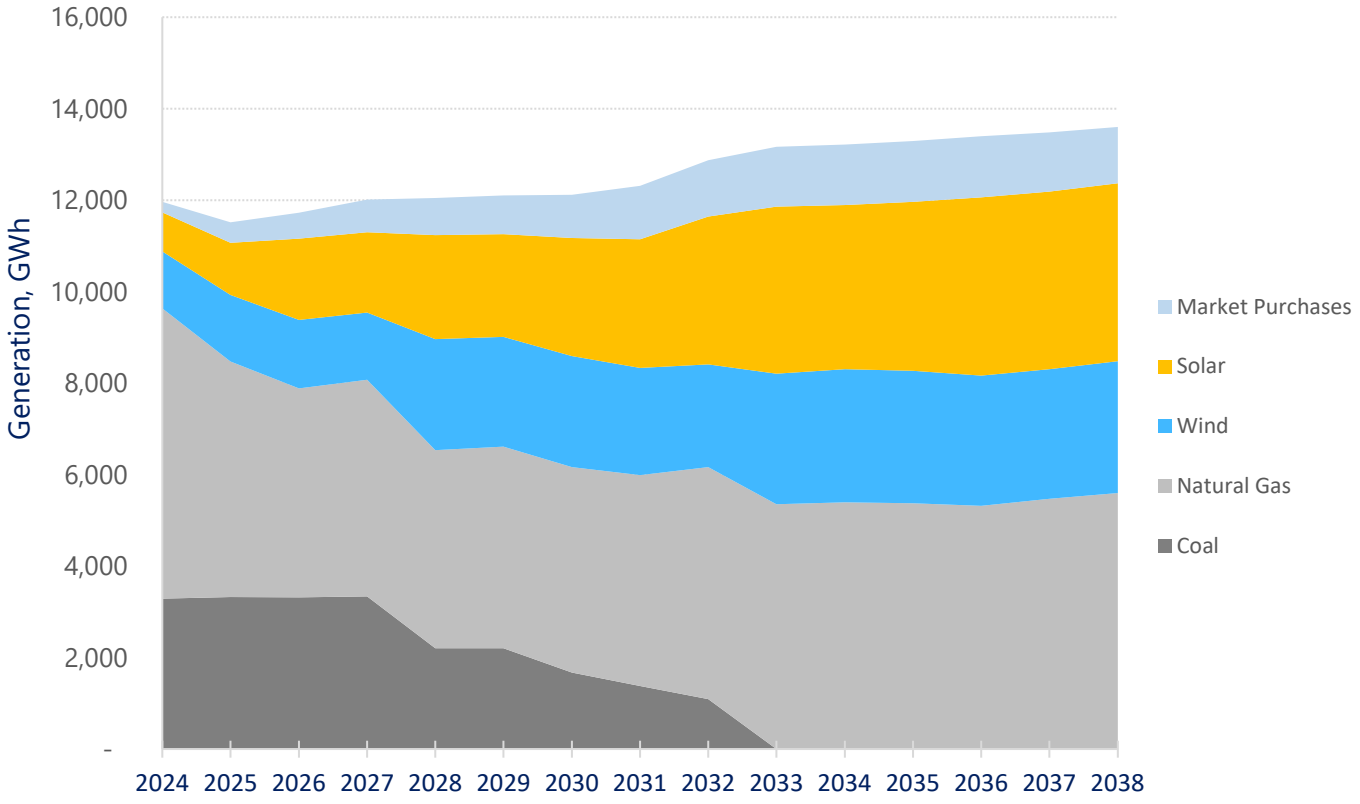
New Resource Capacity Additions, MW



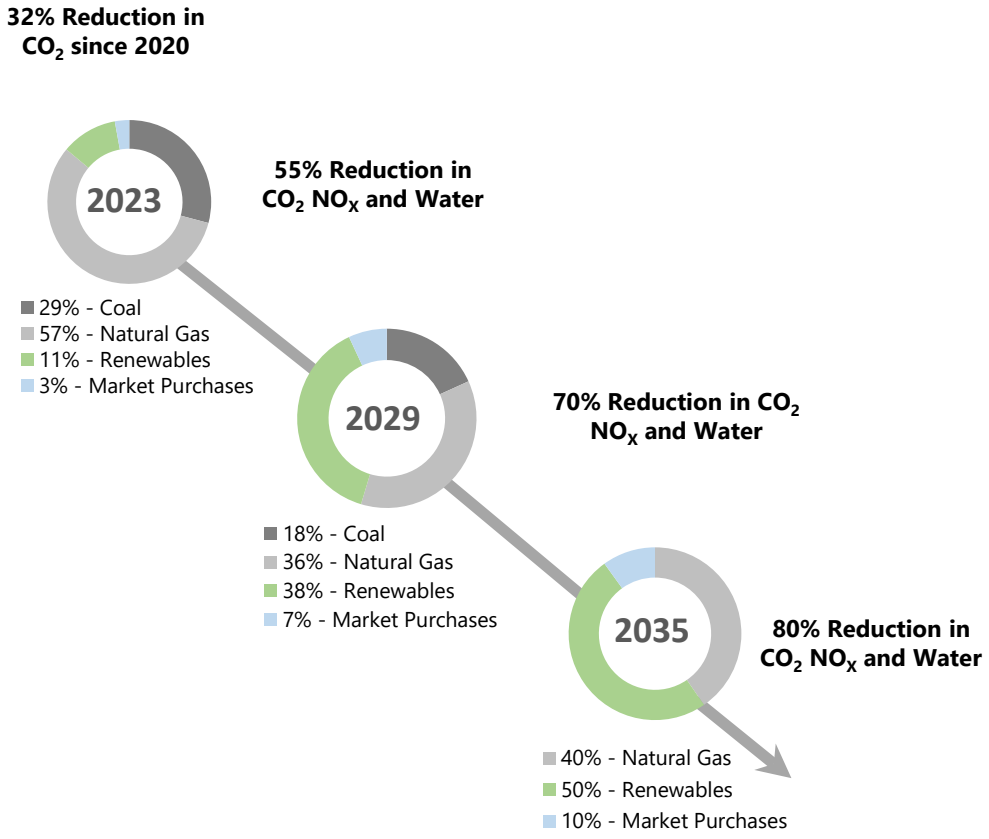


TEP Balanced Portfolio
Generation Mix, GWh

The Balanced Portfolio Generation Mix
(MWh)



Steady Progress Through 2035
(Significant Reductions from 2020)



Balanced Portfolio

- Implementation of Clean Energy Transition
- Achieve through ASRFP
  - Resource Diversification
  - Long-term Sustainability
  - Lower Cost
- Maintain Reliability
  - Allow for Coal Retirements
  - Higher Levels of Renewables
  - Storage and Natural Gas Capacity
- Significant Environmental Improvements by 2035
  - Water
  - CO_2
  - NOx

TEP Portfolios Under Development

Portfolio	Name	Description / Design Objectives	Sensitivity Tests
TEP P01	Reference Case	• Re-evaluates TEP's long-term plan acknowledged by the ACC in 2022 given new outlooks in future loads and resource costs and updated modeling capabilities. • Provides basis for comparison to and amongst other portfolios. • Load growth sensitivity tests to re-evaluate new resource needs and costs in the event demand does not grow or grows beyond current expectations.	High/Low Market Prices High/Low Capital Costs High/No Load Growth
TEP P02	400 New Gas	• Adds 400 MW of eight new, fast-start, fast-ramping aeroderivative combustion turbines in lieu of an equivalently-reliable amount of future solar and storage. • Load growth sensitivity tests to re-evaluate new resource needs and costs in the event demand does not grow or grows beyond current expectations.	High/Low Market Prices High/Low Capital Costs High/No Load Growth
TEP P03	SGS 2 Retire 2027	• Retires Springerville Unit 2 five years early (2027), the same year as SGS 1. • Includes costs for coal contract liquidated damages, coal contract early termination costs, and cost recovery through treatment of SGS 2 as a lower-return regulatory asset.	High/Low Market Prices High/Low Capital Costs
TEP P04	SGS 1+2 Retire 2030	• Retires both Springerville units in 2030 instead of 2027 and 2032. • Assumes same amount of must-take coal volume as reference case but includes coal contract early termination costs.	High/Low Market Prices High/Low Capital Costs
TEP P05	SGS 1+2 Retire 2034	• Retires both Springerville units in 2034 instead of 2027 and 2032. • Extends annual must-take coal volumes in reference case through 2034. • Includes low-sulfur coal handling upgrades for Powder River Basin coal.	High/Low Market Prices High/Low Capital Costs
TEP P06	Heavy Solar	• Decreases future wind from 500 MW to 250 MW and adds solar (and storage if necessary) to reliably achieve the same amount of CO_2 reduction. • Evaluates cost differences and system integration capabilities in the event market conditions, load patterns, or system operations favor relatively more solar deployment. • Evaluates appropriateness of wind/solar capacity mix assumed in other portfolios. • Assumes low capital cost assumptions only for solar.	

TEP Portfolios Under Development

Portfolio	Name	Description / Design Objectives	Sensitivity Tests
TEP P06	Heavy Solar	• Decreases future wind from 500 MW to 250 MW and adds solar (and storage if necessary) to reliably achieve the same amount of CO_2 reduction. • Evaluates cost differences and system integration capabilities in the event market conditions, load patterns, and/or system operations favor relatively more solar deployment. • Evaluates appropriateness of wind/solar capacity mix assumed in other portfolios. • Assumes low capital cost only for solar.	
TEP P07	Heavy Wind	• Increase future wind from 500 MW to 750 MW and decrease solar (and storage if possible) to reliably achieve the same amount of CO_2 reduction. • Evaluates cost differences and system integration capabilities in the event that market conditions, load patterns, and/or system operations favor relatively more wind deployment. • Evaluates appropriateness of wind/solar capacity mix assumed in other portfolios. • Assumes low capital cost assumptions only for wind, but also a $48/kW-year transmission wheeling cost for the additional 250 MW given the lack of available transmission capacity on the east side of TEP's transmission system, which is located closest to high-value wind resources in east NM.	
TEP P08	Mid-Duration Storage / Pumped Hydro	• Replaces all Li-ion battery storage brought into service from 2033-2038 with an equivalently-reliable amount of 10-hour storage brought into service in 2033 with ATB assumptions for cost and round-trip efficiency (80%) and a capacity credit of 75% based on interpretation of TEP's ELCC study. • Assumes reservoir would be located in northern AZ and that only 300 MW could be transmitted before having to purchase additional transmission capacity at $48/kW-year. • Relocates 1,000 MW of storage to remote location to support remote storage.	High/Low Market Prices
TEP P09	Clean Firm Power / Small Modular Nuclear Reactors	• Replaces all Li-ion battery storage brought into service from 2033-2038 with an equivalently-reliable amount of nuclear power brought into service in 2033.	High/Low Market Prices
TEP P10	Market and Transmission Reform	• Increases market depth by assuming 50% more import/export capability and 25% lower market prices.	High/Low Market Prices

Integrated Resource Planning and Procurement

Going forward:

- Planning and procurement will be more tightly integrated
- Procurement will be more informed by long-term needs
- Long-term planning will be more informed by firm proposals
- Actual resource selection and implementation will depend more on market conditions at time of procurement