2022 Generation Planning Process

Rate Advisory Committee Meeting – July 21, 2022

CPS ENERGY

CRA Charles River Associates

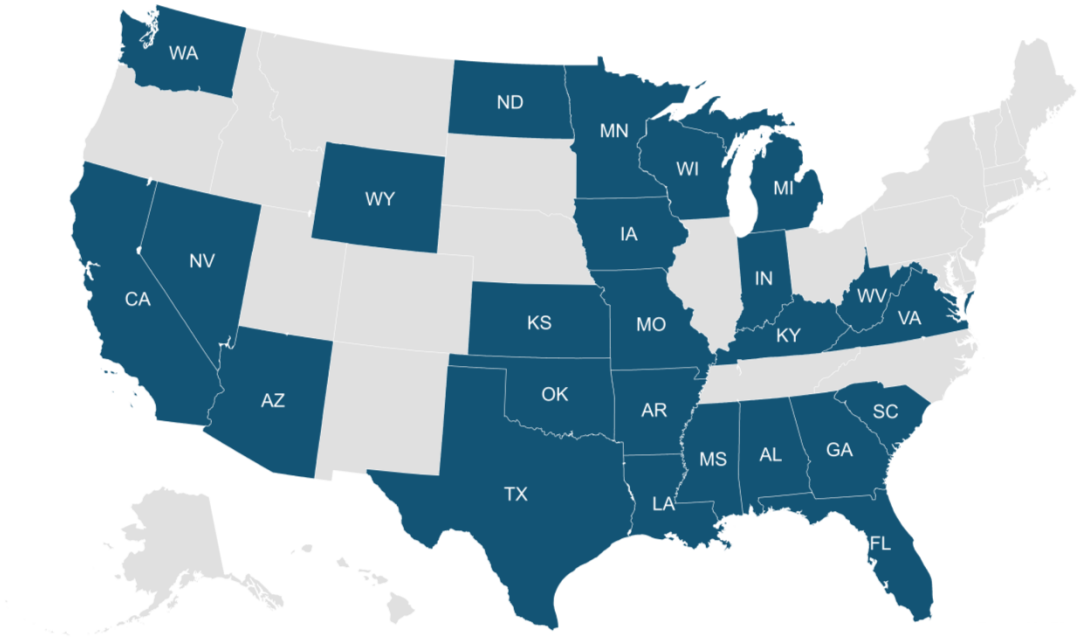
Agenda

- **Introduction to CRA**
- Executive Summary
- Determining Planning Objectives for Scorecard
- Developing ERCOT Market Perspectives
  - Baseline Market Inputs
  - Portfolio & Scenario Analysis

CRA Experience with Electric Utility Planning

Since 2018, CRA has supported investor-owned utilities and publicly owned utilities in 25 states with market analysis, generation strategy and resource planning questions.

States Where CRA Has Recently Supported Utilities in Market Analysis and Planning



Client Examples

NiSource
Black Hills Energy
Alliant Energy
PG&E
Duke Energy
Great River Energy
Liberty
Minnkota Power Cooperative
CPS Energy
Southern Company
OglethorpePower
American Electric Power
PSE Puget Sound Energy
Dominion Energy
entergy
Hoosier Energy
CLECO

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CRA Has Experience with All Aspects of Electric Utility Planning

Our work is frequently used as part of regulatory proceedings and stakeholder engagement processes

Modeling and Analysis

- Market and portfolio analysis
- Analysis in response to stakeholder feedback and requests

Technical Advisory

- Support and advice to market analysis and resource planning teams
- Technical support to stakeholders

Stakeholder Engagement

- Communication of technical analysis
- Interaction with internal and external stakeholder groups

Expert Witness Testimony

- Expert witness support in regulatory proceedings
- Public appearances in front of Boards or Commissions

Recent Client Examples:

Dominion Energy	MiSource	Liberty	Alliant Energy	American Electric Power	Hoosier Energy
Managing overall stakeholder engagement for IRP, DSM, and RFP activities	IRP modeling, lead presenter to stakeholders, testimony to regulators	IRP modeling and stakeholder engagement	IRP modeling, stakeholder engagement, testimony to regulators	IRP modeling, stakeholder engagement, and testimony to regulators in multiple states	IRP analysis and regular engagement with Board members

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CRA Integrated Resource Planning (IRP) Approach

Our five-step IRP approach has been implemented in dozens of IRPs across the US in recent years

Today's Discussion

Identify Planning Objectives

Agree on planning objectives and metrics to measure the performance of the plan against each objective

Develop Market Perspectives

Identify key sources of uncertainty and the potential range of future outcomes, and design internally consistent future scenarios

Develop Resource Portfolios

Design options for future resource plans, often based on different future scenarios and priorities

Portfolio Modeling and Analysis

Evaluate the performance of each resource portfolio against each future scenario, stochastic uncertainty, & extreme risk events

Select Preferred Plan

Identify trade-offs from each resource portfolio and select the preferred portfolio

Determining Planning Objectives

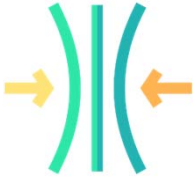
Agreeing on key planning objectives early in the planning process will 1) give clarity and direction for the development of the preferred plan, 2) drive structured trade-off discussions, and 3) help validate and rationalize decisions

Examples of Planning Objectives

System Reliability and Resiliency

CPS Energy Financial Stability

Affordability



System Flexibility

Environmental Sustainability

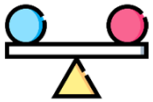
Workforce Impact

Criteria for Good Planning Objectives

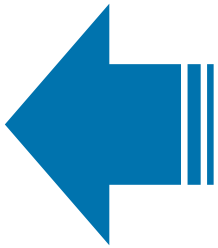
- ✓ Discrete
- ✓ Measurable
- ✓ Specific
- ✓ Collectively exhaustive
- ✓ Balanced
- ✓ Reflects utility situation

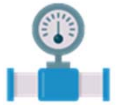
Developing Market Perspectives

CRA and CPS Energy are evaluating major themes in the energy market that could inform scenario design and contribute to stochastic risk assessment.

	Theme	Narrative
	**Reference Scenario (REF)**	• Continuation of historical trends in demand growth, technological developments
	**Carbon-Based Economy (CBE)**	• Reduced environmental regulations and no federal or state-level carbon limits
	**Net Zero Carbon Economy (NZE)**	• Federal or state-level economy-wide net zero carbon targets by 2045
	**Volatile Market (VMA)**	• Geopolitical concerns drive policy decision-making

Key sources of uncertainty to incorporate into analysis.




Commodity Prices

Carbon Policies


Technology Costs


Demand Growth


Market Design

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Initial Options for CPS Energy Portfolio

Three initial options being considered include portfolios where selected new generation capacity are either all-renewable, all-natural gas or an "optimal" blend of natural gas and renewables

Portfolio	Allowed Generation Technologies for New Capacity
Renewable	• Wind, solar, & other • Storage
Natural Gas	• Combined cycle (CC) • Reciprocating internal combustion engine (RICE)
Blended	• Economic maximum renewables: Wind, solar, & other • Economic storage • Natural Gas: Combined cycle & Reciprocating internal combustion engine
TBD	• Pending community input

Notes:
1. Portfolios may be assessed with and without "Sustainable Tomorrow Energy Plan" in Baseline scenario.
2. Emerging technology assumptions to be included.

Capacity is needed to address customer growth and unit retirements (Sommers 1 & 2, Spruce 1).

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Examples of Planning Objectives

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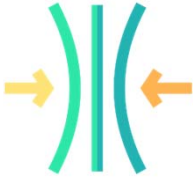

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Turning Objectives into Decision Making Tool

Metrics can be identified for each objective to measure the performance of the resource plan against the objective

Potential Objectives	Potential Metrics	Potential Measures
System Reliability and Resiliency	Capacity Headroom	Reserve Margin
	Diversity of Generation Capacity Mix	Pie Chart of Capacity by Fuel Type
	?	?
Affordability	Average Residential Bill Impact	Incremental Monthly Change (different time periods)
	CPS Energy Financial Metrics	Debt Service Coverage Ratio
	?	?
Environmental Sustainability	Progress Towards City of SA Climate Action & Adaptation Plan Goals	CO_2 Reduction in 2030, 2040, & 2050
	Other Emissions	NOx & SOx Emissions in 2030, 2040, & 2050

Using Scorecard to Aid Decision Making

A scorecard is a information reporting tool that displays the performance of each portfolio against each objective and metric to visualize trade-offs across different portfolio options

Example Scorecard – For Illustrative Purpose Only

Planning Objectives

	System Reliability and Resiliency		Affordability		Environmental Sustainability	
	Reserve Margin	*Capacity Diversity*	*Incremental Monthly Residential Bill Change*	*CPS Energy Financial Metrics*	*CO_2 Reduction in 2030, 2040, and 2050*	*NOx & SOx Emissions in 2030, 2040, & 2050*
Portfolio 1						
Portfolio 2						
Portfolio 3						
Portfolio 4						
Portfolio 5						

Measures

Scorecard Discussion

- Have we considered an exhaustive list of planning objectives?
- What metrics and measures would the RAC find helpful?

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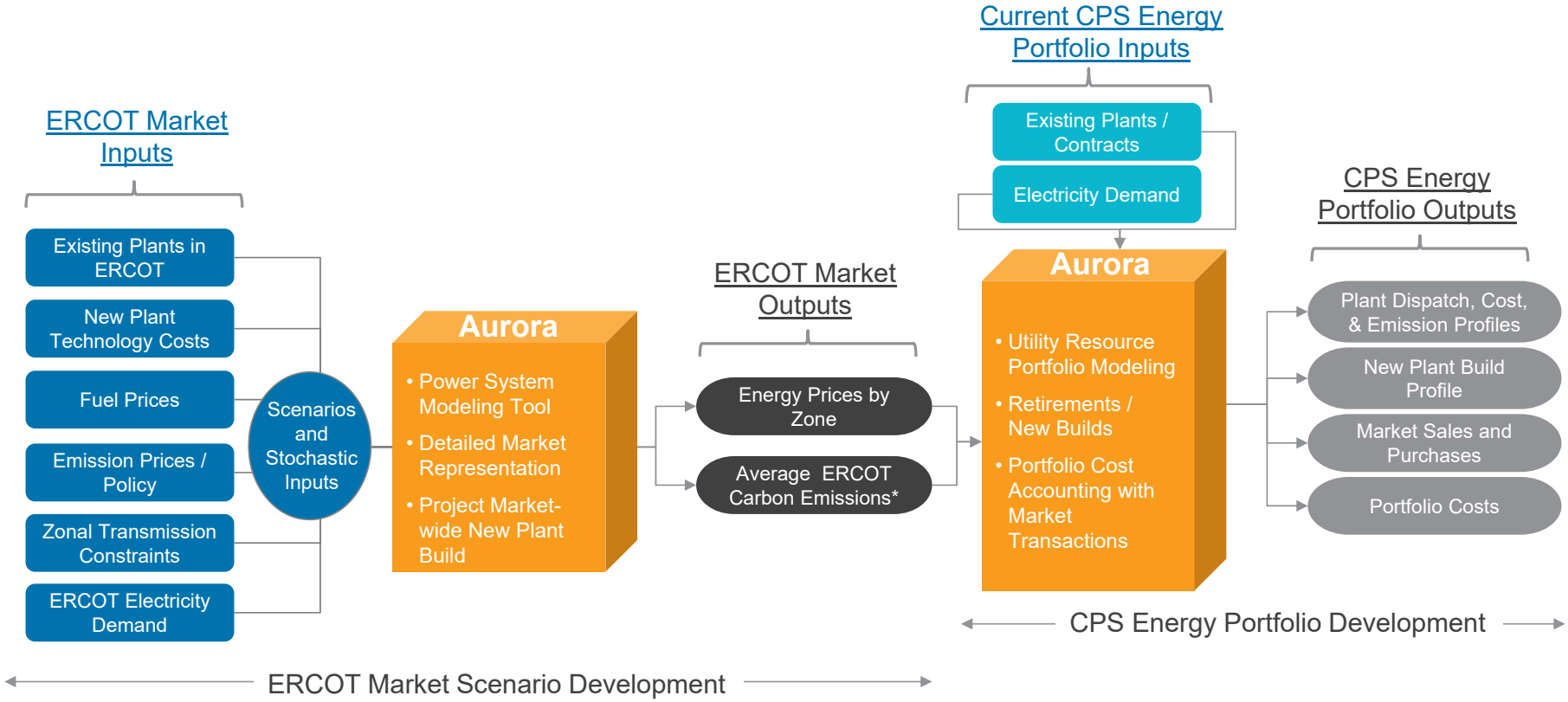
Overall Modeling Process

The modeling process includes ERCOT market analysis and CPS Energy-specific portfolio evaluation



Note: *This is used to measure carbon emissions from electricity purchases by CPS Energy

Key Inputs

We rely on a combination of ERCOT documents, CPS Energy forecasts and CRA analysis of third-party forecasts to develop baseline market inputs for ERCOT

Input	Description	Source for Baseline Assumption
ERCOT Demand Growth	Level of electricity demand which could be affected by level of economic growth, distributed generation, and energy efficiency	ERCOT outlook, supplemented by CRA extrapolation
ERCOT Market Rules	Future changes to the rules governing the ERCOT electricity market that could influence market prices	Current ERCOT rulebook
Delivered Fuel Prices	Prices of natural gas and coal delivered to power plants	CPS Energy Forecast
Carbon Regulation	Future policies governing carbon emissions, which could be in a form of a traded carbon price, carbon tax, or other environmental regulations	CPS Energy Forecast
New Plant Generation Costs	Capital costs of new generation plant, which could be affected by technological innovations and supply chain constraints	CRA analysis of EIA and NREL projections

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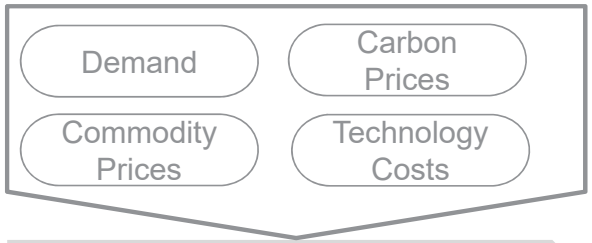
Scenarios vs. CPS Energy Portfolios

Scenarios and portfolios are two distinct concepts. Scenarios are **external** factors, while **portfolios** are CPS Energy decisions



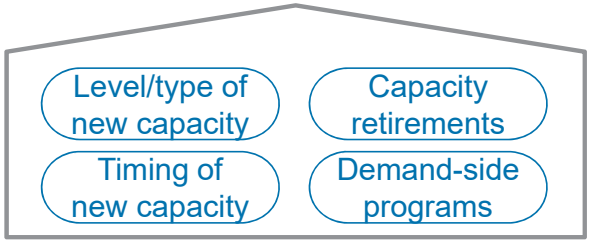
Scenarios

Future states of the world independent of CPS Energy resource decisions

- Reflect diverse, but possible, futures
- Include multiple linked and correlated key variables
- Independent of resources and resource plans

Can Inform

Focus of this section



Portfolios

CPS Energy plans to meet customer requirements in the future

- A combination of decisions taken by CPS Energy to meet the challenges posed by the scenario or address other objectives
- Typically include decisions on new resources and retirements

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Three initial options being considered include portfolios where selected new generation capacity are either all-renewable, all-natural gas or an "optimal" blend of natural gas and renewables

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Notes:
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2. Emerging technology assumptions to be included.

Capacity is needed to address customer growth and unit retirements (Sommers 1 & 2, Spruce 1).

Modeling Request

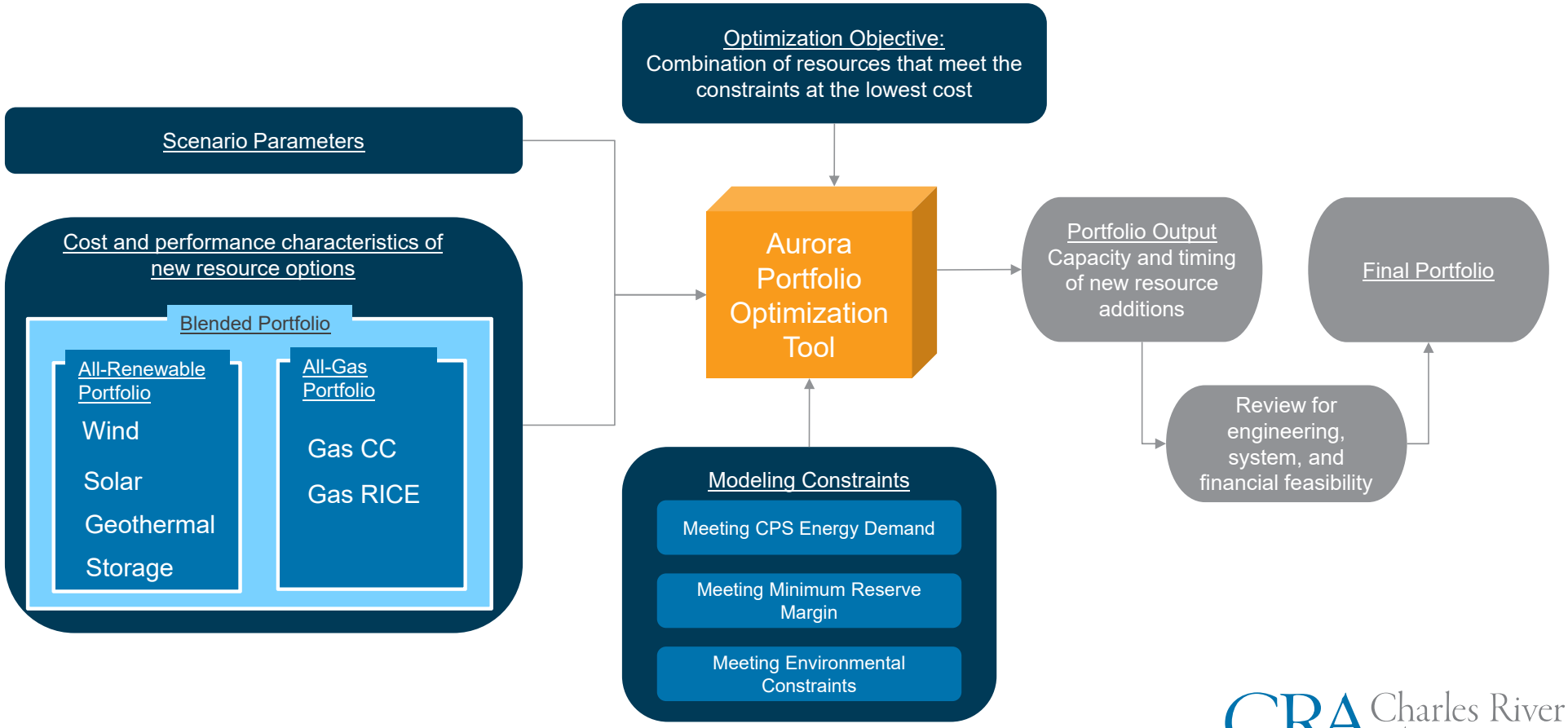
Public Citizen requested the following portfolios be modeled.

Portfolio	Proposed Changes to Capacity Mix
Retire Coal	• Retire Spruce 1 by 2025 and Spruce 2 by 2028. • Replace with the most favorable mix of wind, solar and batteries.
Retire Coal with Spruce 2 Gas Conversion as a Bridge	• Retire Spruce 1 by 2025 or 2028. • Convert Spruce 2 to gas by 2025 or 2028 and run till 2035. • Replace Spruce 2 with the most favorable mix of wind, solar and batteries.
Retire All Fossil Fuel	• Retire Spruce 1 by 2025 and Spruce 2 by 2028. • Retire Braunig 1, 2 and 3 by 2024. • Retire Sommers 1 by 2026 and Sommers 2 by 2028. • Retire Arthur Von Rosenberg and Rio Nogales by 2030. • Retire all Milton B Lee units by 2035 or 2040 • Replace with the most favorable mix of wind, solar and batteries.

Note: Also see RAC gen plan input from the Feb 2022 meeting in the Appendix.

Approach to Selecting New Resources for Portfolios

Aurora is used as a tool to facilitate the selection of new resources for each portfolio



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Focus of this section

- Demand
- Carbon Prices
- Commodity Prices
- Technology Costs

Scenarios
Future states of the world independent of CPS Energy resource decisions

- Reflect diverse, but possible, futures
- Include multiple linked and correlated key variables
- Independent of resources and resource plans

Informs

- Level/type of new capacity
- Capacity retirements
- Timing of new capacity
- Demand-side programs

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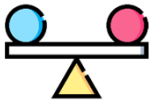	**Reference Scenario (REF)**	• Continuation of historical trends in demand growth, technological developments
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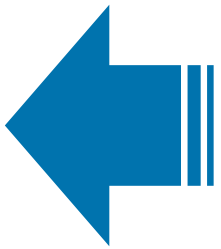

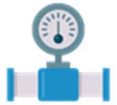

Commodity Prices

Carbon Policies

Technology Costs

Demand Growth

Market Design

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Scenario Design Considerations

CRA and CPS Energy are evaluating major themes in the energy market that could inform scenario design. The table below provides a ***preliminary*** view of ***potential*** scenario design. These are not final scenarios to be modeled.

Theme	Commodity Prices	Carbon Policies	Technology Costs	Demand	ERCOT Market Design Change
Reference Scenario (REF)	Baseline	Baseline	Consensus	Baseline	Confirmed changes only
Carbon-Based Economy (CBE)	Low	No Price	Consensus	High driven by low prices	Confirmed changes only
Net Zero Carbon Economy (NZE)	Low due to electrification drive	High carbon price	Fast decline with ITC/PTC	High driven by electrification	Capacity market launched & seasonal reserve margins
Volatile Market (VMA)	High	No price to alleviate inflation pressure	Slow decline due to trade restrictions	Low due to high energy prices	Confirmed changes only

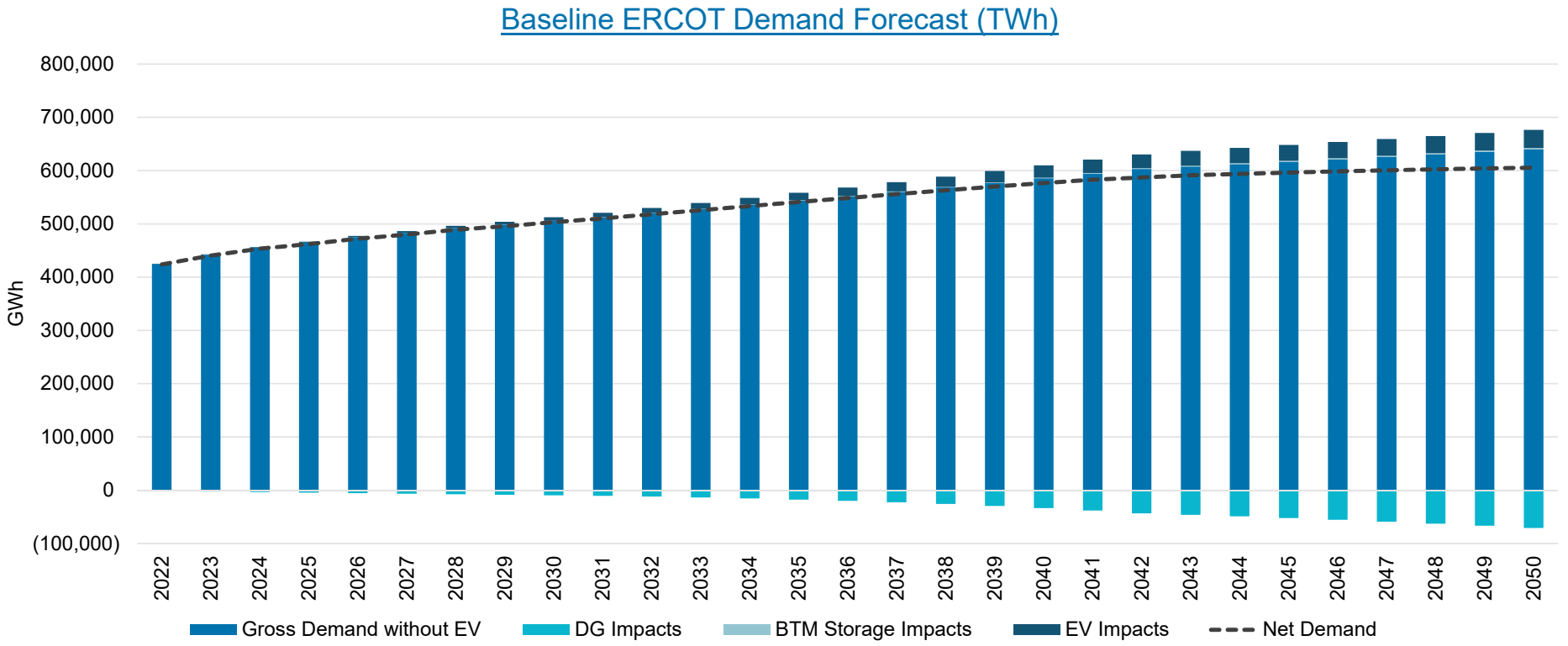
Discussion and Next Steps

- Continue collaboration with the RAC & other stakeholders
- Finalize scorecard
- Further develop scenario designs & portfolio concepts

Appendix

Baseline Demand Growth

Gross demand, including EV charging impact, is expected to grow by 2.0%/year. The projected growth in distributed generation (DG) reduces gross demand growth. Demand net of DG (Net Demand) is expected to grow by 1.3%/year.



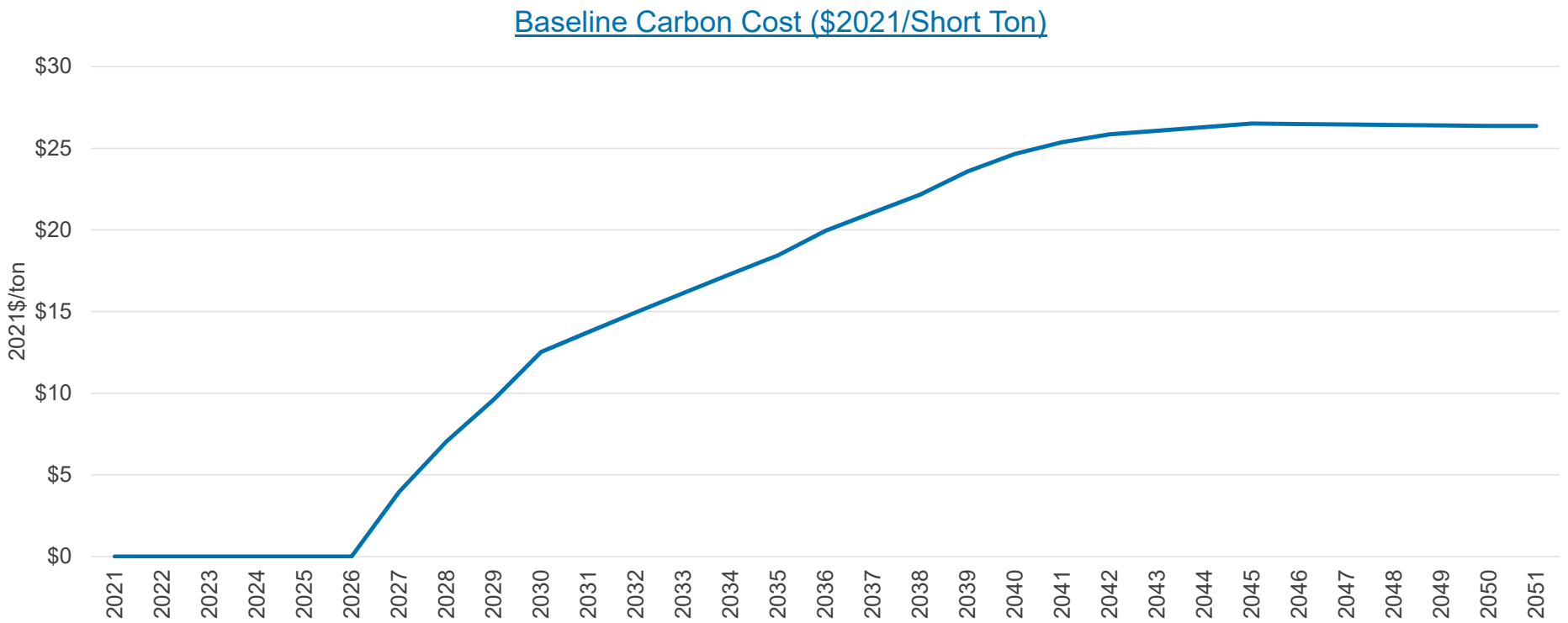
ERCOT Market Rules

The PUCT approved a blueprint for the design of the wholesale electric market in ERCOT in December 2021, which aims to reform the ERCOT wholesale market in two phases. The following table summarizes the proposed enhancements

Phase I Enhancements	Description	Expected Impact on Prices	Included in Baseline
Operating Reserve Demand Curve	Modify ORDC by reducing the Minimum Contingency Level (MCL) to 3,000 MW and set the high system-wide offer cap and value of lost load to $5,000/MWh	• Reduce extreme price spikes • Provide additional support for dispatchable resources	Yes, as the change is confirmed
Demand Response (DR) Emergency Response Service Fast Frequency Response Service Loads in Non-Spinning Reserve Service Firm Fuel Product Voltage Support Compensation Contingency Reserve Service		• Contribute to reducing extreme price spikes	No, as the detailed design of the changes are not yet finalized

Carbon Emission Regulation

Carbon policies could take the form of a carbon price, carbon tax or other environmental regulations that impact generation costs. Carbon pressure, whichever form it might take, is generally modeled as an additional generation cost on a $/short ton basis. CPS Energy staff develops the Baseline carbon cost assumptions



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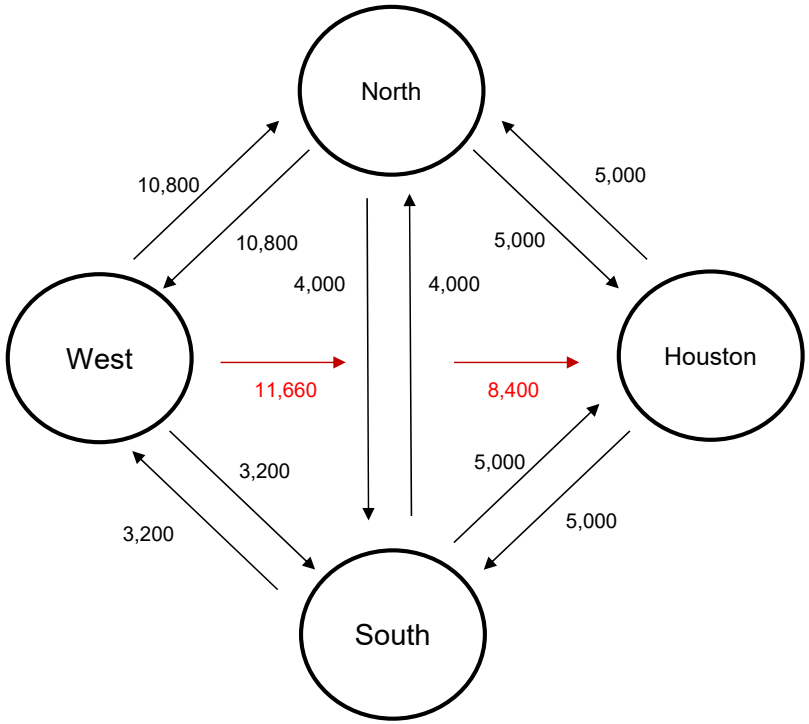
Additional Consideration – Transmission Constraints

Zonal Transmission Capacity (MW)



- CRA's market analysis is performed on a zonal level, meaning that price formation is analyzed for regions with persistent, significant transmission congestion, as opposed to at every node across the system.
- Actual realized prices will differ at the nodal level within these zones, and changes in local transmission topology and local supply and demand dynamics could significantly alter nodal pricing dynamics over time. However, the zonal approach evaluates the expected long-term trends at the major pricing hubs over a 25-year period.
- The current transfer capabilities across the four ERCOT zones are shown to the left (in MW). Due to rapid change in the resource mix, individual transmission constraints have emerged in different parts of the system, including West Texas and South Texas.

How is Congestion Reflected?

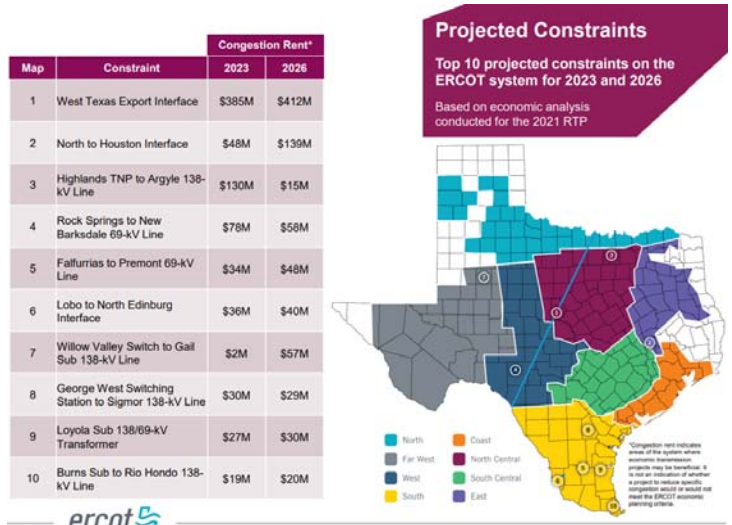
- ERCOT is undertaking a number of specific transmission projects, with near-term (within next six years) efforts primarily designed to address issues within the Far West and South.
- While these near-term projects focus more on nodal level constraints, ERCOT also analyzes future transmission system needs using a range of future demand and supply scenarios. Current findings identify the need to expand transmission between the West and the load centers to facilitate high penetration of wind and solar capacity.
- For the ERCOT market analysis, CRA is evaluating adoption of some of the high priority improvement options to facilitate more accurate zonal resource allocation, including:
  - West Texas Export Interface
  - North to Houston Interface

Improvement options identified in 2022 Long-Term West Texas Export Study

Improvement Option	Steady-State Voltage Stability Limit[14] (GW)		Estimated New Double-Circuit Miles[15]	Production-Cost Savings ($M)		TSP Cost Estimate ($M)[16]
	2023	2030		2023	2030	
Base Case	12.24	13.75	-	-	-	-
Option 1 (4AC)	16.46	18.35	1,009	135	642	2,738
Option 2 (3AC+HVDC)	16.49	18.78	1,274	170	783	5,203
Option 3 (5AC)	17.45	19.16	1,248	150	742	3,459

Top 10 Projected Constraints on the ERCOT System for 2023 and 2026

Map	Constraint	Congestion Rent* 2023	Congestion Rent* 2026
1	West Texas Export Interface	$385M	$412M
2	North to Houston Interface	$48M	$139M
3	Highlands TNP to Argyle 138-kV Line	$130M	$15M
4	Rock Springs to New Barksdale 69-kV Line	$78M	$58M
5	Falfurrias to Premont 69-kV Line	$34M	$48M
6	Lobo to North Edinburg Interface	$36M	$40M
7	Willow Valley Switch to Gail Sub 138-kV Line	$2M	$57M
8	George West Switching Station to Sigmor 138-kV Line	$30M	$29M
9	Loyola Sub 138/69-kV Transformer	$27M	$30M
10	Burns Sub to Rio Hondo 138-kV Line	$19M	$20M



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Source: ERCOT Long-term West Texas Study Report, 2021 Report on Existing and Potential Electric System Constraints and Needs

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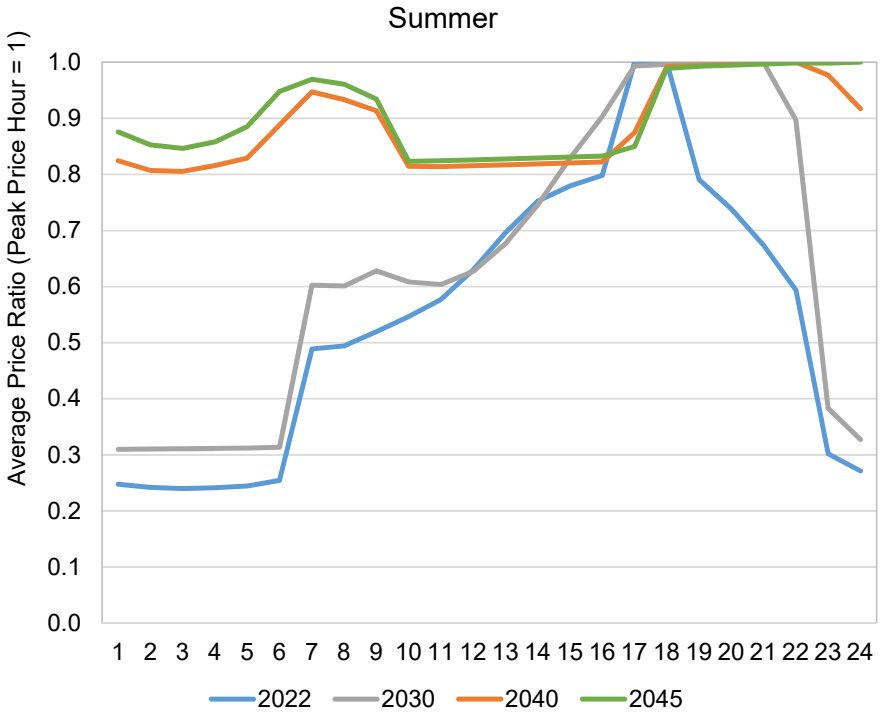
Hourly Price Shape Trends over Time

Ratio of Hourly Price to Peak Price over a 24-Hr Period



- Significant renewable penetration in ERCOT is likely to shift peak price hours from hours 16-18 towards hours 19-22 over time
- Peak price hours are also expected to be more sustained through the evening and overnight periods
- The introduction of storage resources of longer duration could further flatten loads and prices

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RAC Gen Plan Input

Feb 2022 RAC meeting (page 1 of 2)

- ***Generation Resources:***
  - What are the energy sources being used right now
  - Combined cycle plants: cost
  - Nuclear
  - Cost of shutting down/replacing older plants
  - Spruce -> natural gas
  - Purchase of 200 MW of solar energy
  - Renewables: current & future methods, cost estimates
  - “New tech: how much $ paid for by __?” as screening tool
  - Solar: farms or rooftop?
  - Rooftop solar & battery

- ***Energy Efficiency:***
  - Energy efficiency & demand response
  - Effect of removing STEP on energy demand (over past 4 years)
  - Include STEP into demand grid/model

RAC Gen Plan Input

Feb 2022 RAC meeting (page 2 of 2)

- ***Modeling:***
  - Clarity around emissions projections
  - Discussion around assumptions of modeling
  - Models for all clean energy sources
  - Rate of return for each scenario
  - Include contracted renewables/how will renewables be modeled?
  - Absence of Braunig plants
  - Maximize clean energy & reserve energy
  - View examples from other areas
  - What simulations are we using
  - Model of probability of different generation & price outcome
  - Capture future weather in model
  - Safe # for renewables? Dispatchable vs non-dispatchable recommended breakdown

Scenario vs Stochastic

Because generation decisions are generally capital intensive and long-lived, understanding and incorporating future risk and uncertainty is critical to making sound decisions. Generation analysis can use both scenarios and stochastic analysis to perform a robust assessment of risk

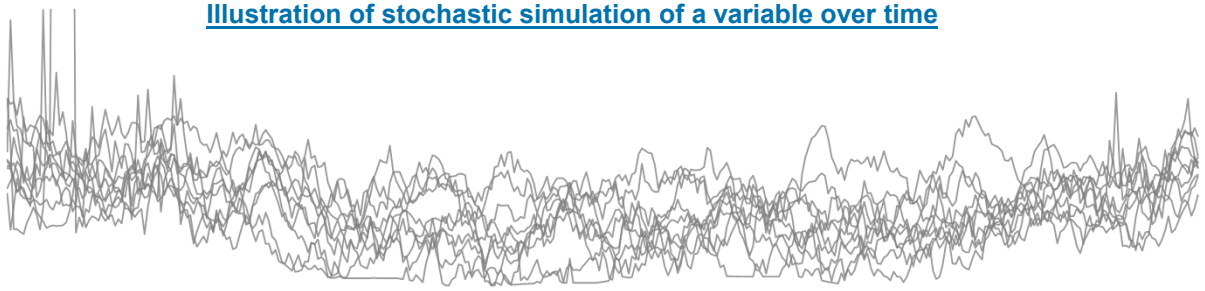
A **scenario** is a single integrated set of assumptions

- Can be used to answer the "What if…" questions.
- For example, major themes such as regulatory changes and technological shifts can change fundamental outlook for all key drivers.
- Using scenarios to explore what if these major themes materialize, and can tie portfolio performance directly to a "storyline"

Stochastic analysis is based on development of random distributions of input assumptions

- Can be used to evaluate volatility and "tail-risk" impacts
- For example, stochastic can be applied on commodity prices to evaluate the portfolio performance under a broad range of future commodity price outcomes
- The interactions between market price volatility and commodity price volatility are more complex than what can be assessed under "expected" conditions

Illustration of stochastic simulation of a variable over time



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Narratives for Scenario Design

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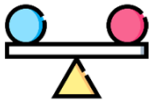
	**Reference Scenario (REF)**	• Continuation of historical trends in demand growth, technological developments • Current consensus view on future commodity and carbon prices • ERCOT market design change as approved and finalized
	**Carbon-Based Economy (CBE)**	• Reduced environmental regulations and no federal or state-level carbon limits • Policies supportive of domestic gas production, leading to relatively low gas prices • High demand growth due to on-shoring of industry from other jurisdictions
	**Net Zero Carbon Economy (NZE)**	• Federal or state-level economy-wide net zero carbon targets by 2045 • Large-scale electrification of buildings and transport results in high demand growth • Incentives for renewable electricity generation, reducing cost of technologies • Implementation of carbon cap-and-trade programs, with relatively high carbon prices
	**Volatile Market (VMA)**	• Geopolitical concerns drive policy decision-making • High commodity prices due to restrictions on energy trades • Slow declines in renewable technology costs due to trade restrictions

Sources of Uncertainty for Scenario Analysis

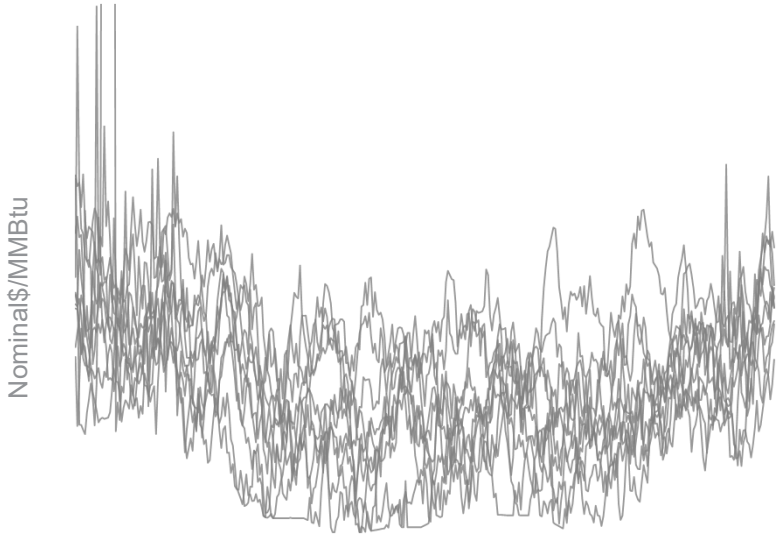
CRA and CPS Energy are evaluating key sources of uncertainty to incorporate into scenario analysis. Examples of uncertainties being evaluated are discussed below

 Commodity Prices	Natural gas prices exhibit significant volatility with Henry Hub natural gas prices ranged from $1.75/MMBtu in May 2020 to $8.14/MMBtu in May 2022. Future evolution of gas prices will depend on geopolitical development, domestic regulations, new resource finds, and the pace of energy transition
 Carbon Policies	Recent state-led initiatives have seen carbon prices ranging from $14/ton in Eastern US States to $31/ton in California. Future evolution of carbon policies will depend on political consensus, policy mechanism and carbon emission targets
 Technology Costs	Following decades of declines in the cost of renewable generation costs, supply-chain and geopolitical issues are threatening to reverse the declines. Future evolution of technology costs will depend on the resolution of supply-chain issues, investment in R&D and US trade policies (on-shoring vs free trade)
 Demand Growth	Continued improvements in appliance efficiency, increases in adoption of electric vehicles, and growth in distributed generation could fundamentally change demand growth outlook going forward
 Market Design	The PUCT approved a blueprint for the updated design of the wholesale electric market in ERCOT in December 2021. Some proposed changes, once confirmed, could fundamentally alter the economic decisions for new generation investment within ERCOT, affecting the price outlook

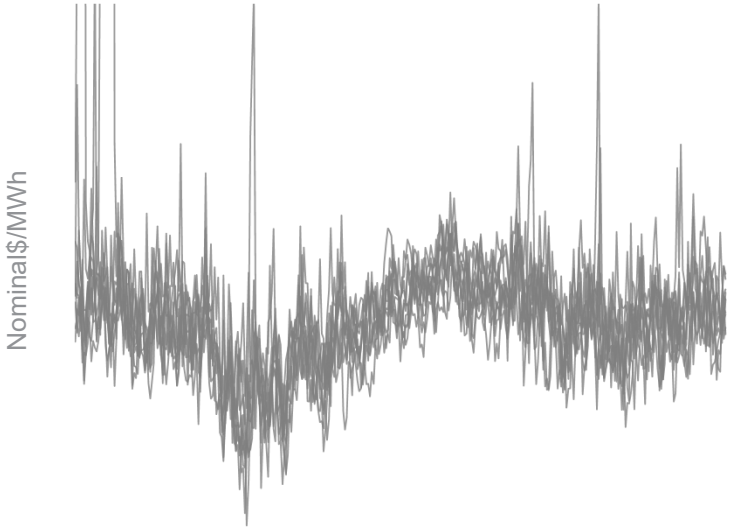
Commodity Price Stochastic Analysis

Stochastic price iterations can test a wider range of commodity price conditions than are considered in the deterministic scenarios, explicitly testing high-impact short-duration events that expose customers to costs.

Illustrative Stochastic Simulation of Natural Gas Prices (10 simulations)



Illustrative Power Price Outputs Using Stochastically Simulated Natural Gas Prices



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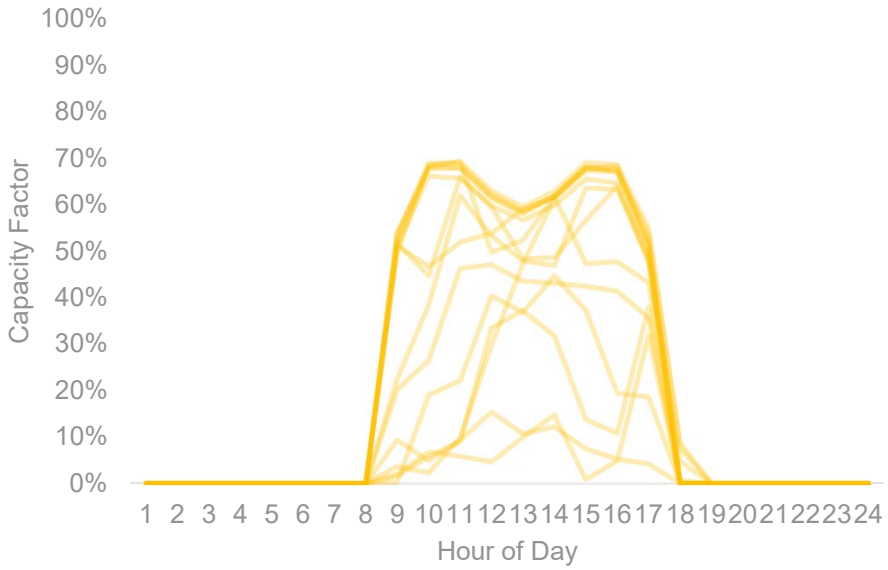
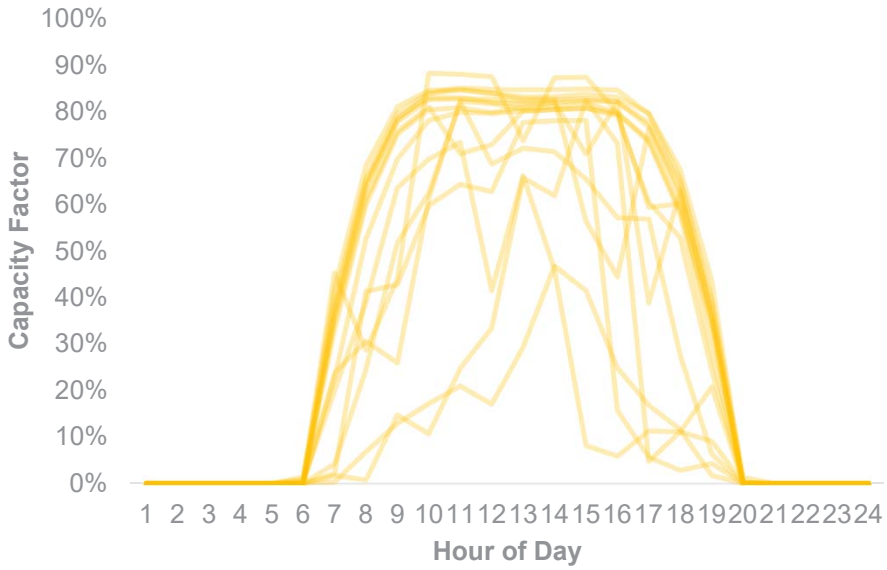
Renewable Output Stochastic Analysis

Renewable outputs are intermittent with random variations based on weather conditions. Using stochastic analysis to produce a wider sample of renewable production profiles can allow each portfolio to be tested against periods of low output that coincide with high market prices (or vice versa).

Illustrative Stochastic Simulation of Solar Output in January (10 simulations)



Illustrative Stochastic Simulation of Solar Output in July (10 simulations)



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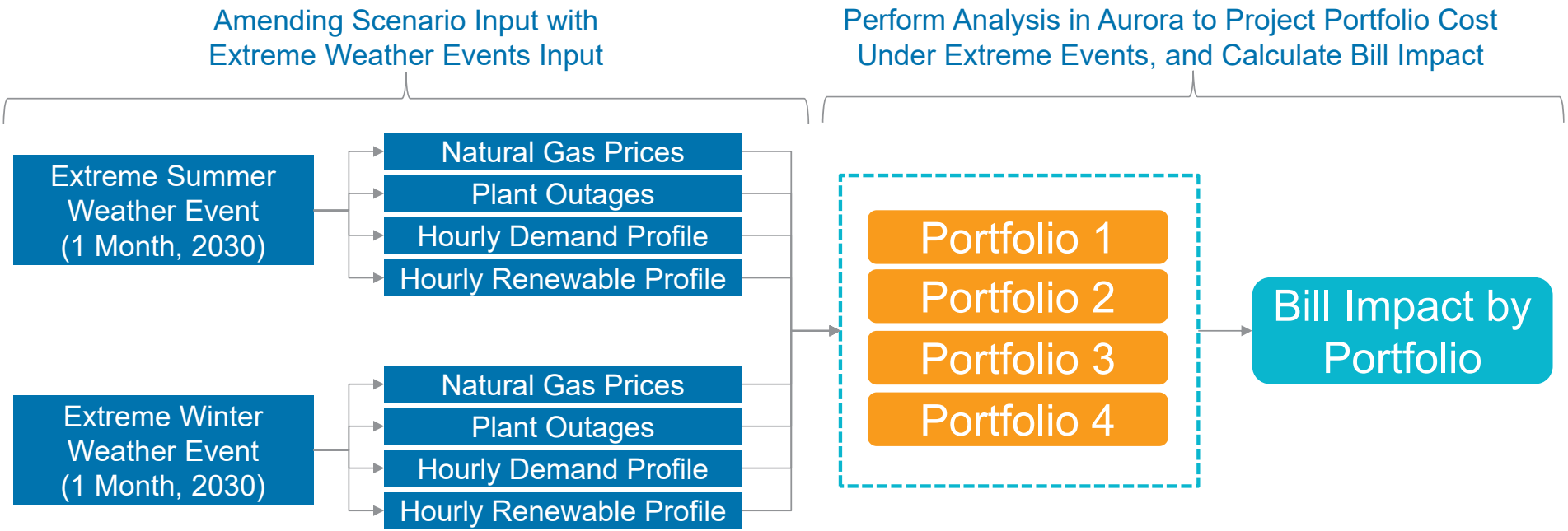
Extreme Weather Events

CRA and CPS Energy are evaluating approaches to test the robustness of the resource portfolios against extreme weather. We are currently considering a single year test using inputs based on previous summer and winter weather events in Texas to project impact of the portfolios under extreme weather conditions



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