

2027 IRP Stochastic Variable Modeling and Risk Discussion

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IRP Advisory Council
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List of Acronyms and Terms

Stochastic: Randomly determined; having a random probability distribution or pattern that may be analyzed statistically but may not be predicted precisely.

Correlation: A measure of the relationship or connection between two variables.

Covariance: The measure of the joint variability of different stochastic variables.

Autocorrelation: The similarity of variance for a stochastic variable with a previous version of itself.

NPV: Net present value.

MMBtu: Million British thermal units

Agenda

- Overview of Stochastic Analysis (Information and Learning)
  - Where stochastic variables are used in the preferred portfolio selection
  - Variable selection
  - AURORA implementation
- Proposed Changes for the 2027 IRP (Looking for Feedback)
  - How can we best communicate the results?
- Feedback and Questions (You don’t have to wait until the end!)

Risk Evaluation Discussion



Where Stochastics Exist in IRP Process

Inputs

- Model Inputs
- Stakeholder Feedback

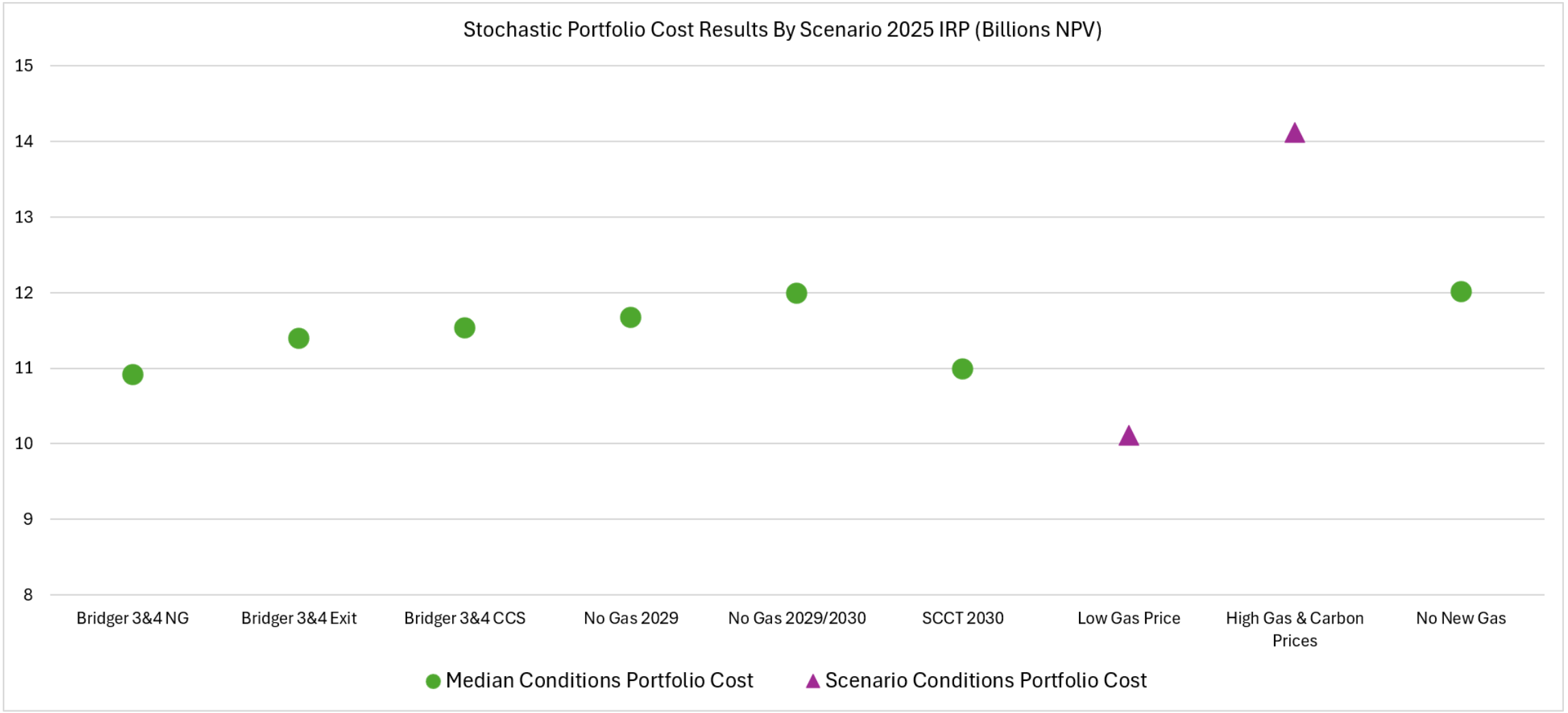
Portfolio Building

- Long-Term Capacity Expansion Modeling
- Reliability Analysis

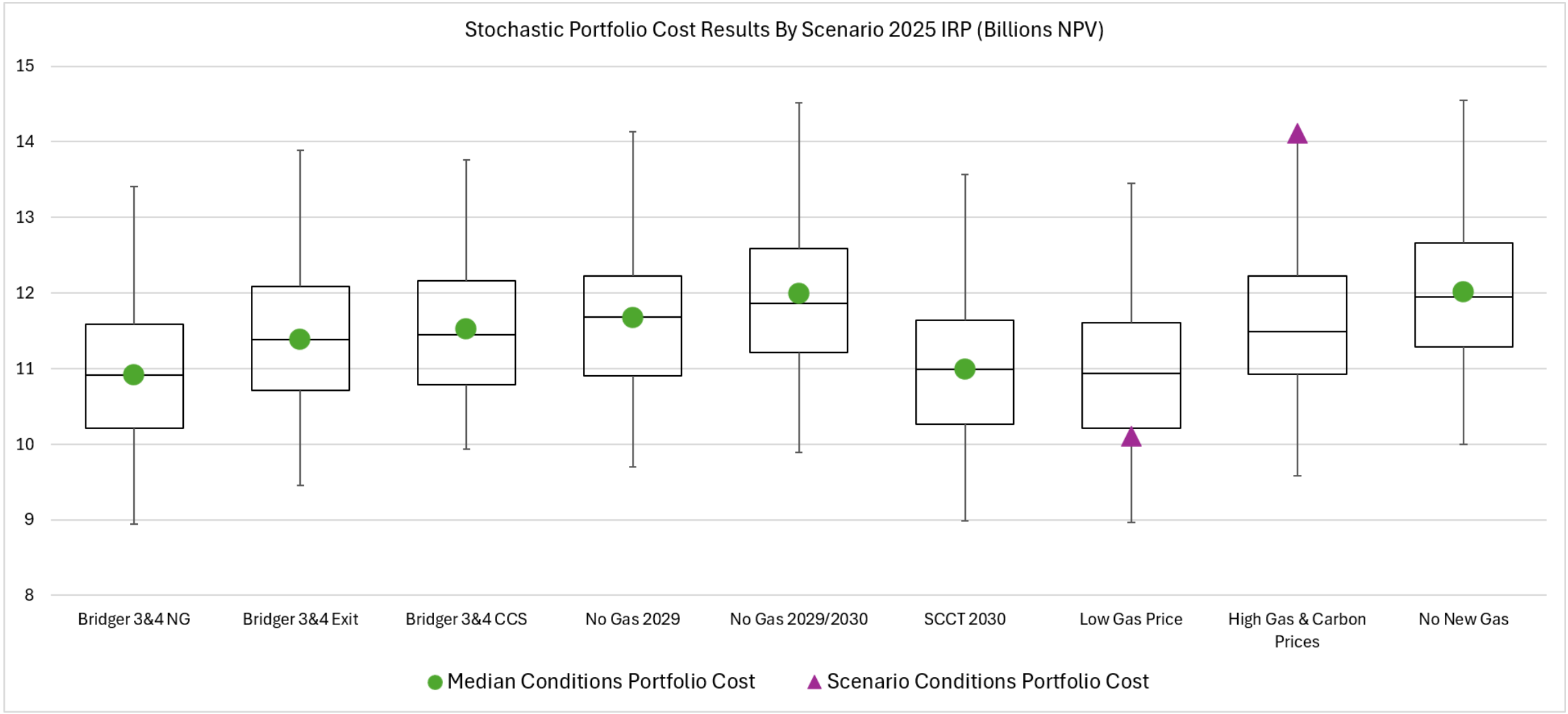
Portfolio Costing

- Planning Case Portfolio Cost Analysis
- Risk Quantification

2025 IRP Main Cases Stochastic Analysis



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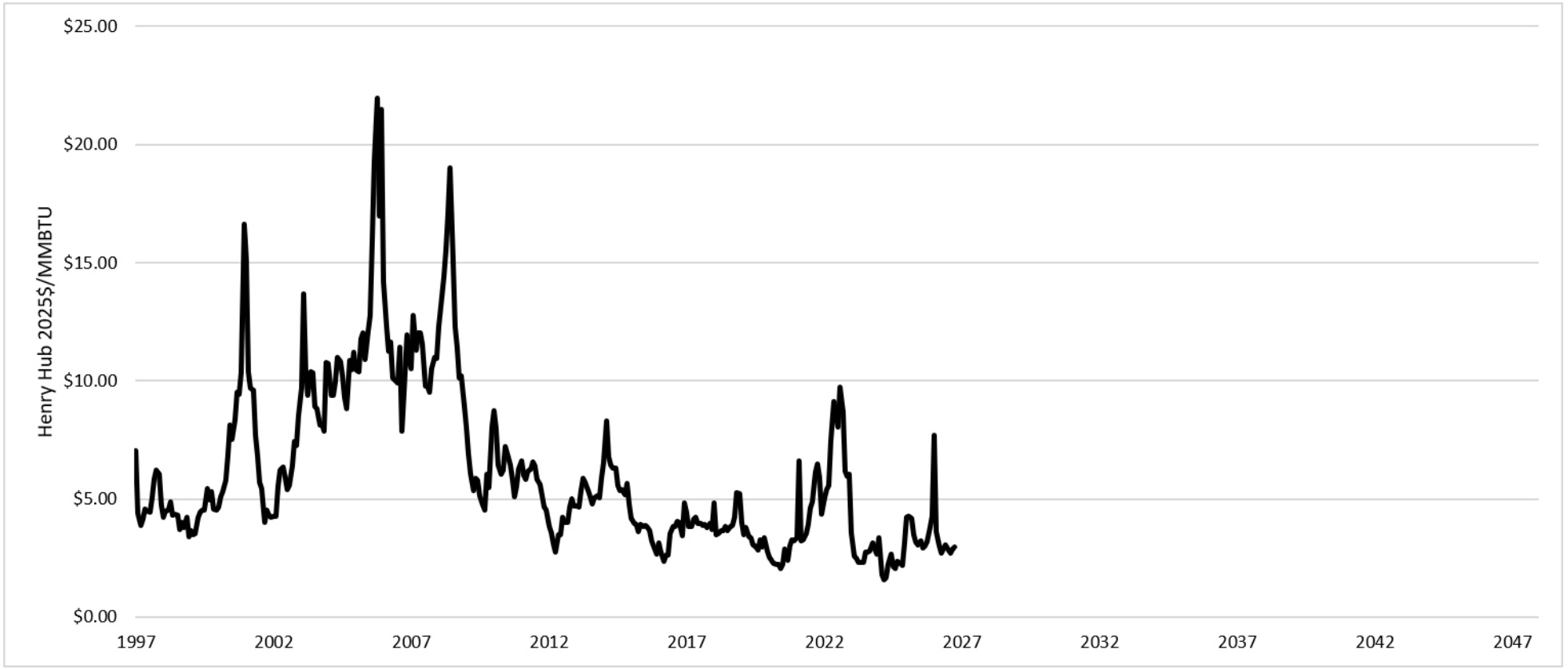


Variable Selection: Identifying Variables

Good Candidate Criteria

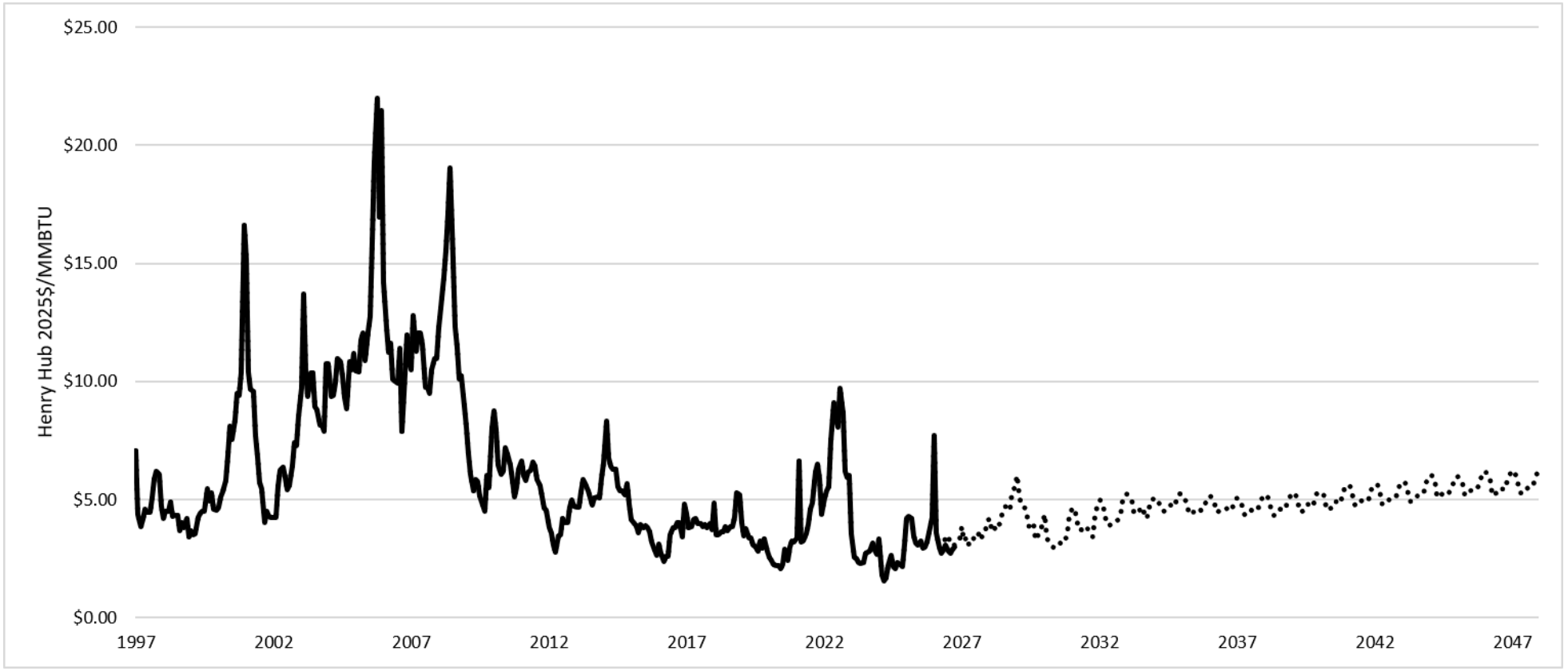
- Variable that could be expected to change materially in a way that could change results
- Variables that have random components that approximate a known distribution
  - Variables with sufficient history to estimate random components
  - Variables whose historical variance can be expected to match future variance
- Variables whose impact to IRP model can reasonably be estimated

Variable Selection: Monthly Natural Gas Prices



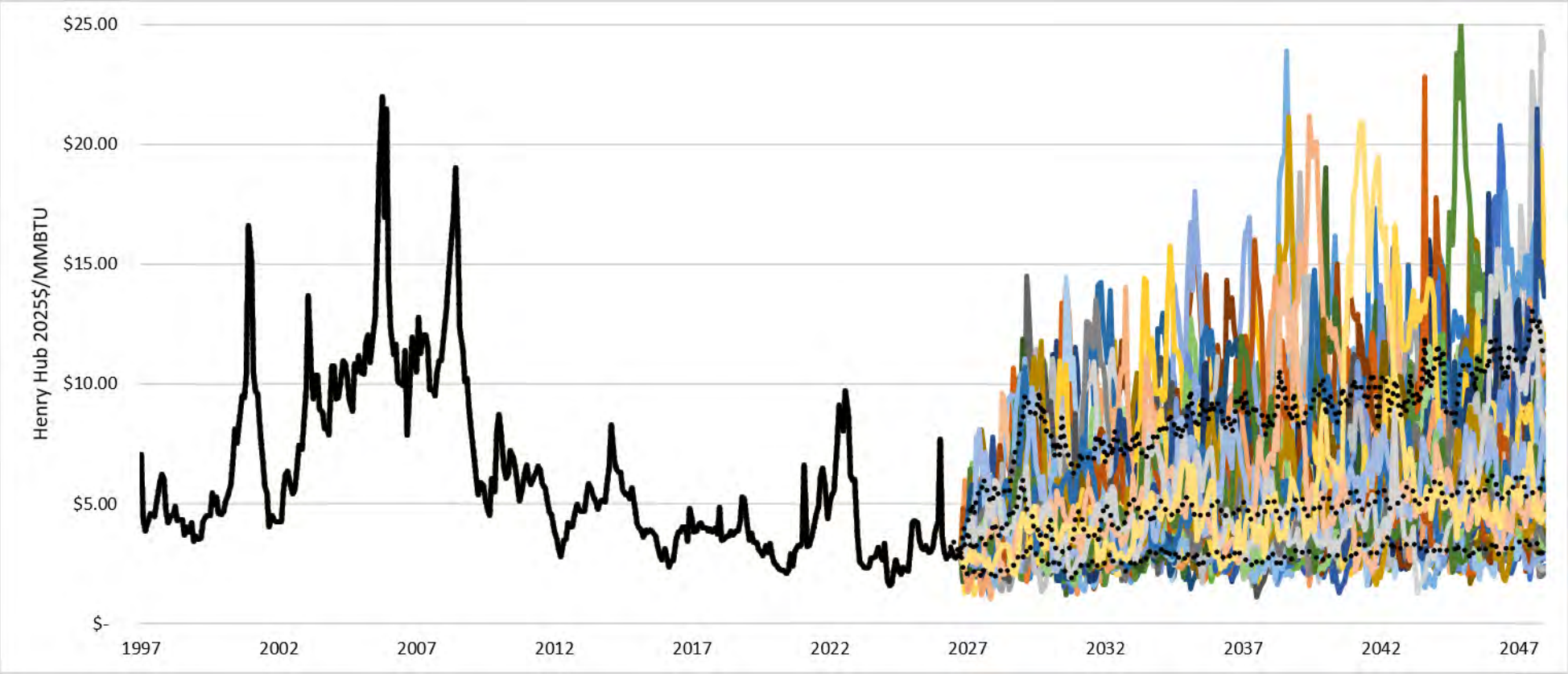
Sources: https://www.eia.gov/dnav/ng/hist/rngwhhdm.htm, https://fred.stlouisfed.org/series/CPIAUCSL

Variable Selection:
Monthly Natural Gas Prices



Forecast is strictly for example purposes only.

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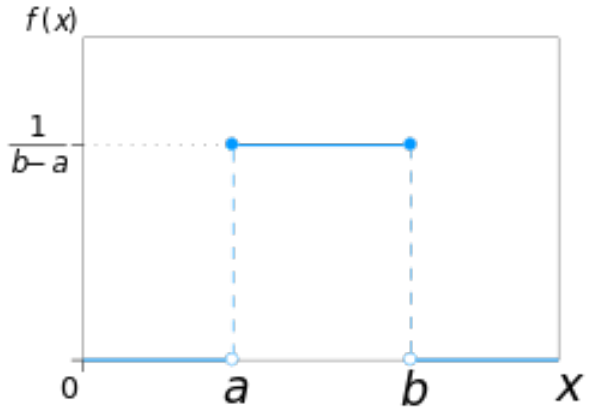


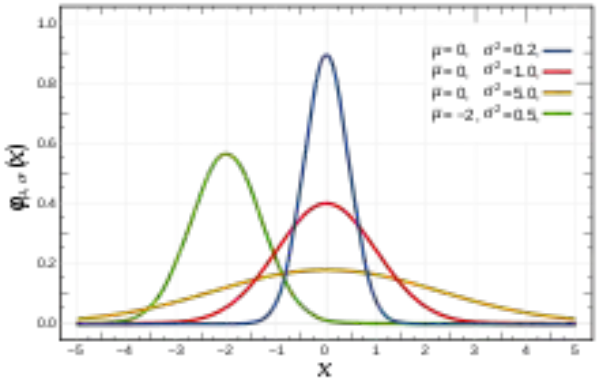
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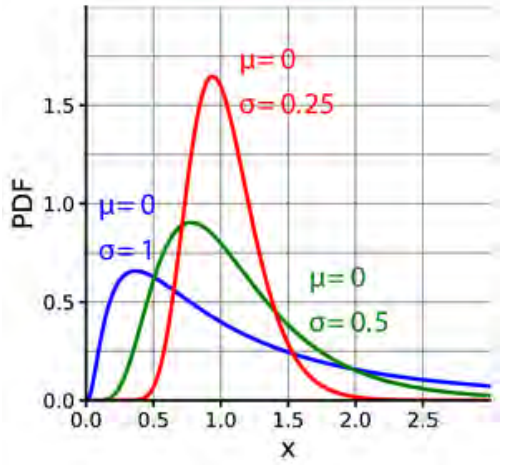
AURORA Implementation: Distributions

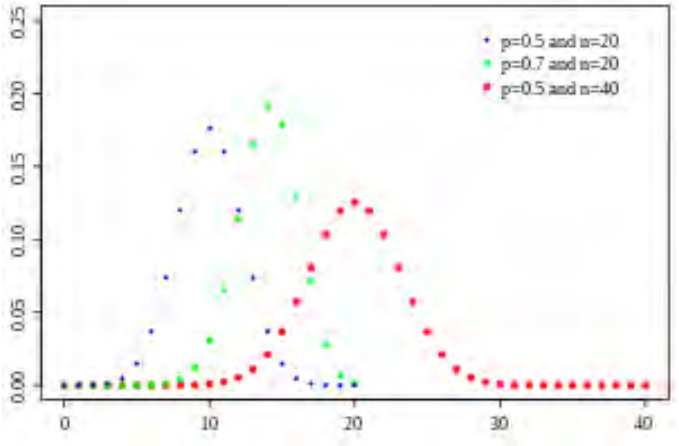
Counterclockwise from upper left

- Uniform-continuous equal probability between points [a,b]
- Normal-continuous symmetric distribution defined by a mean and standard deviation
- Binomial-pass/fail distribution defined by a probability of passing
- Lognormal-continuous heavy tailed distribution defined by a mean and standard deviation









AURORA Implementation: Covariance

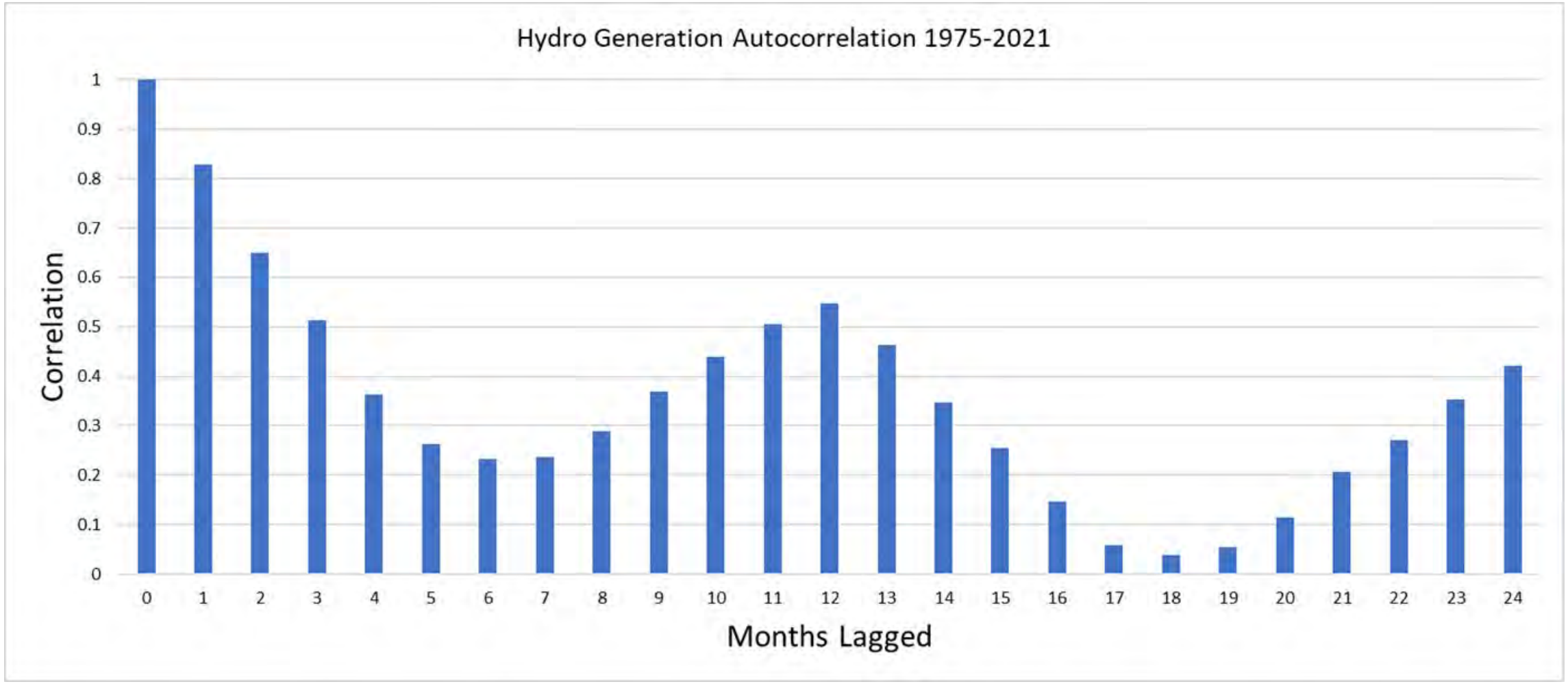
Within AURORA, as one input is varied, other inputs that are correlated to it can also be changed consistent with their linkage in the real data.



2025	Pacific Northwest	Desert Southwest	CAISO
Summer Covariance	0.59	0.60	0.21
Winter Covariance	0.86	0.43	0.06
Summer Peak (MW)	27,609	31,103	49,780
Summer Coincident Peak (MW)	25,422	30,184	39,977
Winter Peak (MW)	31,203	17,294	34,491
Winter Coincident Peak (MW)	31,203	15,212	31,638
Summer Diversity (MW)	2,187	919	9,803
Summer Seasonal Benefit (MW)	3,594	N/A	N/A
Winter Diversity (MW)	0	2,082	2,853
Winter Seasonal Benefit (MW)	N/A	13,809	15,289

Source: *U.S. Energy Information Administration. Hourly Electric Grid Monitor: Region Data. Accessed November 5, 2026.*

AURORA Implementation: Autocorrelation



2027 IRP Stochastic Variables

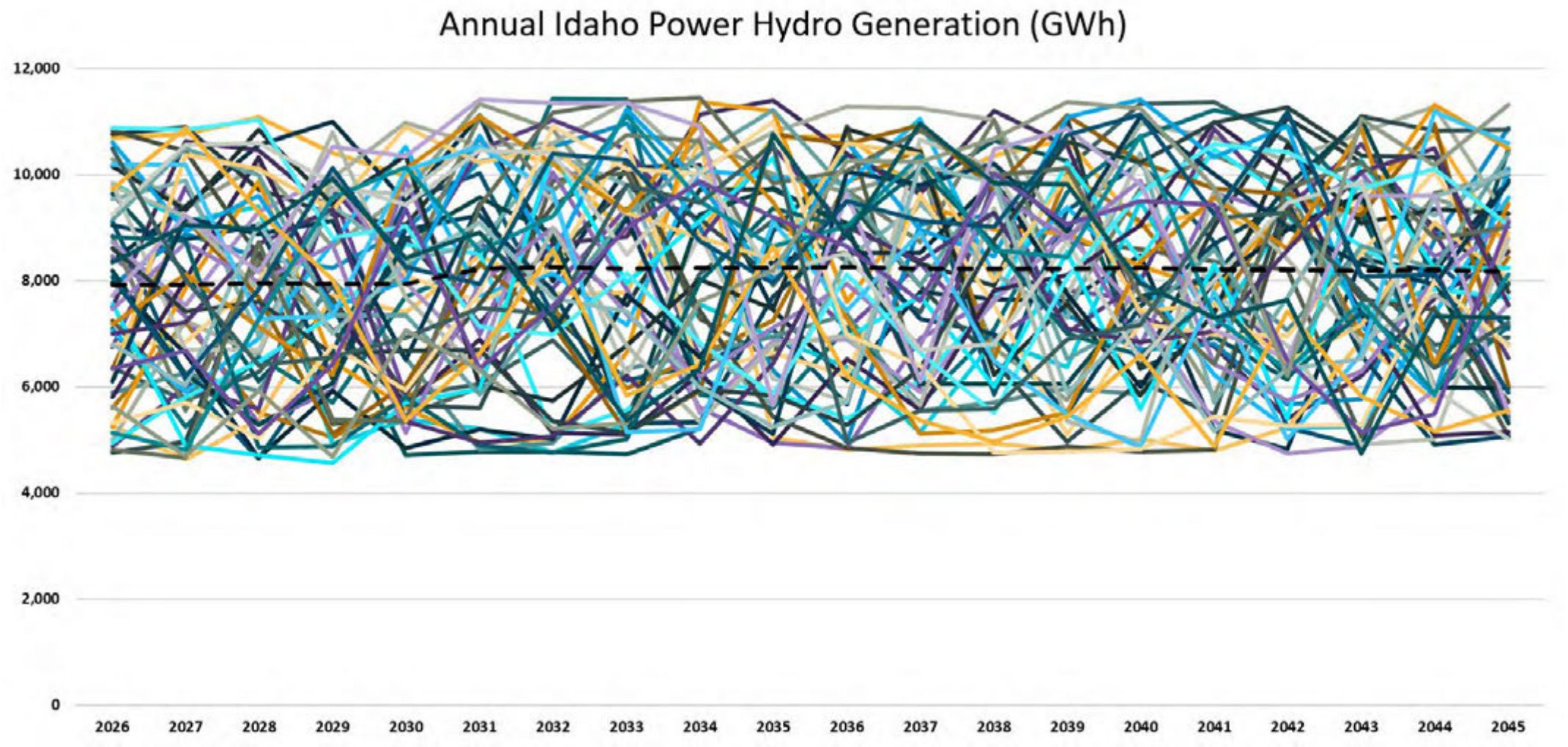
- Increased demand → Increased need for generation, increased market prices
- Increased hydro supply → Decreased need for non-hydro energy, decreased market prices
- Increased gas prices → Decreased dispatch of gas resources, increased market prices
- Increased carbon prices → Decreased dispatch of carbon emitting resources, increased market prices
- Increased REC Prices → Increased dispatch of REC-eligible resources, decreased market prices

Statistics Summary

Variable	Distribution	Covariance	Autocorrelation	Model Goal
Load	Normal	High, decreasing with distance	High, long lag	Study typical load variability
Hydro Conditions	Uniform	Medium, decreasing with distance	Seasonal, low y/y	Study typical hydro variability
Natural Gas Prices	Log Normal	High	Seasonal, trend reverting	Study typical gas variability
Carbon Prices	Log Normal	N/A	High	Study wide range of policy options
Rec Prices	Log Normal	N/A	High	Study wide range of policy options

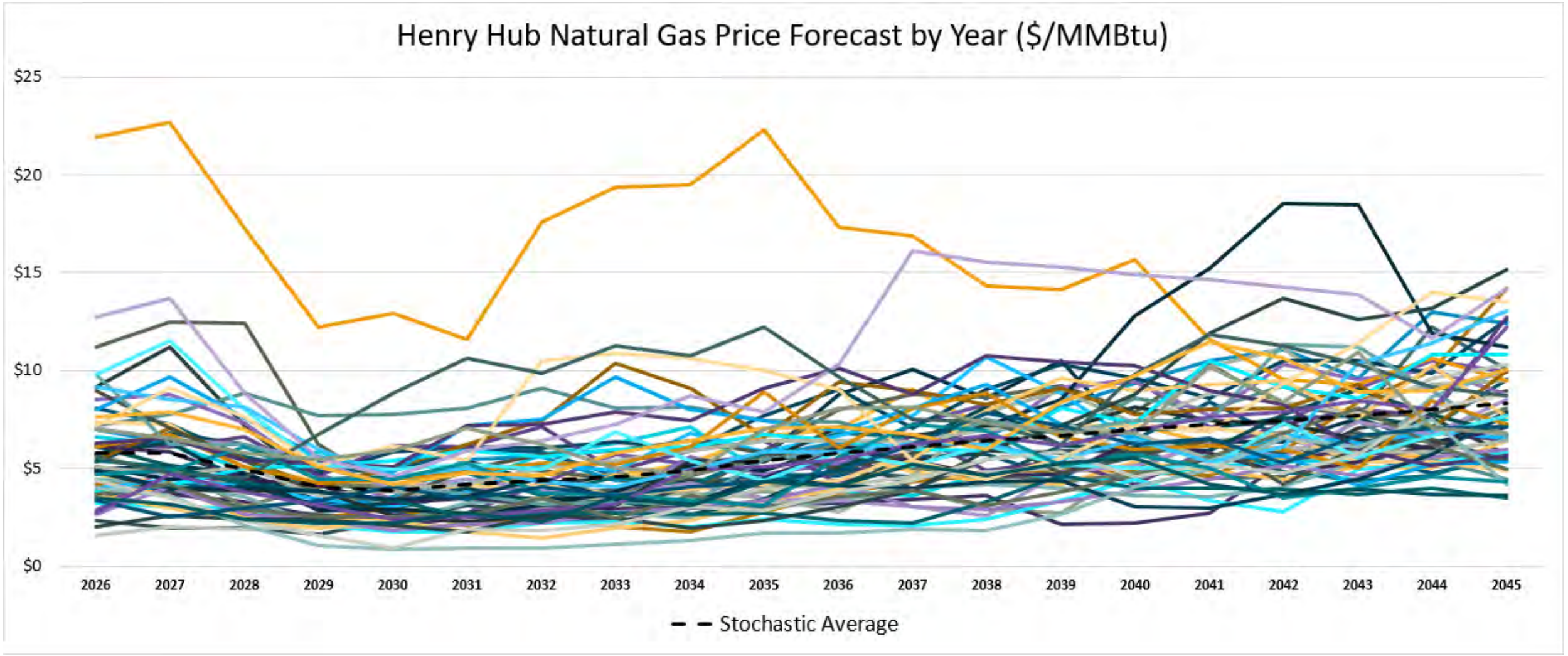
2027 IRP Stochastic Variables

2025 IRP Examples



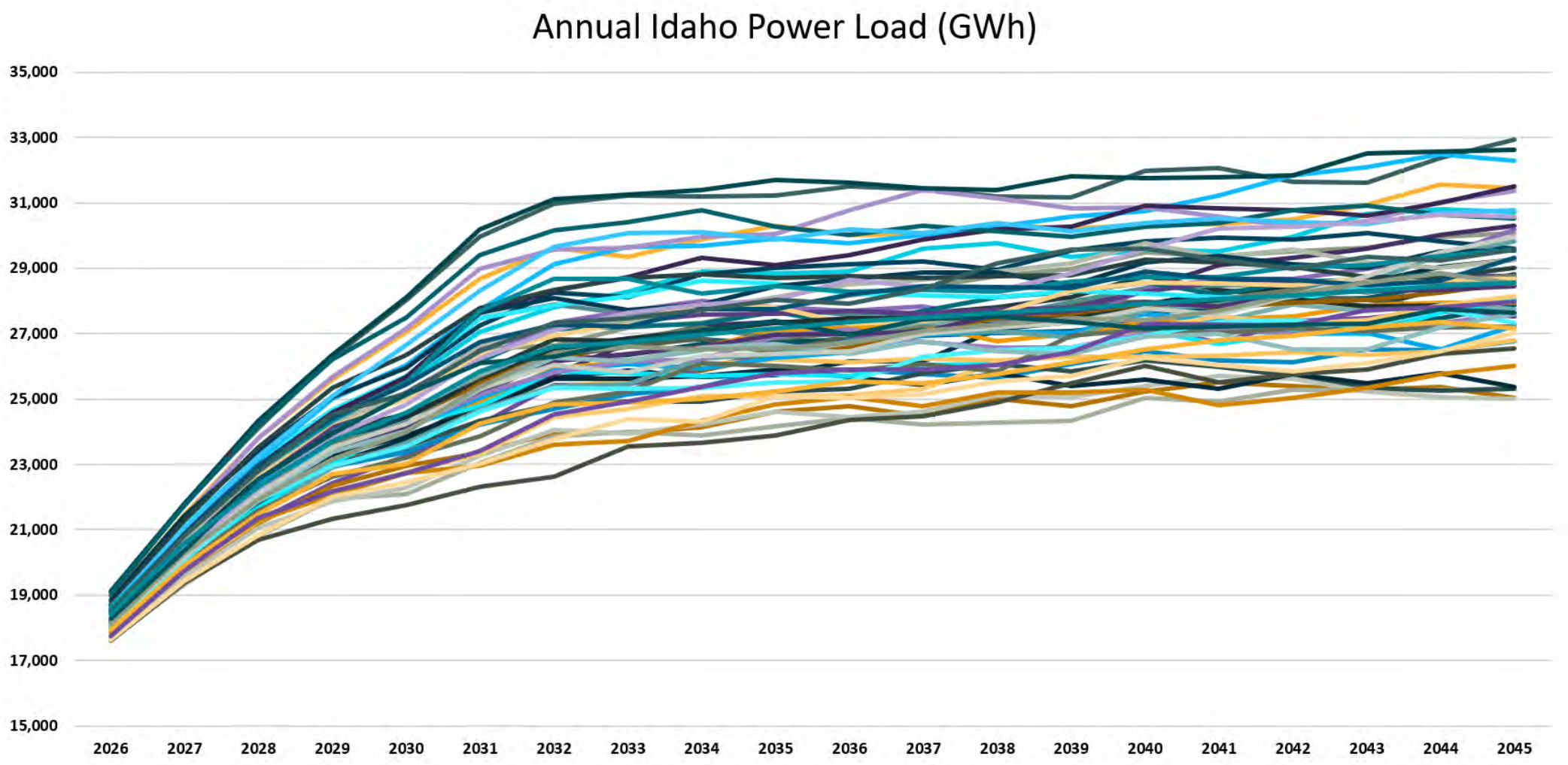
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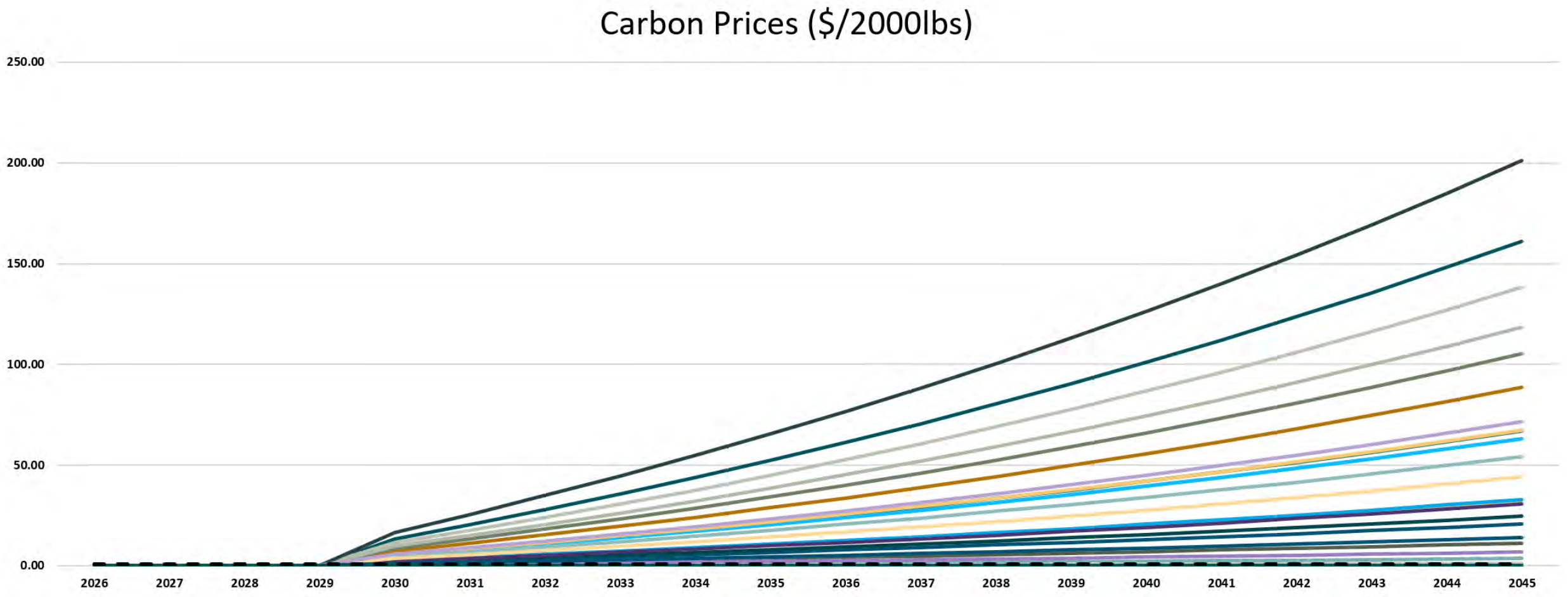
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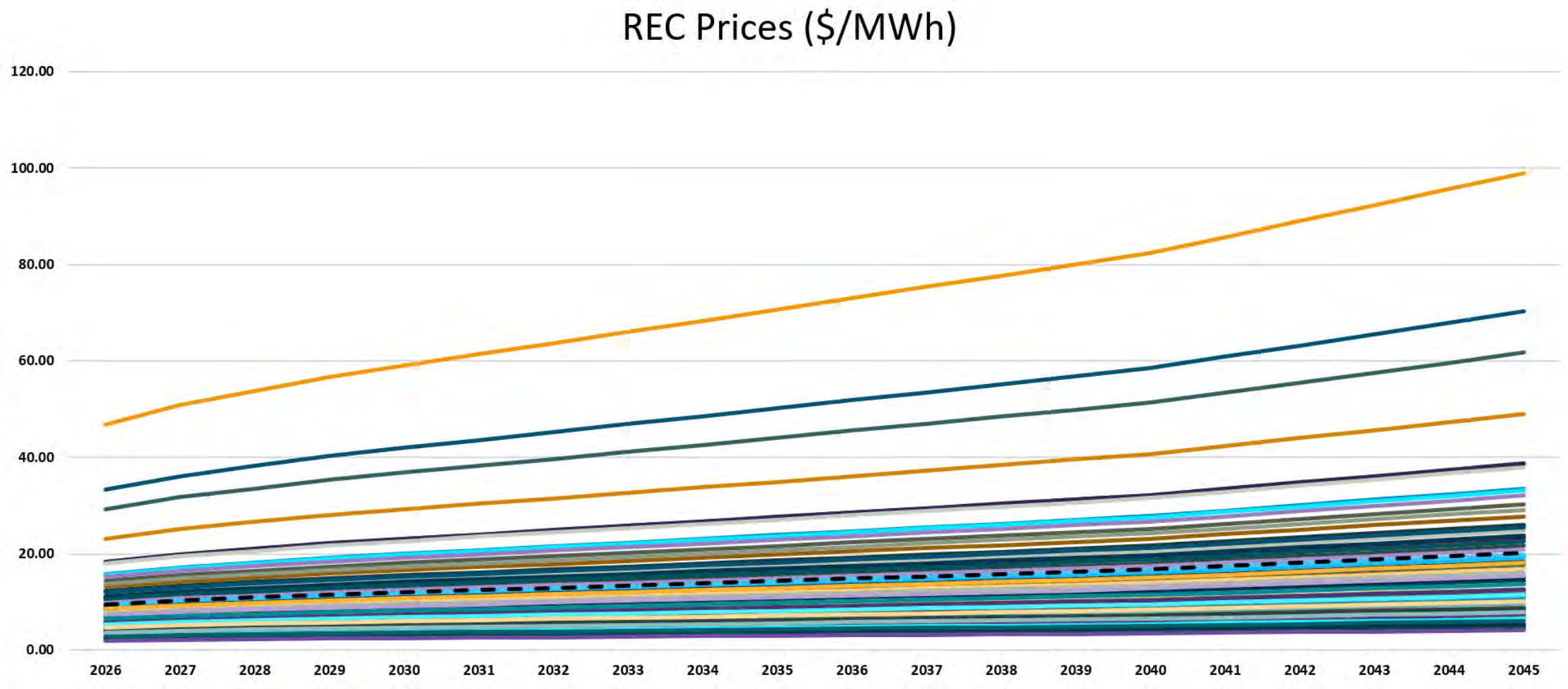
2027 IRP Stochastic Variables

2025 IRP Examples



2027 IRP Stochastic Variables

2025 IRP Examples



2025 IRP Stochastic Results Presentation

Rank	With 111(d) Portfolio	1st	2nd	3rd	4th	5th	6th	7th	8th	9th
1	Bridger 3&4 NG	38	19	2	0	1	0	0	0	0
2	Low Gas Price	15	32	10	2	0	0	1	0	0
3	SCCT 2030	5	8	47	0	0	0	0	0	0
4	Bridger 3&4 Exit	0	0	0	33	16	6	2	2	1
5	Bridger 3&4 CCS	0	0	0	14	31	3	5	2	5
6	High Gas & Carbon Prices	2	1	0	10	8	13	26	0	0
7	No Gas 2029	0	0	0	0	4	36	20	0	0
8	No Gas 2029/2030	0	0	0	1	0	2	5	51	1
9	No New Gas	0	0	1	0	0	0	1	5	53

2027 IRP Stochastic Results
Presentation Feedback Resquested

Iteration	Hydro	Gas	Load	Carbon	REC	Preferred Portfolio	No New Gas	Low Gas Price Optimized	High Gas High Carbon Price Optimized
21	102%	258%	98%	$0	492%	3	2	4	1
22	105%	107%	101%	$0	35%	1	4	2	3
23	111%	87%	100%	$42	62%	1	4	2	3
24	90%	51%	103%	$0	32%	2	4	1	3
25	99%	99%	109%	$25	95%	2	4	1	3
26	105%	69%	99%	$1	47%	1	4	2	3
27	95%	91%	101%	$0	83%	1	4	2	3
28	90%	86%	110%	$0	104%	1	4	2	3
29	99%	81%	91%	$55	123%	2	4	1	3
30	95%	91%	114%	$10	23%	1	4	2	3

Don't Trust This Data at Face Value

Thank You!

