Stochastic Variable Modeling and Risk Discussion

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Agenda

- Overview of Stochastic Analysis (information and learning)
  - Definitions
  - Why use Stochastic Variables
  - Variable Selection
  - AURORA Implementation
- Proposed Improvements for the 2023 IRP (looking for feedback)
  - Increased Iterations
  - New Variables
  - Wider Scope
  - Scenario Simplification
- Feedback and Questions (You don’t have to wait until the end!)

Definitions

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

Probability Density Function (PDF): The relative likelihood of observed occurrence over the variable space

Where Stochastics in IRP Process

Inputs

- Model Inputs
- Stakeholder Feedback

Portfolio Building

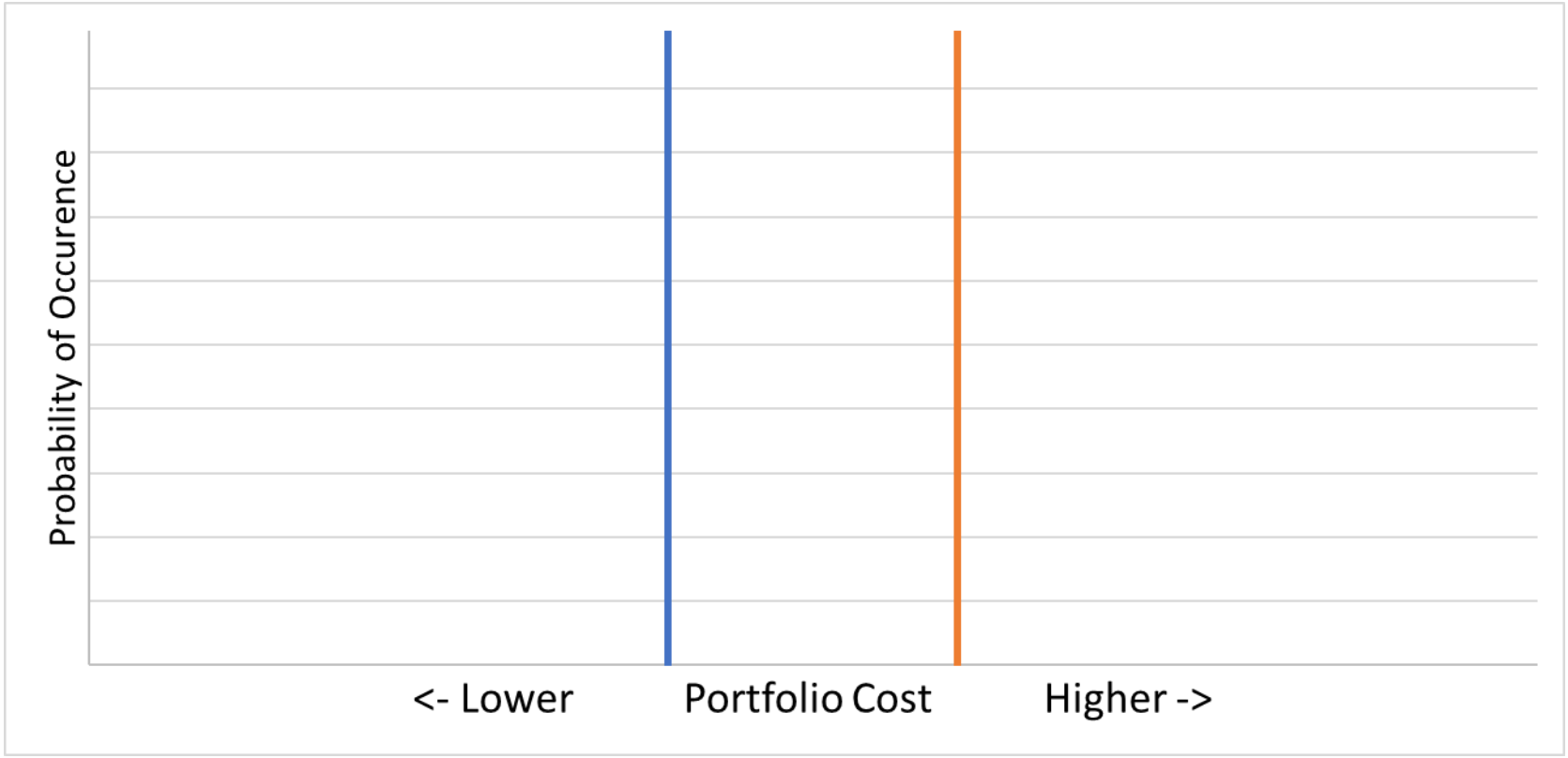
- Scenarios and Sensitivities
- Long Term Capacity Expansion Modeling

Portfolio Costing

- Costing run
- Risk quantification

Risk Evaluation Discussion

Why Use Stochastic Variables for IRP Analysis?



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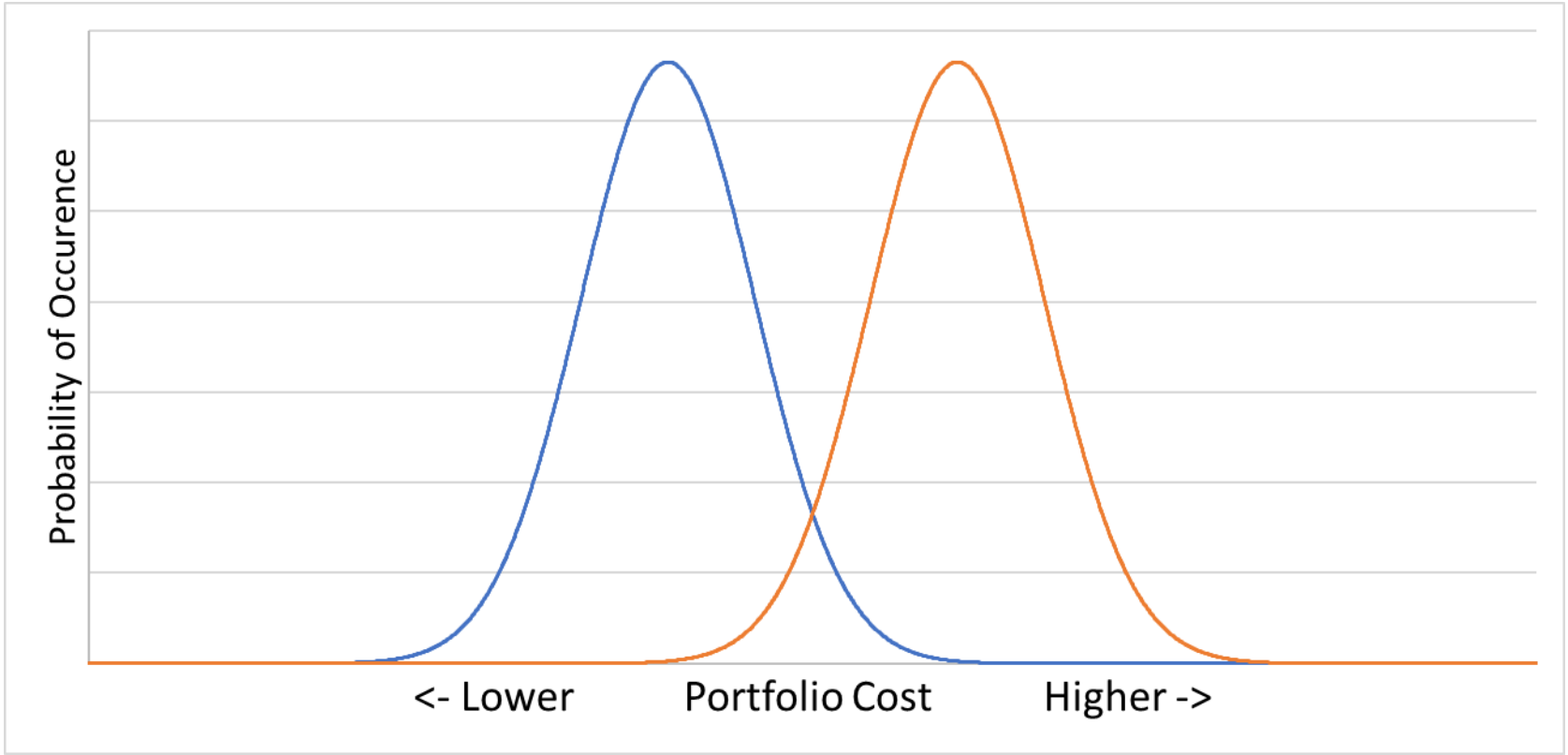

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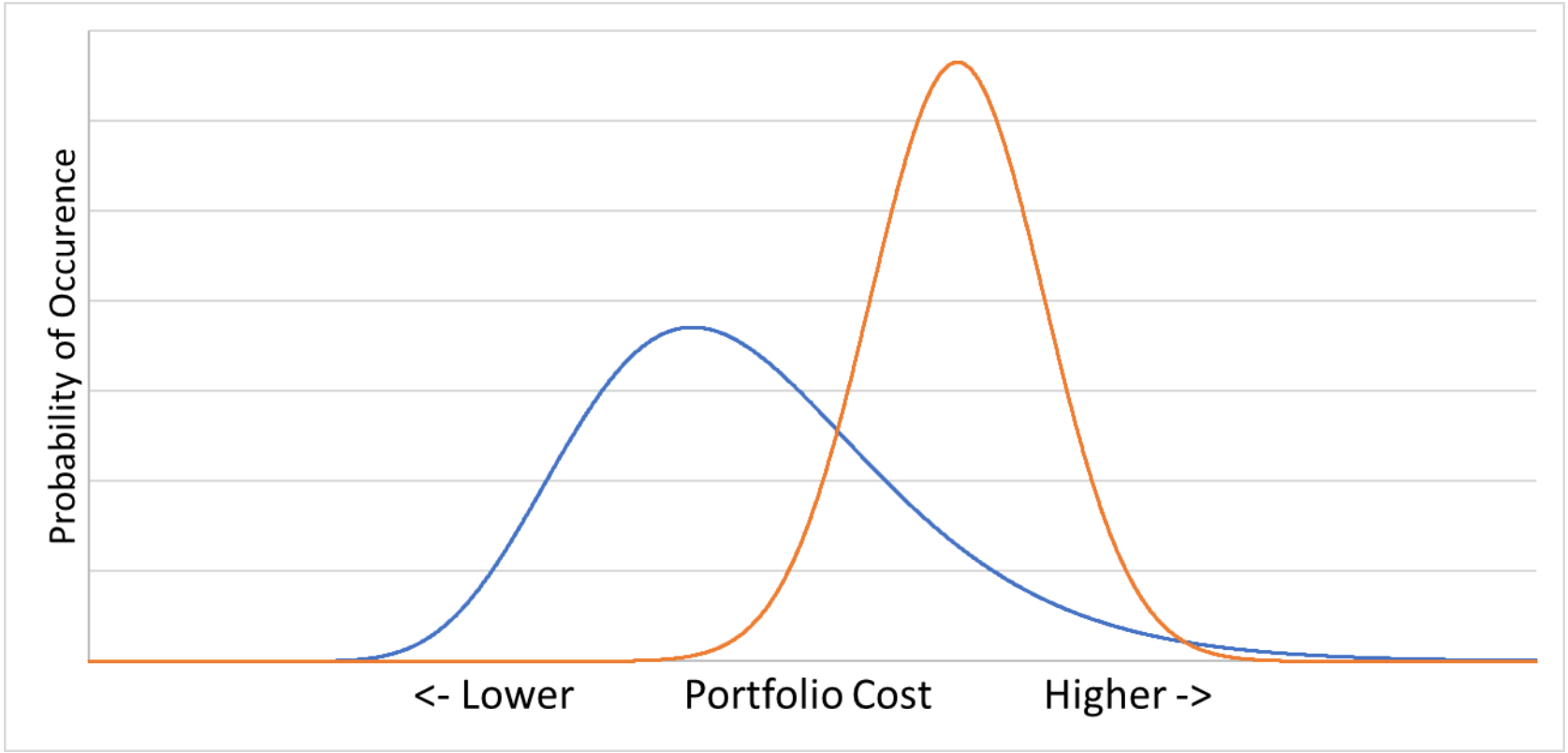


Variable Selection:

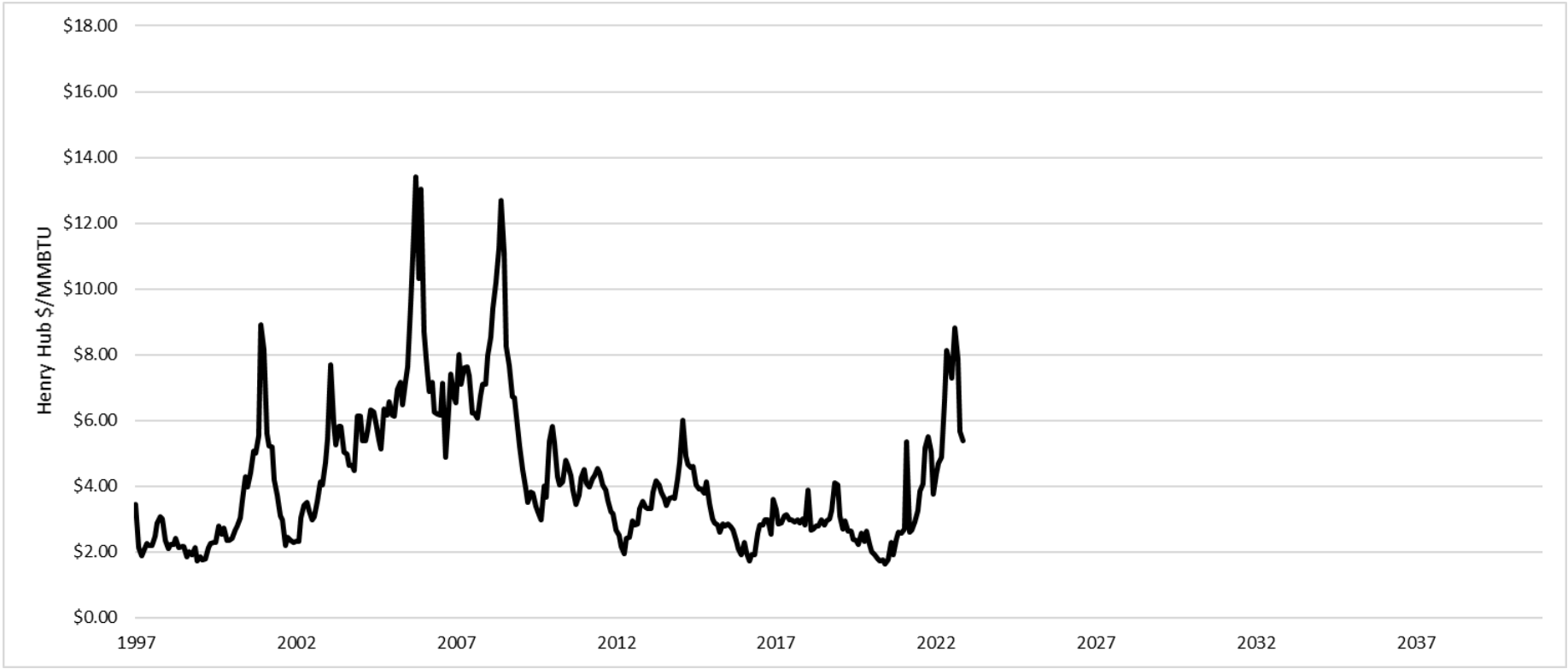
Identifying Variables

Good Candidate Criteria

- Variables that have random components that approximate a known Probability Density Function
- Variables with sufficient history to estimate random component
- Variables whose impact to IRP model can reasonably be estimated
- Variables whose historical variance can be expected to match future variance

Variable Selection:

Monthly Natural Gas Prices



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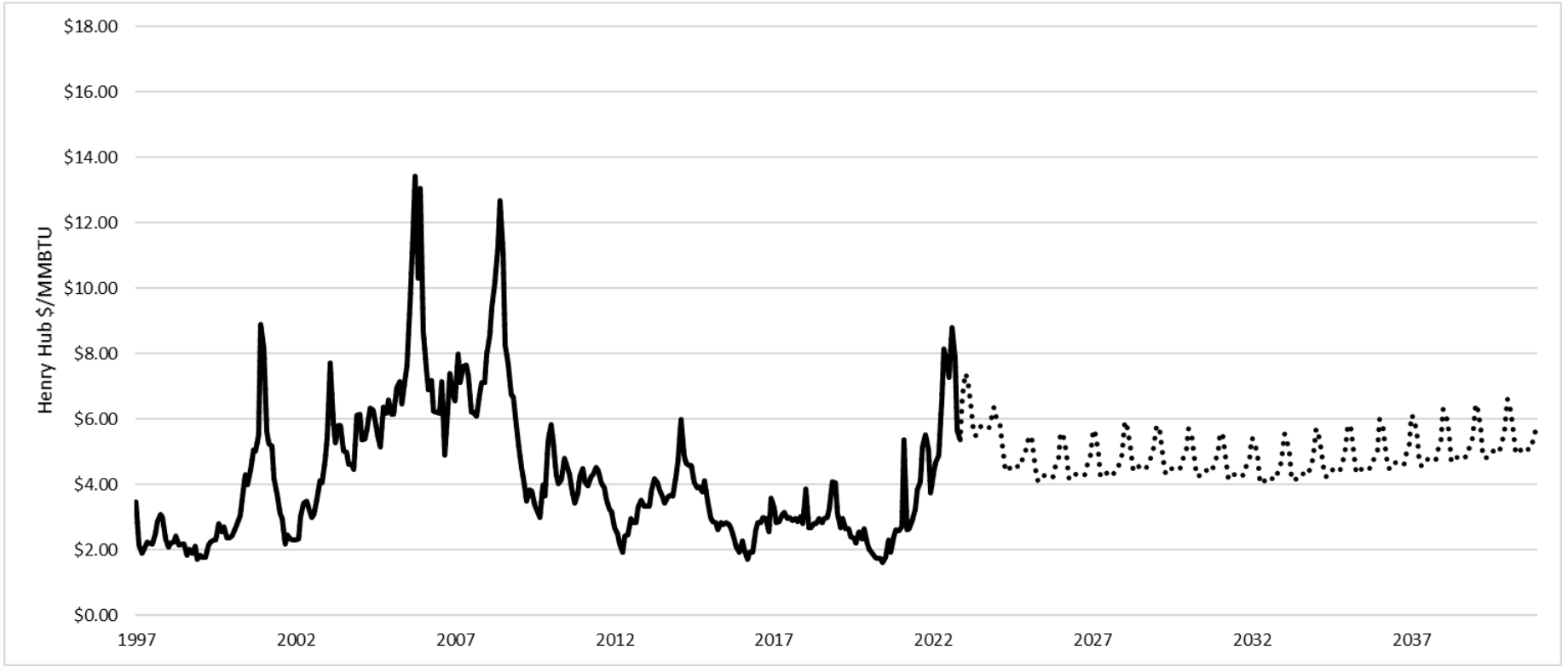

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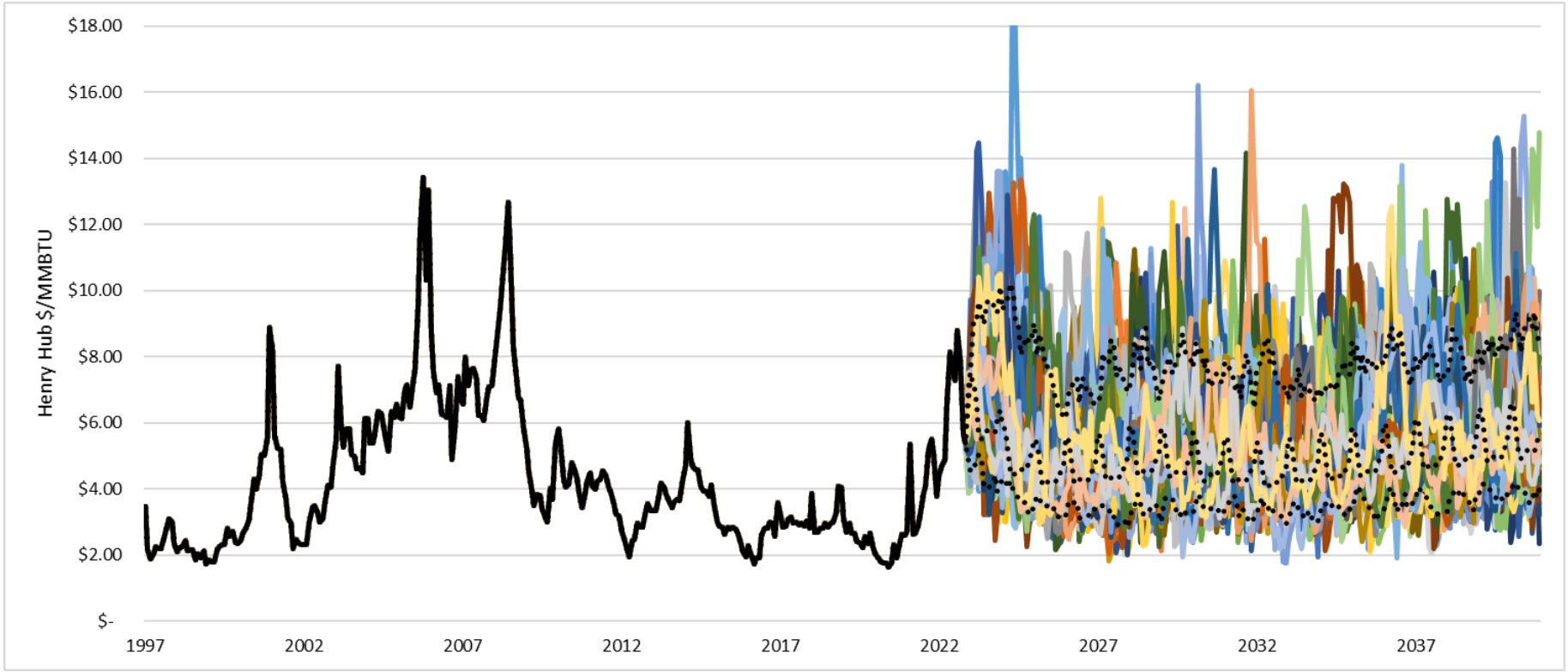
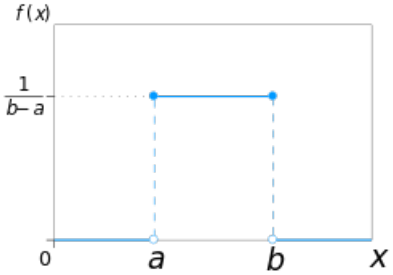
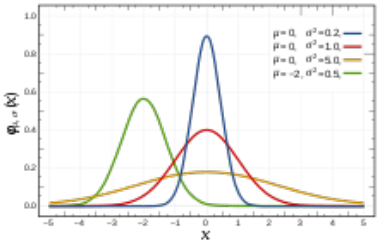


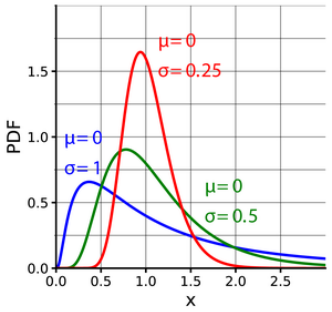
AURORA Implementation: Distributions

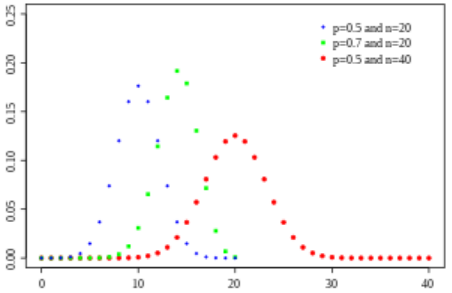
Counterclockwise from Upper Left

- 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:

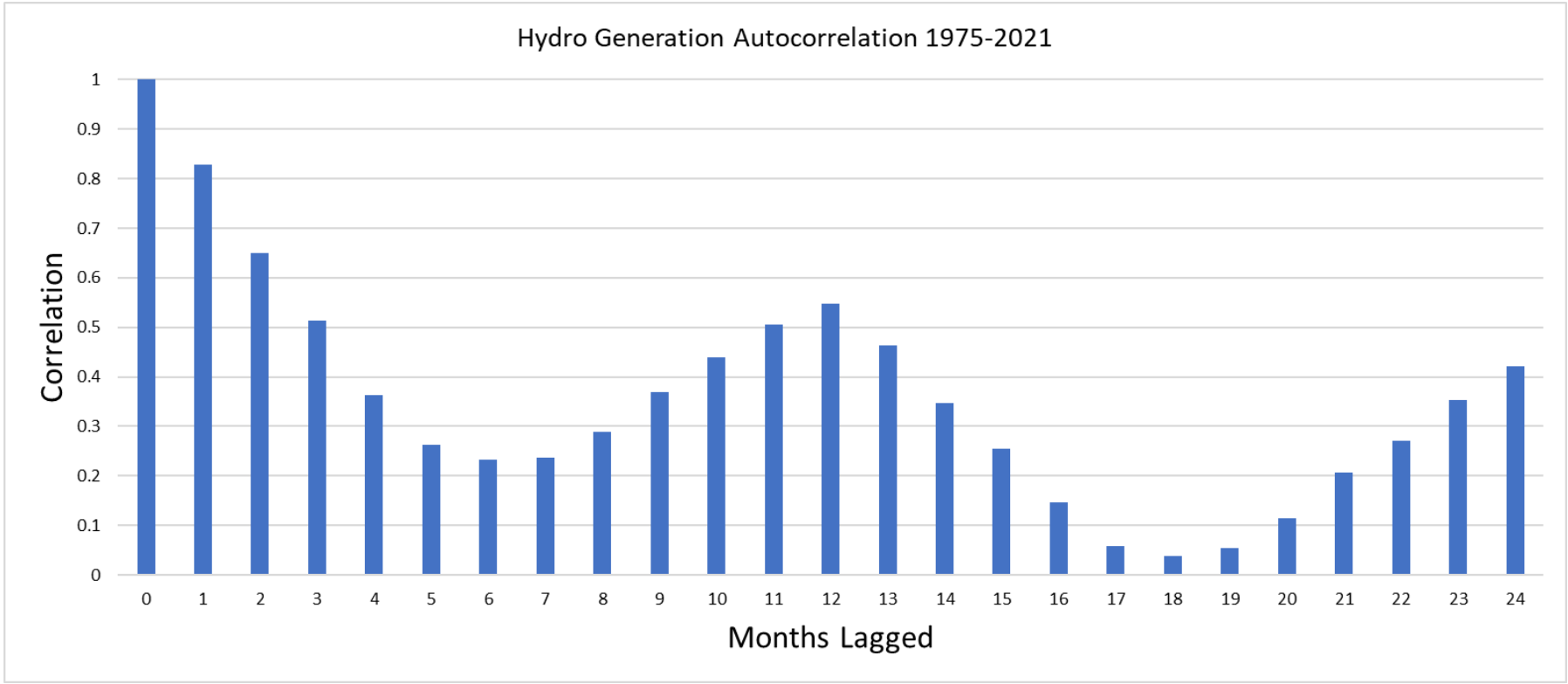
Covariance

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.

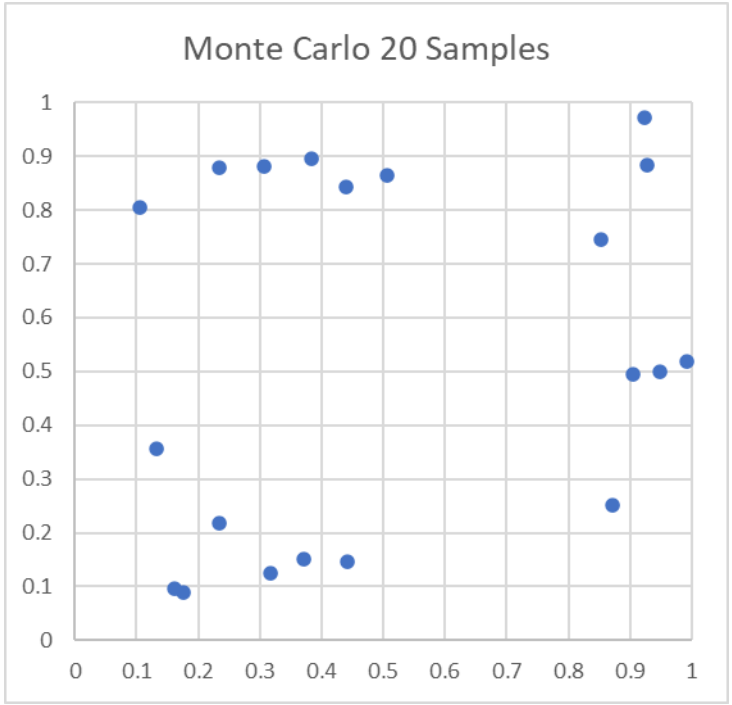
Airport	City	Region	Distance Miles	Coincident Boise Summer Peak Weather °F Deviation	Respective Area Summer Peak Weather °F Deviation
BOI	Boise	Intermountain	0	17.7	17.7
GEG	Spokane	Intermountain	287	12.0	16.8
SLC	Salt Lake city	Intermountain	289	8.8	18.9
RNO	Reno	Intermountain	335	7.0	17.0
PDX	Portland	Pacific	343	3.1	15.2
SEA	Seattle	Pacific	399	1.6	14.6
LAS	Las Vegas	Intermountain	520	5.3	14.4
SFO	San Francisco	Pacific	522	-0.5	12.7
BKF	Denver	Rockies	649	0.0	21.2
LAX	Los Angeles	Pacific	675	1.2	11.2
PHX	Phoenix	Desert SW	736	4.3	13.1
SAN	San Diego	Pacific	750	1.4	10.2
ABQ	Albuquerque	Desert SW	780	0.8	13.8
ELP	El Paso	Desert SW	973	-0.7	15.4

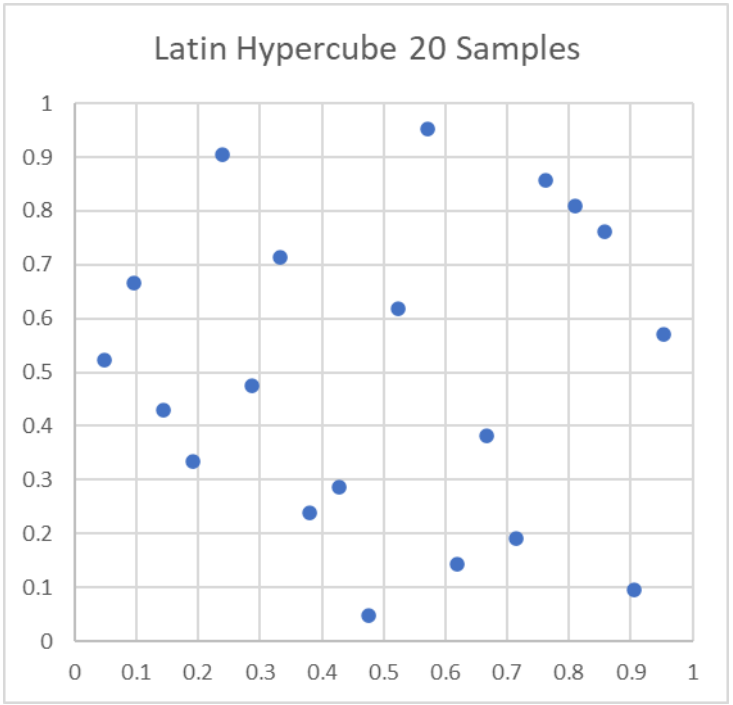
AURORA Implementation:

Autocorrelation

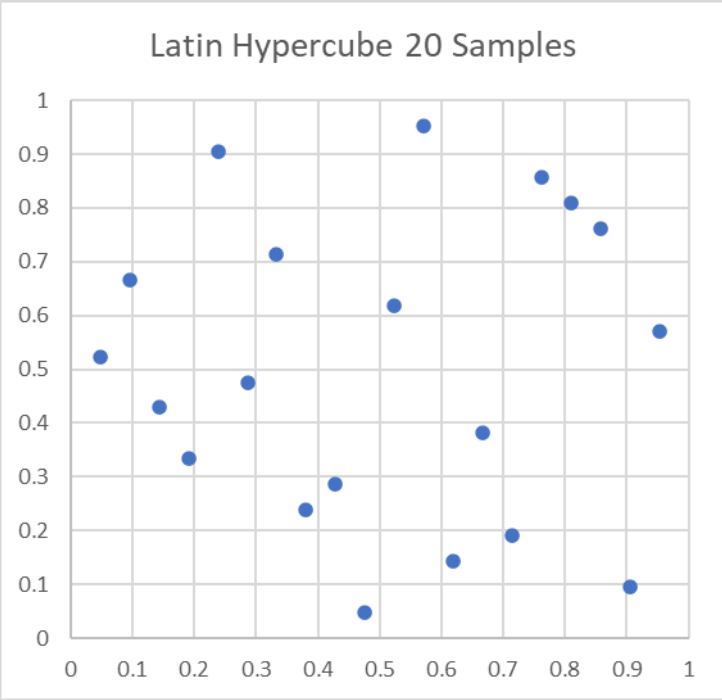


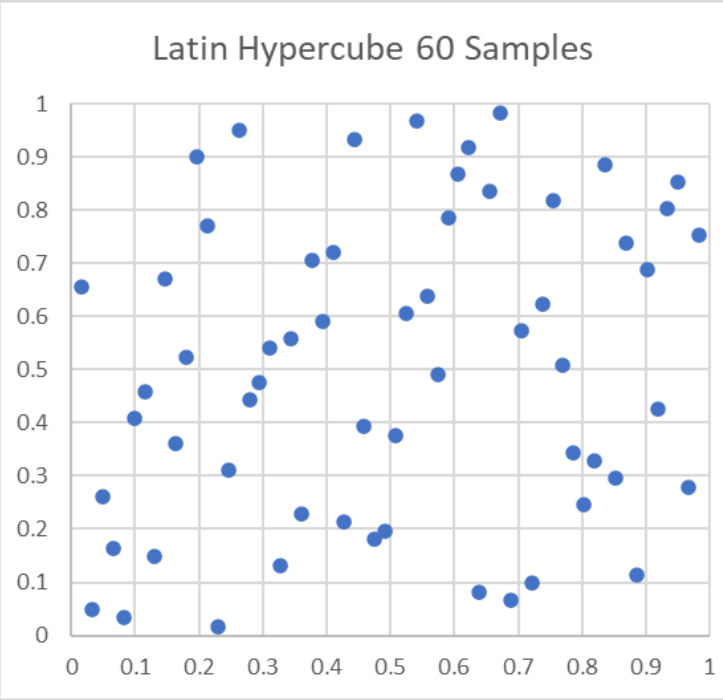
AURORA Implementation: Monte Carlo vs. Latin Hypercube





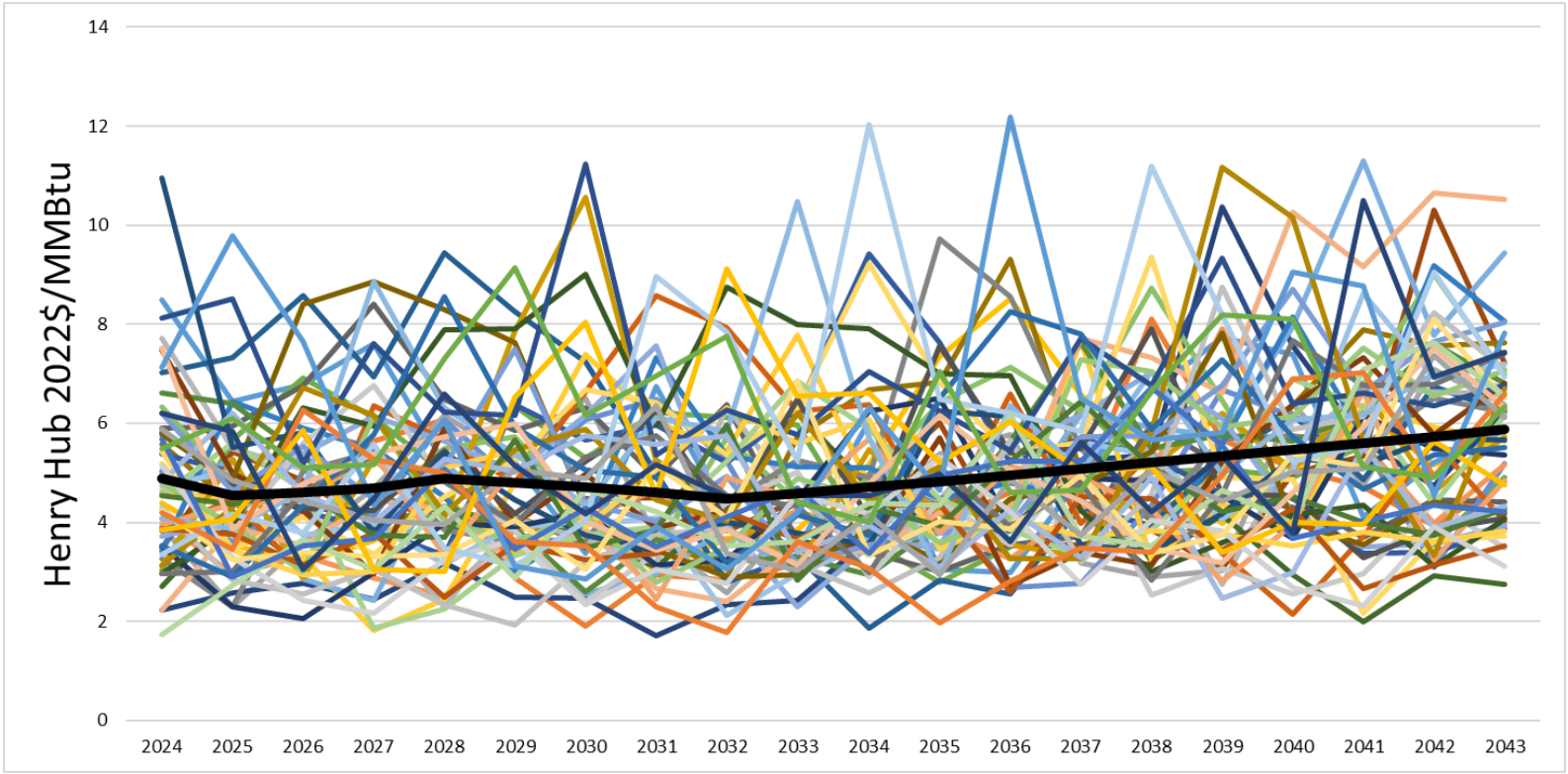
2023 Improvement: Increased Iterations





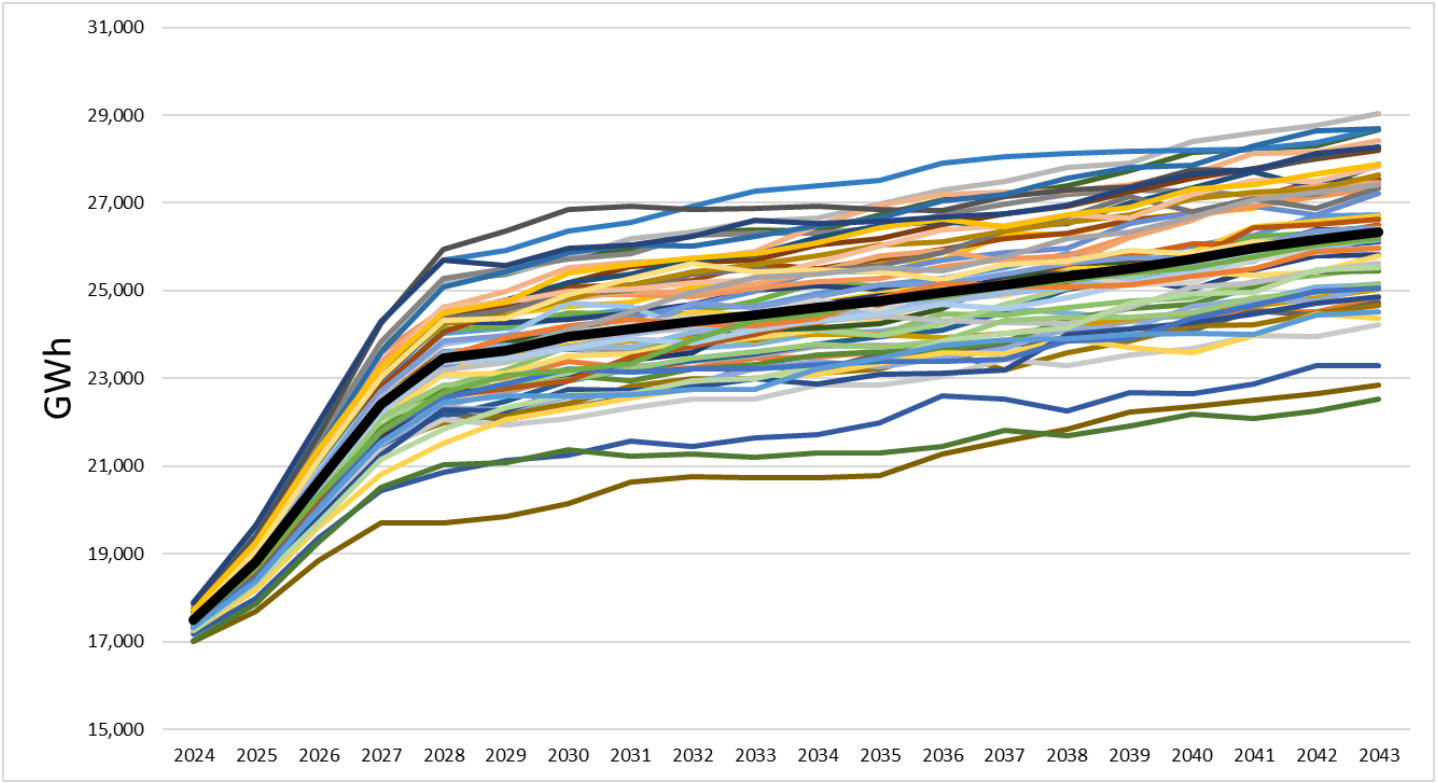
2023 IRP Stochastic Variables

Preliminary Average Annual Natural Gas Prices



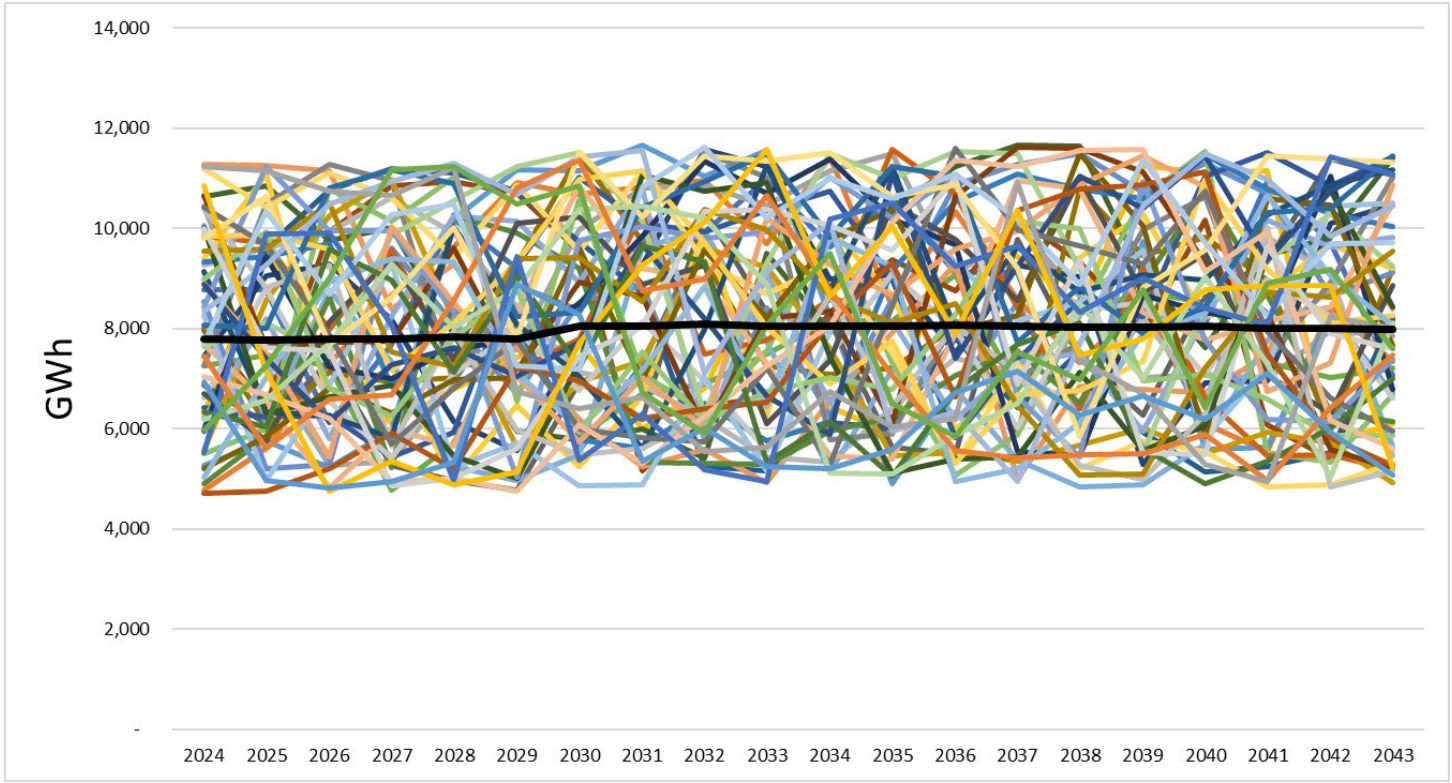
2023 IRP Stochastic Variables

Preliminary Idaho Power Customer Load



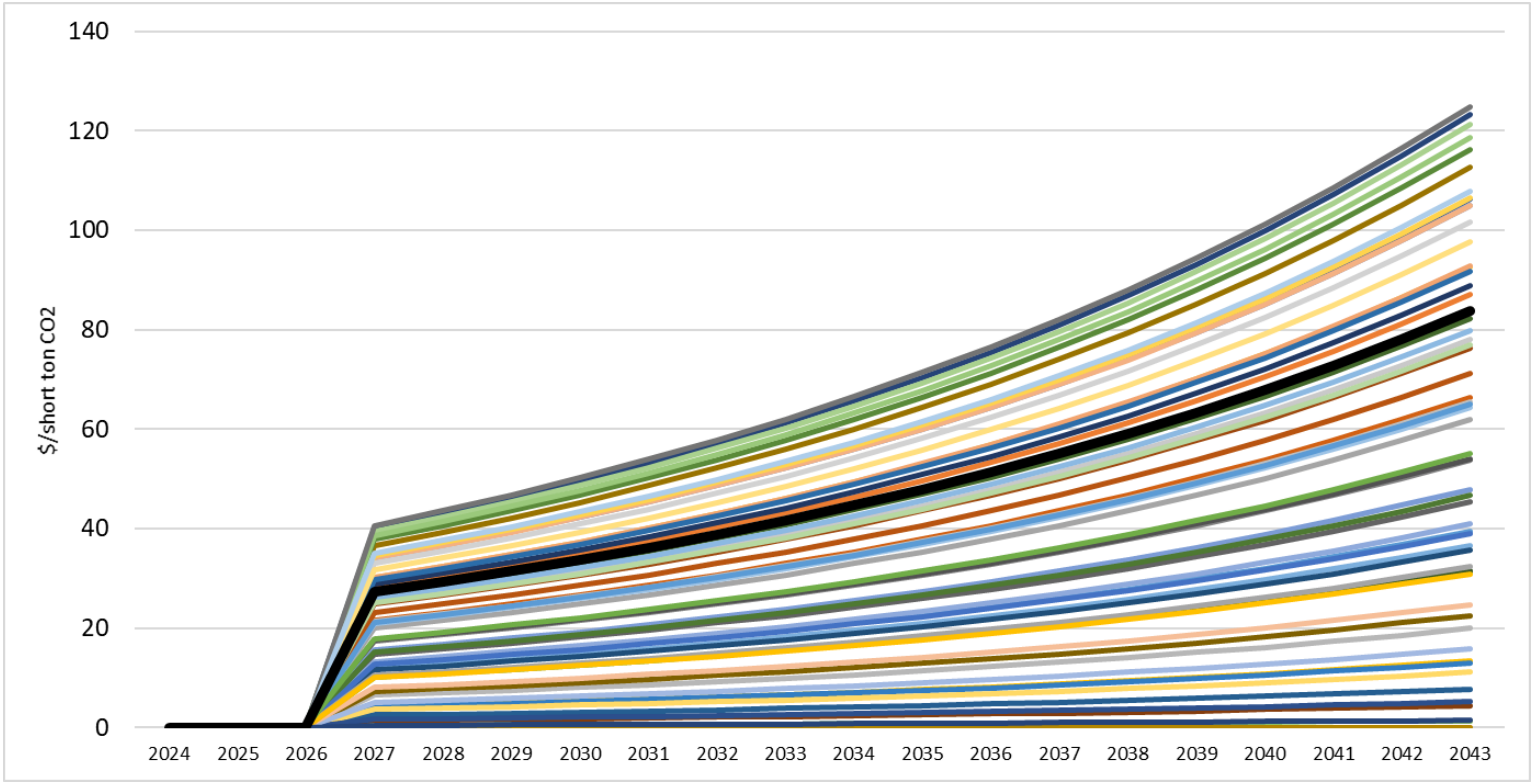
2023 IRP Stochastic Variables

Preliminary Idaho Power Hydroelectric Generation Variability



2023 IRP Stochastic Variables

Preliminary Carbon Prices

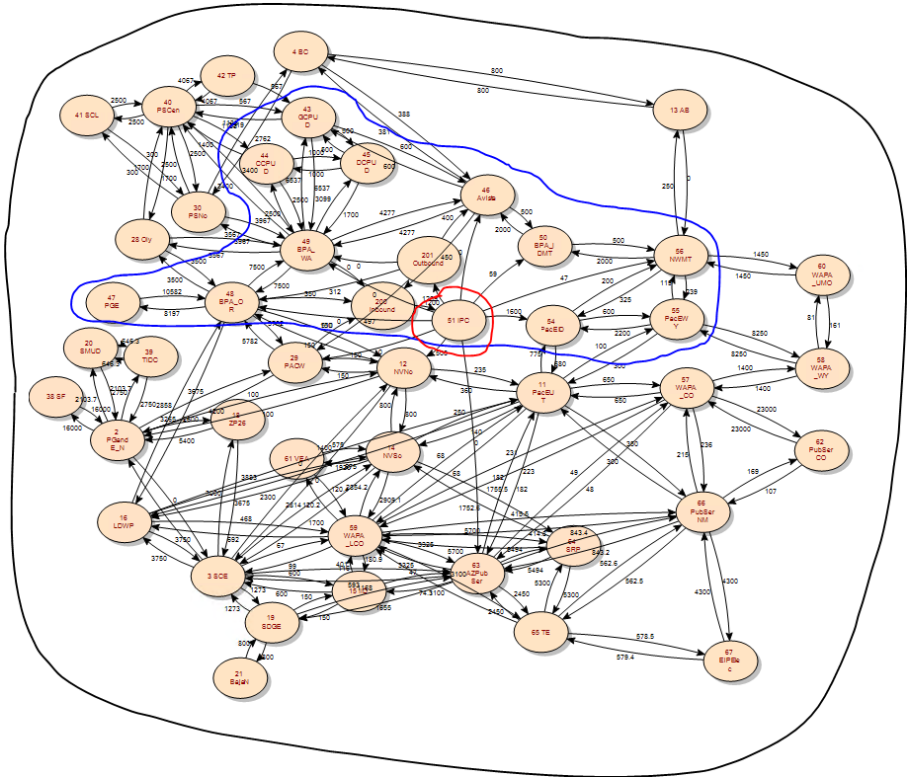


2023 Improvement: Wider Scope

Load

Hydro

Gas



2023 IRP Changes: Scenarios

- Removal of separate carbon price and gas price sensitivities
- High Market Price “Scenario”
  - Increased Average Demand → Increased Market Prices
  - Increased Peak Demand → Increased Market Prices
  - Increased Hydro Supply → Decreased Market Prices
  - Increased Gas Prices → Increased Market Prices
  - Increased Carbon Prices → Increased Market Prices

Thank you!

Questions?