Stochastic Variable Modeling and Risk Discussion

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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.

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

NPV: Net present value.

Agenda

- Overview of Stochastic Analysis (Information and Learning)
  - Where stochastic variables are used in the preferred portfolio selection
  - Variable selection
  - AURORA implementation
- Proposed Improvements for the 2025 IRP (Looking for Feedback)
  - New variables
- Feedback and Questions (You don’t have to wait until the end!)

Risk Evaluation Discussion

Where Stochastics Exist in IRP Process

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Inputs

- Model Inputs
- Stakeholder Feedback

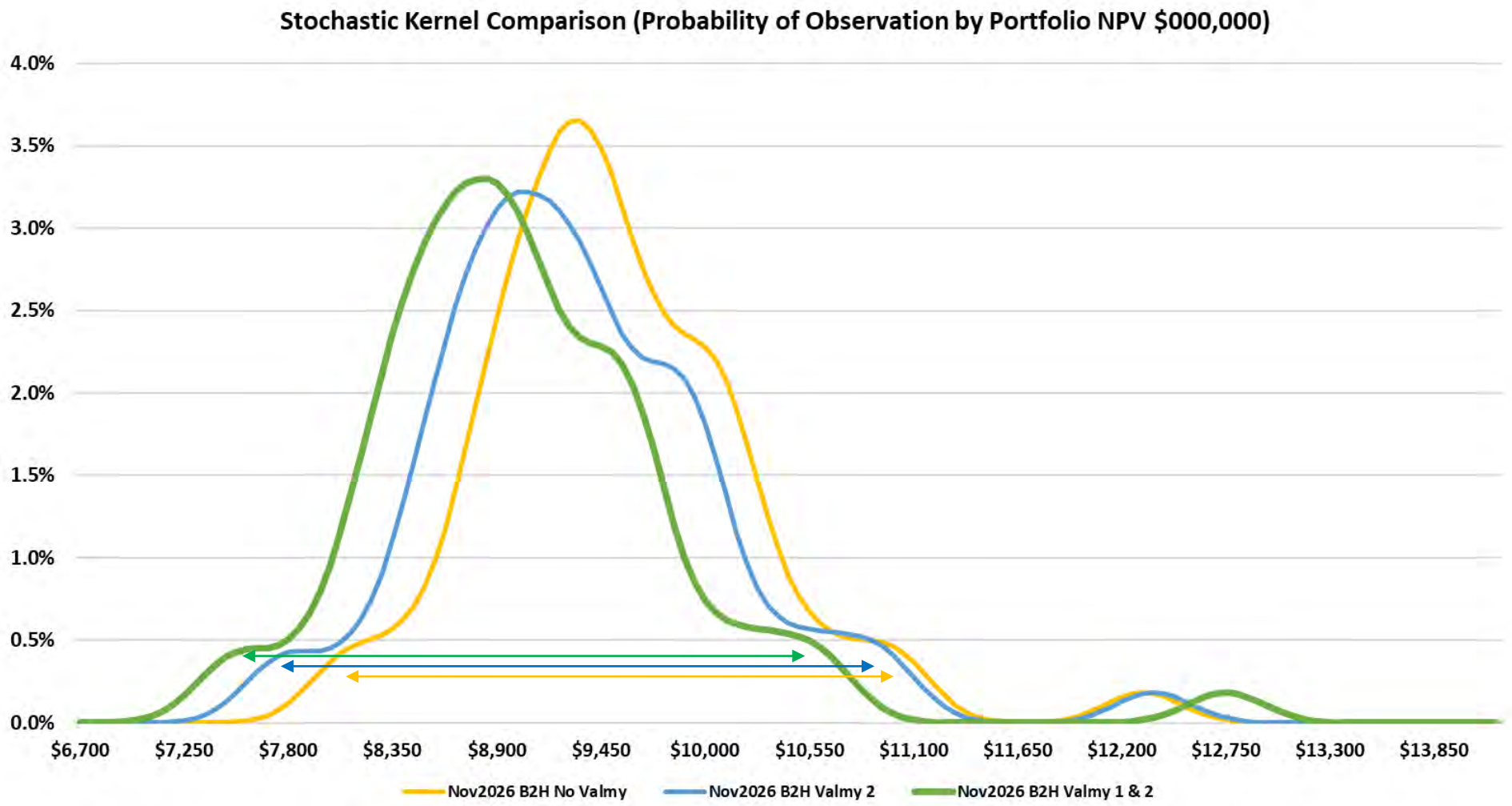
Portfolio Building

- Long-Term Capacity Expansion Modeling
- Reliability Analysis

Portfolio Costing

- Planning Case Portfolio Cost Analysis
- Risk Quantification

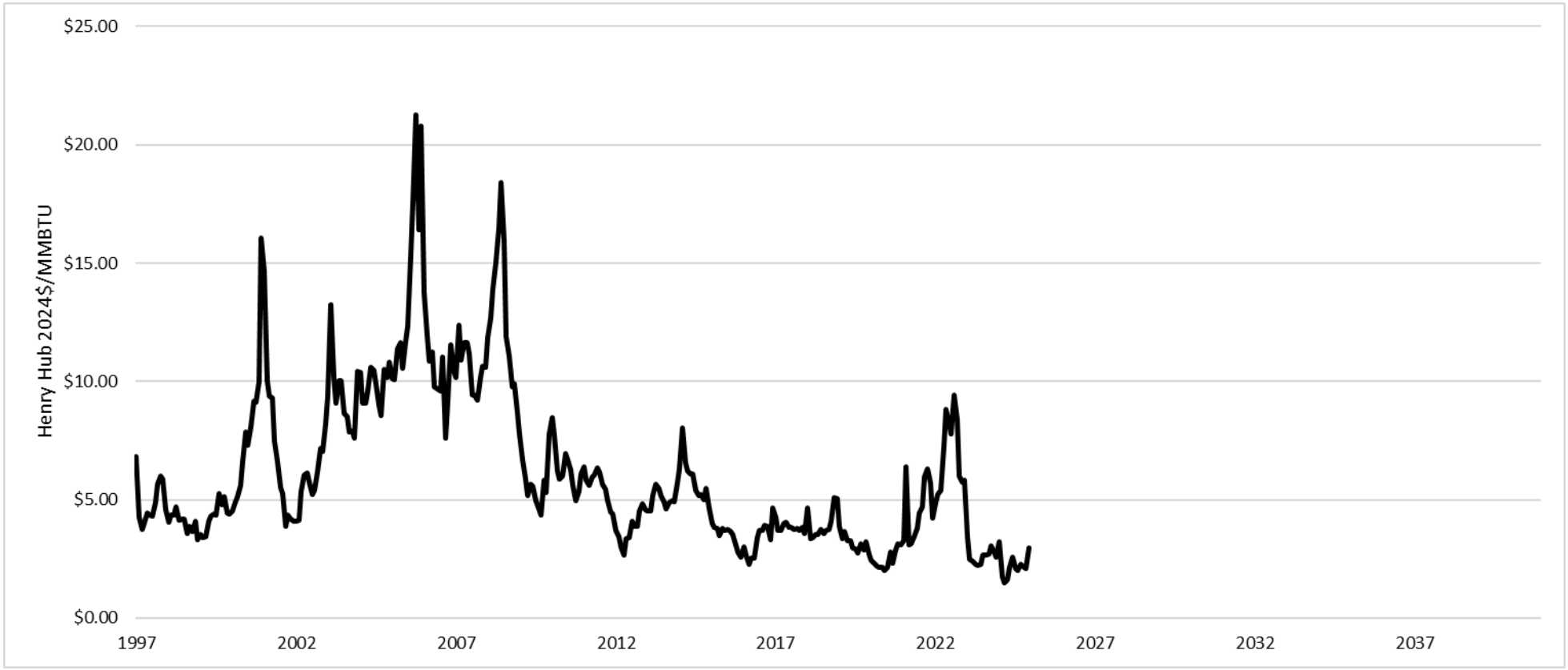
2023 IRP Valmy Conversion Stochastic Analysis



Variable Selection: Identifying Variables

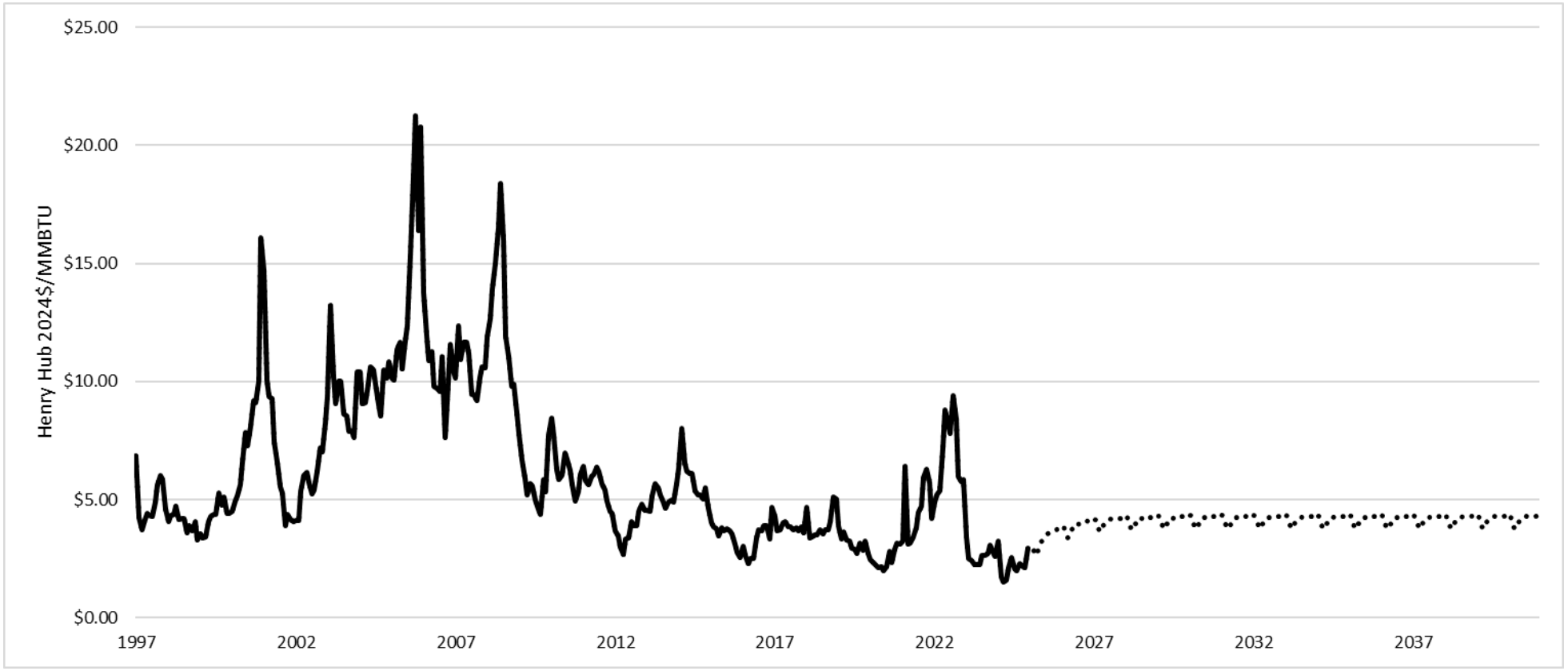
- Good Candidate Criteria
  - Variable that could be expected to change materially in a way that could change results
  - Variables that have random components that approximate a known PDF
    - Variables with sufficient history to estimate random components
    - Variables whose historical variance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

Variable Selection: Monthly Natural Gas Prices



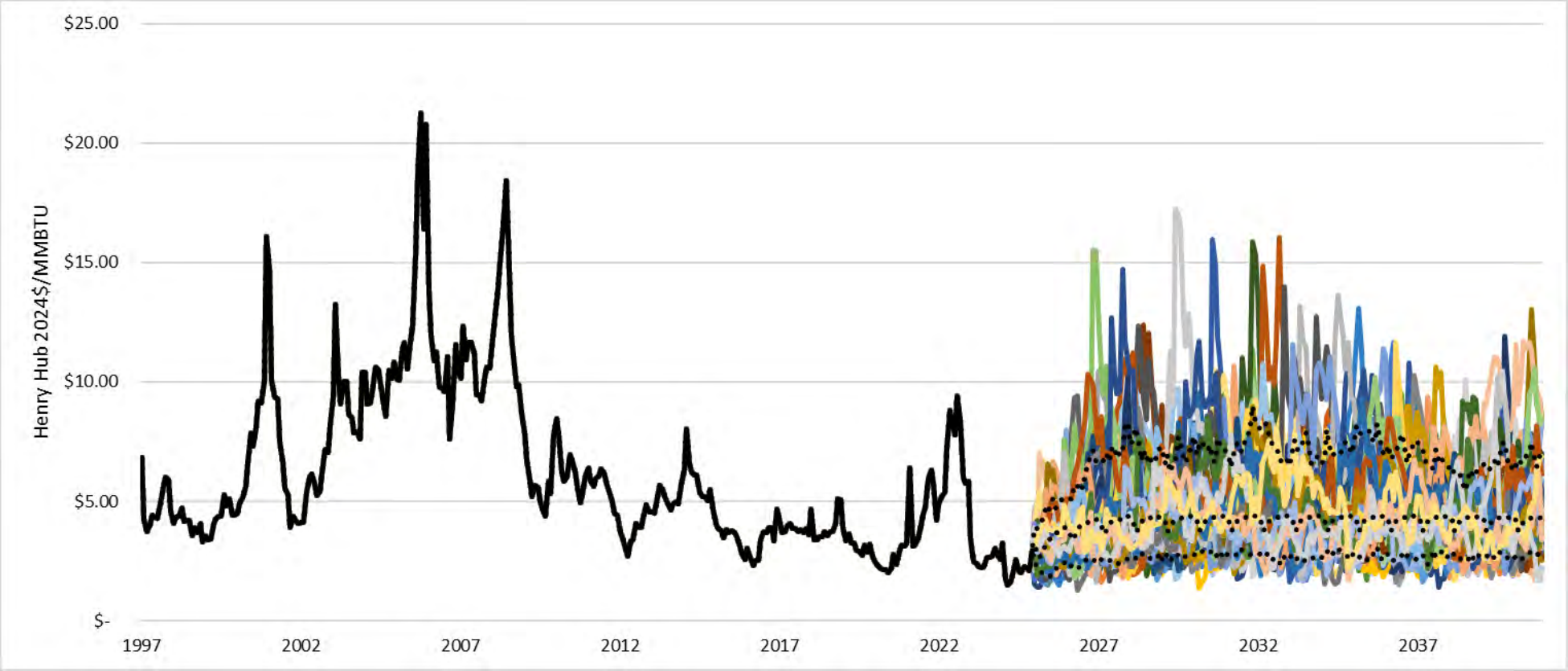
Sources: https://www.eia.gov/dnav/ng/hist/rngwhhdm.htm, https://fred.stlouisfed.org/series/CPIAUCSL

Variable Selection: Monthly Natural Gas Prices



Forecast is strictly for example purposes only.

Variable Selection: Monthly Natural Gas Prices



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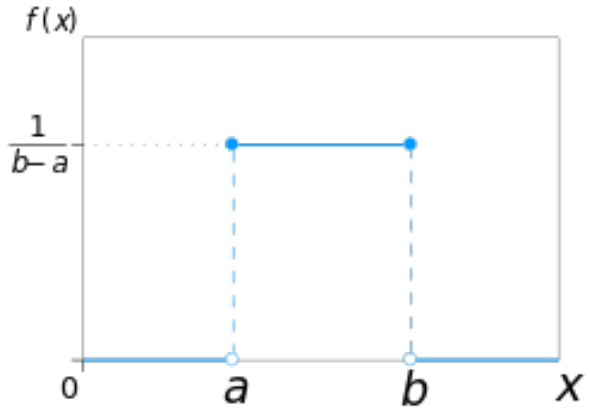
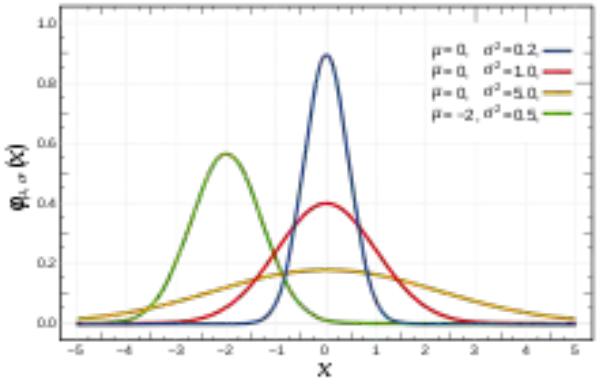
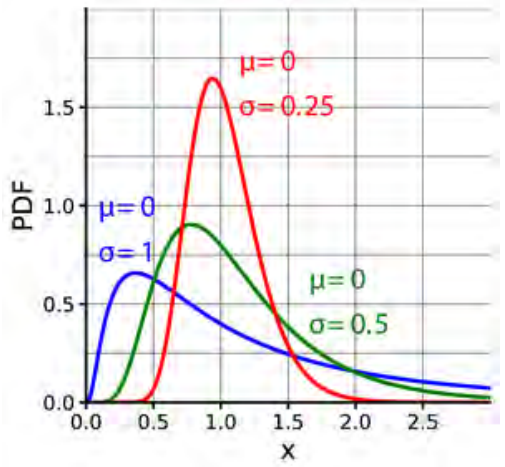
AURORA Implementation: Distributions

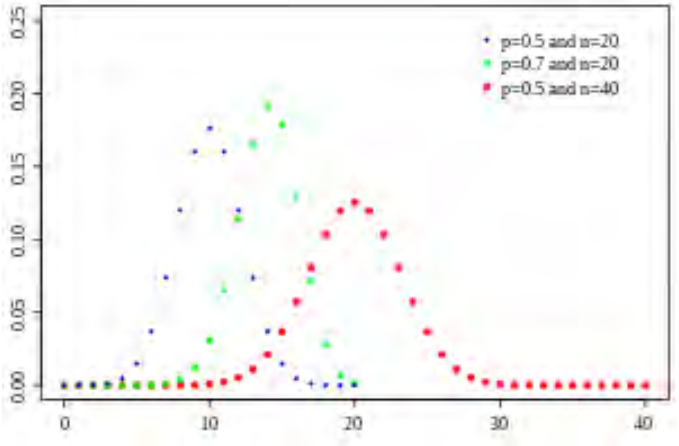
Counterclockwise from upper left

- 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







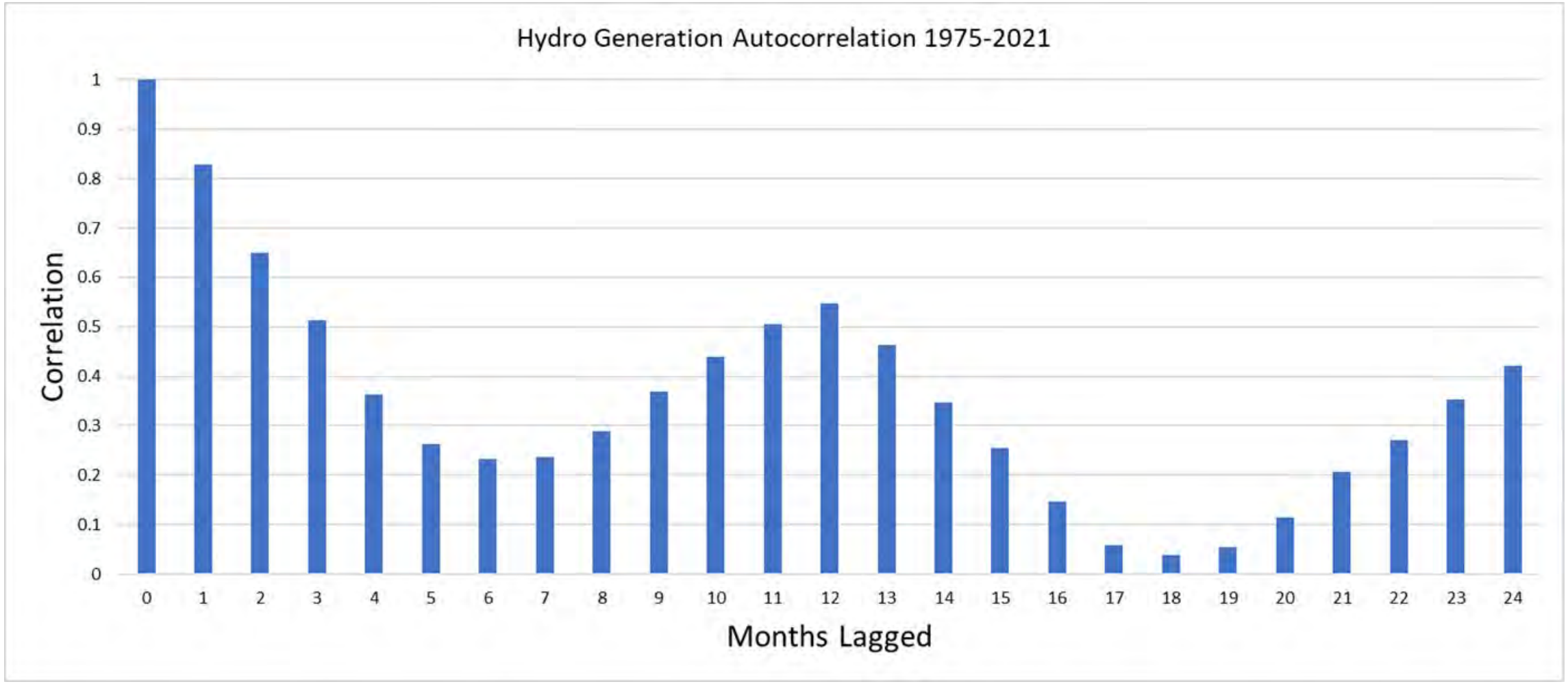


AURORA Implementation: Covariance

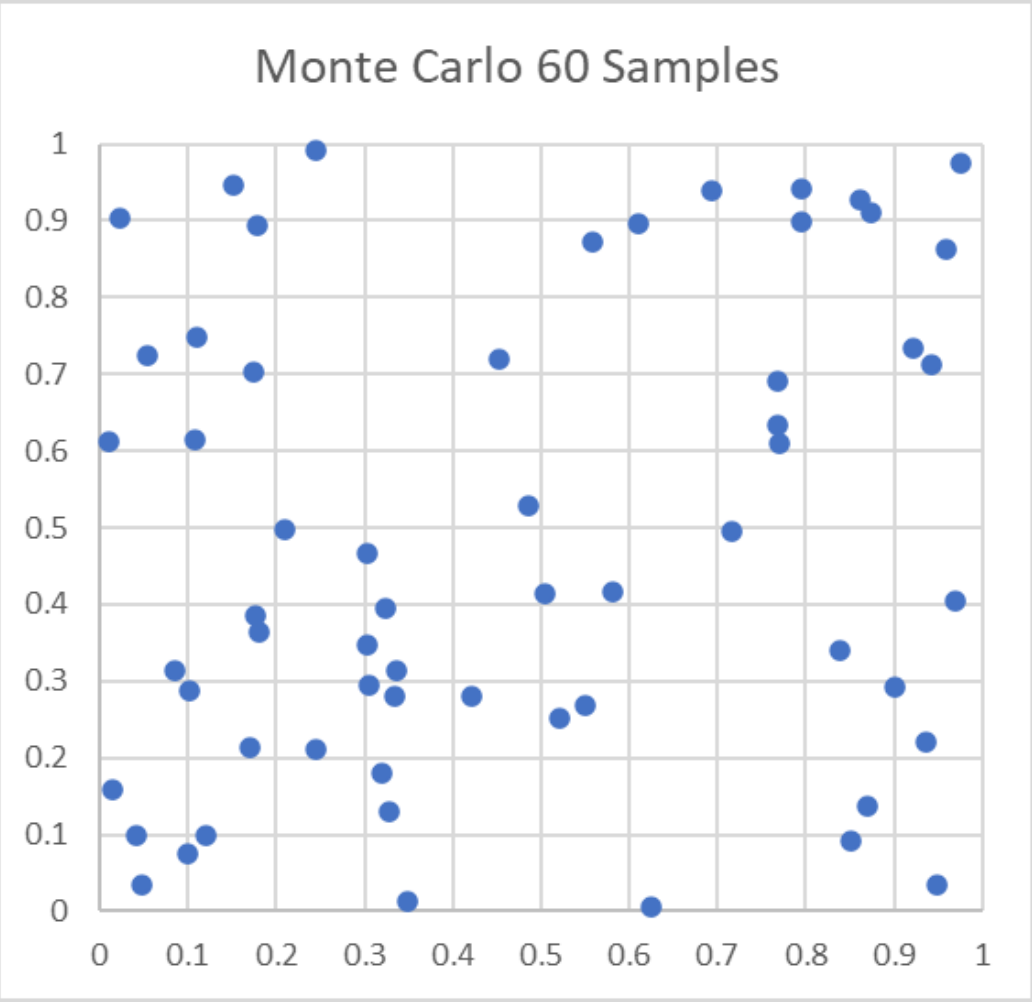
- Within AURORA, as one input is varied, other inputs that are correlated to it can also be changed consistent with their linkage in the real data.

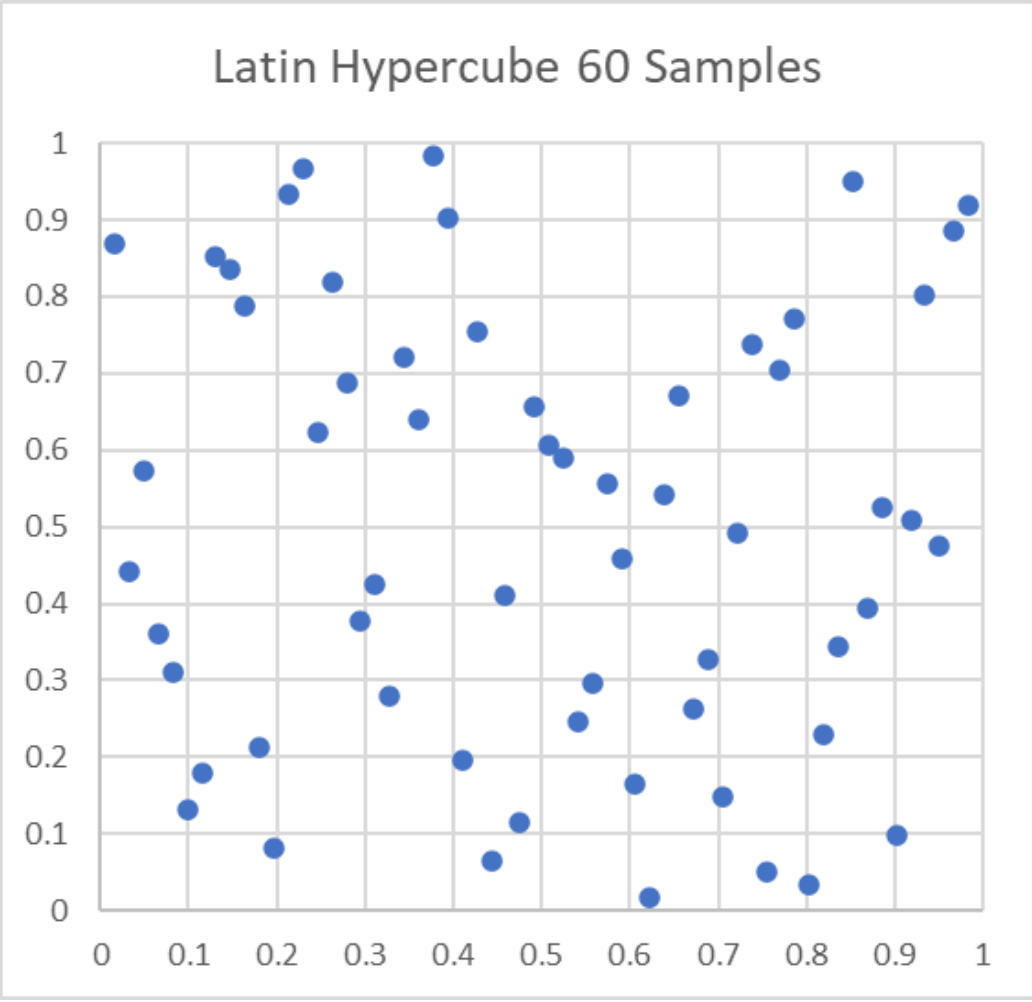
Airport	City	Region	Distance Miles	Coincident Boise Winter Peak Weather °F Deviation	Respective Area Winter Peak Weather °F Deviation
BOI	Boise	Intermountain	0	-20.8	-20.8
GEG	Spokane	Intermountain	287	-15.2	-20.7
SLC	Salt Lake city	Intermountain	289	-13.0	-19.4
RNO	Reno	Intermountain	335	-11.4	-19.4
PDX	Portland	Pacific	343	-11.0	-15.8
SEA	Seattle	Pacific	399	-8.3	-14.6
LAS	Las Vegas	Desert SW	520	-5.5	-15.3
SFO	San Francisco	Pacific	522	-4.4	-10.2
BKF	Denver	Rockies	649	-13.8	-27.1
LAX	Los Angeles	Pacific	675	-3.0	-10.2
PHX	Phoenix	Desert SW	736	-3.2	-14.9
SAN	San Diego	Pacific	750	-2.2	-9.6
ABQ	Albuquerque	Desert SW	780	-3.8	-17.3
ELP	El Paso	Desert SW	973	-2.5	-18.5

AURORA Implementation: Autocorrelation



AURORA Implementation: Monte Carlo vs. Latin Hypercube





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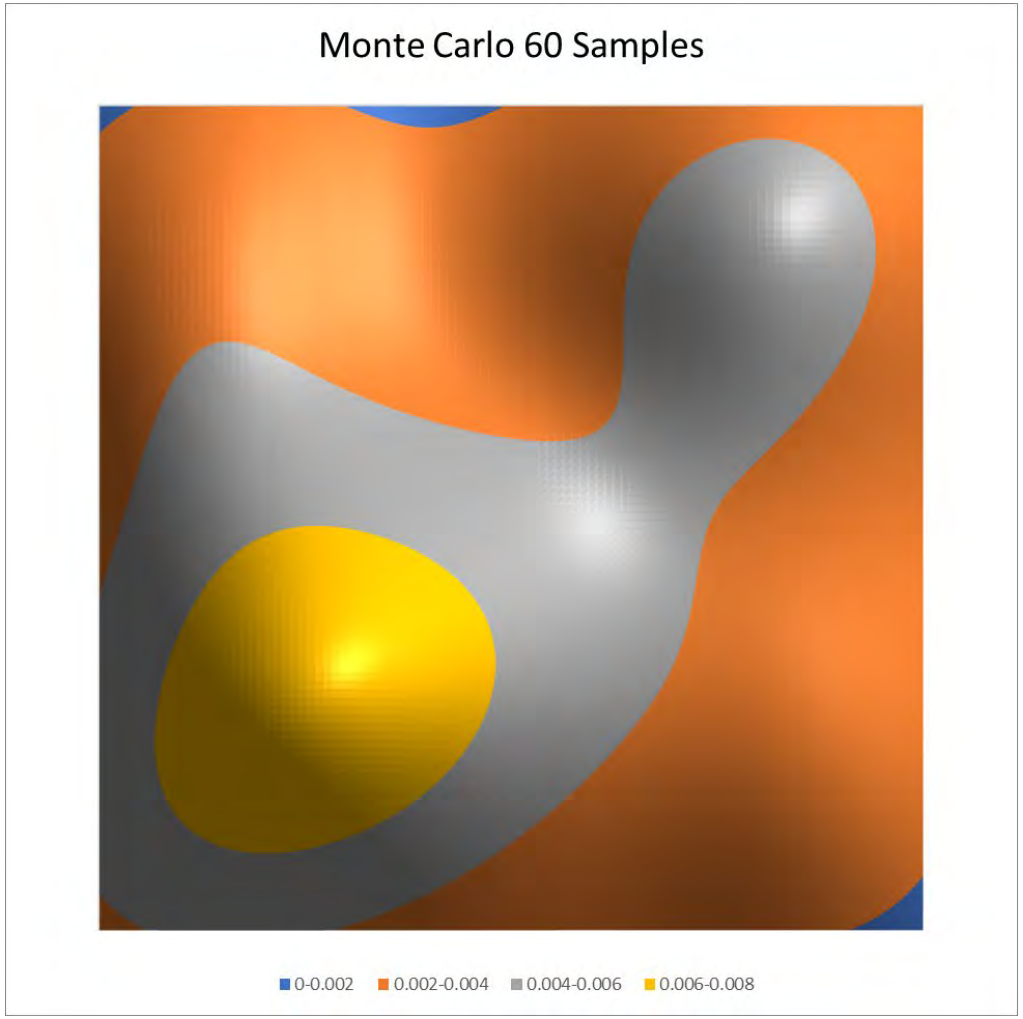
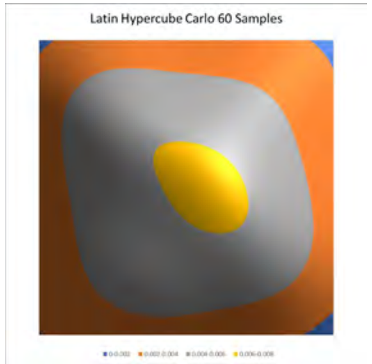
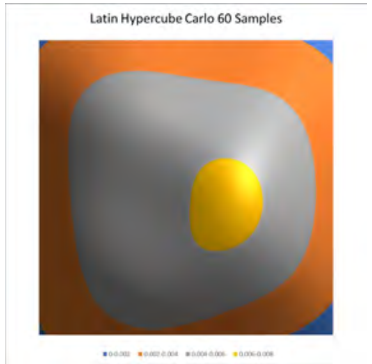
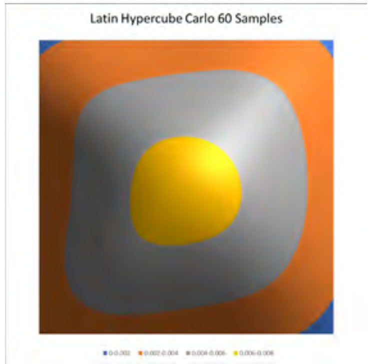


Monte Carlo Kernels

Latin Hypercube Kernels





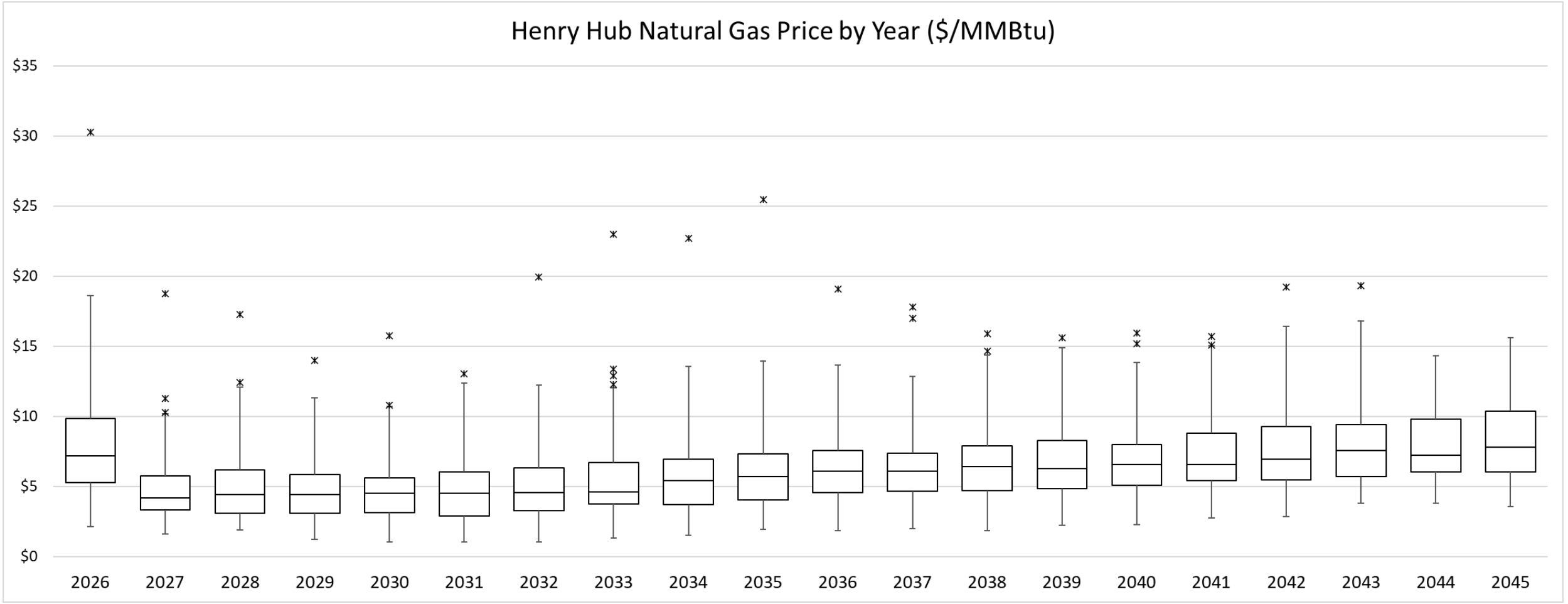


2025 IRP Stochastic Variables

- Increased average demand → Increased need for generation, increased market prices
- Increased peak demand → Increased use of capacity resources, 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

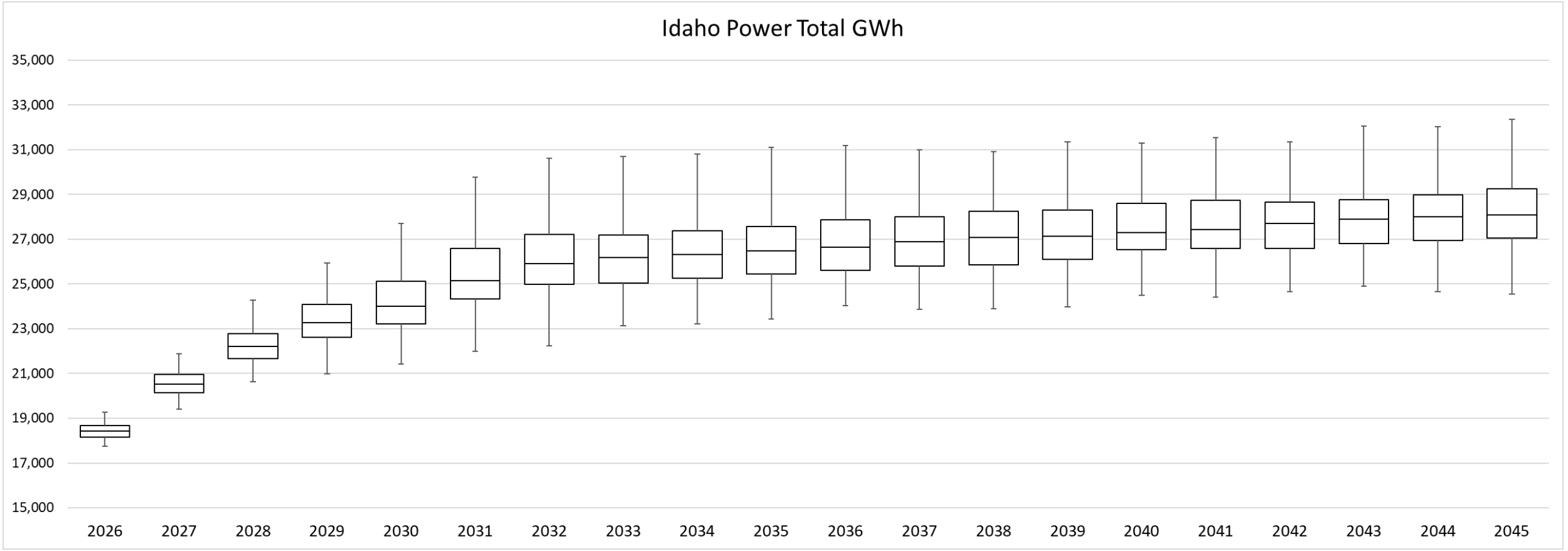
2025 IRP Stochastic Variables

Preliminary Average Annual Natural Gas Prices



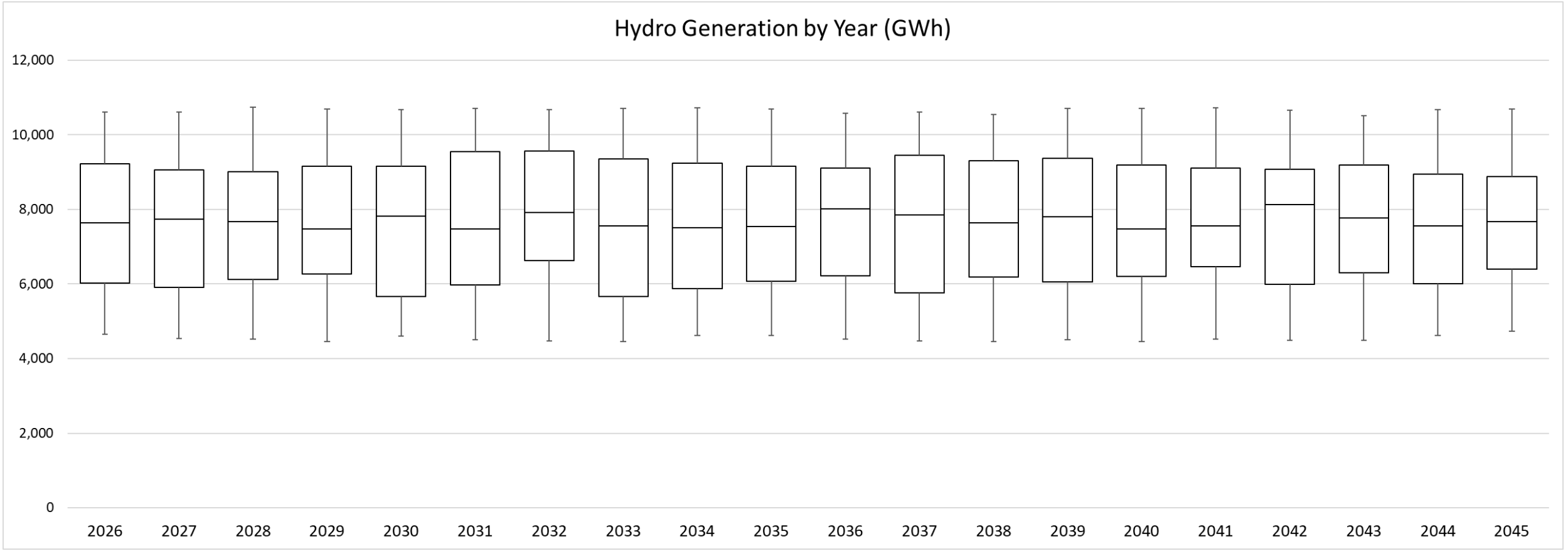
2025 IRP Stochastic Variables

Preliminary Customer Load



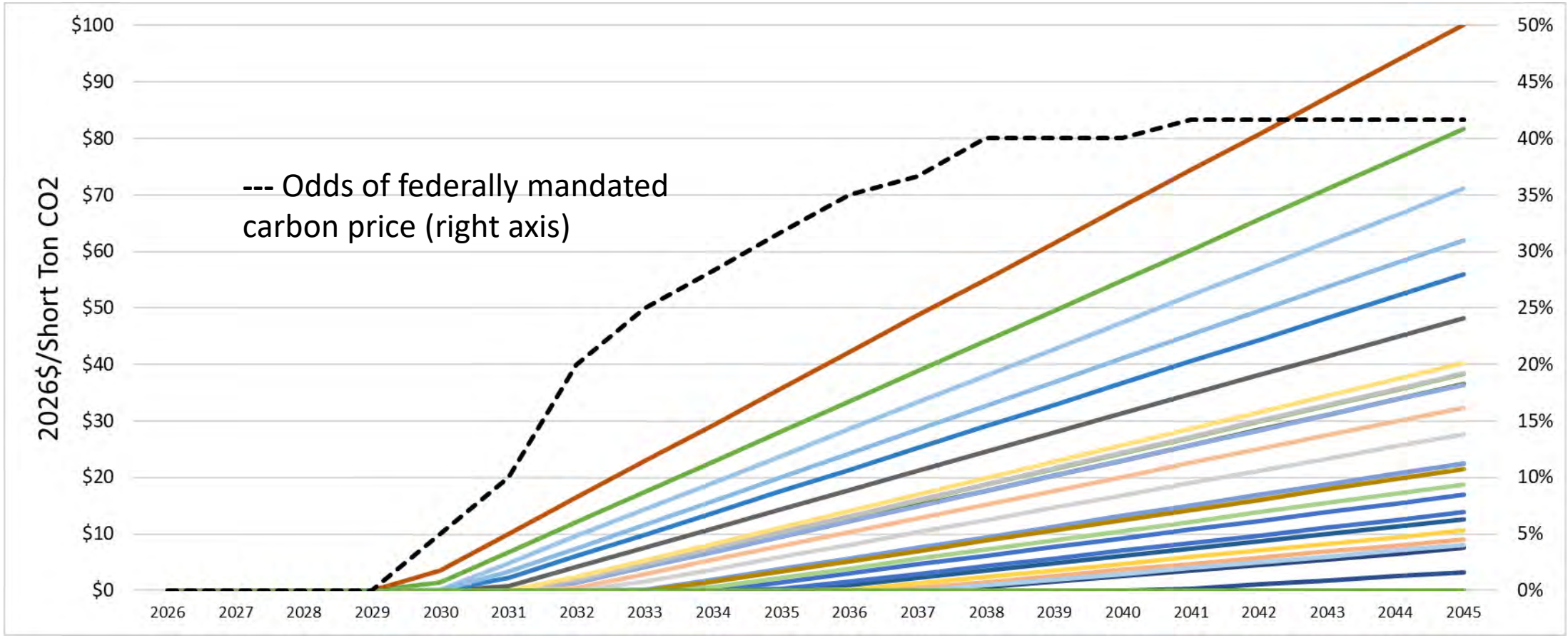
2025 IRP Stochastic Variables

Preliminary IPC Hydroelectric Variability



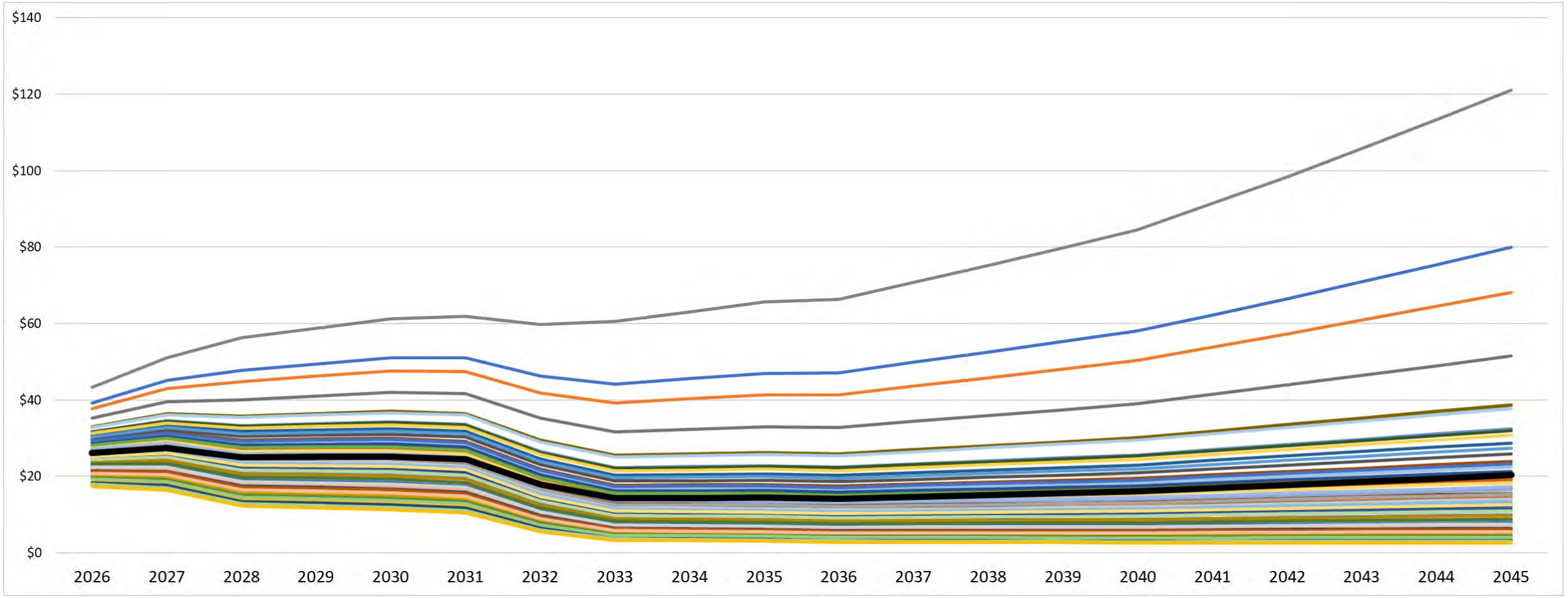
2025 IRP Stochastic Variables

Preliminary Carbon Prices



2025 IRP Stochastic Variables

Preliminary REC Prices



Thank You!