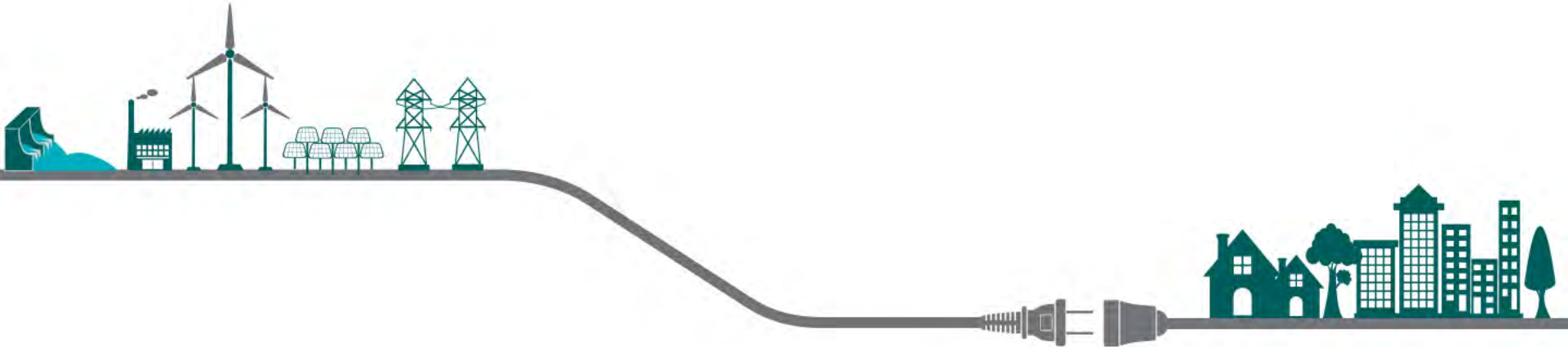


# Stochastic Variable Modeling and Risk Discussion



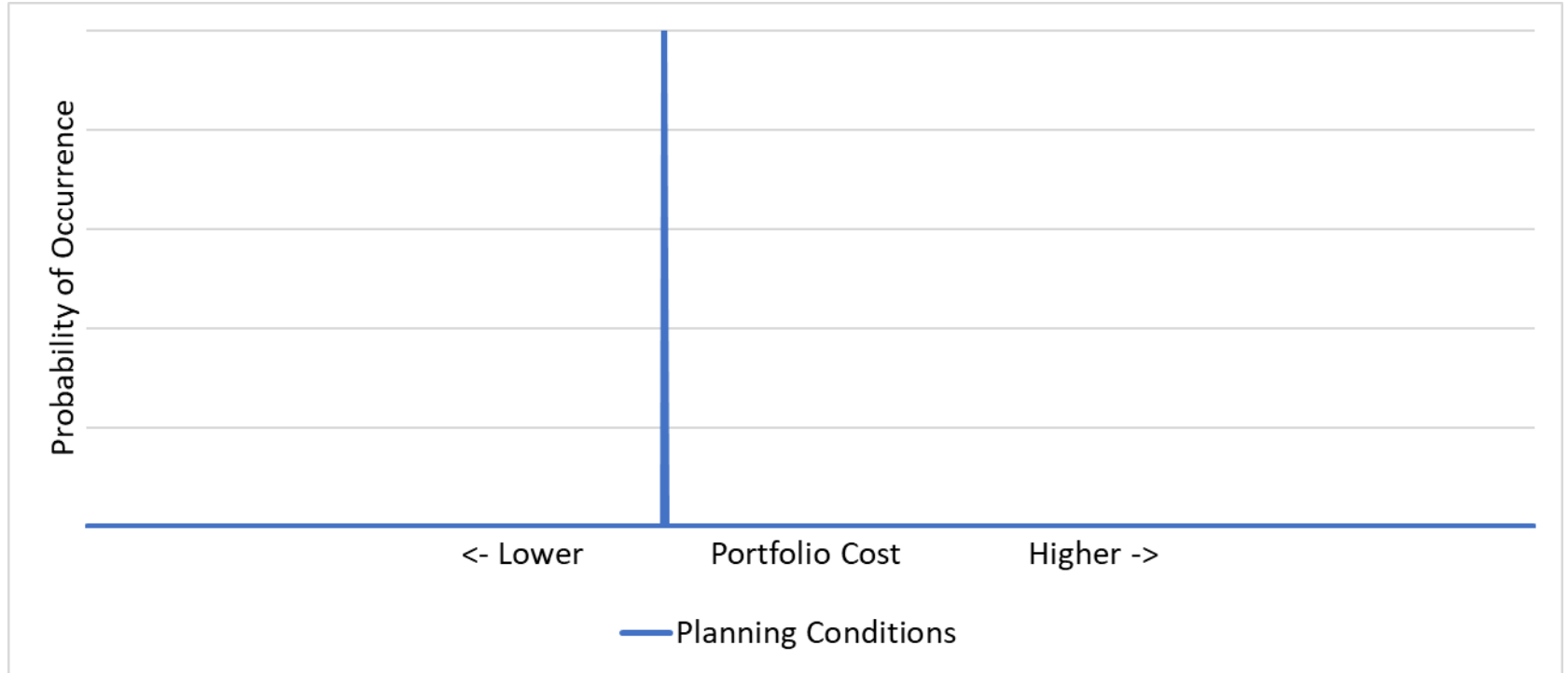
Greg Strang, Resource Planning  
August 10, 2021

# Definition

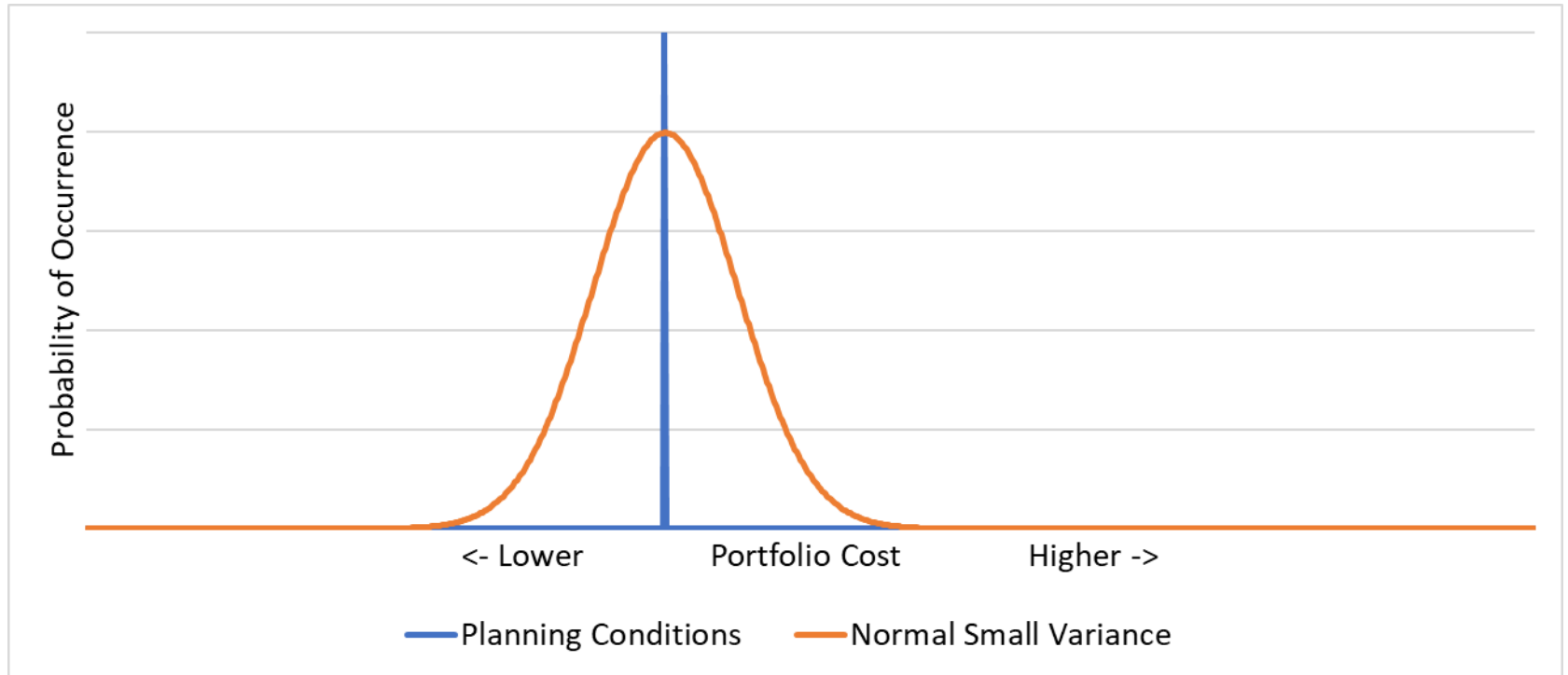


**Stochastic:** randomly determined; having a random probability, distribution or pattern that may be analyzed statistically but may not be predicted precisely

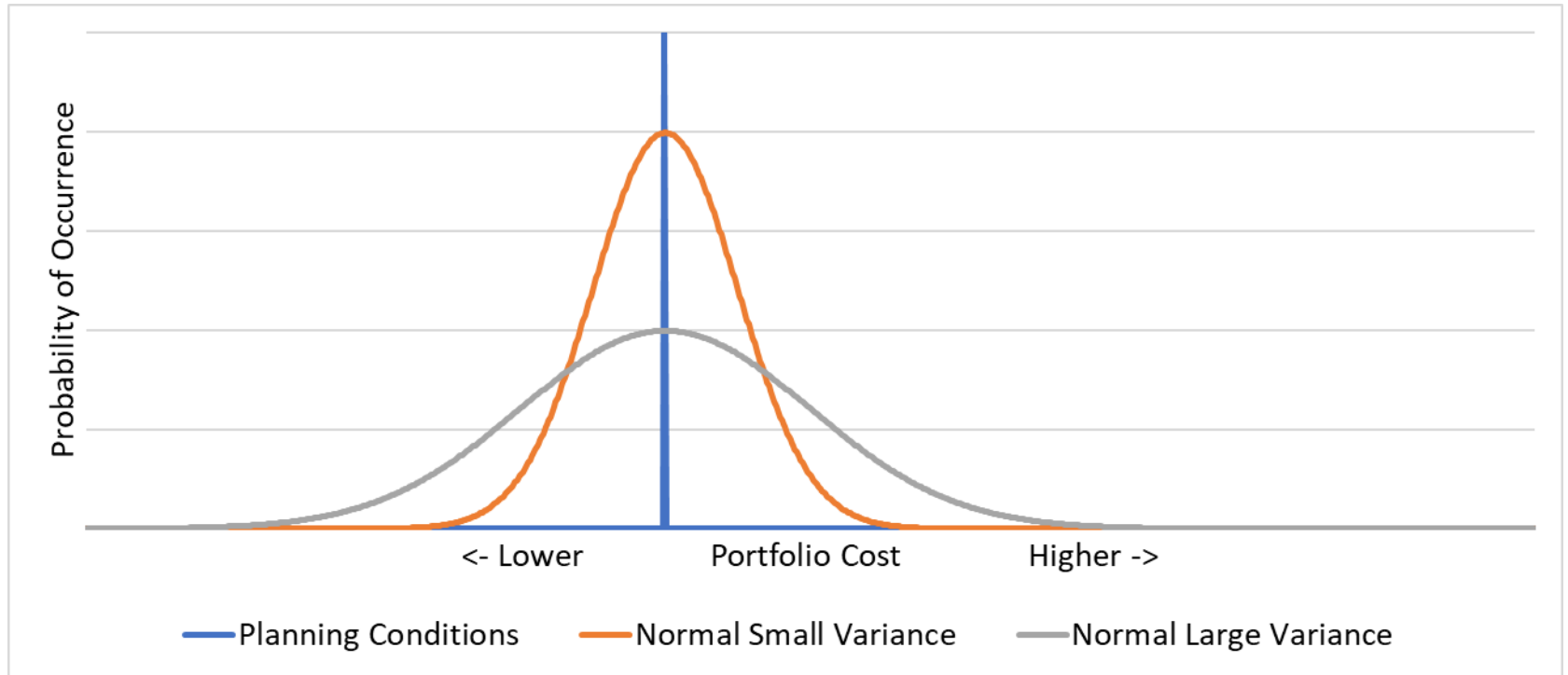
# Why Use Stochastic Variables for IRP Analysis?



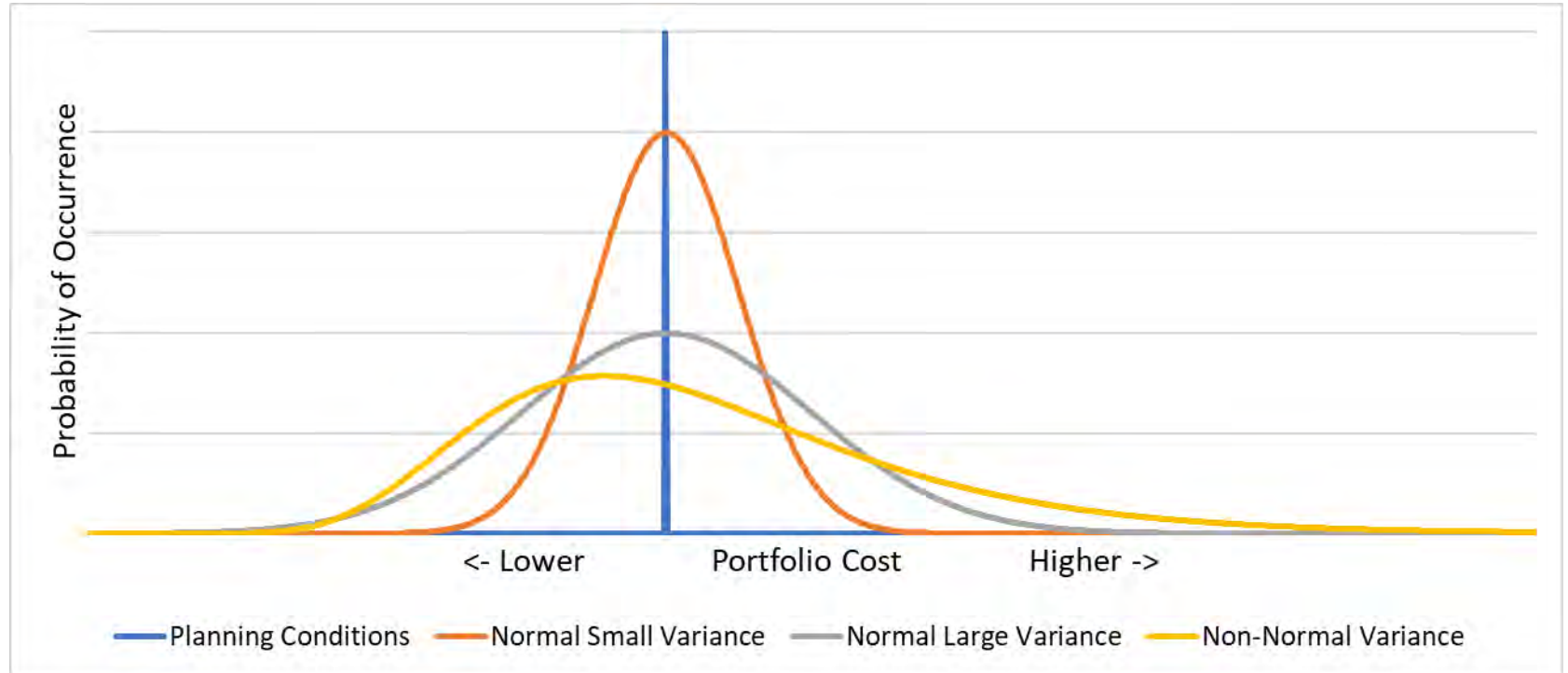
# Why Use Stochastic Variables for IRP Analysis?



# Why Use Stochastic Variables for IRP Analysis?



# Why Use Stochastic Variables for IRP Analysis?



# Identifying Variables



## Good Candidate Criteria

- Variables that have random components of large size that approximate a known probability density function
- Variables with sufficient history to estimate random component
- Variables whose impact to the IRP model can reasonably be estimated
- Variables whose historical variance can be expected to match future variance

# Natural Gas Prices

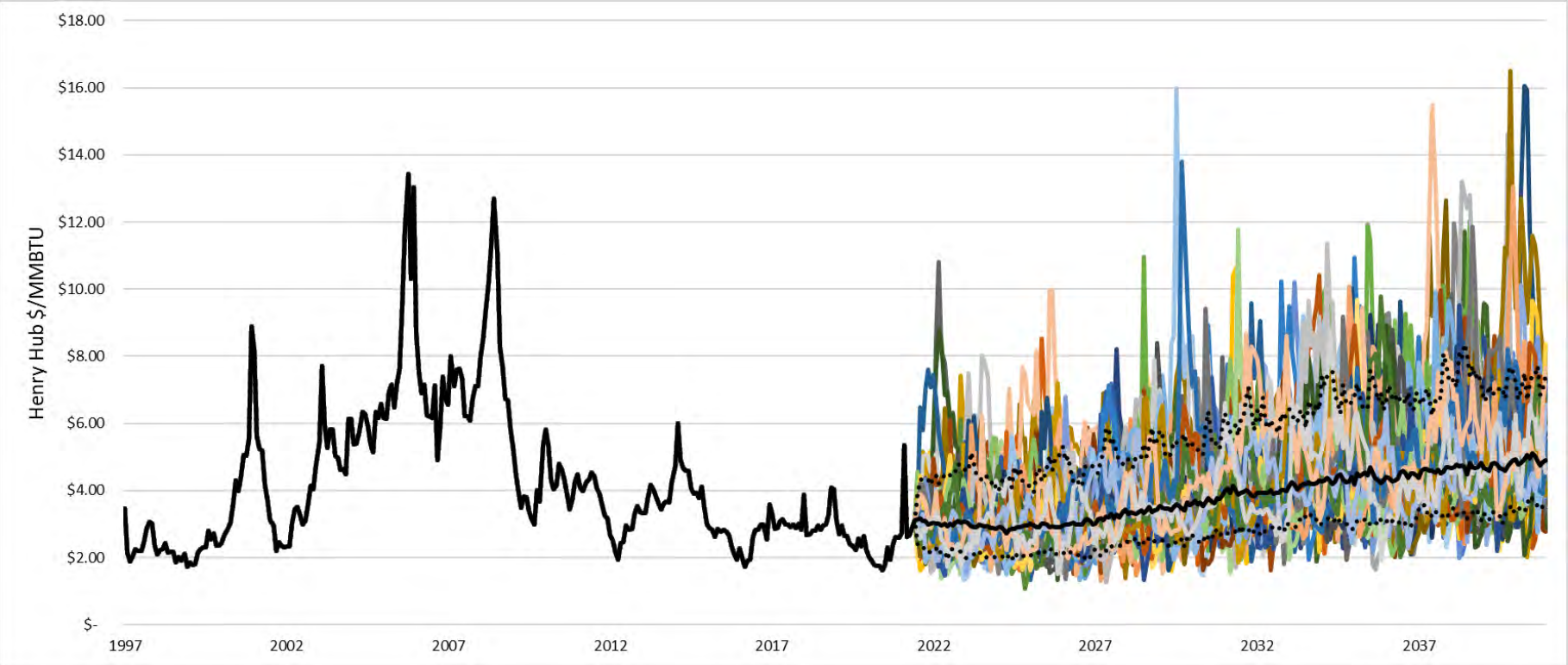




# Natural Gas Prices

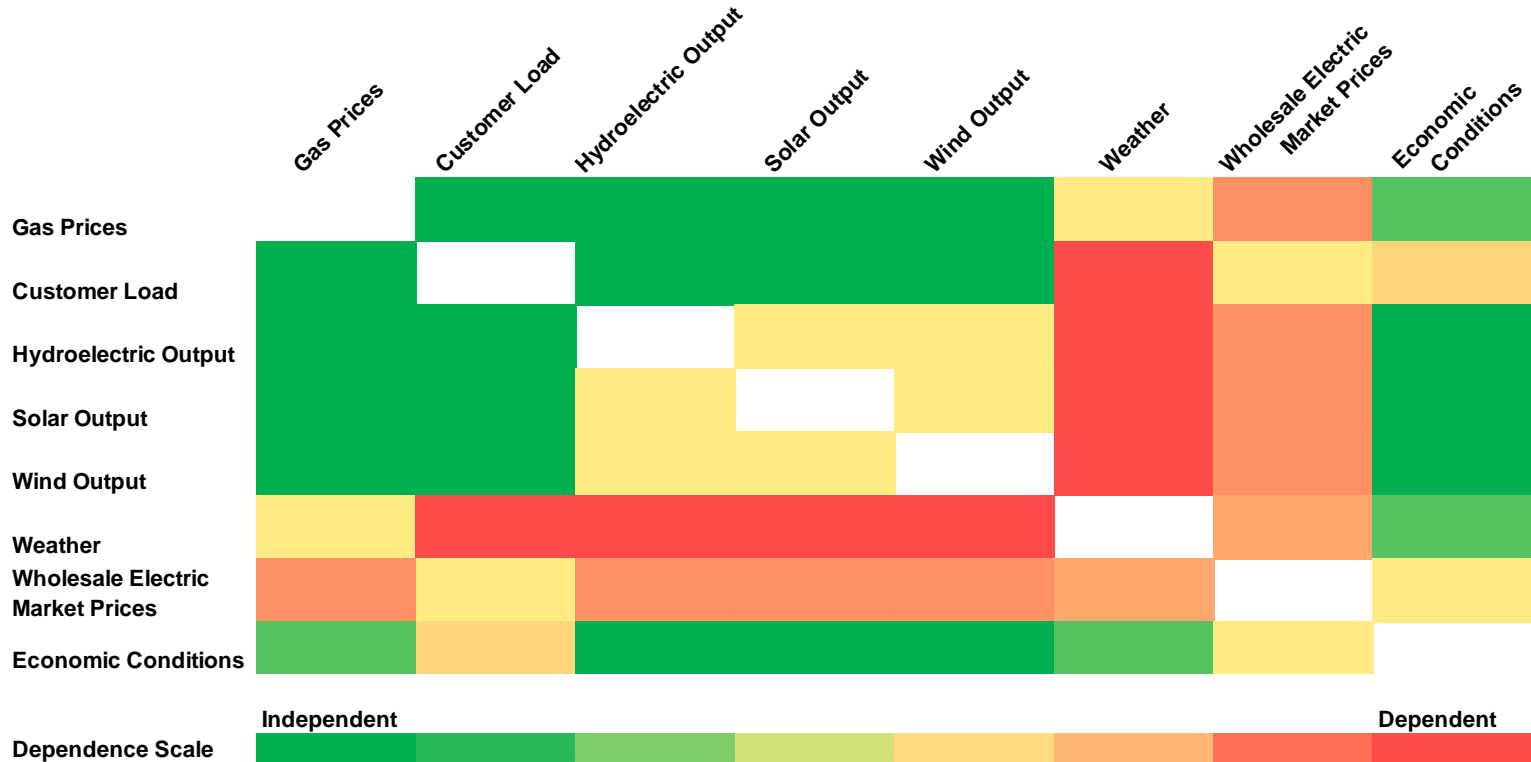


# Natural Gas Prices



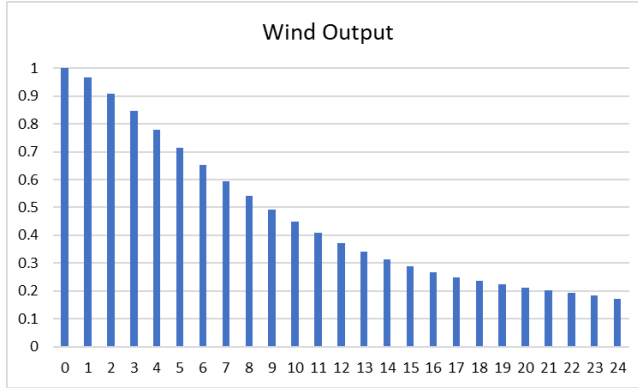
# Dependence or Independence

Hypothetical Stochastic Variable Correlation Matrix

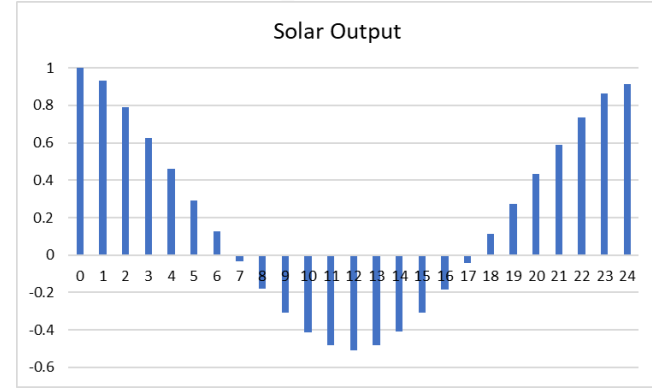


# Time Dependence

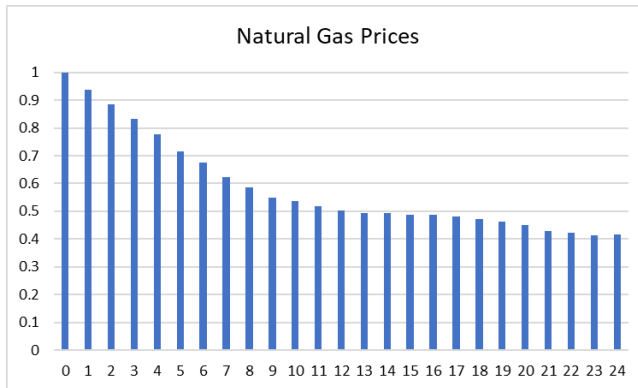
Wind Output



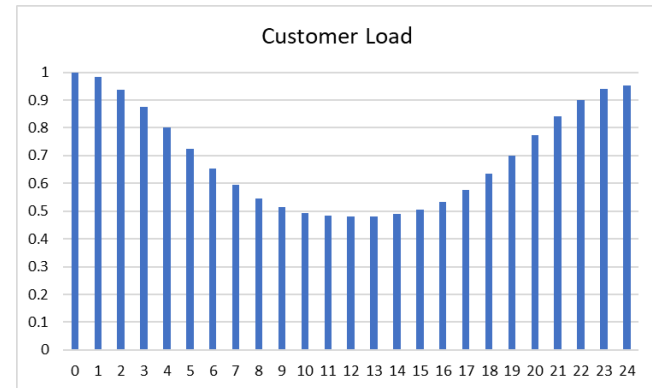
Solar Output



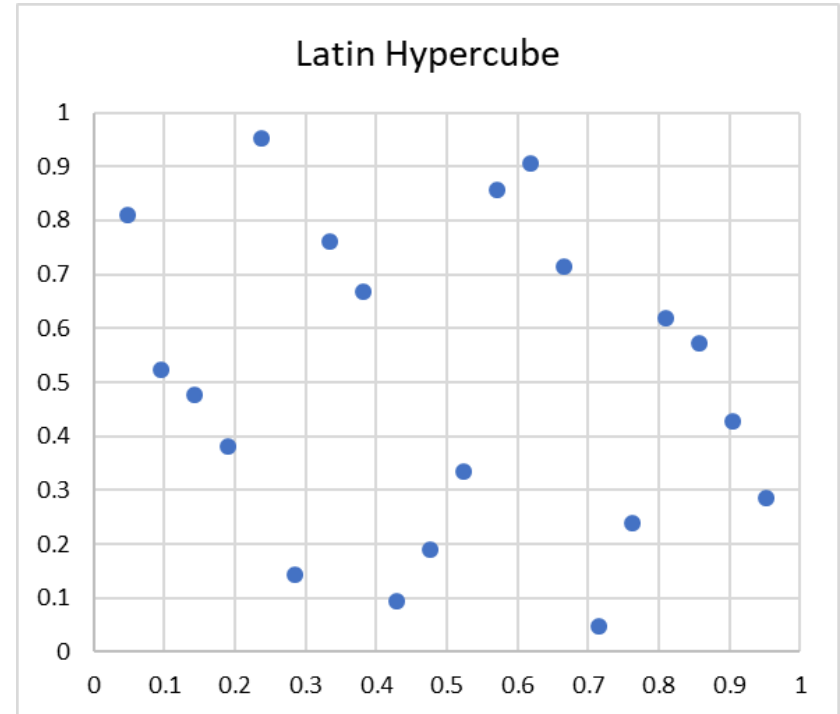
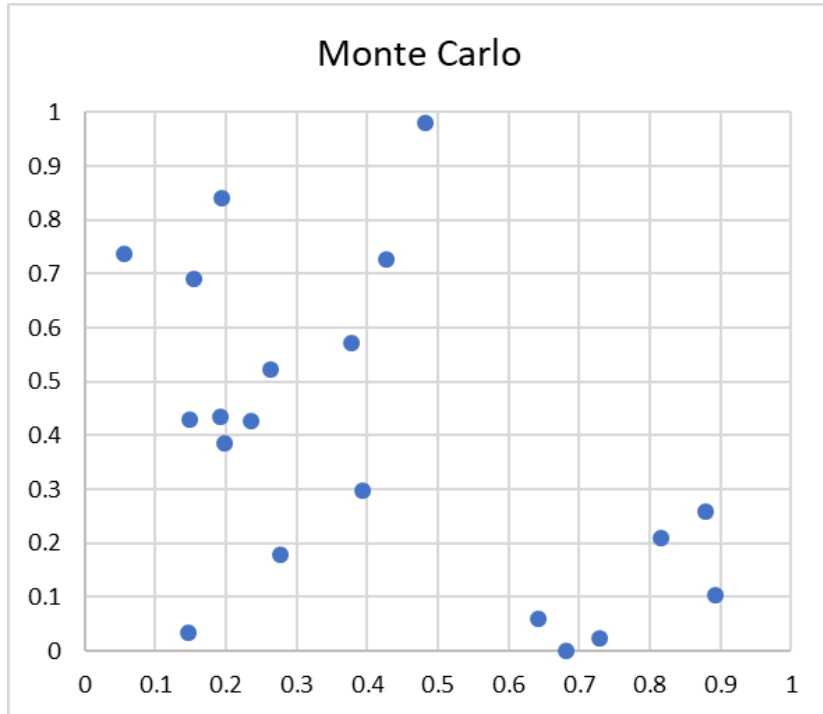
Natural Gas Prices



Customer Load

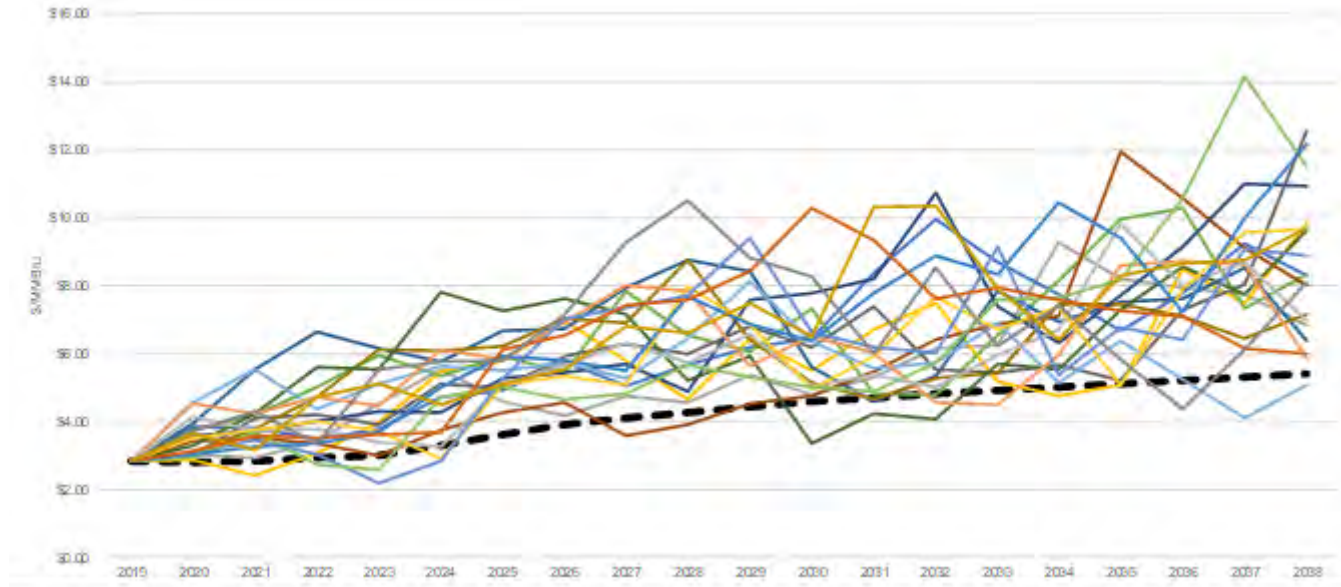


# How Stochastic Analysis is Implemented for this IRP Cycle



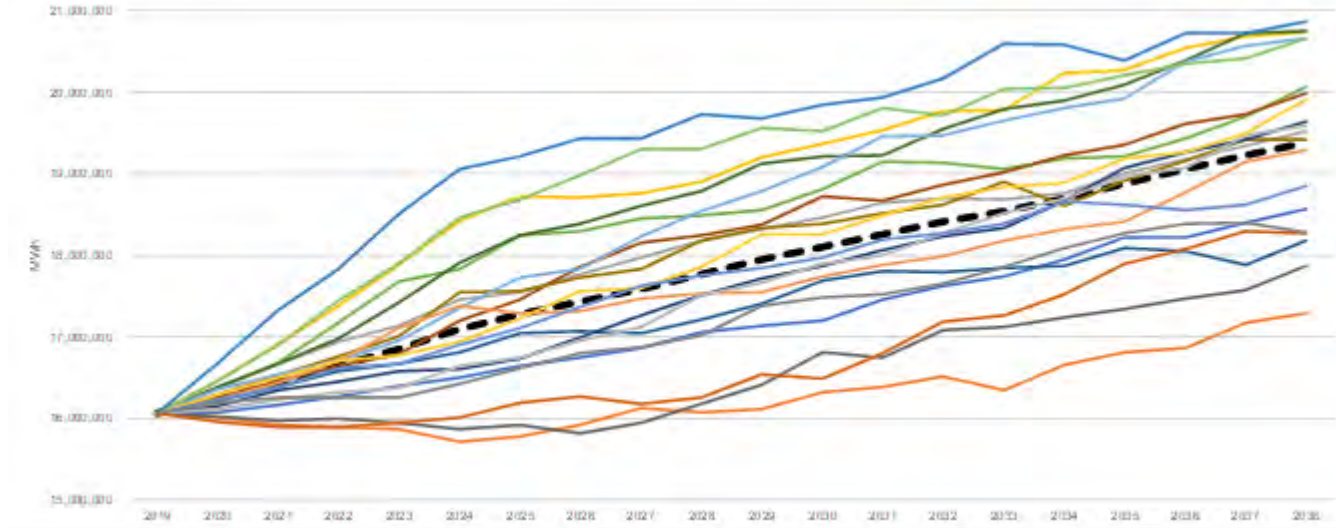
# 2019 IRP Stochastic Variables

## Average Annual Natural Gas Prices



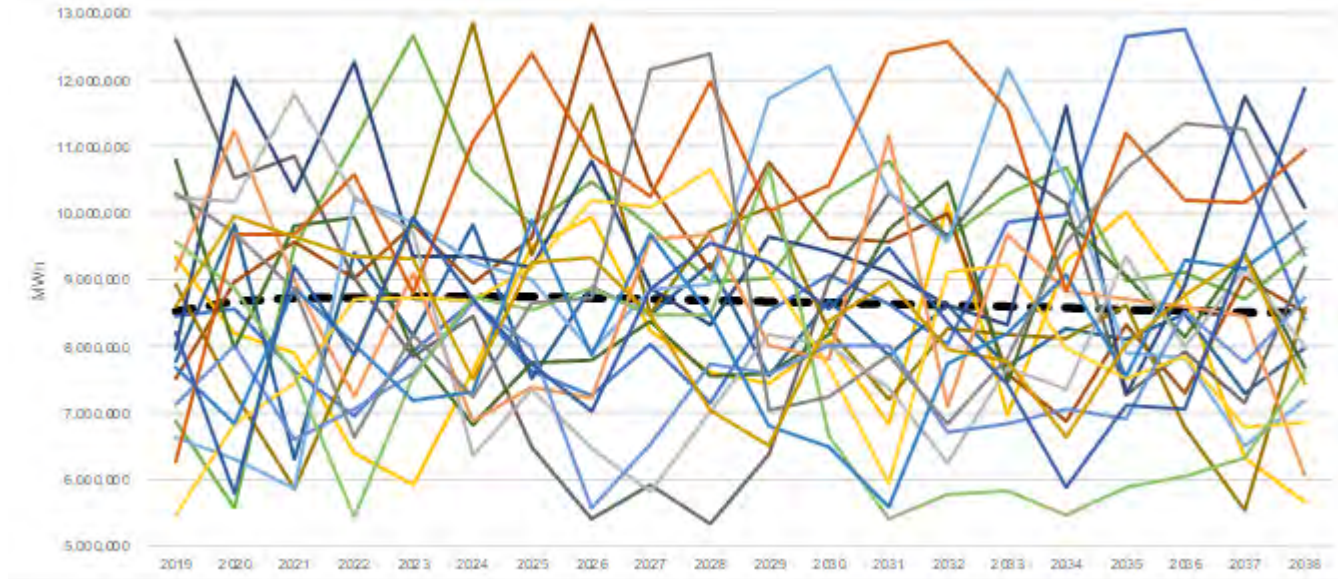
# 2019 IRP Stochastic Variables

## Customer Load



# 2019 IRP Stochastic Variables

## Hydroelectric Variability





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**Thank you!**

**Questions?**

