Q4:  Explain the principal components driving the model

Component one: Natural Gas Price Model

The model is used to simulate the Natural Gas spot prices into the future.

Based on the daily spot prices dataset for natural gas at Henry Hub from 1998 to 2018, we calibrate the parameters(reversion rate, mean level, volatility) for the Ornstein-Uhlenbeck mean reverting stochastic model. More specifically, the reversion rate and mean level can be calculated from the coefficients of a linear fit between the log prices and their first difference scaled by the time interval parameter. And the volatility can be calculated from the deviation between predicted value and real value. (Appendix 1)

The formula below is the fitted model:

= -1.2665 \* (1.3629 - Xt) \* + 0.7281dzt, where dzt ~ N(0, )

Component two: Temperature Model

The model is used to simulate hourly dry bulb temperature.

The temperature series is modeled as a sum of two compoments, a deterministic non-linear function that explains the seasonal temperature for a given hour in a given year and a stochastic component that explains deviations of actual temperature from average values.

For the deterministic component, we generate a sinusoidal model to fit the deviations of actual temperature from average values. (Appendix 2)

Y = 22.77\*sin(0.01734 \* x + -1559) + 0.01598\*sin(5.488\*x+ 2.264)

For the stochastic component, after analyzing PACF in residuals, we use a AR model to fit the residuals. (Appendix 3)

Xt = 1.317\*Xt-1 -0.15082\*Xt-2 - 0.20443\*Xt-3 + 0.01574\*Xt-4 + 0.1394\*Xt-23 + 0.0028747\*Xt-24 -0.14879\*Xt-25 + 0.091294\*Xt-47 + 0.006776\*Xt-48 -0.088026\*Xt-49

Component three: Electricity Price Model

The model is used to simulate hourly day-ahead electricity prices. And the log electricity prices are modeled with two additive components: a deterministic and stochastic component.

For the deterministic component, we use regression decision tree which takes into account observed electricity price changes due to changes in fuel (natural gas) prices, the daily temperature, the hour of the day, day of the week and holidays. (Appendix 4)

Random Forest, train error, validation error, test error.? Do or not do?

For the stochastic component, after analyzing PACF in residuals, we use a AR model to fit the residuals. (Appendix 5)

Xt = 0.98789\*Xt-1 - -0.15461\*Xt-2 + 0.00017018\*Xt-3 + 0.0030077\*Xt-4 + 0.12462

\*Xt-23 + 0.32529\*Xt-24 - -0.39366\*Xt-25 + 0.017337\*Xt-48

Component four: Hybrid Electricity Model & Economic Dispatch

Based on Natural Gas Price model, Temperature model and Electricity Price hybrid model, we simulates market scenarios. Then, given the each market scenario, dispatch is performed on each set of simulated price paths to compute a set of daily cash-flows. Thus 90% and 95% cash-flow-at-risk are generated from the distribution of cash-flows.

Appendix 4



Appendix 2



Appendix 3



Appendix 4



Appendix 5

