Synthetic Time Series Generation in Energy Portfolio Optimization

Jia Zhou*, Hany S. Abdel-Khalik
Purdue university
zhou646@purdue.edu, abdelkhalik@purdue.edu

Paul Talbot, Cristian Rabiti
Idaho National Laboratory
paul.talbot@inl.gov, cristian.rabiti@inl.gov

In recent years energy markets have undergone dramatic changes as more variable renewable energy sources (VREs) are constructed. While energy demand fluctuates independently, the variable renewable energy availability is highly time-dependent. As a result, there are new challenges to determine the value of different components in energy portfolios, especially nuclear energy. To obtain a holistic understanding of the value of various components in an energy portfolio, a data-analytic-enabled differential analysis of system cost for a small region is presented in this work. Stochastic time series generation for various type of signals such as wind speed and energy demand is developed using data mining techniques which allows one to identify the dominant features and trends in the available demand data that are later employed to generate representative histories amenable for downstream portfolio optimization analysis. The ultimate goal is to enable a suitable analysis to determine the value of any type of energy producer to the system, contingent on various markets and policy decisions. The synthetic time-series samples are required to be statistically viable. The produced samples must be independent but with the same distribution characteristic. That means each sample will have the fundamental properties as the original training data but not a duplication of it. To achieve that, detrending algorithms are proposed based on a number of features extracted from the time series. Different detrending algorithms are employed including a new randomized window decomposition algorithm, a window thresholding algorithm for peak detection, a Fourier series decomposition, and Auto-Regressive Moving Average (ARMA). Demonstration of the application of these algorithms will be presented using an implementation under the INL’s RAVEN uncertainty quantification and risk analysis software framework.