

# COMP 652: Project

Due on Thursday, April 23 2015

*Presented to Dr. Doina Precup*

Geoffrey Stanley  
Student ID: 260645907

## Introduction

The reliability of modern day energy markets is the responsibility of independent system operators (ISO) who are tasked with the governance of the energy network within a pre-defined geographic region. PJM Interconnection is such an organization. It is responsible for the proper functioning of the electric grid in Delaware, Illinois, Indiana, Kentucky, Maryland, Michigan, New Jersey, North Carolina, Ohio, Pennsylvania, Tennessee, Virginia, West Virginia and the District of Columbia.

It ensures that loads on the system, such as cities, are serviced by a sufficient amount of generators, such as nuclear, natural gas or wind power plants at any given hour of the day. It does so by holding hourly auctions requesting that producers offer the quantity of megawatts they are capable of producing and at what cost. Next, based on the demand for a given hour the ISO will request that the producers bring their generators online, prioritizing the most inexpensive power first while also ensuring that the grid operates at a sufficient level of reliability and redundancy.

The first priority of the ISO is the reliability of the system. If it does not provide a sufficient amount of power to satisfy the loads in the system it risks causing a brown out or a black out in the entire system. It also must ensure a certain level of redundancy as if a line or a power plant suddenly fails the energy grid must continue to operate as a whole. It's second priority is to provide loads with the most inexpensive power that it can find, nuclear is cheaper than natural gas, and natural gas cheaper than coal.

As such, the price of power through out the energy grid can be seen as being driven by three categories of variables: demand, supply and physical. Within the demand component variables will be ones that influence the amount of power being drawn from the grid. These will be things such as weather, season, day of the week, hour of the day, whether it's a holiday or normal work week. Supply will be made up of all factors influencing how generators are changing their bidding behavior. This will mostly be driven by fuel costs; uranium, natural gas, coal and the amount of wind. Physical variables will be the current status of the network; what outages and constraints there are on the system.

Congestion...

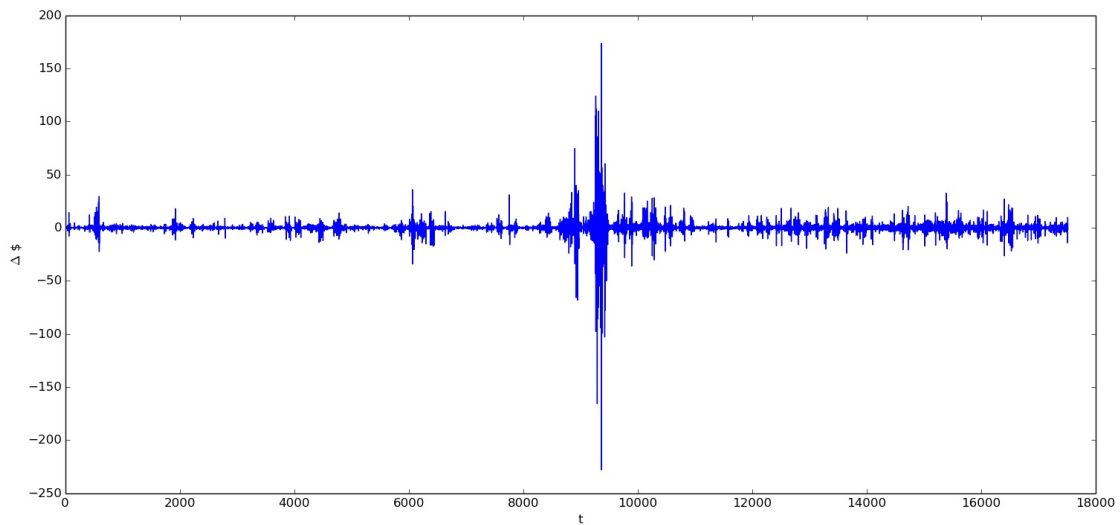
In order to protect generators from unforeseen congestion events products called up to congestion (UTC) contracts were created...

## Methodology

Ignoring potential variables such as fuel costs, weather and outages; as a first attempt in trying to evaluate the value of a UTC contract a Markov Chain Monte Carlo (MCMC) approach will be used. The objective will be to use the previous distribution of differences between UTC contract prices and the last known price to estimate the most likely value in the future. A similar method to the one used by Landauskas [2]

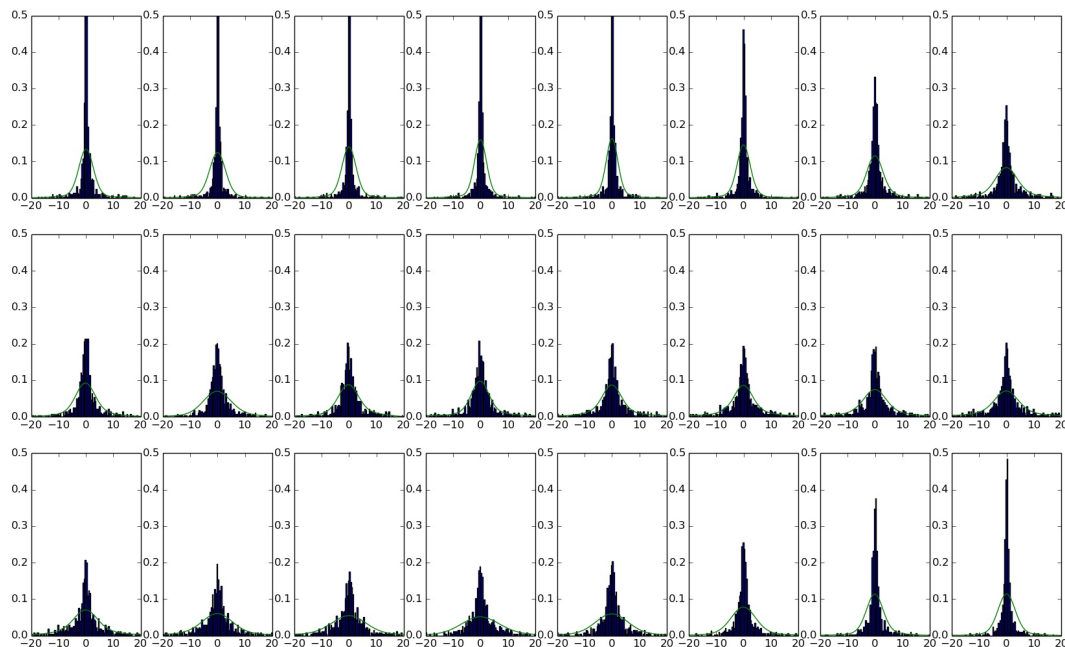
In order to attempt to reduce the effect of variables outside of normal seasonality aggregates of nodes were selected; Eastern Hub and Western Hub. These hubs are an average of a few hundred different pricing nodes within their regions.

Eastern Hub and Western Hub Price differences between January first 2013 and January first 2015 were consistent except for a period in January 2014. The differences in price from one hour to the next for this two year period can be seen in the following figure:



Because of the tendency of price differences to be within a rather tight range with the exception of a few outliers 10% of the top and bottom will be removed when evaluating their distributions.

The differences in price distributions between hours of the day is significant:



The figure above shows the price differences for hours ending 0 through 23. The x-axis is the difference in price and the y-axis is the probability 0 to 1 of that difference. Evening hours 22, 23 and 0 through 6 are much less volatile than the others. As such, the UTC contracts should be evaluated on an hourly basis given the price it was worth at the same hour the previous day.

**Set-up**

**Results**

**Conclusions**

# Bibliography

- [1] Eric Jones, Travis Oliphant, Pearu Peterson, et al. SciPy: Open source scientific tools for Python, 2001–. [Online; accessed 2015-04-20].
- [2] Mantas Landauskas and Eimutis Valakevicius. Modelling of stock prices by the markov chain monte carlo method. *Intellectual Economics*, 5(2(10)):244–256, 2011.