

FORECASTING NODAL PRICE SPREADS IN ELECTRICITY MARKETS



Ayan Nandi

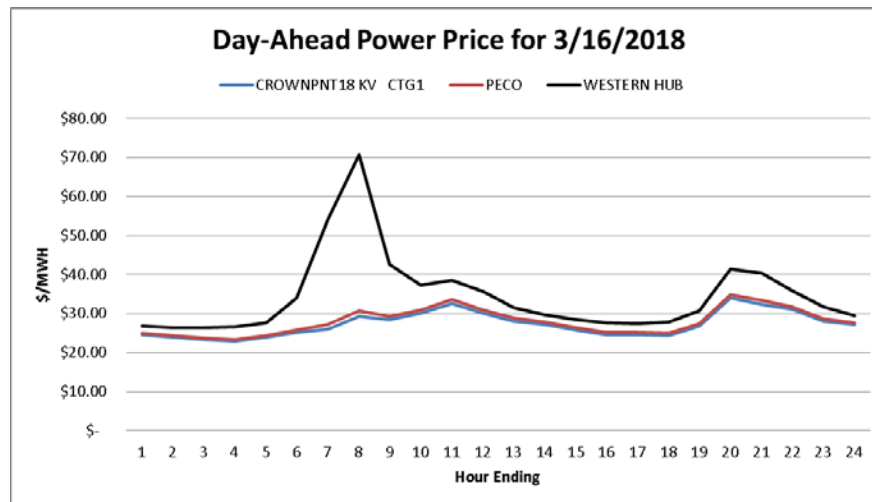
Problem Statement

- The Power Price at a particular Node (Nodal LMP) can be more volatile than that of the surrounding aggregate Zone or Hub.
- This can pose as a Financial Risk to the owner of Generation or a Load Server, whose financial settlement is based on the power price at the location, but has likely hedged at the more liquid Zone or Hub in the Forward Market.



Problem Statement

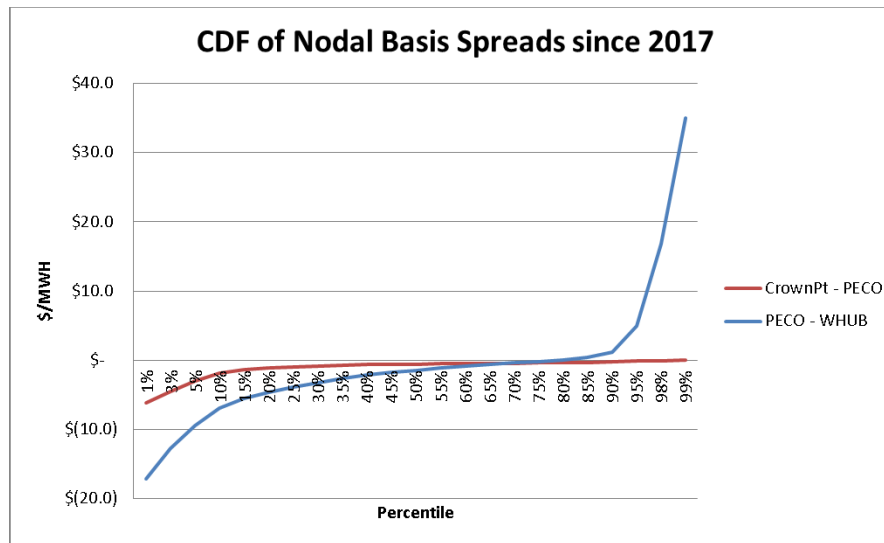
- Here Crown Point represents the Day-Ahead power price at a generator node in New Jersey, PECO represents the price at the larger zone (Philadelphia), and Western Hub is an aggregate which represents the entire market of Pennsylvania-Jersey-Maryland (PJM).



- Being able to forecast these price spreads would allow an energy market participant to better manage risk, either through:
 - A generation owner nominating sufficient fuel purchases if profitable running hours could be determined in advance, thus avoiding fuel imbalance charges.
 - A load server being able to enter into a basis swap to cover their additional risk being present, with information available a day or two in advance of delivery date.

Solution

- We can either try to forecast the spreads directly, or discretize the output based on their historical distribution.



- The spread (either discrete or continuous) will be our Y-variable of prediction.

Methodology

- The independent (X-variables) which we will use are market factors such as
 - Hourly Forecasted Load (demand for power), both at the Zonal Level
 - Cleared of Forecasted Generation, aggregated by Fuel Type
 - Possibly a map of all generation units nearby or within a specific market.
 - Fuel Prices for all fuel types (Coal, Natural Gas, Diesel) for multiple locations
 - Renewable Generation
 - Temperature and Weather Factors
- This data will be available either through a vendor to which I have access (Energy Velocity), or directly from the PJM ISO website. All of the data being used here is publicly available.
- Techniques we will explore are:
 - Random Forest Regression / Classification
 - Multinomial (or Softmax) Classification
 - Neural Networks (MultiLayered Perceptron) Regression/Classification
 - Linear Regression
- We will use five fold cross validation to see how well our model generalizes, with potential metrics of MAPE (mean absolute percentage error), Accuracy, and R squared.

Methodology

Some sample data of Forecasted Generation within the PJM ISO and Day Ahead forecasts of Zonal Load:

Reporting Area Name	Prime Mover Description	Fuel Type	Generation Market	Generation Type	Local Datetime (Hour Beginning)	Time Zone	Sum Load MW	Sum Generation MW	Record Count
PJM ISO		Coal	INT HOURLY	NET	12/21/2017 0:00	EST	86468.2	32775.2	1
PJM ISO		Hydro	INT HOURLY	NET	12/21/2017 0:00	EST	86468.2	375.8	1
PJM ISO		Multiple Fuels	INT HOURLY	NET	12/21/2017 0:00	EST	86468.2	3.2	1
PJM ISO		Natural Gas	INT HOURLY	NET	12/21/2017 0:00	EST	86468.2	28206.7	1
PJM ISO		Nuclear	INT HOURLY	NET	12/21/2017 0:00	EST	86468.2	35496.6	1
PJM ISO		Oil	INT HOURLY	NET	12/21/2017 0:00	EST	86468.2	216.5	1
PJM ISO		Other	INT HOURLY	NET	12/21/2017 0:00	EST	86468.2	34.9	1
PJM ISO		Other Renewables	INT HOURLY	NET	12/21/2017 0:00	EST	86468.2	667.4	1
PJM ISO		Wind	HOURLY	NET	12/21/2017 0:00	EST	86468.2	1973.935	1
PJM ISO		Wind	INT HOURLY	NET	12/21/2017 0:00	EST	86468.2	2149.8	1
PJM ISO		Coal	INT HOURLY	NET	12/21/2017 1:00	EST	84345.21	32775.2	1
PJM ISO		Hydro	INT HOURLY	NET	12/21/2017 1:00	EST	84345.21	375.8	1

Load Region	Load Market	Local Datetime (Hour Ending)	Time Zone	GMT Datetime (Hour Beginning)	Actual Load MW- Average	Day Of Load Forecast MW- Average	Day Ahead Load Forecast MW- Average
AEP	HOURLY	3/11/2018 1:00	EST	3/11/2018 5:00	13868.7	14124	14124
APS	HOURLY	3/11/2018 1:00	EST	3/11/2018 5:00	5610.49	5817	5817
ATSI	HOURLY	3/11/2018 1:00	EST	3/11/2018 5:00	6838.87	6927	6927
COMED	HOURLY	3/11/2018 1:00	EST	3/11/2018 5:00	9632.02	9858	9858
DAY	HOURLY	3/11/2018 1:00	EST	3/11/2018 5:00	1689	1757	1757
DEOK	HOURLY	3/11/2018 1:00	EST	3/11/2018 5:00	2656.24	2671	2671
DOM	HOURLY	3/11/2018 1:00	EST	3/11/2018 5:00	10601.68	10837	10837
DUQ	HOURLY	3/11/2018 1:00	EST	3/11/2018 5:00	1379.96	1393	1393
EKPC	HOURLY	3/11/2018 1:00	EST	3/11/2018 5:00	1391.13	1477	1477
PJM EAST	HOURLY	3/11/2018 1:00	EST	3/11/2018 5:00	28425.4	28392	28392
AEP	HOURLY	3/11/2018 2:00	EST	3/11/2018 6:00	13796.84	13971	13971
APS	HOURLY	3/11/2018 2:00	EST	3/11/2018 6:00	5532.73	5743	5743
ATSI	HOURLY	3/11/2018 2:00	EST	3/11/2018 6:00	6697.99	6763	6763
COMED	HOURLY	3/11/2018 2:00	EST	3/11/2018 6:00	9359.91	9363	9363
DAY	HOURLY	3/11/2018 2:00	EST	3/11/2018 6:00	1640	1716	1716
DEOK	HOURLY	3/11/2018 2:00	EST	3/11/2018 6:00	2625.55	2606	2606
DOM	HOURLY	3/11/2018 2:00	EST	3/11/2018 6:00	10522.92	10713	10713

Questions?
