ECE 364 Project Option #3: Virtual bidding in NYISO's markets

Spring 2025

1 Project Background

This project focuses on virtual trading in New York ISO's[1] electricity markets using historical Day-Ahead (DA) and Real-Time (RT) price data. Students will develop a classification model and trading strategy to identify profitable trading opportunities. For this project, we focus on predicting when the Day-Ahread (DA) price will be lower than the Real-Time (RT) price and making a profit on the difference. A quick overview of how the electricity market works is given in §2, but feel free to use online resources to get a better understanding.

You are provided the following dataset with six `.csv` files:

- Load Forecasts (Table 1): `DAM_NYISO_LoadForecast_2015.csv`, `DAM_NYISO_LoadForecast_2016.csv`
- DA Prices (Table 2): `DAM_NYISO_Zonal_LBMP_2015.csv`, `DAM_NYISO_Zonal_LBMP_2016.csv`
- RT Prices (Table 3): `RTM_NYISO_Zonal_LBMP_2015.csv`, `RTM_NYISO_Zonal_LBMP_2016.csv`

id	Eastern Date Hour	Zone Name	DAM Forecast Load	GMT Start Hour

Table 1. DAM_NYISO_LoadForcast_%YEAR.csv Headers

id	Eastern Date Hour	Zone Name	Zone PTID	DAM Zonal LBMP	DAM Zonal Losses	DAM Zonal Congestion	DAM Zonal Price Version

Table 2. DAM_NYISO_Zonal_LBMP_%YEAR.csv Headers

id	Eastern Date Hour	Zone Name	Zone PTID	TWI Zonal LBMP	TWI Zonal Losses	TWI Zonal Congestion	TWI Zonal Price Version

Table 3. RTM_NYISO_Zonal_LBMP_%YEAR.csv Headers

Basic explanation for Table 1, Table 2, and Table 3:

1. DAM Forecast Load is the forecasted load for the next day.
2. DAM/TWI Zonal LDMP are the DA and RT prices for each zone respectively.
3. List of zones: CAPITL, CENTRL, DUNWOD, GENESE, HUD VL, LONGIL, MHK VL, MILLWD, N.Y.C., NORTH, WEST

[1] `https://www.nyiso.com`

The goal is to generate daily trading signals (buy/no action) and bid prices for 264 zone-hour combinations (11 zones × 24 hours) with the following restrictions:

- Daily budget of $250,000
- The number of parameters for your model must not exceed 15 million
- Train only on the 2015 data. 2016 data is used as the test dataset.

The output of your model and trading algorithm should be a `prediction.csv` file with headers seen in Table 4.
Note: To ensure effective evaluation, head and content of prediction.csv file must exactly match the format, case of text matters.

id	Eastern Date Hour	Zone Name	Zone PTID	DA Lower	Bid Price

Table 4. output.csv Headers

1. Eastern Date Hour, Zone Name, Zone PTID are the same as the files given in Table 2. and Table 3.
2. DA Lower is either a 1 (indicating that your model predicts that the current DA price will be lower than its corresponding RT price, meaning that a trade is viable), or 0 (current DA price will be higher than its corresponding RT price and no trade is viable).
3. Bid Price is the price your trading algorithm recommends when a trade opportunity is predicted (DA Lower = 1). If DA Lower = 1, then Bid Price needs to be a value representing the maximum price you are willing to pay in the DA market for that option.
4. Profit from your output is calculated as follows: For each zone and time: Profit = (RT Price – Bid Price) but only when all of the following conditions hold:
   (a) Your model predicted a trade DA Lower = 1 (profit viable).
   (b) The actual DA price is lower than the RT price.
   (c) The bid clears (i.e., Bid Price > actual DA price).
   Otherwise, profit is zero. Note that the daily budget for all bids in a day is $250,000. The budget does not cary over to the next day.

2 How the Electricity Market Works: NYISO's DA and RT Markets

The New York Independent System Operator (NYISO) manages the electricity grid and operates two key markets: the Day-Ahead (DA) Market and the Real-Time (RT) Market. These markets balance supply and demand while ensuring grid reliability. Below is a quick breakdown to help you get started. Note: for project purposes, there are simplifications we have made explained above. Below is strictly how the actual market works.

1. Day-Ahead (DA) Market:
   - When: Participants submit bids 24 hours before electricity is needed.
   - Purpose: Forecast demand and schedule generation/resources.
   - Process:
     (a) Bids/Offers: Generators submit the price they're willing to supply power, and buyers (utilities, traders) submit bids.
     (b) Clearing: NYISO matches supply and demand to set hourly zonal prices.

   (c) Commitment: Generators are financially obligated to deliver power at the cleared price.
   - Virtual Bidding: Traders can place financial bids (no physical generation) to profit from price differences between DA and RT markets.
2. Real-Time (RT) Market:
   - When: Adjusts every 5 minutes based on actual grid conditions.
   - Purpose: Address real-time imbalances in supply/demand.
   - Process:
     (a) Continuous Updates: Prices fluctuate based on unexpected changes (e.g., outages, weather).
     (b) Settlement: Final hourly RT prices are averages of 5-minute intervals.
     (c) Physical Delivery: Generators adjust output to meet real-time demand.
3. Locational Marginal Pricing (LMP)
   - Definition: The price of electricity at a specific location (zone) and time, reflecting:
     (a) Energy Cost: Base cost of generation.
     (b) Congestion Cost: Transmission limits between zones.
     (c) Losses: Energy lost during transmission.
   - Example: If a transmission line is congested, LMPs rise in high-demand zones (e.g., NYC).
4. Virtual Bidding
   - Mechanism:
     (a) Buy DA, Sell RT: Profit if DA price $<$ RT price.
     (b) Sell DA, Buy RT: Profit if DA price $>$ RT price.
   - Impact:
     (a) Reduces price gaps between DA and RT markets.
     (b) Increases market efficiency by incorporating financial participants.

3 Deliverables

The following are the deliverables of this project:

- A prediction model and trading algorithm to generate trading signals.
- The number of parameters in the model must not exceed 15 million.
- You are free to use any publicly available model (pre-trained or otherwise) but it is not a requirement.
- You should be constructing the feature and labels from the given data for training purposes, as well as the training and testing pipeline.

4 Submission

1. Submit all your code, including pipeline, training and evaluation, as a `.zip` file.
2. Submit **prediction.csv** file in kaggle for evaluation.
3. Submit a 2-page report (1-inch margin, 12-point font) and include
   - Your approach, model, algorithm, and any other design choice.
   - Hyperparameters that you used for training.
   - Training and test results.
   - Any other interesting details about the approach or model.