Identifying Extreme Events in Wholesale Energy Markets

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Goal: minimize the risk of trading electricity on California’s wholesale energy market for our sponsor, Tether Energy, by creating a dataset of extreme price events and their causes

Background
California has a deregulated electricity market, allowing generators to sell electricity into the wholesale market at different prices. These prices are determined locally, at hubs known as “nodes”. The California Independent System Operator (CAISO) manages the reliability of the electrical grid, but electricity prices are still significantly more volatile than stock prices, regularly increasing and decreasing over 300%, making it risky to trade on this market.

Step 1: Identify the extreme price events
Step 2: Determine the causes of these events
Step 3: Plan to create a model to predict future extreme events
Identifying Extreme Events

Initial Price Data

- 15 Minute Intervals
- 2016 to 2019
- 400+ Nodes

What We Want

- Create a usable sized dataset of extreme events that can’t be “explained” solely by month or time of day

Method

- Chose dates, times, and prices that were:
  - Greater than 99.8 percentile for month and for time of day at each node
  - Less than 0.2 percentile for month and for time of day at each node
- Prioritized extreme highs by cutting off highest 90% of lows and lowest 10% of highs

Result

- Found 30,927 extreme prices on 431 unique days
- Price usually increases by ~$20/MWh from 1pm to 7pm at one node
- Median (blue) and mean (grey) price plotted against time of day
- Price usually high in December but low in May at one node
- Median (blue) and mean (grey) price plotted against month

What We Want

- Create a usable sized dataset of extreme events that can’t be “explained” solely by month or time of day

Time of day (left) and month (right) affect electricity prices

Median (blue) and mean (grey) price plotted against month and time of day

Results

- 30927 Extreme Prices
- 26967 Extreme Highs
- 431 Unique Days
- 3960 Extreme Lows

Price Spike at GRIZZLY_7_N_101 on 6-20-2017
Determining the Causes

Manual Research

- Scanned through online news sources to determine causes of extreme events
  - LA Times, SF Chronicle, Bloomberg Terminal, Wikipedia, The Fresno Bee, etc.
- Found many different causes including *wildfires, floods, poor air quality*, and *storms*

Coordinate Mapping

- Found locations of nodes to determine whether events on same day were one event or multiple

Public Datasets

- Downloaded hourly temperature data to connect *extremely hot* and *extremely cold* days to some extreme events
- Webscraped CAISO website for every planned and unplanned *generator outage* in California
- Downloaded CAISO curtailment data and found some extreme low prices were probably caused by *excessive solar or wind production*