



Wholesale Energy Markets

CFRM Seminar

Jan 15, 2019


The Energy Authority

- Serves public utilities nationwide for trading and analytics.
- Analytics team provides various forecasting and analysis services.
- A few dozen analysts in the team.
- Office in Jacksonville FL and Bellevue WA.



Myself...

- Eina Ooka
 - Senior Quantitative Analyst
 - 7.5 years at TEA



Eina Ooka
Senior Quantitative Analyst
Seattle, Washington

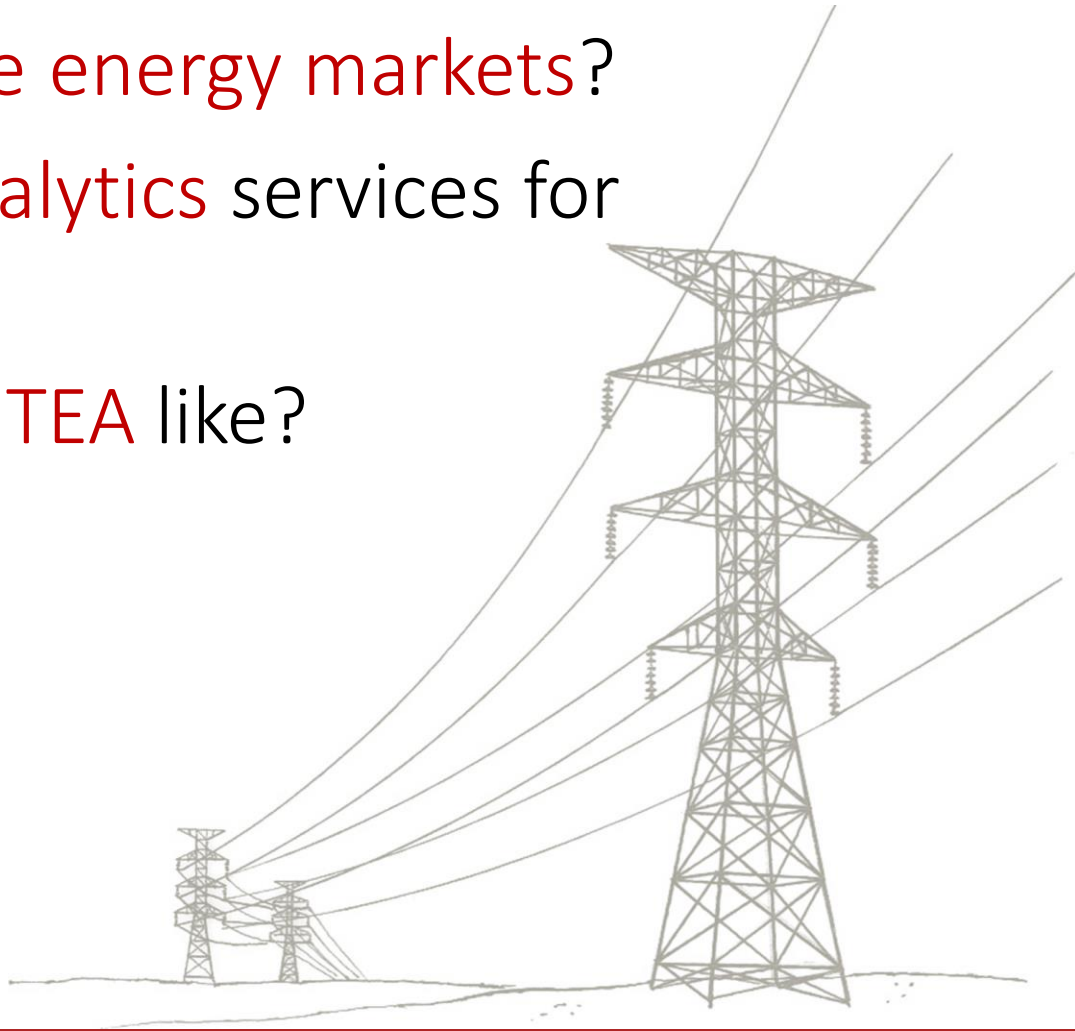
A quantitative analyst and a practitioner specialized in stochastic modeling and forecast development. Utilizing machine-learning methodologies together with statistical methods to better forecast energy markets.

~ Area of Expertise ~
 Multivariate Stochastic Modeling: GLM, Gaussian process, PCA, copula, hierarchical modeling.
 Time Series Analysis: ARIMA, heteroscedastic models, outlier detection, seasonal decomposition.
 Machine Learning: regularization, feature selection, RandomForest, Neural Network.
 Deep Learning: time series regression using LSTM, GRU, Conv1dNN.
 Cost-Production Model: AURORAxmp, Planning&Risk.
 Coding: R, Shiny, (Python)

~ Eina's GitHub page ~
<https://github.com/einaooka> (Conference presentations available).

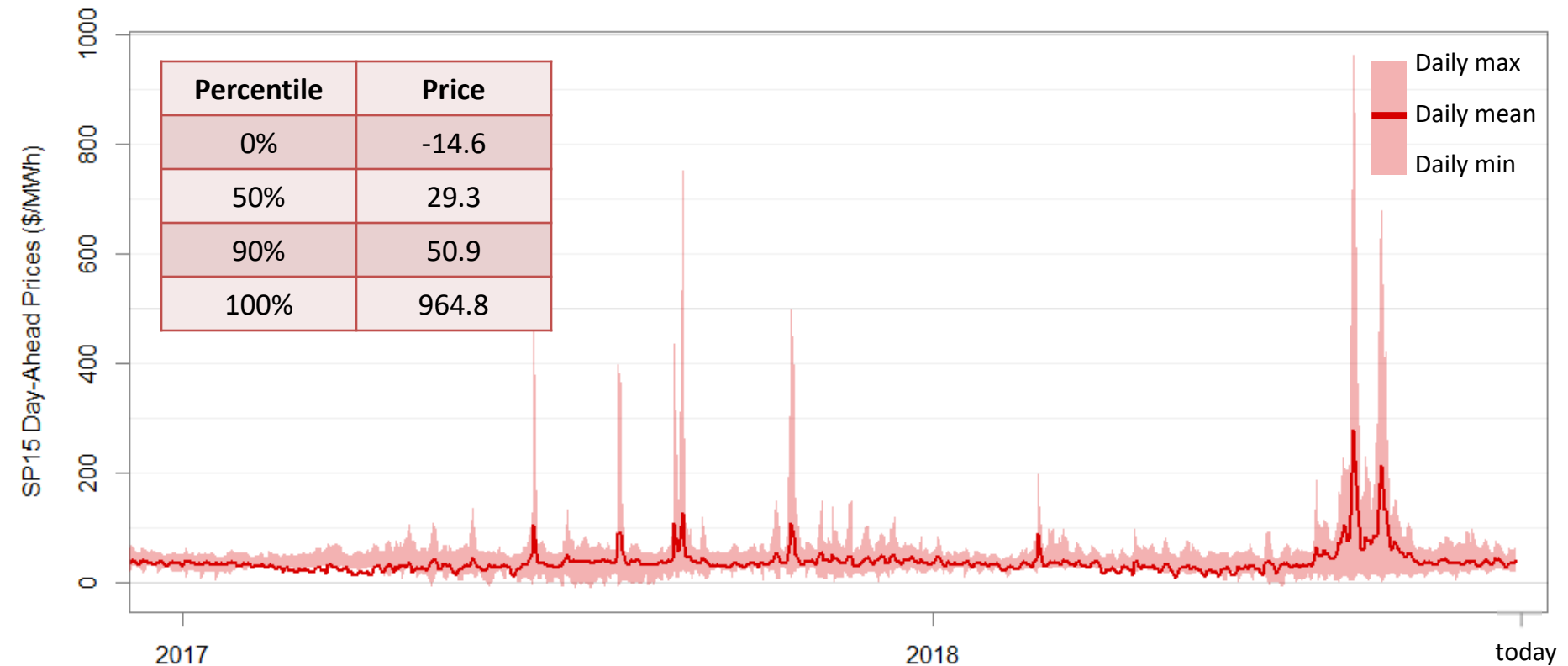
Agenda

- ✓ What are **wholesale energy markets**?
- ✓ Discuss types of **analytics** services for power utilities.
- ✓ What is working at **TEA** like?



Wholesale Energy Markets

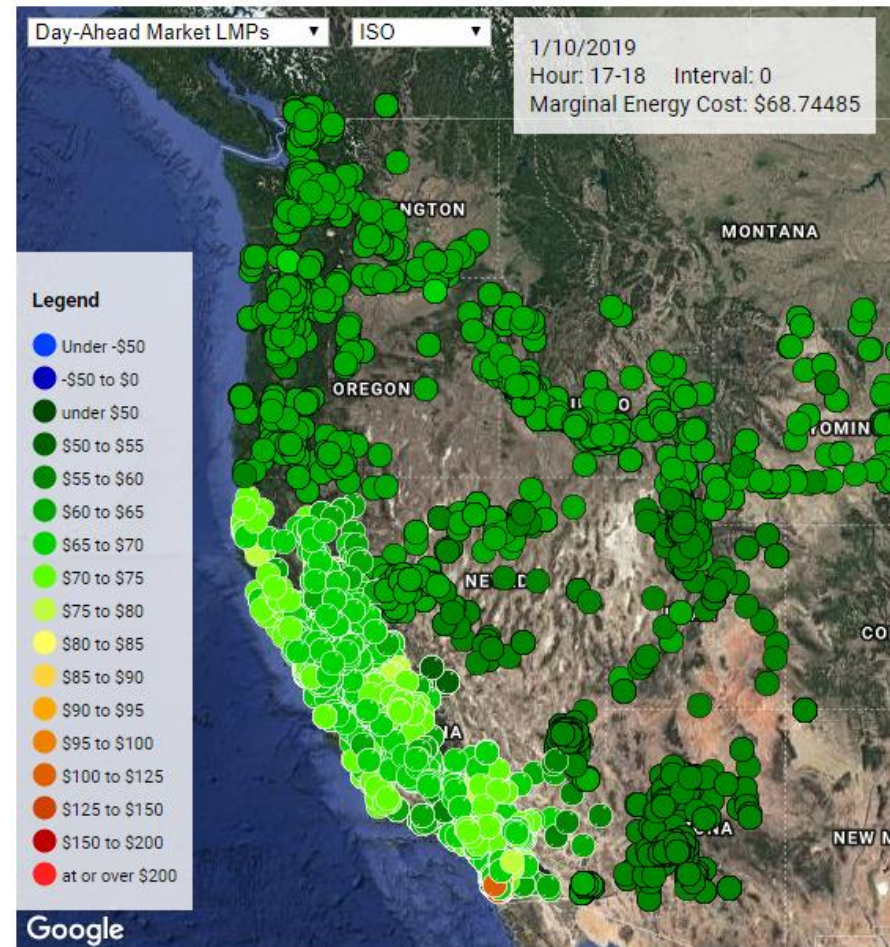
Wholesale Energy Price



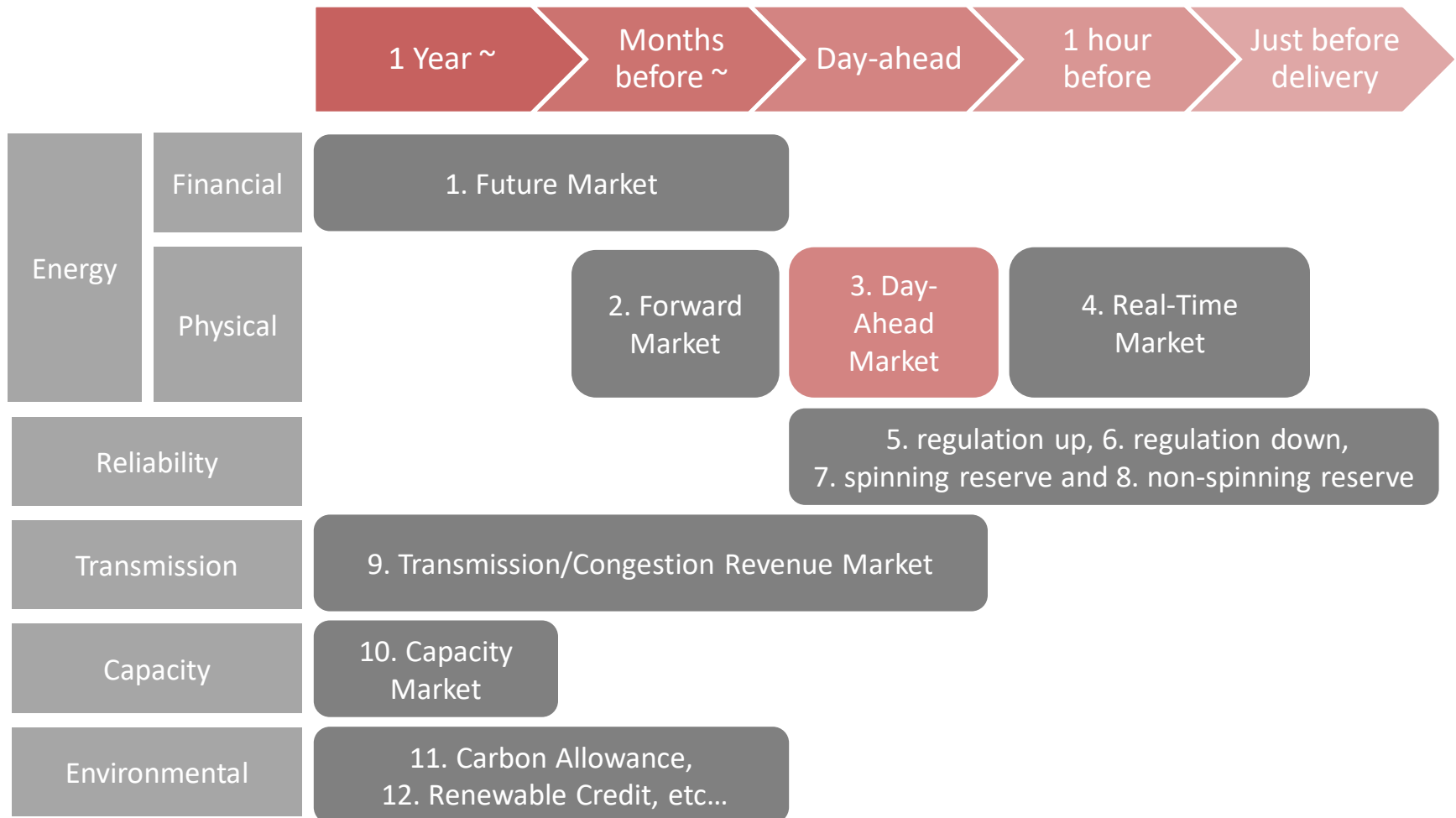
- Energy can't be stored → Volatility.

How many price nodes?

- Answer: thousands.
- Some markets are organized in a way that it generates a price at every resource and load node.
- This design incentivizes market participants to act in accordance with the benefit of the entire grid.

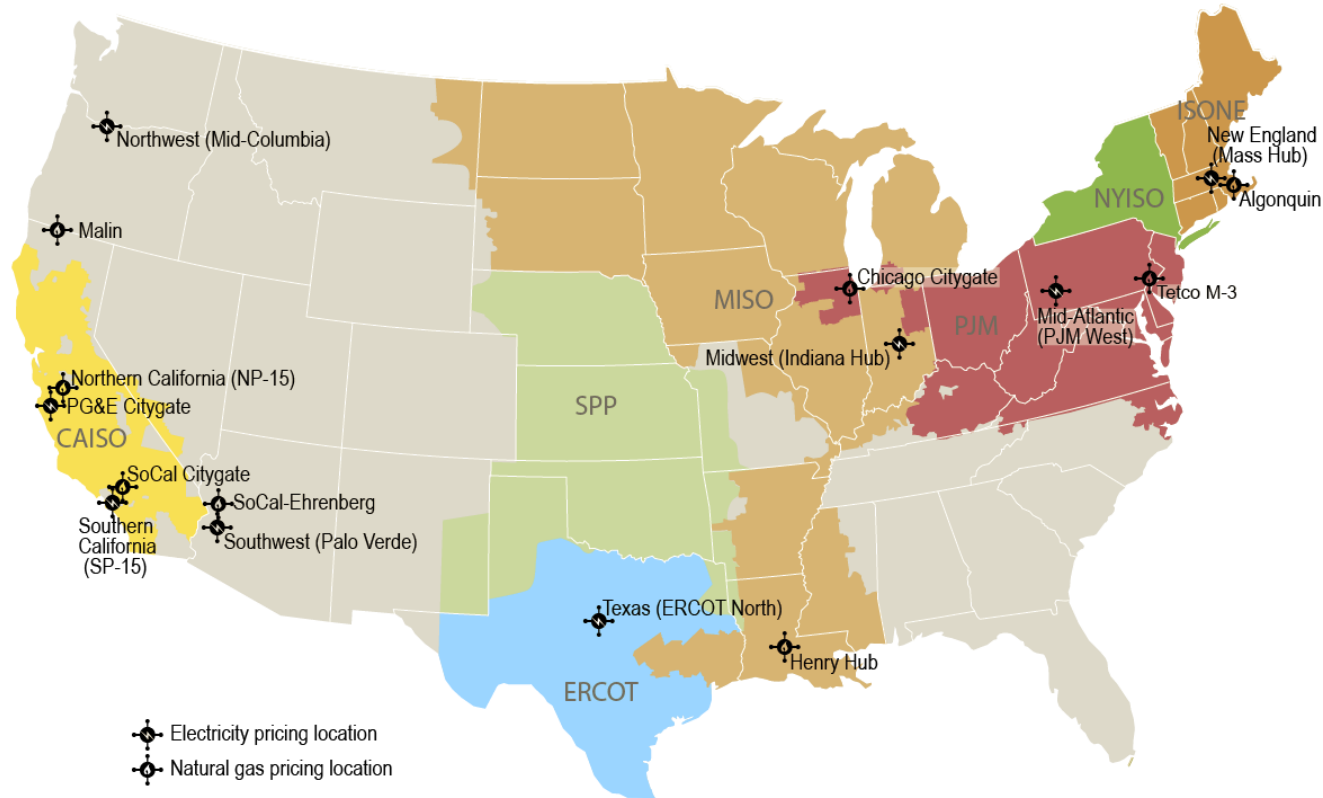


Wholesale Energy Markets



Markets & Market Designs

Selected price hub locations for wholesale electricity and natural gas reported by Intercontinental Exchange



Note: Colored areas denote Regional Transmission Organizations (RTO)/Independent System Operators (ISO)

Source: U.S. Energy Information Administration based on Ventyx Energy Velocity Suite

Utility Analytics

Wholesale Analytics

- Market Analysis
 - what's the impact of the wind generation in a region?
- Forecasting
 - Power prices
 - Load
 - Generation
 - Thermal
 - Variable & Hydro
- Optimization
 - Resource dispatch
 - How should I run my hydro generator for the next 2 weeks?
 - When should I schedule maintenance outages?
 - Bid strategies
 - Transmission right auctions
 - How much should I bid on which transmission lines?
- Risk Management
 - Stochastic portfolio modeling
 - Hedging strategies
 - Dynamic delta hedging
- Long Term Resource Planning
 - Investment and divestitures
 - What type of resources should we build at where?



Retail Analytics

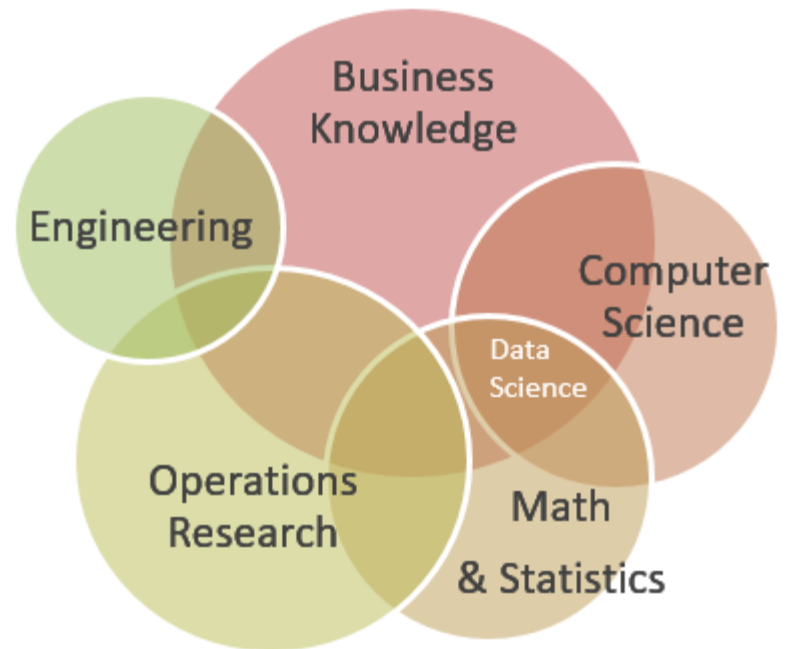
- Smart meter data analysis
- Distribution system analysis & optimization
- Retail rate analysis
- Customer behavior analysis and communication strategy

And many more...



Analytics Team

- Team is made up of analysts with different backgrounds.
- Varying technical and quantitative skills.
- Large perspective vs detail-oriented views.



Portfolio in a Spreadsheet

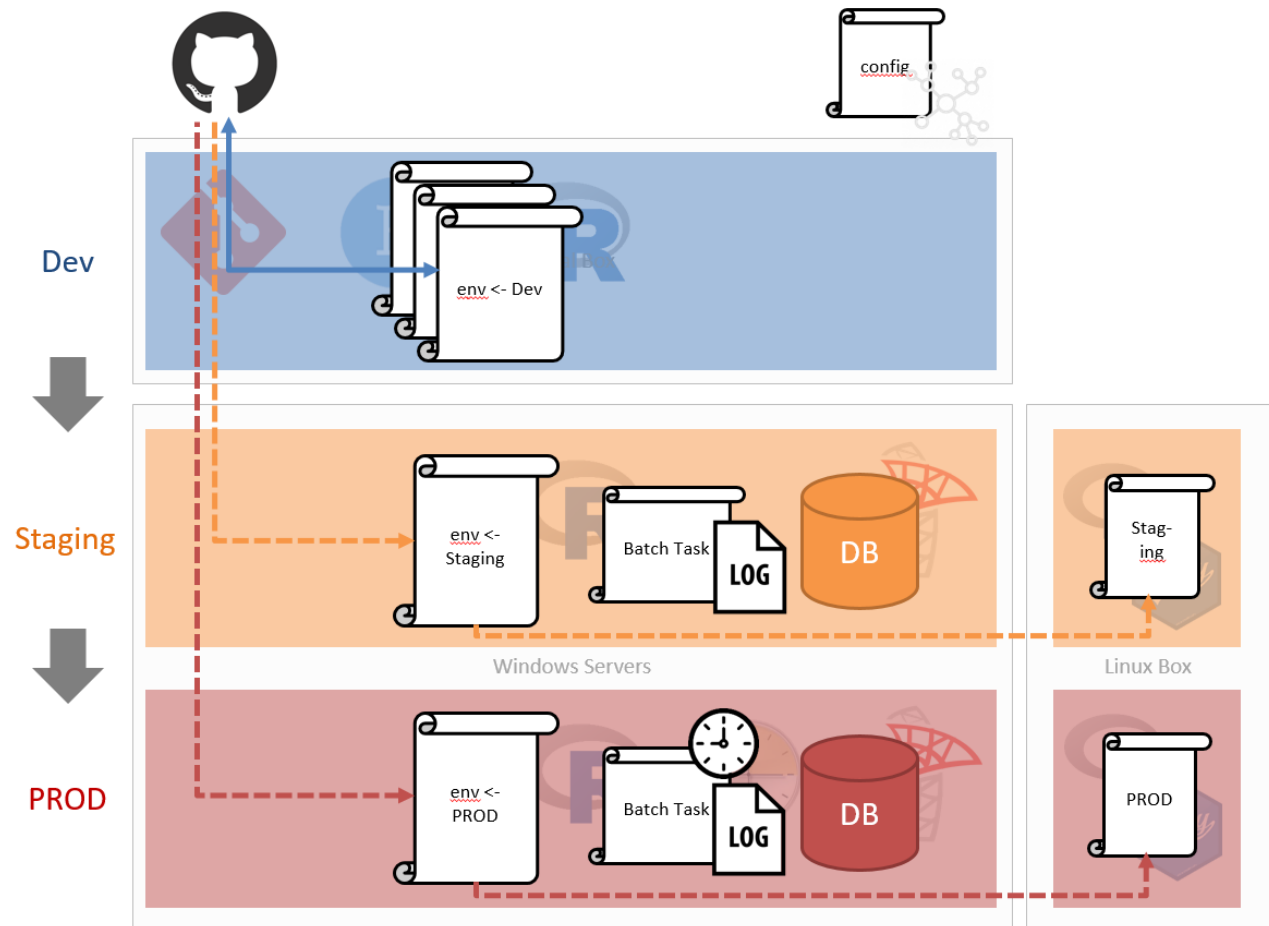
Forecasting

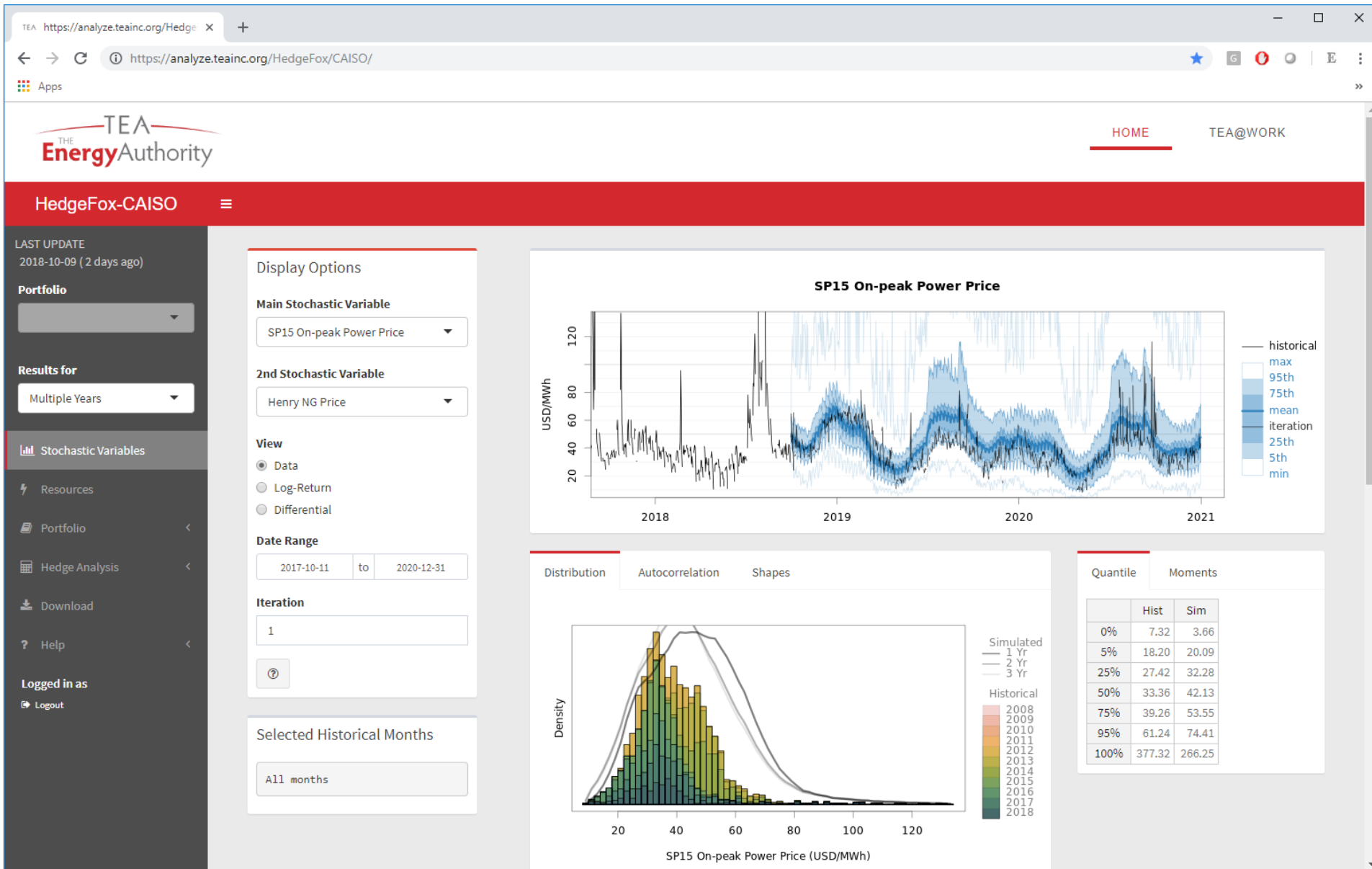
- Forecasts are utilized for trades, portfolio management, and many other internal and external purposes.
- Models are written mostly in **R**.
- Utilize many methods:
 - Time series analysis
 - Statistical methods
 - Machine learning technics
 - Monte-Carlo methods

Forecast	Region	Number of services
Load Forecast		
1 Short-term load forecast	All Regions	68 PODs (23 clients)
2 Mid-term load forecast	PNW, CAISO	16 PODs (14 clients)
3 Long-term econometric load forecasts	All Regions	~60 rate classes (9 clients)
4 Long-term non-economic load forecast	All Regions	~50 rate classes (8 clients)
Generation Forecast		
5 Short-term slice forecast	PNW	1
6 Long-term slice forecast	PNW	1
Price Forecast		
7 Short-term DA LMP forecast	MISO, PJM, SPP	72 nodes
8 Long-term Basis Differential Forecast	PNW, CAISO	14 nodes
Stochastic Forecast		
9 Long-term Henry NG Forecast		1
10 Long-term Kerr Hydro Forecast	PNW	1
11 Long-term California Hydro Forecast	CAISO	1
12 HedgeFox	PNW, CAISO	2 (15 clients)

Rigor From Computer Science

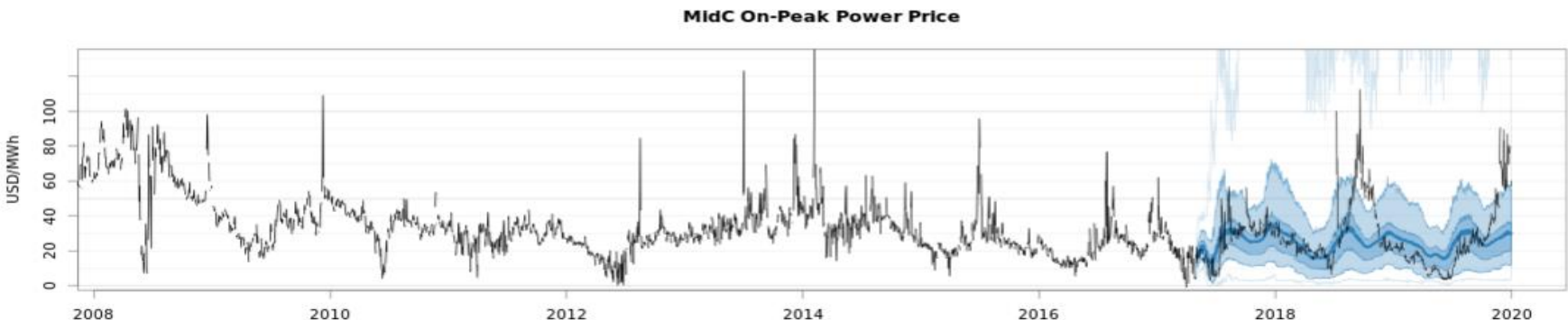
- Secure
 - Data storage
 - Source management
 - Deployment
 - Reliable model execution.



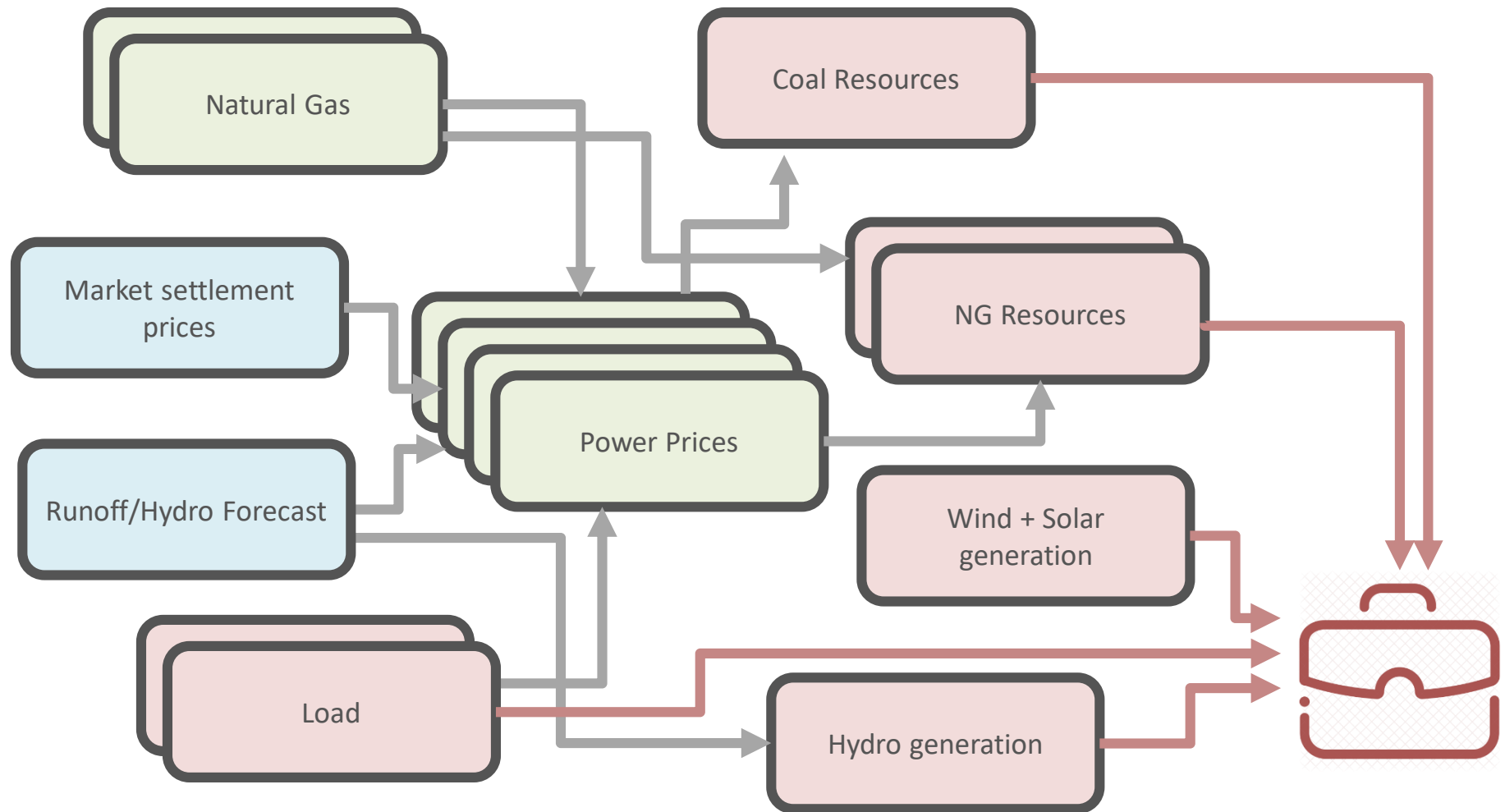


Power Price TS Characteristics

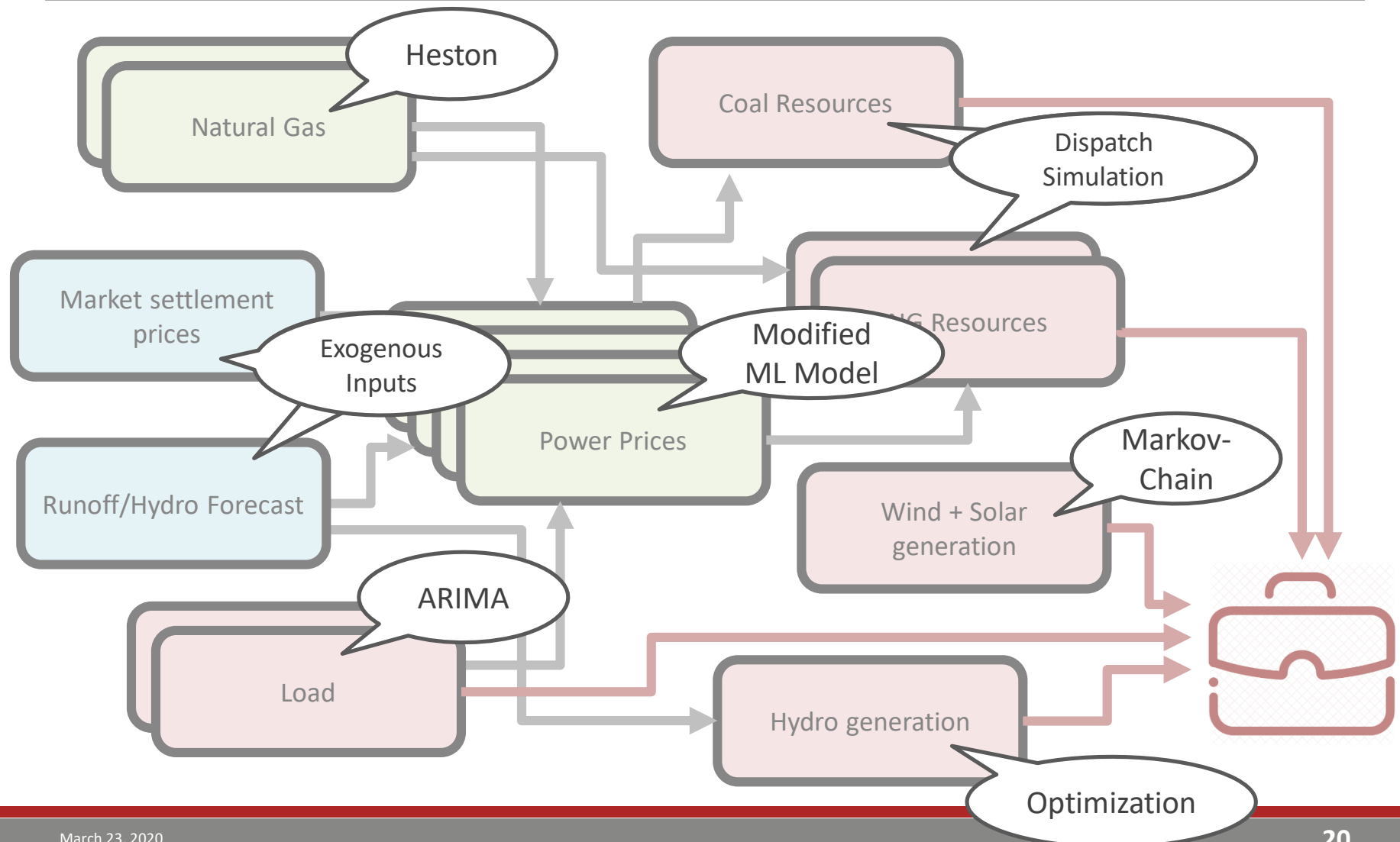
- Autocorrelation
- Seasonal and weekly shapes
- Volatility & Heteroscedasticity
 - Seasonal and weekly variability
- Multivariate cross-correlation and non-linear dependency
 - NG, load, regional hydro and other variable generation
- Non-normal distributions
 - fat tails
 - Extreme peaks and drops
- Negative prices
- Consistency with market expectations
- Consistency between monthly, daily and hourly data.



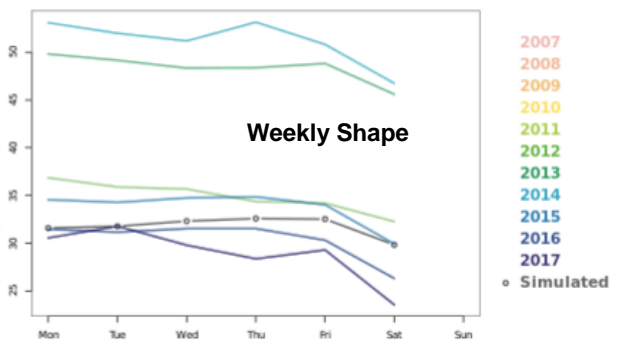
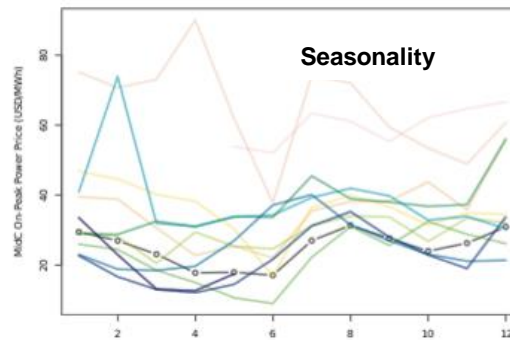
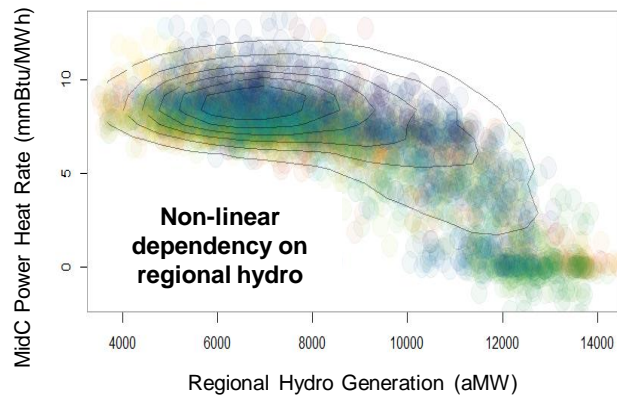
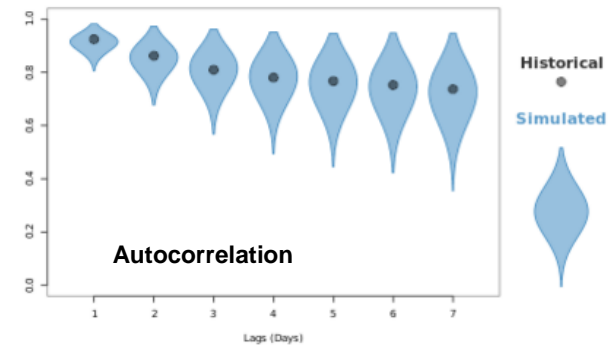
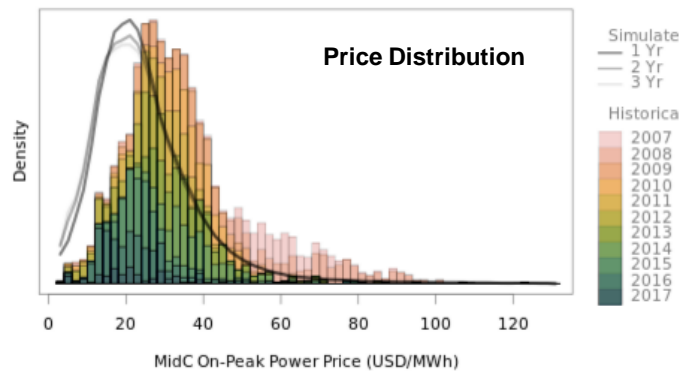
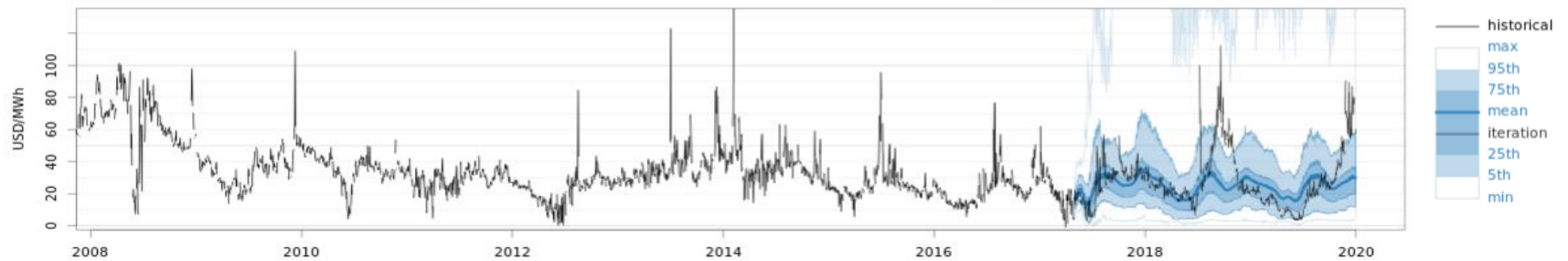
MC Simulation Approach



MC Simulation Approach



Mid-C Power Price (Historical + Simulated)



Questions?