Energy Market Time Series Forecasting: Balancing Demand and Supply

Amrutha Gabbita agabbita@purdue.edu
Ridvan Kanca rkanca@purdue.edu
Sahana Reddy reddy47@purdue.edu
Alexander Scarcelli ascarcel@purdue.edu
Matthew Lanham lanhamm@purdue.edu

Purdue University — Mitchell E. Daniels, Jr. School of Business

BUSINESS PROBLEM FRAMING

Business Problem

Focus on pinpointing locations for grid-scale battery installations to elevate energy distribution across New York.

Purpose

The analysis supports our B2B product and has potential applications in national security by assessing regional market opportunities and identifying gaps.

Importance

Identifying and filling gaps in generation or storage is critical for improving our competitive edge and optimizing battery usage.

Context

Our current focus is on the commercial market, using analytics to assess regional energy fluctuations

Business Benefits

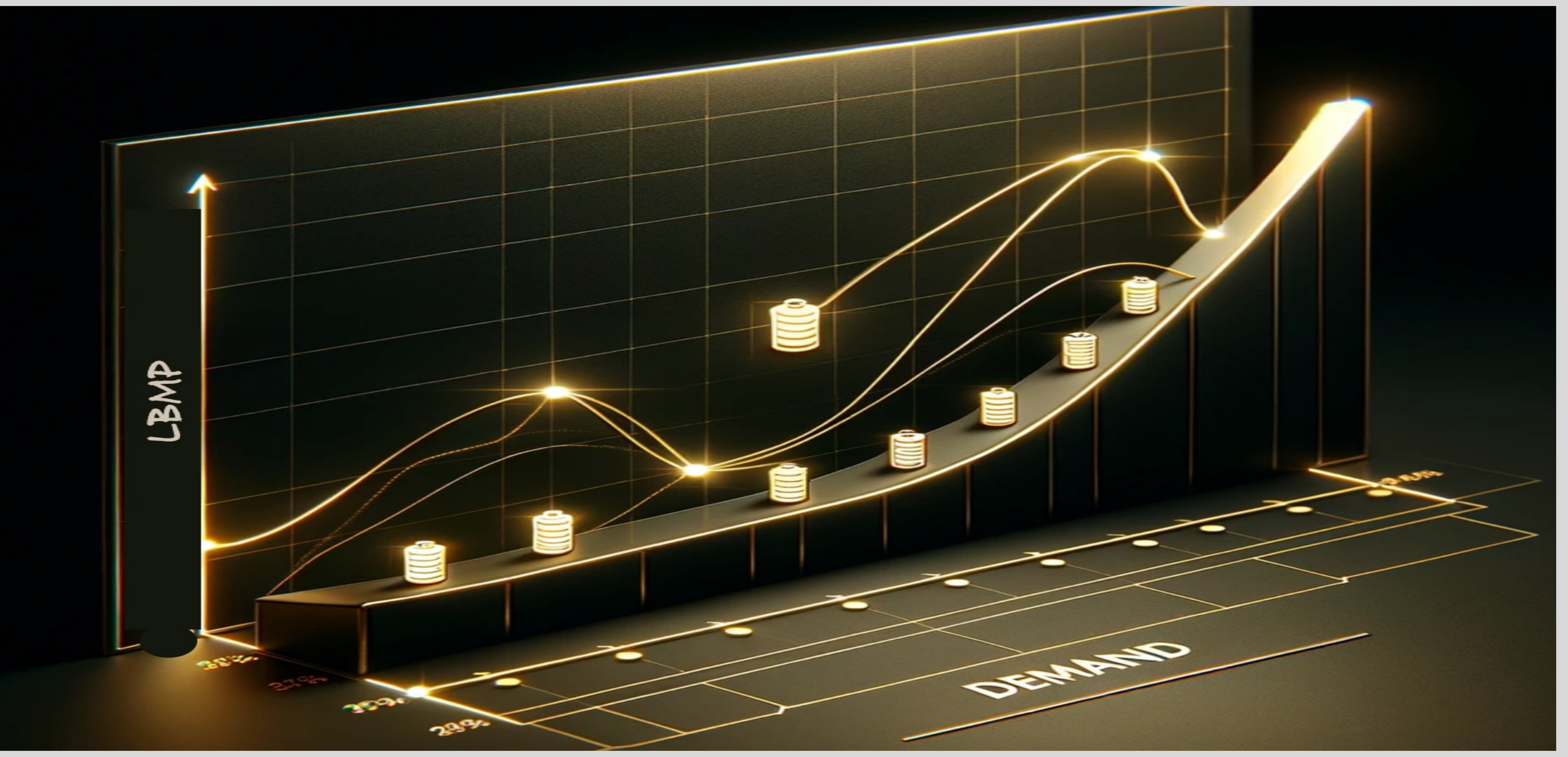
Our findings aim to enhance operational efficiency and profitability through informed strategic decisions.

Stakeholders

We target the commercial sector, with an eye toward future national security applications, involving both B2B and possibly B2G relationships.

End Goal

The project seeks to improve how grid-scale batteries are managed, leading to better market positioning, cost savings, and possibly lower energy prices for consumers.



ANALYTICS PROBLEM FRAMING

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1 OBJECTIVES

Analyze hourly energy demand and supply

Evaluate grid infrastructure

Assess renewable energy variability and predictability

Identify regions for optimal grid-scale battery deployment,

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2 ASSUMPTIONS

Assume 2020 data at an hourly level is representative of seasonal hourly trends for 2024 and beyond

3 METRICS

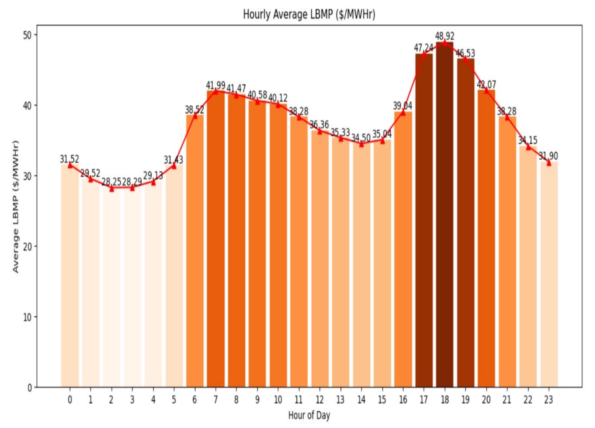
MAPE (Target of 5% or lower deemed successful)

4 STRATEGY

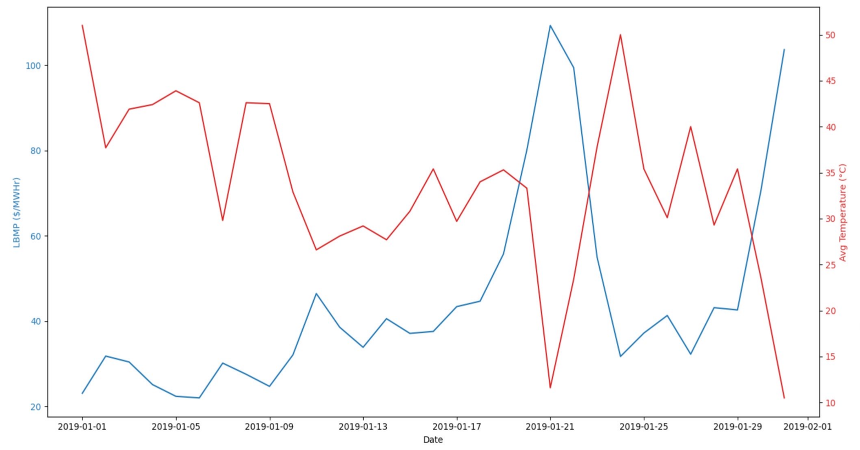
Leverage open-source algorithms like SARIMAX, ARMA, and relevant neural network architectures along with K-Means clustering to forecast hourly energy

DATA

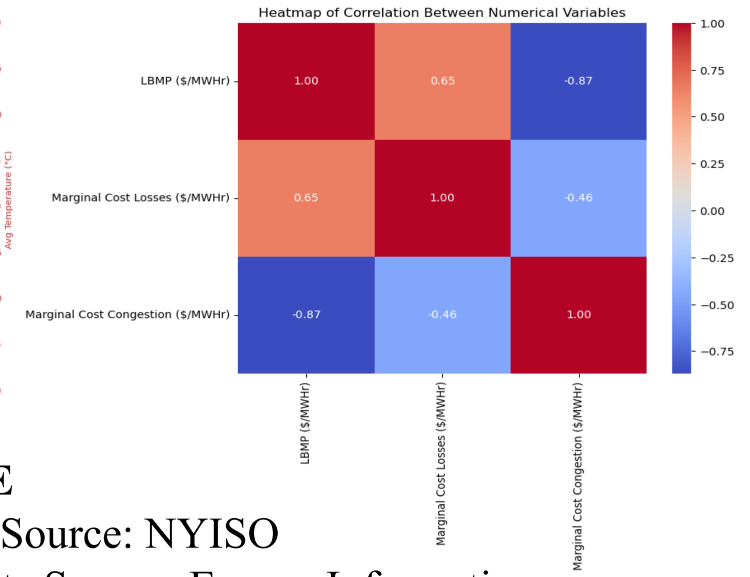
Average LBMP by Hour



Weather – LBMP relationship



Correlation Matrix



Column Name	Description	Type	Example
Time Stamp	This column records the date and time of a record	String	1/1/2019 0:00
Name	Street address of the place of interest.	String	59TH STREET_GT_1
PTID	This column contains unique identifiers assigned to each address.	Int	25648
LBMP ($/MWHr)	"Locational Based Marginal Pricing". The price of electricity at a specific location on the grid, calculated per megawatt-hour	Float	25.57
Marginal Cost Losses ($/MWHr)	least bit marginal price. The lowest price at which electricity can be sold in the wholesale market at a given time	Float	1.07
Marginal Cost Congestion ($/MWHr)	The costs associated with congestion in the power grid.	Float	-14.97

DATA SOURCE

- Primary Data Source: NYISO
- Secondary Data Source: Energy Information Administration

PREPROCESSING

- Aggregate Timestamp column and filter and impute any null values with forward fill

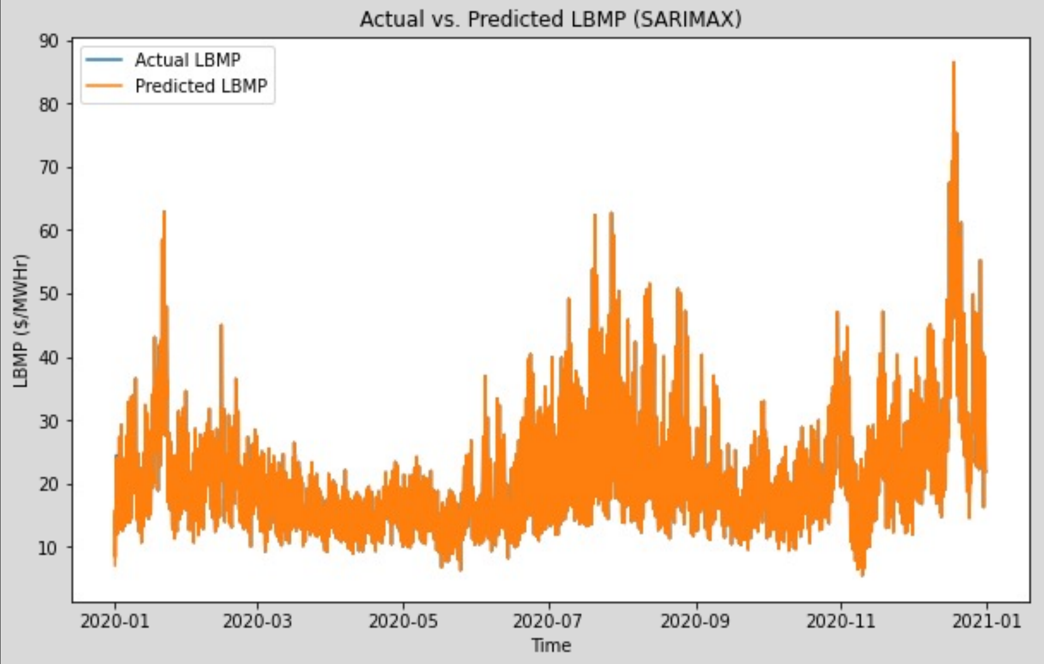
METHODOLOGY SELECTION

Data → Data Preprocessing → Feature Engineering → Scaling → K-Means clustering → Model Building → Model Comparison → Prediction

MODELS USED:

- SARIMAX,Neural Network, ARMA, ARIMAX

MODEL BUILDING



SOLUTION ARCHITECTURE

- SARIMAX
- Exogenous Variables: Marginal Cost osses ($/MWHr) , Marginal Cost Congestion ($/MWHr),rolling_mean_3 h, LBMP_lag_2h
- Goal MAPE: Less than 5%
- MAPE of Optimal Model: 1.957%

ENGINEERED FEATURES

- Lagged Variables: The LBMP lagged for the previous 24 hours, 2 days, 1 week
- Rolling Means: Rolling mean of past 3, 12, 24, and 168 hours

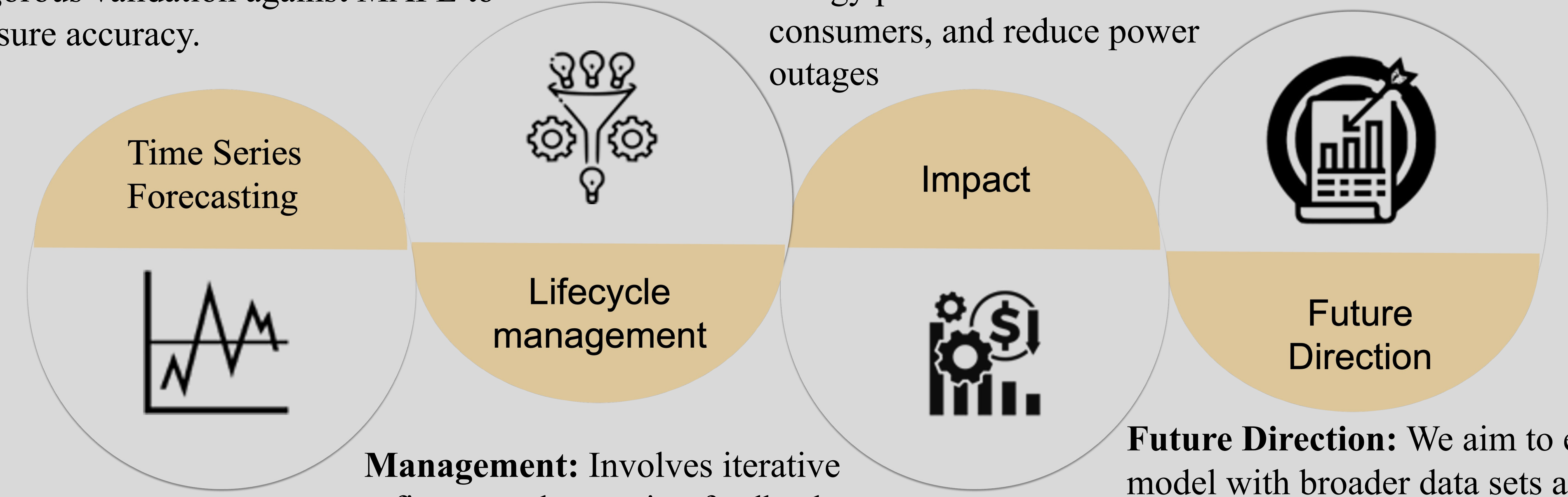
FUTURE DEVELOPMENT

- Improving feature selection techniques (Wrapping, etc.)
- Neural Network training and testing
- Determine optimal model for each season

DEPLOYMENT AND LIFE CYCLE MANAGEMENT

Deployment: SARIMAX-based model to predict hourly LBMP. Includes rigorous validation against MAPE to ensure accuracy.

Impact: Improve operational efficiency and cost reduction for energy providers and consumers, and reduce power outages

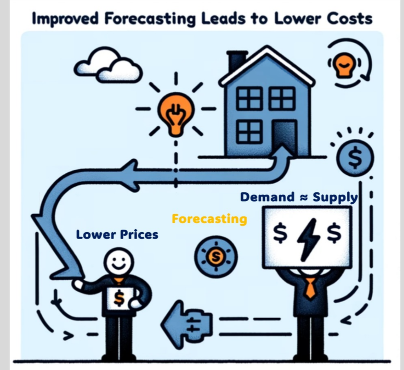


Management: Involves iterative refinement, leveraging feedback and cutting-edge research to enhance model precision and adaptability to market changes.

Future Direction: We aim to enrich our model with broader data sets and sophisticated machine learning techniques, focusing on renewable energy integration and smart grid advancements .

BENEFITS:

- Reduce consumer pricing particularly for time-of-use based plans
- Avoid market failures and blackouts from peaking demand and surging prices



DIGITAL VERSION