# Forecasting Electricity Demand in Seattle

## Beating the Government Forecast

Michael Jehl
Metis 2021

**75%**

Monthly electricity bill wasted

**$350 billion**

Americans spend on electricity annually

**7%**

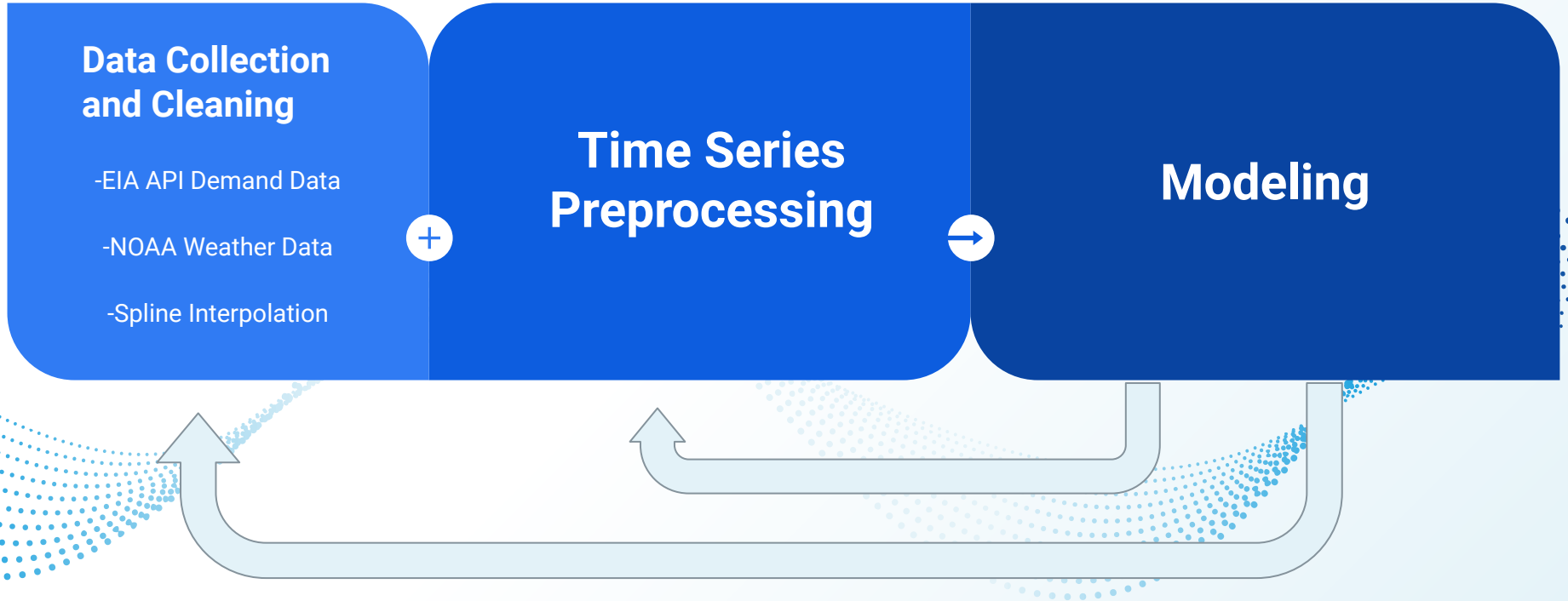
Electricity generated and distributed is lost

Source: Environmental Defense Fund

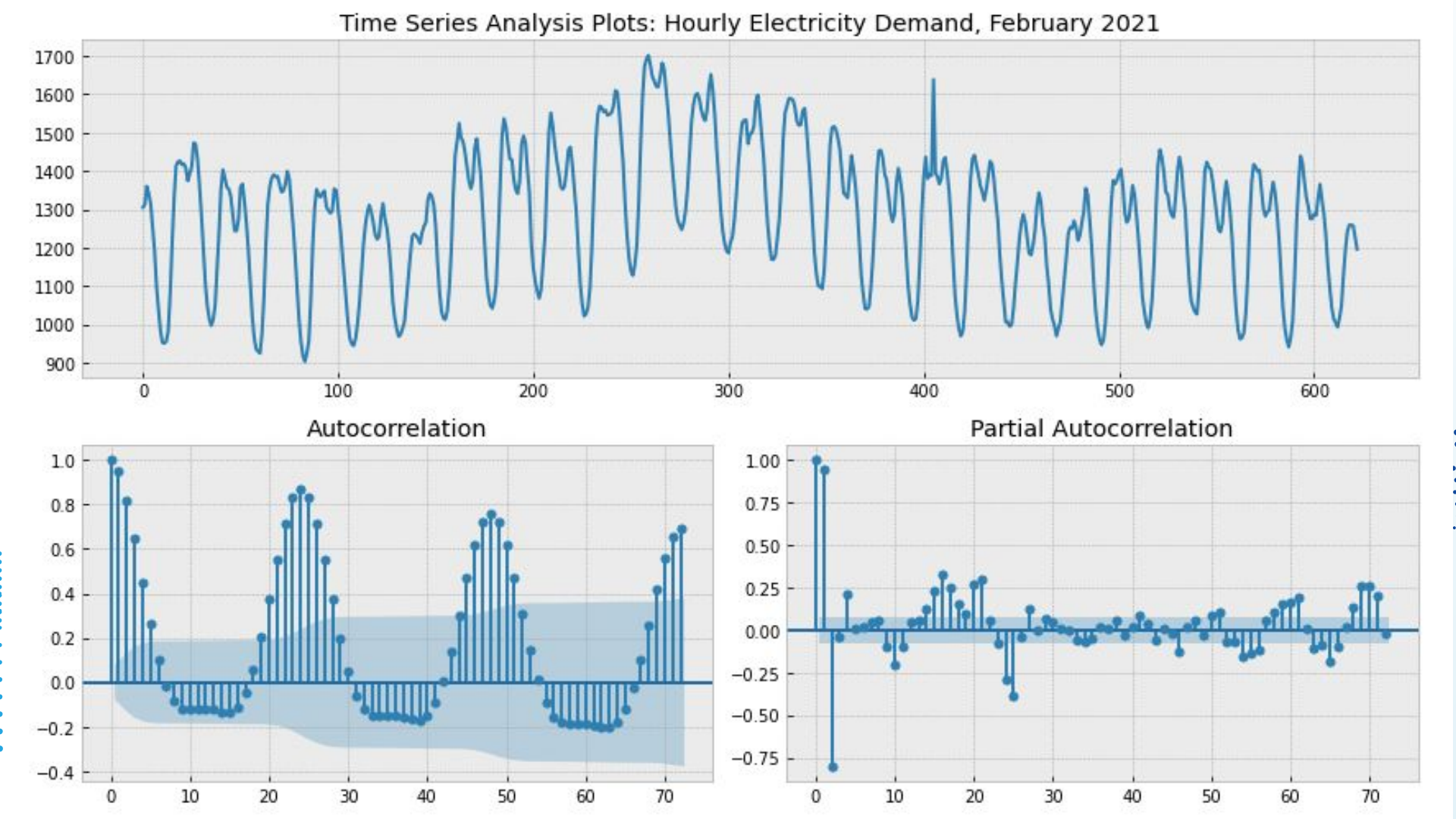
# Building a time series forecasting model

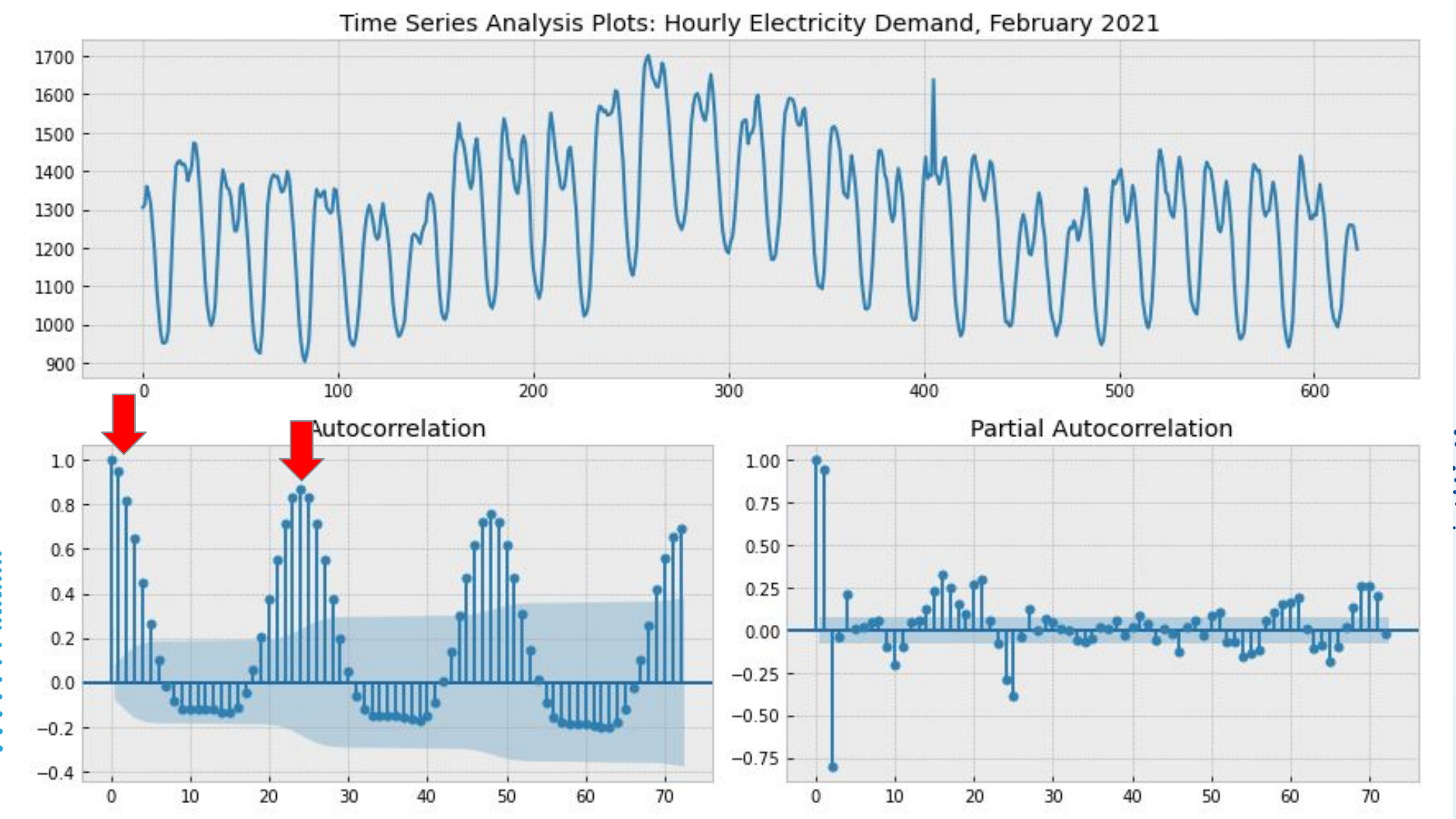
with machine learning

# Project Workflow



# Time series preprocessing: Handling non-stationarity


Time Series Analysis Plots: Hourly Electricity Demand, February 2021
Autocorrelation
Partial Autocorrelation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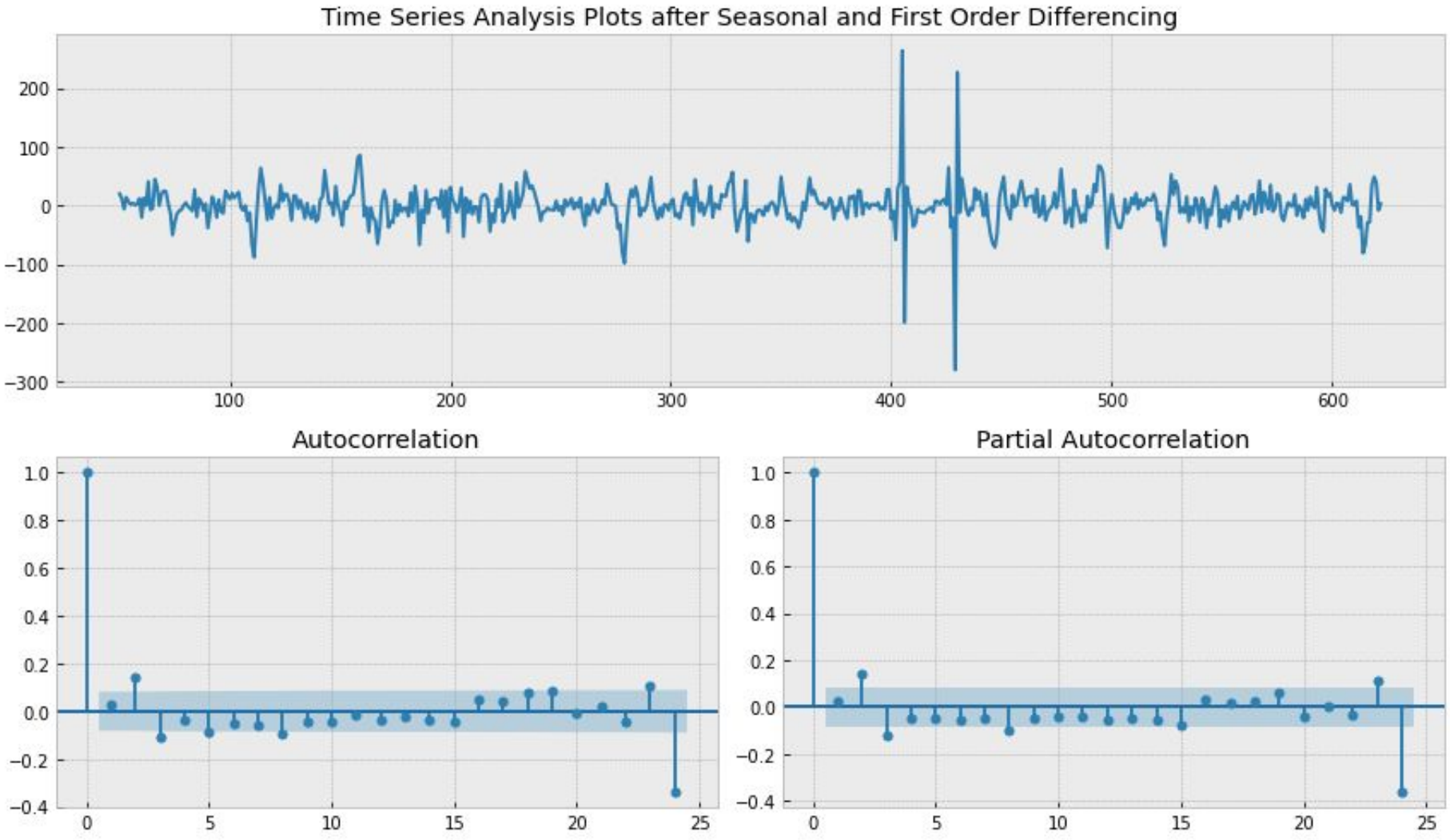
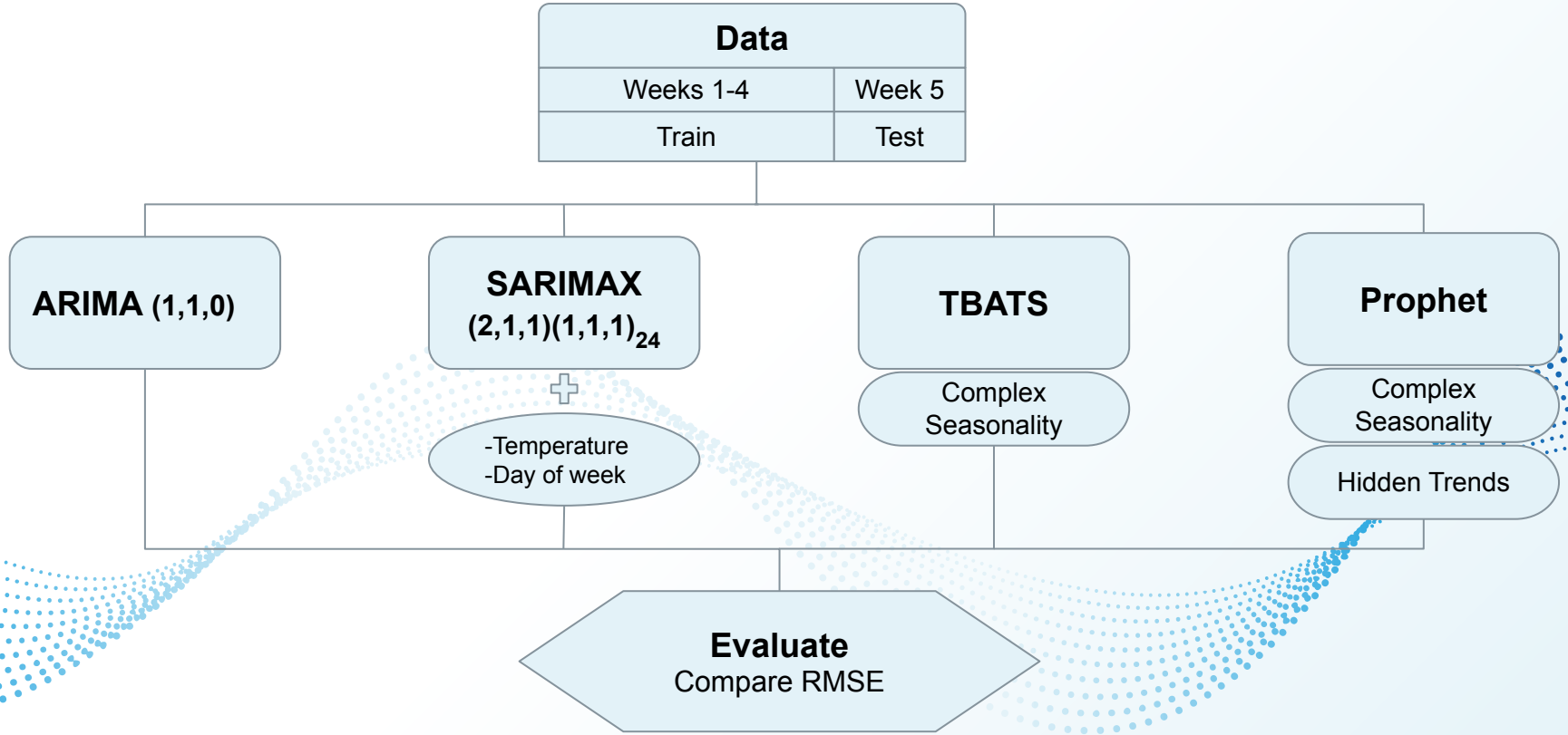
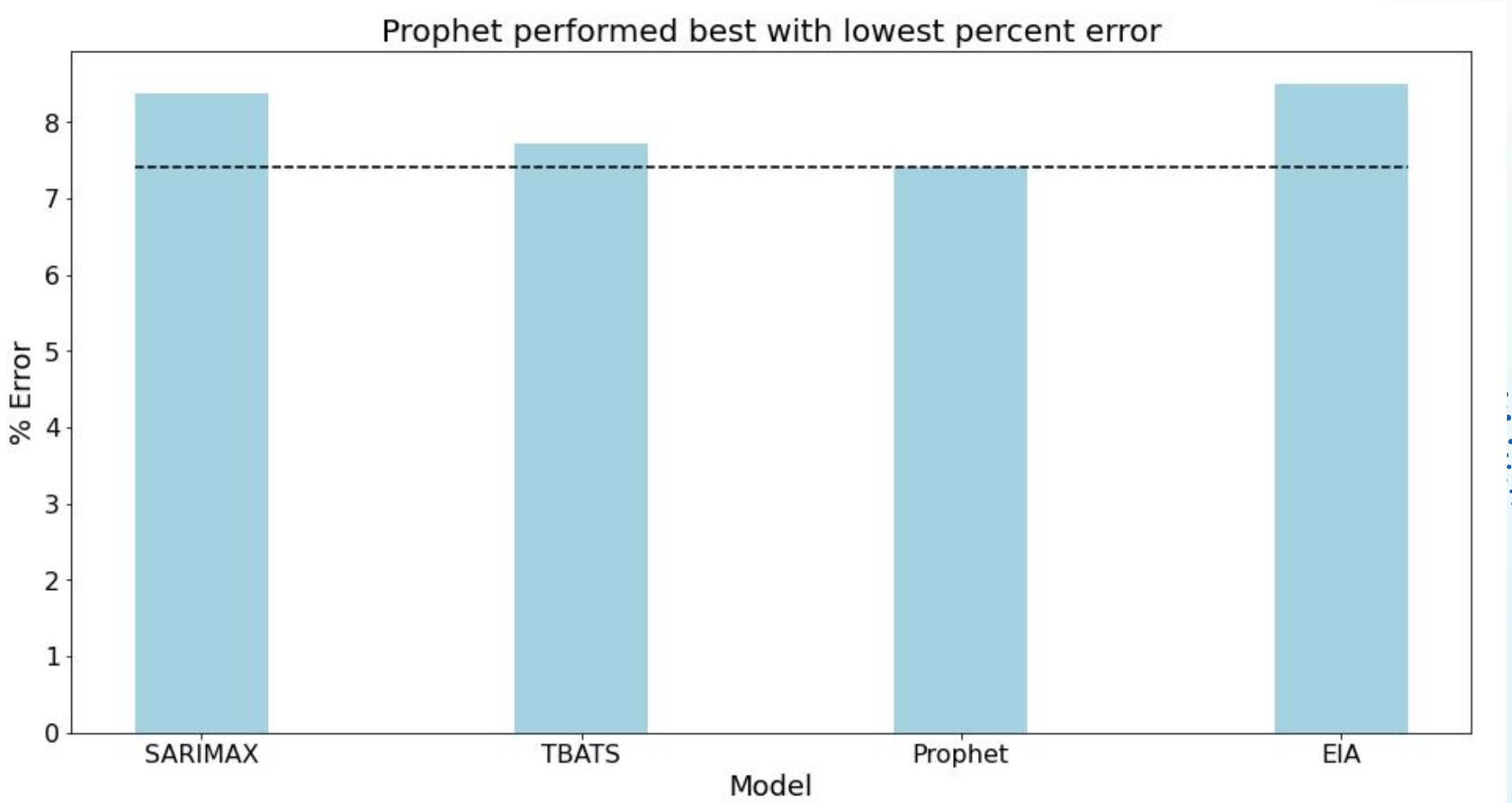

Time Series Analysis Plots after Seasonal and First Order Differencing
200
100
0
−100
−200
−300
100
200
300
400
500
600
Autocorrelation
1.0
0.8
0.6
0.4
0.2
0.0
−0.2
−0.4
0
5
10
15
20
25
Partial Autocorrelation
1.0
0.8
0.6
0.4
0.2
0.0
−0.2
−0.4
0
5
10
15
20
25

# Modeling

# Modeling Workflow

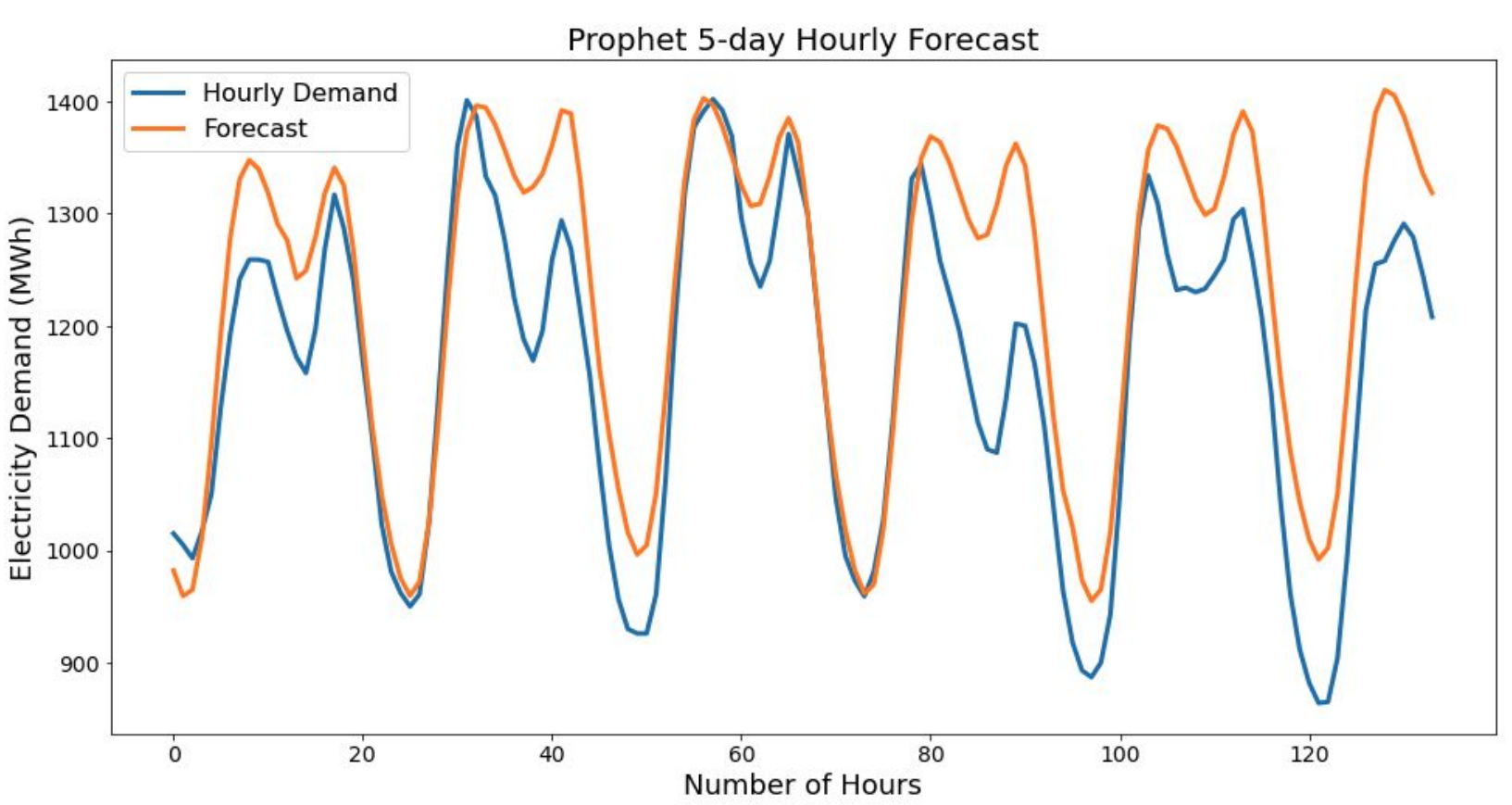


# Model Evaluation



# Prophet

## RMSE = 86.06MWh



# Prophet Outperforms Government Forecast

| Model | RMSE | Forecast Bias |
|---|---|---|
| **Prophet** | 86.06 | +32.59 |
| **EIA** | 98.72 | -55.81 |

- More accurate
- Less biased
- Potential savings up to **$1,397/hr**

# Impact

Enhanced forecasting tool

Better prepared for high-demand spikes

Lower operational costs

# Thank you!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# Appendix

# Statistical Tests for Stationarity

ADF Test Results

- Null hypothesis: the series has a unit root
- P-value = 0.65
- Null hypothesis cannot be rejected

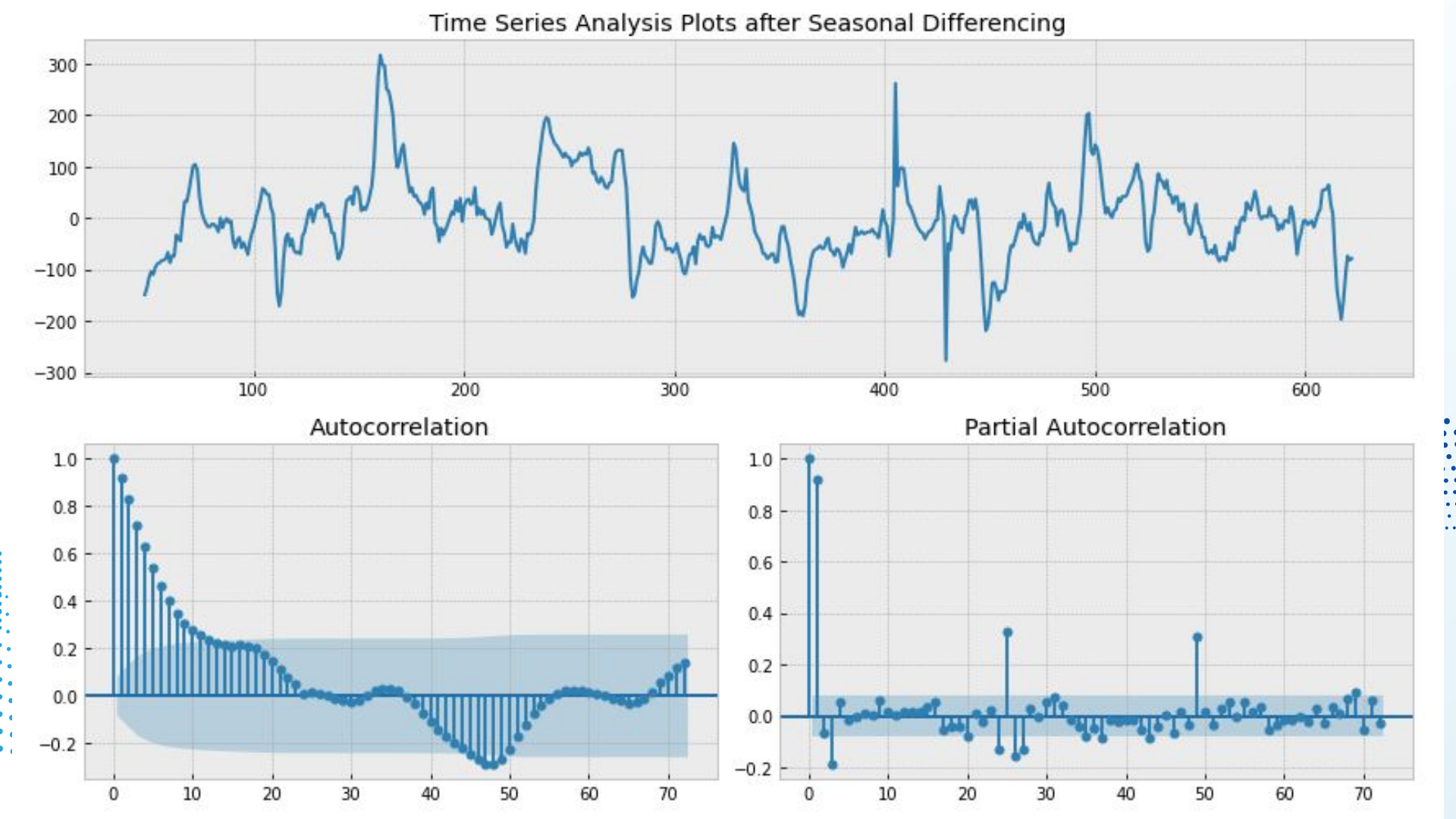
**ADF indicates non-stationarity**

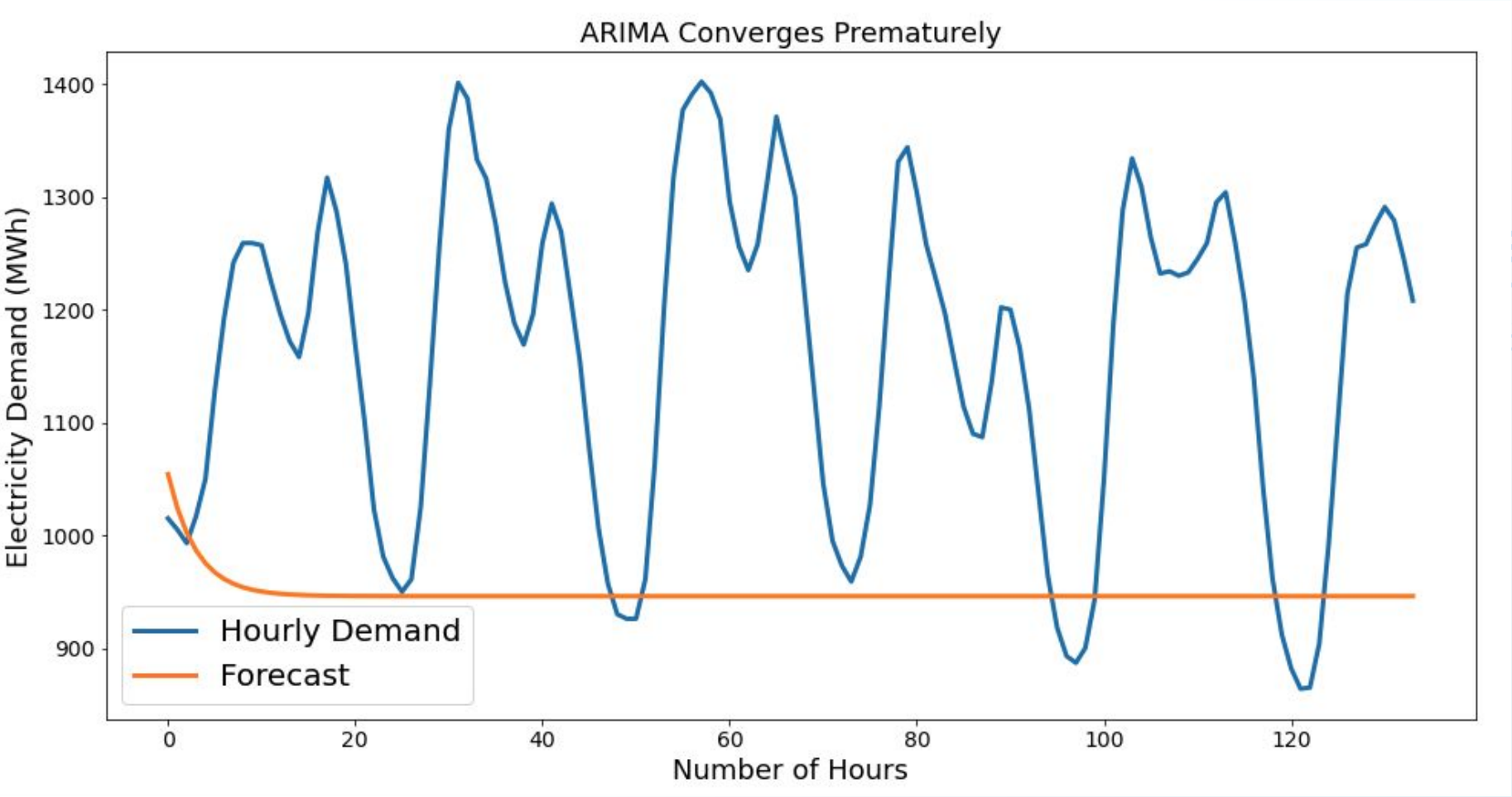
KPSS Test Results

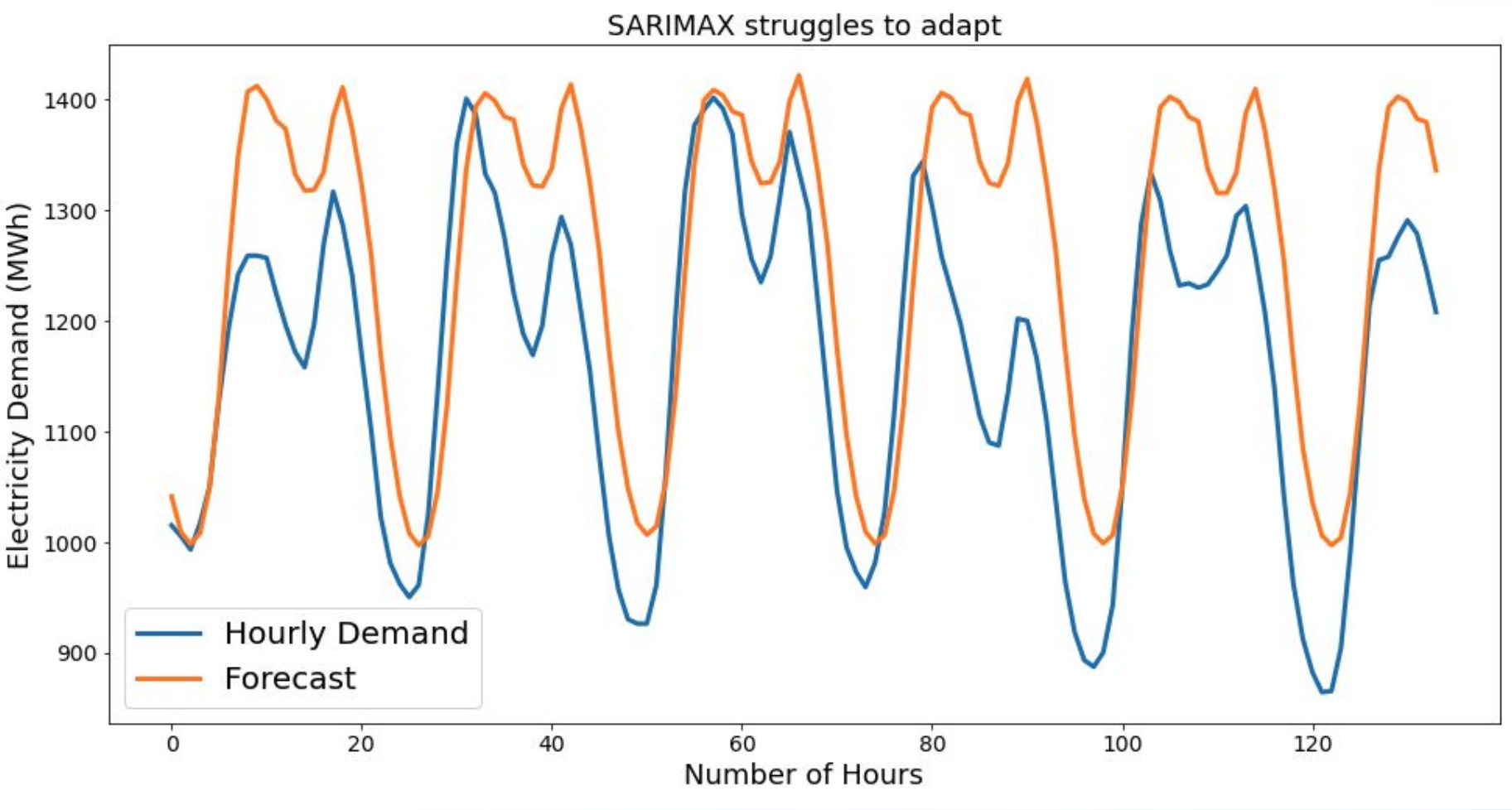
- Null hypothesis: the process is trend stationary
- P-value = 0.04
- Null hypothesis can be rejected

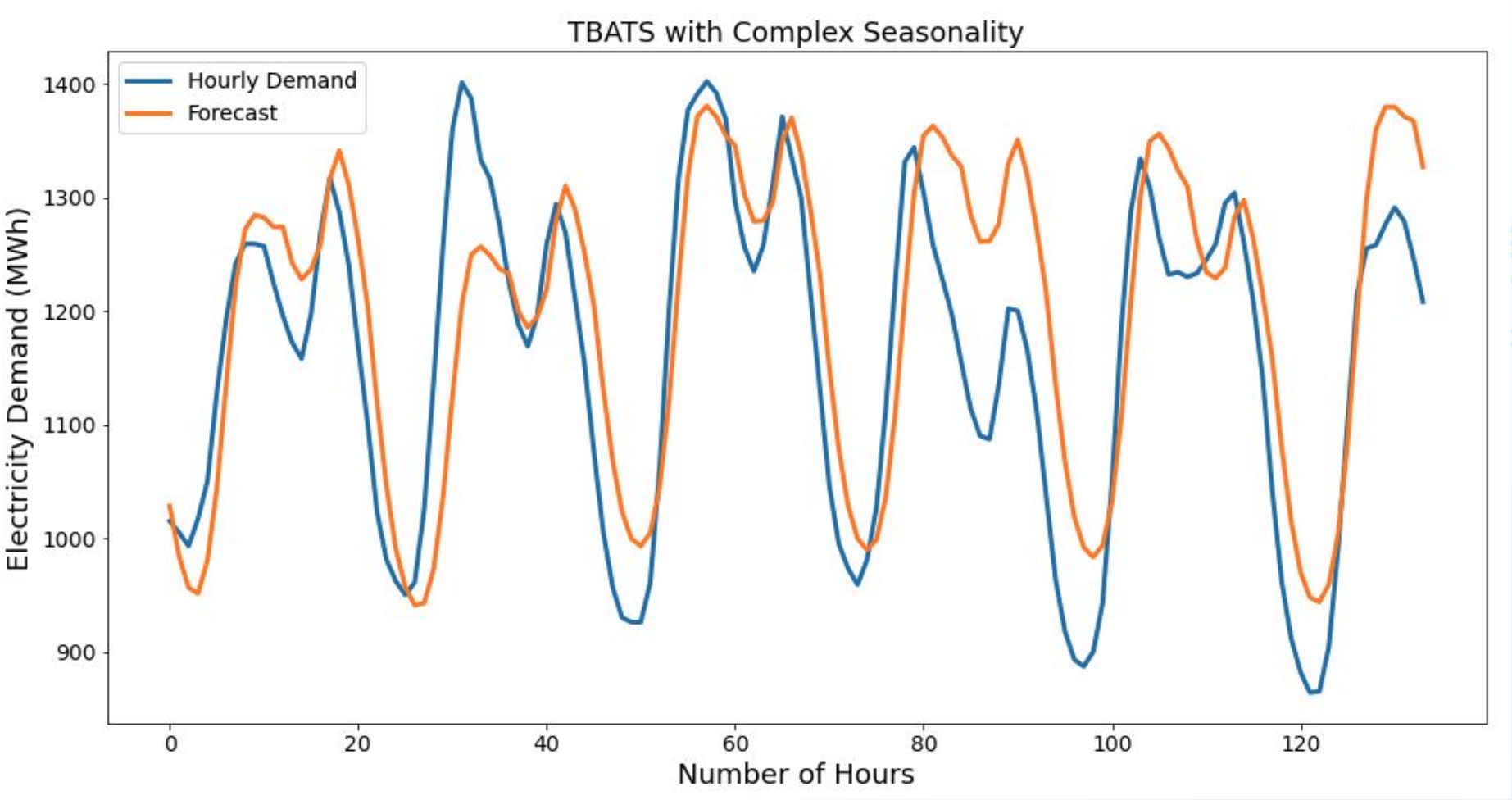
**KPSS indicates non-stationarity**

**The series is non-stationary. Let's see how differencing at lag 1 and 24 can help.**


Time Series Analysis Plots after Seasonal Differencing
Autocorrelation
Partial Autocorrelation


ARIMA Converges Prematurely
Electricity Demand (MWh)
1400
1300
1200
1100
1000
900
0
20
40
60
80
100
120
Number of Hours
Hourly Demand
Forecast


SARIMAX struggles to adapt
Electricity Demand (MWh)
1400
1300
1200
1100
1000
900
0
20
40
60
80
100
120
Number of Hours
Hourly Demand
Forecast


TBATS with Complex Seasonality
Hourly Demand
Forecast
Electricity Demand (MWh)
1400
1300
1200
1100
1000
900
0
20
40
60
80
100
120
Number of Hours