- Author: Steve Eckardt
- Date: November 24, 2025
- Project: Time Series Analysis - Final Presentation
- Bangladesh Electricity Demand Forecasting
- Time Series Analysis using SARIMA Model (2015-2025)

Agenda

1) Problem Statement
2) Exploratory Data Analysis
3) Graph Historical Cycles and Trends
4) Feature Engineering
5) SARIMA Parameters
6) Graph 24-Month Forecast
7) Model Validation
8) Graph Model Validation
9) Results

PROBLEM STATEMENT

THE DATASET

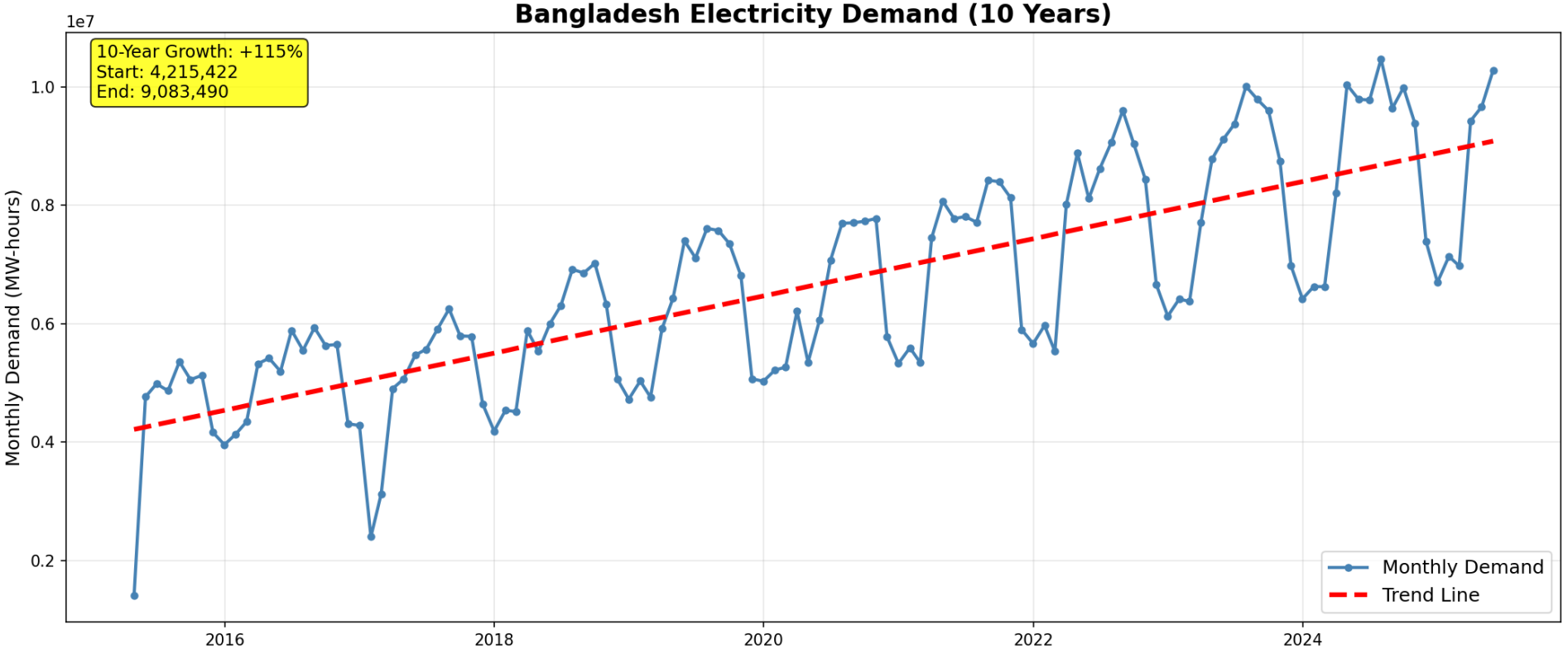
- Bangladesh electricity demand data
- 10 years (2015-2025)
- 92,650 hourly measurements
- Source: Bangladesh Power Development Board

THE CONTEXT

- Rapid economic growth in Bangladesh
- Electricity demand increasing significantly
- Need accurate forecasts for planning

THE GOAL

- Forecast monthly electricity demand for next 24 months


Bangladesh Electricity Demand (10 Years)
1e7
10-Year Growth: +115%
Start: 4,215,422
End: 9,083,490
Monthly Demand (MW-hours)
1.0
0.8
0.6
0.4
0.2
2016
2018
2020
2022
2024
Monthly Demand
Trend Line

EXPLORATORY DATA ANALYSIS

MAJOR FINDINGS

1. STRONG GROWTH TREND
   - Demand doubled over 10 years (+111%)
   - Consistent year-over-year increase
2. SEASONAL PATTERN
   - Peak: August
   - Low: December
   - 47% difference between peak and low
3. PREDICTABLE CYCLES
   - Pattern repeats every year
   - Makes forecasting reliable

FEATURE ENGINEERING

Data Preparation

Step 1: Clean Outliers

- Detected 96 erroneous values (0.1% of data)
- Used IQR statistical method
- Replaced with rolling median

Step 2: Aggregate Data

- Hourly → Monthly totals
- Summed all hours within each month
- 92,650 hours → 122 months

Result

Clean monthly dataset ready for forecasting model

SARIMA PARAMETERS

MODEL: SARIMA(1,1,1)(1,1,1,12)

NON-SEASONAL PARAMETERS (p,d,q)

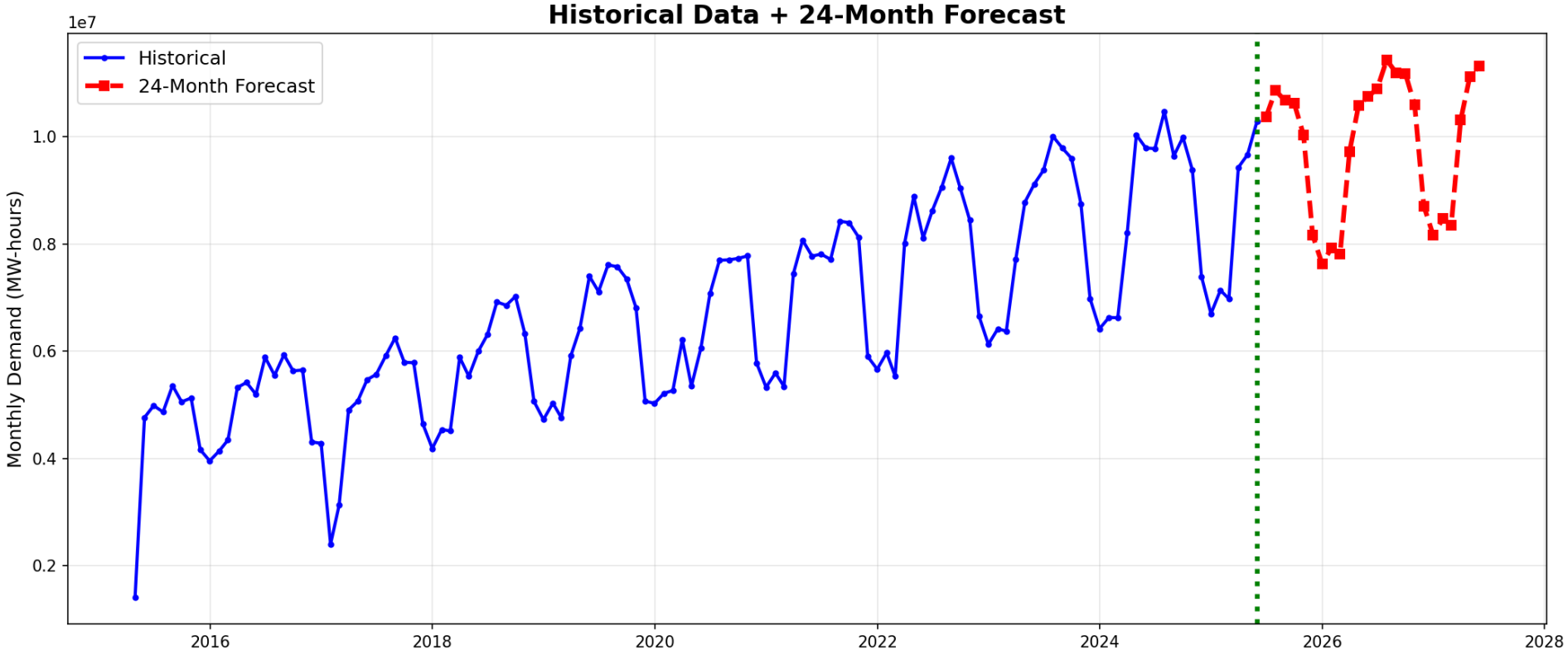
- p = 1 Autoregressive order (uses 1 past value)
- d = 1 Differencing order (removes trend)
- q = 1 Moving average order (uses 1 past error)

SEASONAL PARAMETERS (P,D,Q,s)

- P = 1 Seasonal AR (uses value from 1 year ago)
- D = 1 Seasonal differencing (removes seasonal pattern)
- Q = 1 Seasonal MA (uses error from 1 year ago)
- s = 12 Season length (12-month cycle)

PARAMETER SELECTION

- d=1: ADF test showed non-stationarity (p=0.84)
- After differencing: stationary (p=0.000006)
- D=1: Standard for monthly data with yearly seasonality
- AR and MA orders: Started with (1,1) for simplicity


Historical Data + 24-Month Forecast
1e7
Historical
24-Month Forecast
Monthly Demand (MW-hours)
1.0
0.8
0.6
0.4
0.2
2016
2018
2020
2022
2024
2026
2028

Model Validation

VALIDATION METHODOLOGY

TRAIN/TEST SPLIT

- Training: 98 months (April 2015 - May 2023)
- Testing: 24 months (June 2023 - May 2025)
- Model trained on historical data only
- Predictions compared against withheld test data

ACCURACY METRICS

- MAPE: 4.59% (Mean Absolute Percentage Error)
- MAE: 376,340 MW-hr (Mean Absolute Error)
- RMSE: 426,875 MW-hr (Root Mean Squared Error)

PERFORMANCE ASSESSMENT

- Target: <10% MAPE
- Achieved: 4.59% MAPE
- Rating: EXCELLENT
- Predictions within 5% of actual values on average

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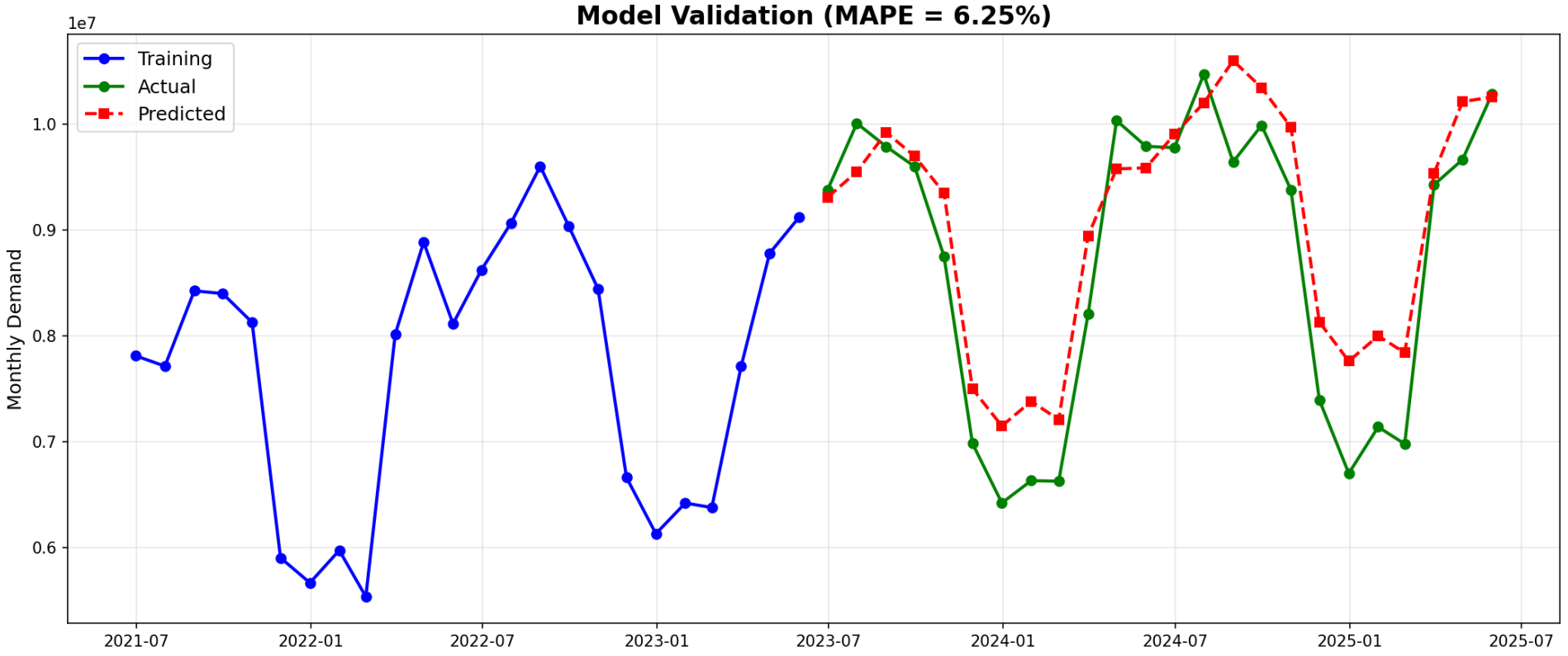
Model Validation (MAPE = 6.25%)
1e7
Training
Actual
Predicted
Monthly Demand
1.0
0.9
0.8
0.7
0.6
2021-07
2022-01
2022-07
2023-01
2023-07
2024-01
2024-07
2025-01
2025-07

RESULTS

24-MONTH FORECAST (June 2025 - May 2027)

FORECAST OUTPUT

- Average demand: 9.5M MW-hr/month
- Peak: August 2026 (11.2M MW-hr)
- Low: December 2026 (6.7M MW-hr)
- Projected growth: 8% year-over-year

MODEL PERFORMANCE

- Validation MAPE: 4.59% (Excellent)
- Successfully captures trend and seasonality
- Reliable for 24-month planning horizon

KEY FINDINGS

- Demand growth continues steadily
- Seasonal pattern persists (August peak, December low)
- Infrastructure planning should account for 47% seasonal swing

LIMITATIONS

- Assumes historical patterns continue
- Does not account for external factors (climate, policy, development)