# FCAS Project Presentation:

## Forecasting fuel consumption
## At Nation Level – US
## for


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# Business Problem

- **Problem Description:** To design a forecasting model for accurate prediction of variants of refinery products consumption in the US.
- **Stakeholder:** Valero Energy Corporation, a fortune 500 company involved in manufacturing and marketing of fuel and petrochemical products and power.
- **This would help them:**
  - Plan operations
  - Foresee cash flows
  - Optimize and manage procurement of inventory

# Forecasting Problem

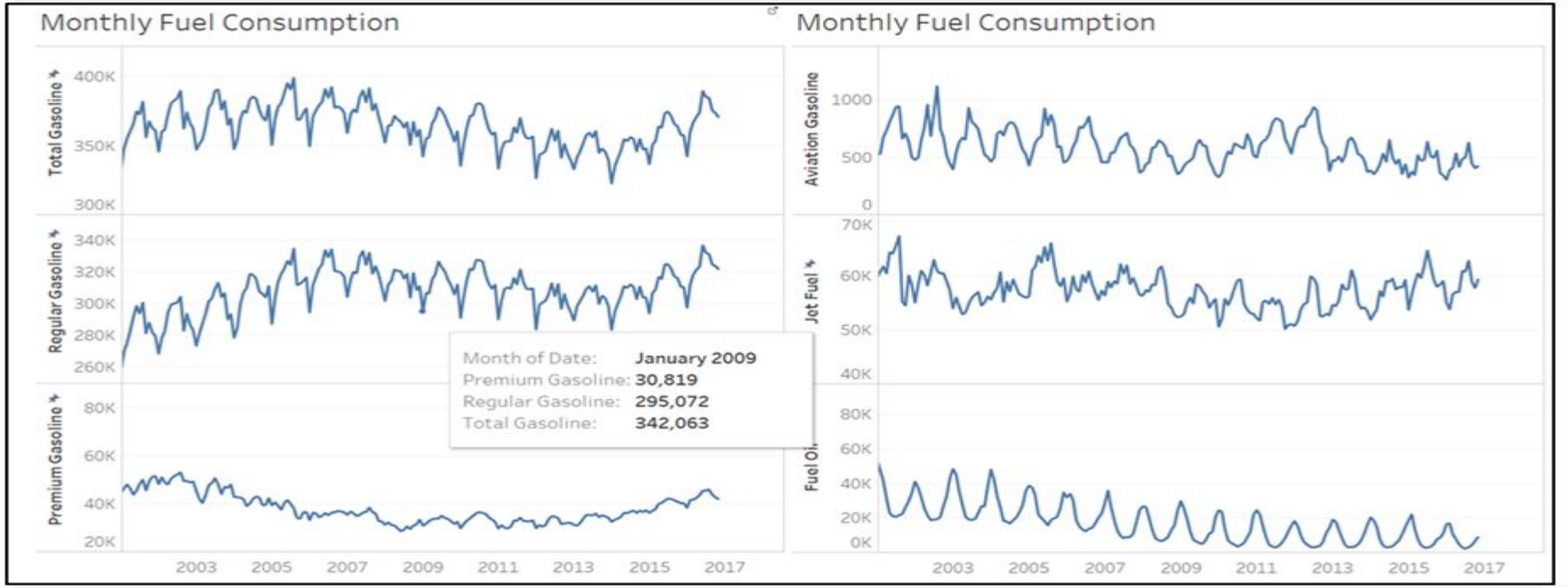
- **Objective:** To design a forecasting model for accurately predicting consumption of different refinery products in the US for 2016. The intent is to use consumption patterns to optimize on supply side factors / constraints.
- **Type of Modelling:** Forecasting
- **Method:** This is a supervised learning problem where we try to train the model based on past data regarding different fuel consumption in the US.
- **Success Criteria:** Minimize the Mean Absolute Percentage Error (MAPE). Lower the MAPE closer the predicted consumption to the actual consumption

# Data Description

- **Data Description** : The data contains 22 years of historical monthly data on different types of US refinery products including price information.
  - --**Source:** US Energy Information Administration (Forms EIA-782C, "Monthly Report of Prime supplier sales of Petroleum Products for local consumption"
  - --**Key Characteristics:** Month – Year Level ; Available Period: Jan 1983 to Dec 2015
  - --**Series to be analyzed** (Observation period 2001 to 2015)
    - o Total Gasoline
    - o Regular Gasoline
    - o Premium Gasoline
    - o Aviation Gasoline,
    - o Jet fuel and
    - o Fuel oil

# Data Description

DATA Source - https://www.eia.gov/dnav/pet/pet_sum_mkt_dcu_STX_m.htm

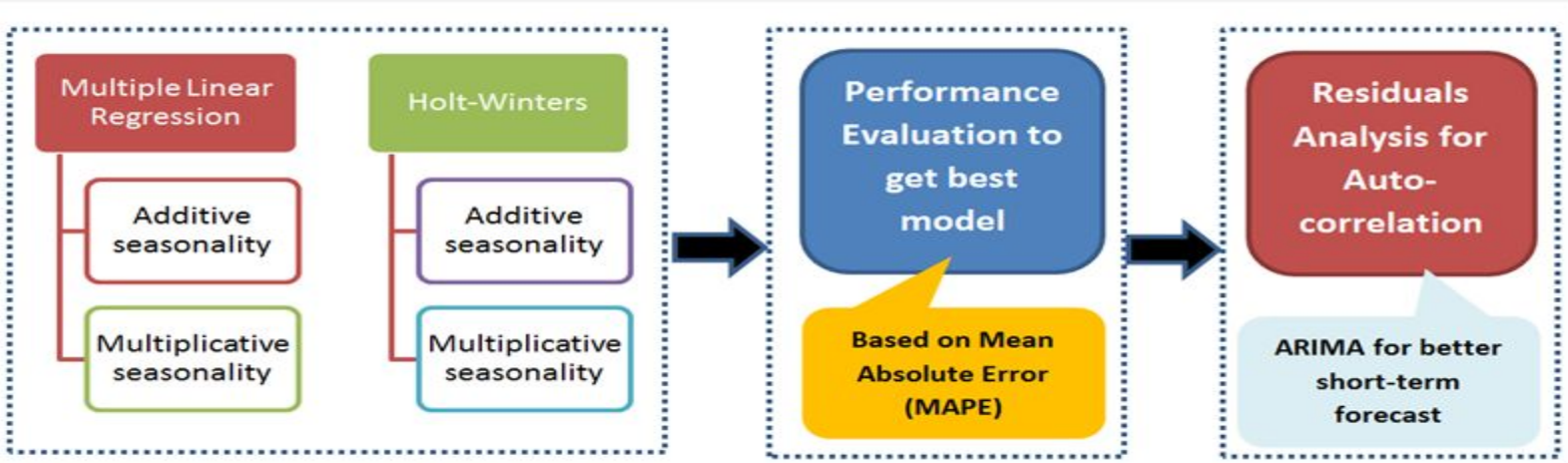



***Components observed:*** Level, Seasonality and Trend (With Noise)

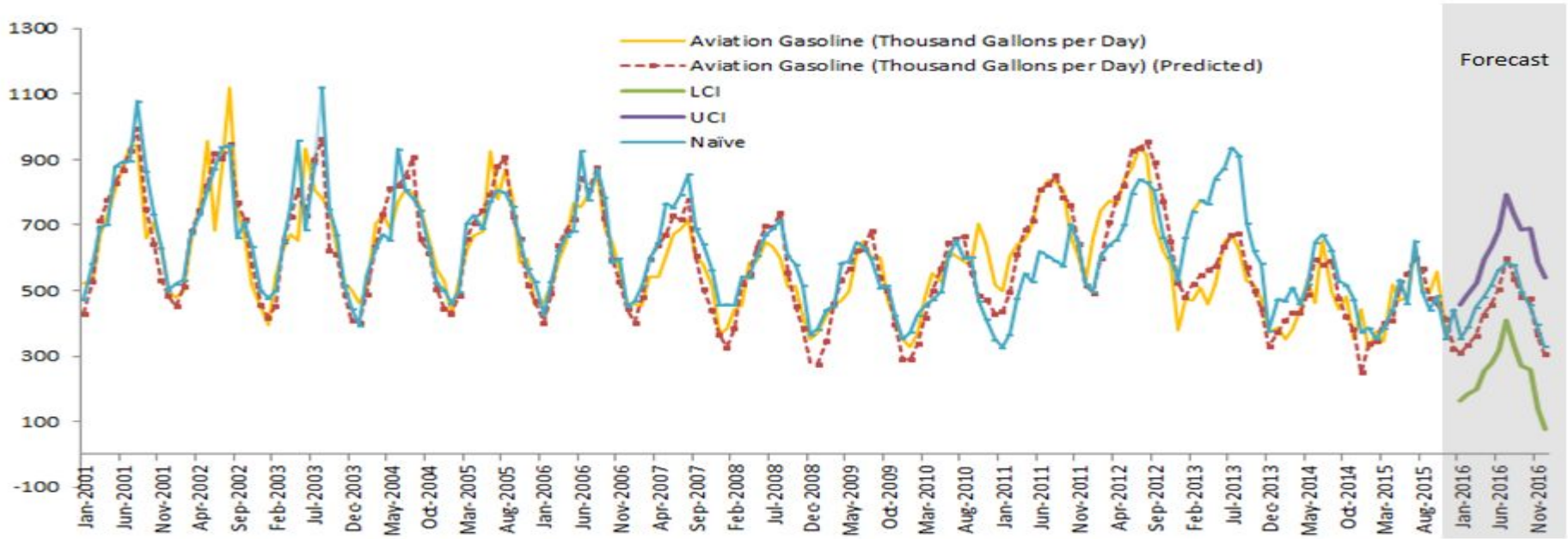
# Methods

- External information such as price, CPI and income tested but no correlation observed
- Data Partitioning : validation period - 12 months, training period 168 months
- We have considered forecasting methods that consider both trend and seasonality.

- The following predictive models were performed and their performance evaluated to arrive at the final model

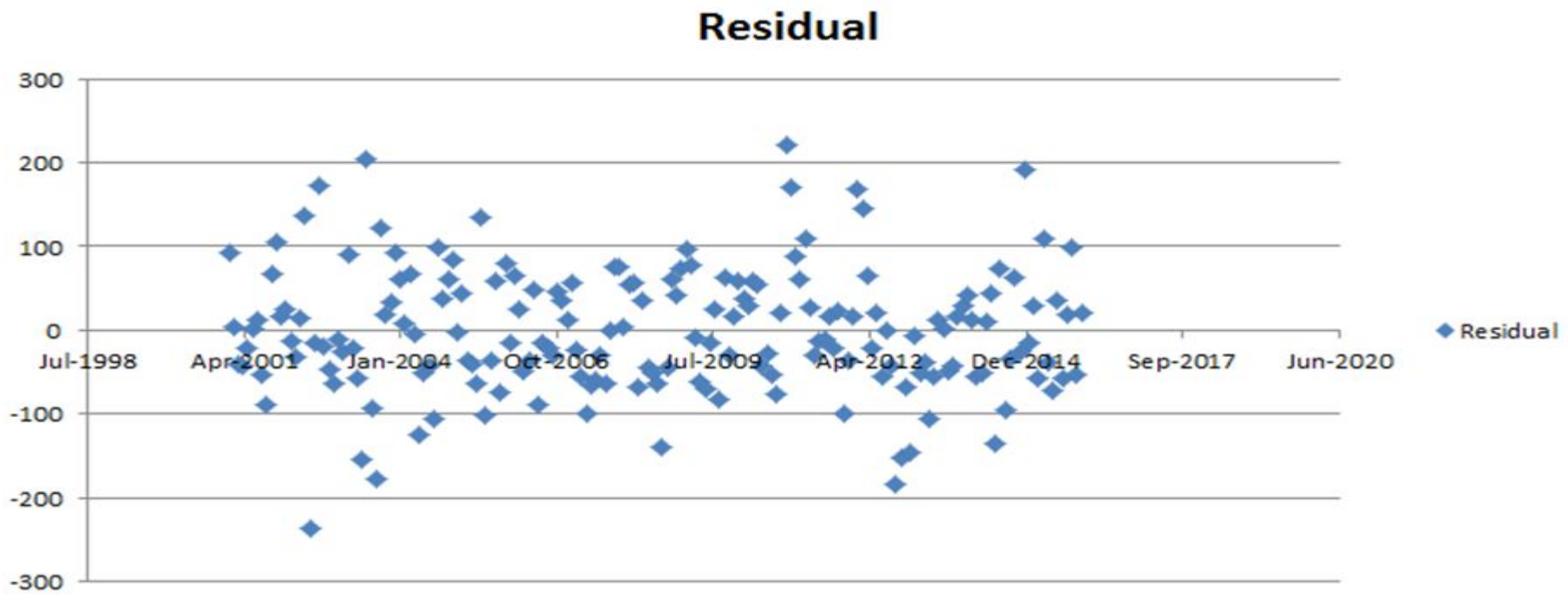


# Actual, Predicted and Forecasted Values for Aviation Gasoline – Holt Winter Multiplicative Model



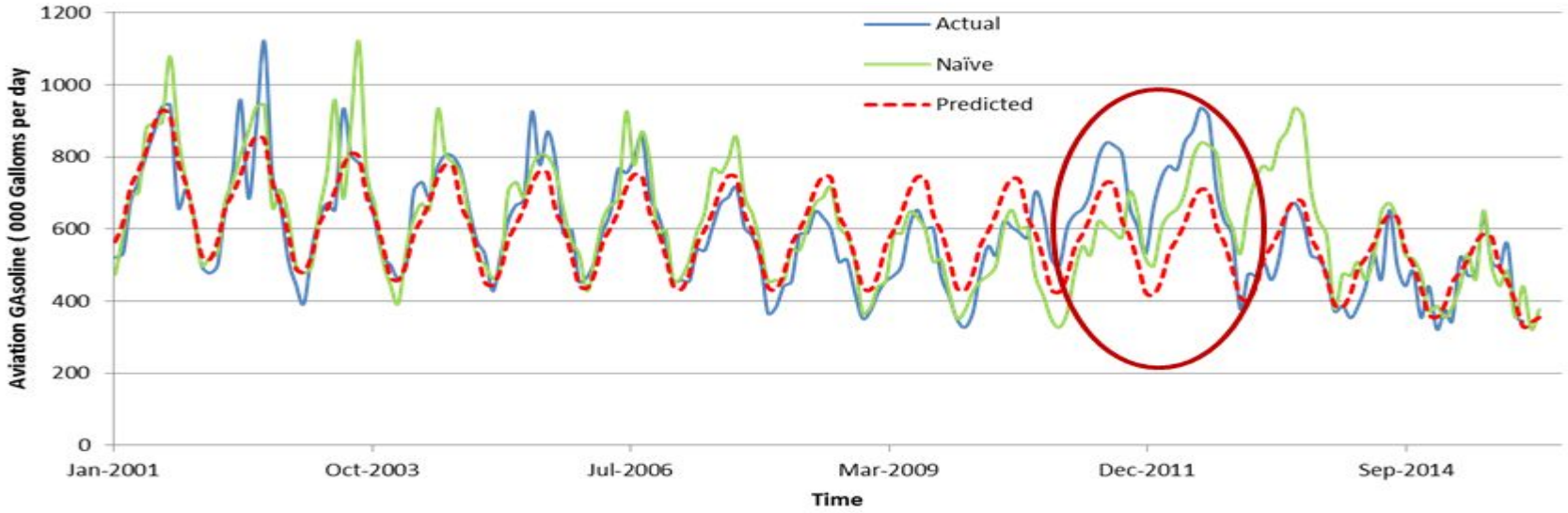

The graph shows Actual Values, Predicted Values, Naïve Prediction and Forecasted values

# Residual Plot– Holt Winter Multiplicative Model



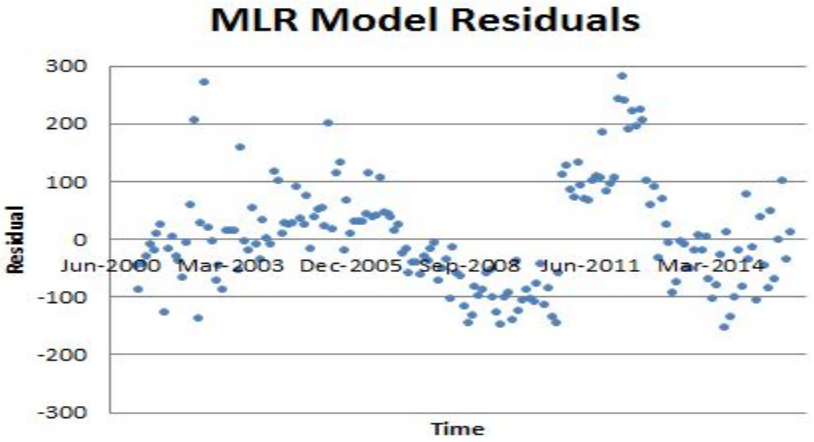

Plot of residuals from Holts Winter Multiplicative Model with time

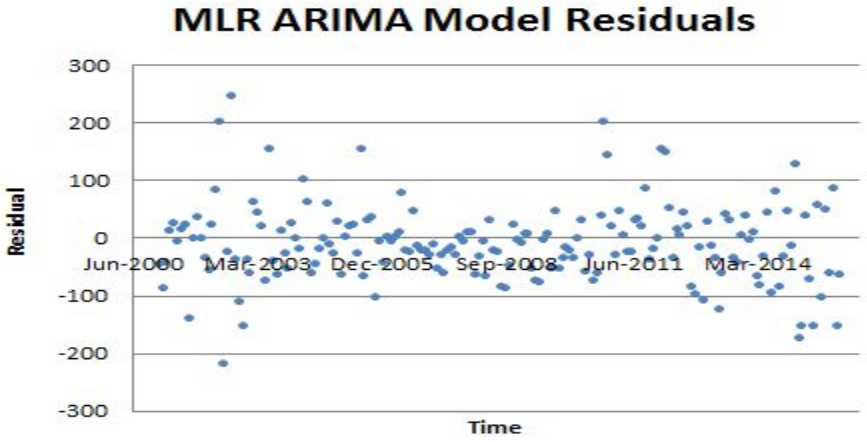
# Actual, Predicted and Forecasted Values for Aviation Gasoline – MLR model with multiplicative seasonality

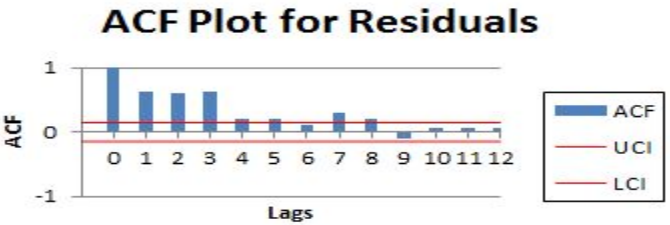



The prediction is off in the circled area, We also looked at autocorrelation in the residuals

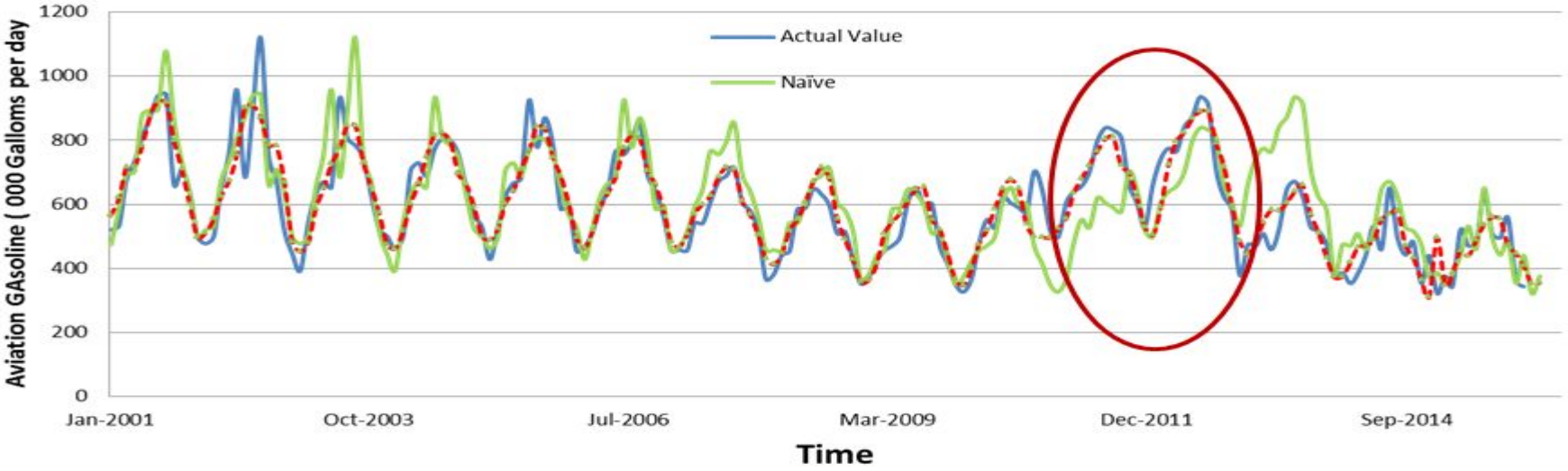
# Residual Plot - MLR and MLR ARIMA model



# EVALUATIONS




Model Prediction Improves by inclusion AR(3)

# EVALUATIONS

- **Short Term Horizon:** The final model is based on running the ARIMA model over Multiple Logistic Regression (MLR) by removing auto-correlation providing us forecasts for the 1st two months in 2016 with high accuracy.
- **Long Term Horizon:** The final model is based on running the Holt's winter which provides us with forecasts of 12 months of fuel consumption with a relatively low accuracy or MAPE

*In Long Term MAPE is relatively more*

*MAPE Improved by ARIMA in short term*

| | Long Term | | Short Term | |
|---|---|---|---|---|
| Type of Fuel | MAPE | Method Name | MAPE | Method Name |
| Total Gasoline | 3.3% | *Holt Winter's Model (Forecasts for 12 months)* | 1.8% | *ARIMA Model over MLR (Forecasts for 2 months)* |
| Premium Gasoline | 11.1% | | 2.2% | |
| Regular Gasoline | 2.6% | | 1.6% | |
| Jet Fuel | 2.3% | | 2.3% | |
| Avaition Gasoline | 11.7% | | 11.3% | |
| Fuel Oil | 21.9% | | 19.3% | |

# RECOMMENDATIONS

- The short term model should be re-run every month for prediction of next month's consumption.
- The long term model should be re-run every 12 months for prediction of next 12 month's consumption.
- External factors such as environmental, political, and economical risks are not accounted in the model
- Price and profitability should be considered in conjunction with the consumption pattern and prediction to plan production accordingly