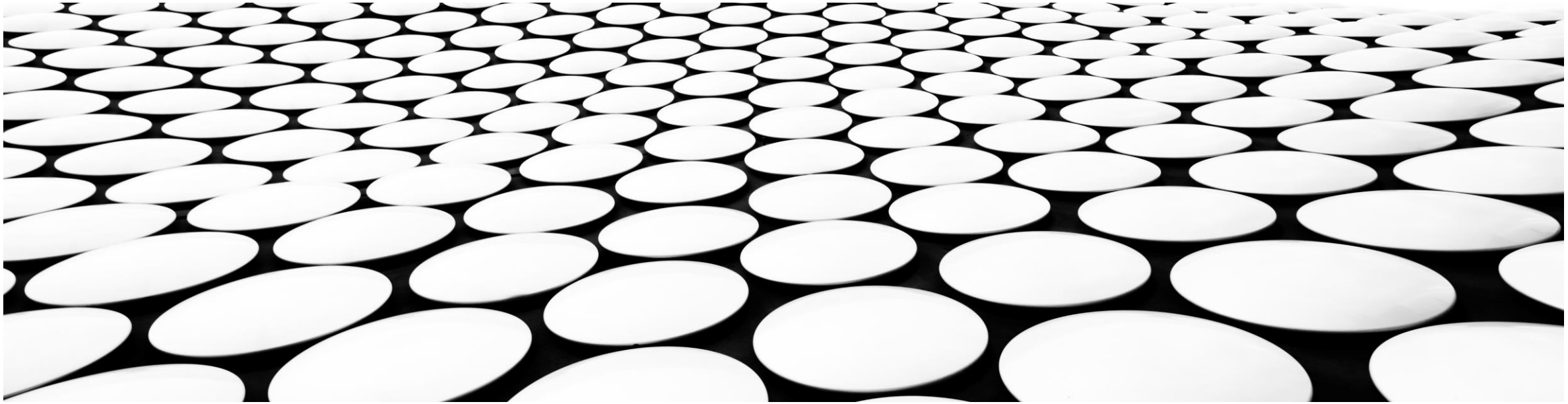
SAMPLE LIVE PRESENTATION - CARBON EMISSIONS FORECASTING



PROBLEM DEFINITION

Global warming is a growing problem caused by greenhouse gases

CO2 emissions are one of main contributors to greenhouse gases

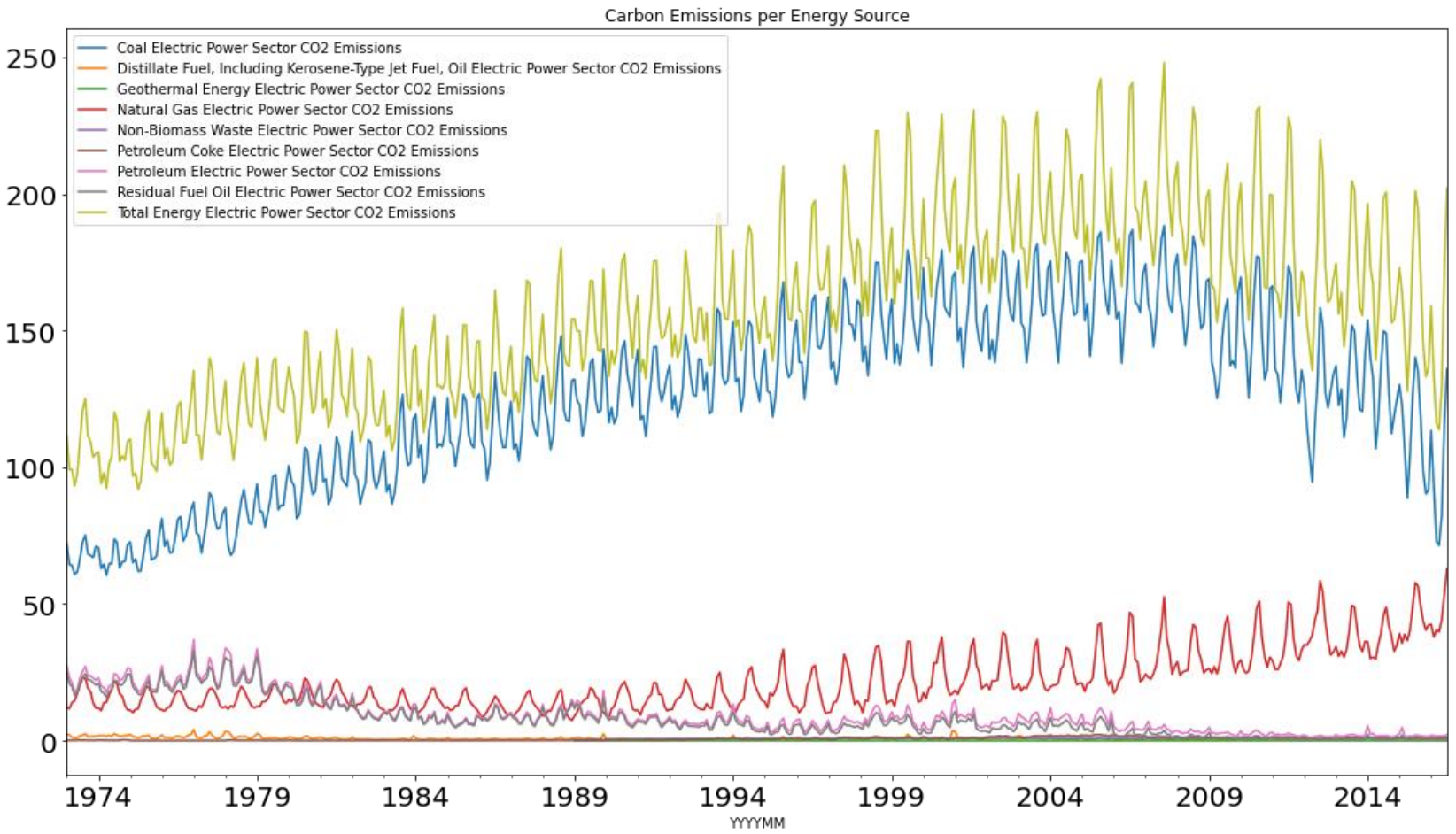
Energy production by humans heavily contribute to CO2 emissions

PROBLEM TO SOLVE

- We need to figure out future CO2 emissions to see how fast the problem is growing
- Can we use time series models to predict CO2 emissions from the use of natural gas?
- What are some policies that can be adopted to reduce natural gas carbon emissions?

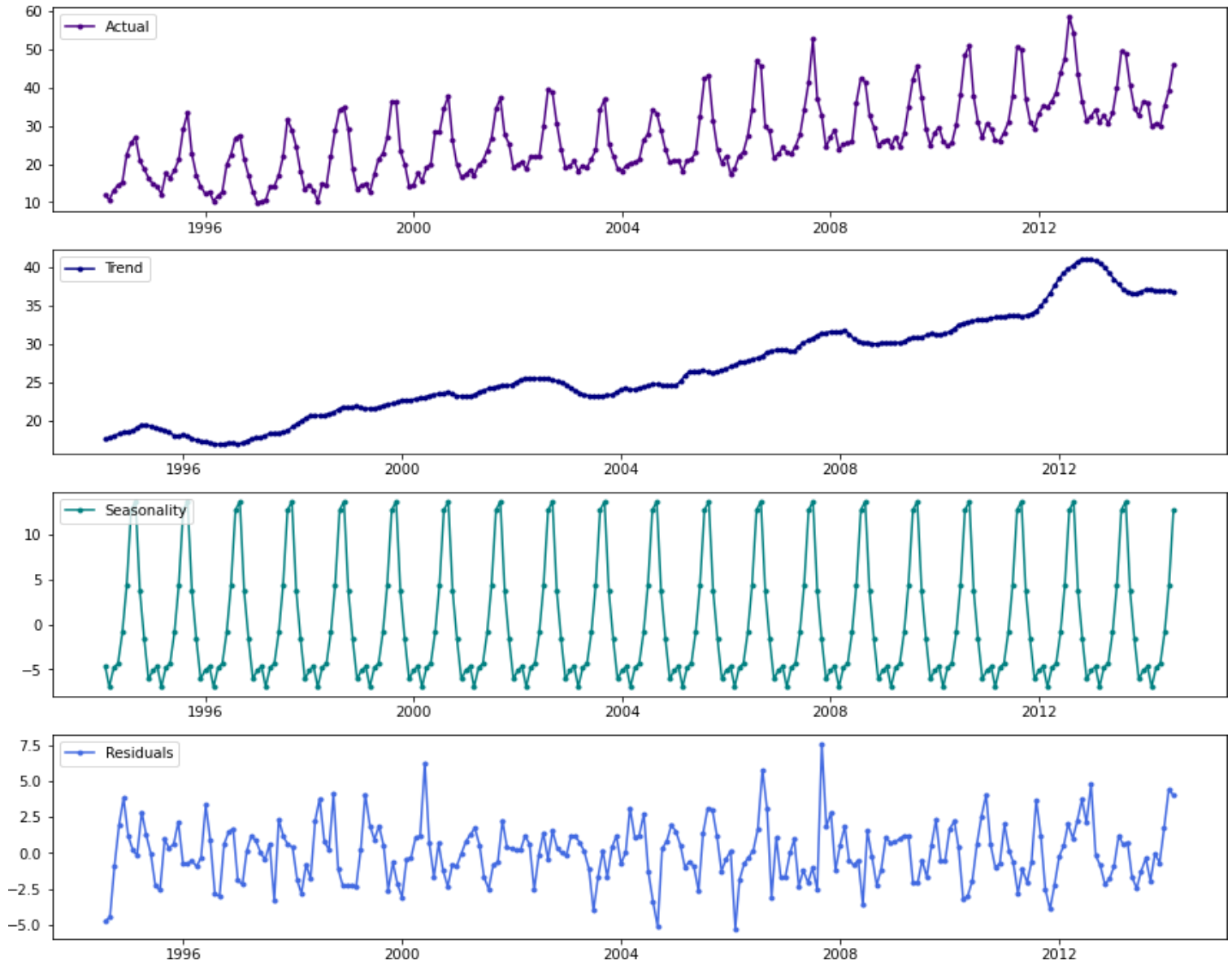
SOLUTION APPROACH

- Data exploration led to a few key takeaways
- CO2 emission values oscillate as the years progress (seasonal)
- Natural gas emissions are steadily increasing (red line)
- Coal emissions have decreased in recent years (blue line)



EMISSIONS SPECIFICALLY DUE TO NATURAL GAS

- The full data set of the training data from January 1994 to July 2014.
- The data can be broken into the following components:
- Trend: (Increasing, decreasing, linear, and non-linear)
- Seasonality: (repeated pattern)
- Residuals: (randomness)



PROPOSED MODEL SOLUTION

SARIMAX is a time series model chosen to forecast emission values

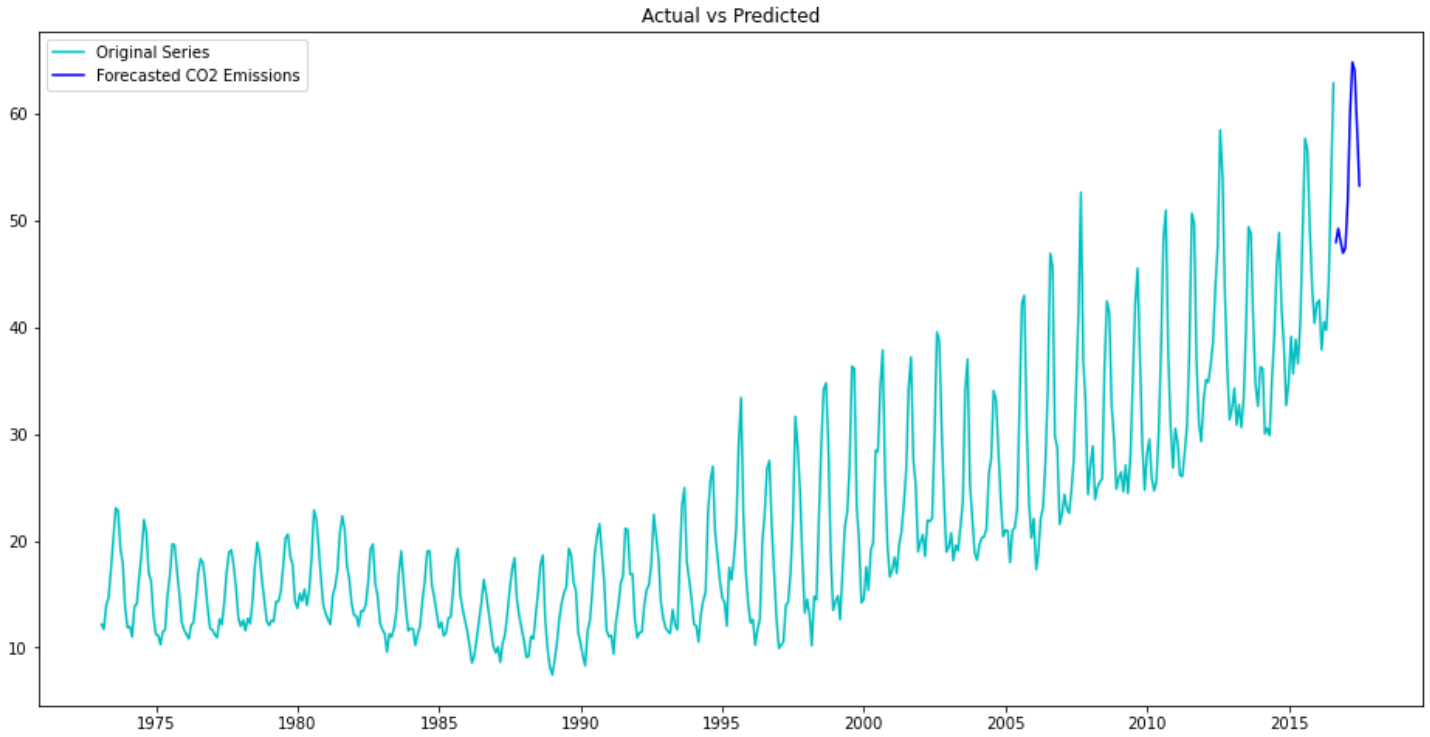
Seasonal Auto Regressive Integrated Moving Average with exogenous factors

SARIMAX takes seasonality and exogenous factors into account along with previous values and noise for calculating predictions

Provided data shows seasonality and other energy source production may impact production

FINAL MODEL SOLUTION

- AR time series model had the best performance out of all models tested
- The appropriate lag value was able to address seasonality
- Forecasted CO2 emissions for natural gas follow the same trend and value magnitude



PROPOSED BUSINESS SOLUTION

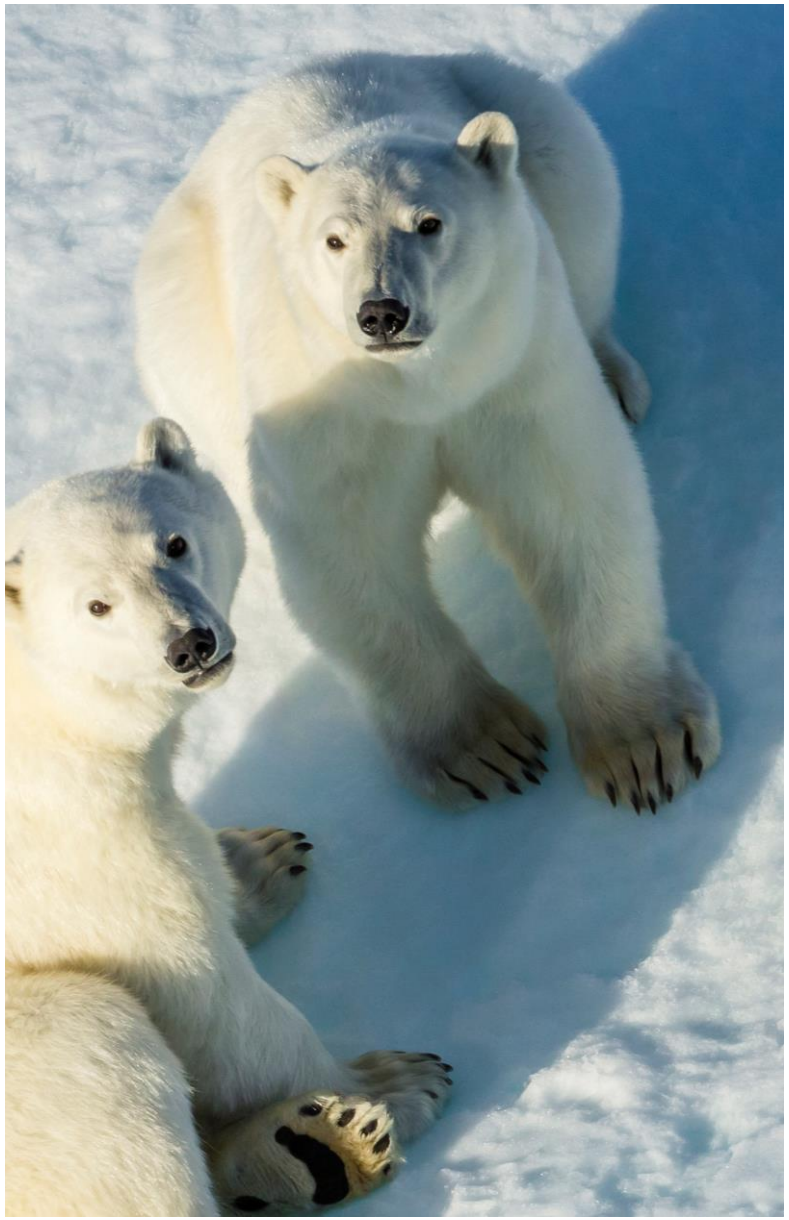
- Alternative energy sources are needed to replace coal and natural gas electric power generation
- Invest in research and technology to develop clean energy sources
- Some examples include
  - Nuclear
  - Solar Power Energy
  - Wind Turbine Energy
  - Ethanol

EXECUTING BUSINESS SOLUTION

- Nuclear power is the least expensive so start there
- Invest in infrastructure for more power plant constructions
- Promote support educational grants and programs for students to study and infuse the workforce
- Risks like nuclear reactor malfunctions are possible but unlikely
- Need to education the public and overcome political games some governments play

EXECUTIVE SUMMARY

- Autoregressive model can predict CO2 emissions with appropriate parameters
- CO2 emissions from natural gas is likely to increase over the next 12 months
- Nuclear energy is a reliable source to replace other energy sources of electricity
- Replacing coal and natural gas power with nuclear power will drastically reduce carbon emissions
- Less CO2 emissions will reduce greenhouse gases contributing to global warming



CARBON EMISSIONS – RISKS & CHALLENGES

- Risks
  - There are clear high upfront costs associated with alternative methods to energy generation, as in the case of wind and solar energy.
  - We are still in the early stage of recognizing these alternatives to be at par with natural gas in terms of the amount of energy required to be generated.
  - There will be a gap between the cost benefits of alternatives to cat5ch up to the already existing natural gas.
- Challenges
  - There will strong opposition from the natural gas industry, including utility providers and the natural gas pipelining industry
  - Maintenance of new equipment such as large solar fields or wind turbines will bring a new challenges and the need for the rise of new industry standards for the same.
  - Policies will need to e put n place offering tax benefits to firms and end users of alternative sources of energy, to get more customers to switch.

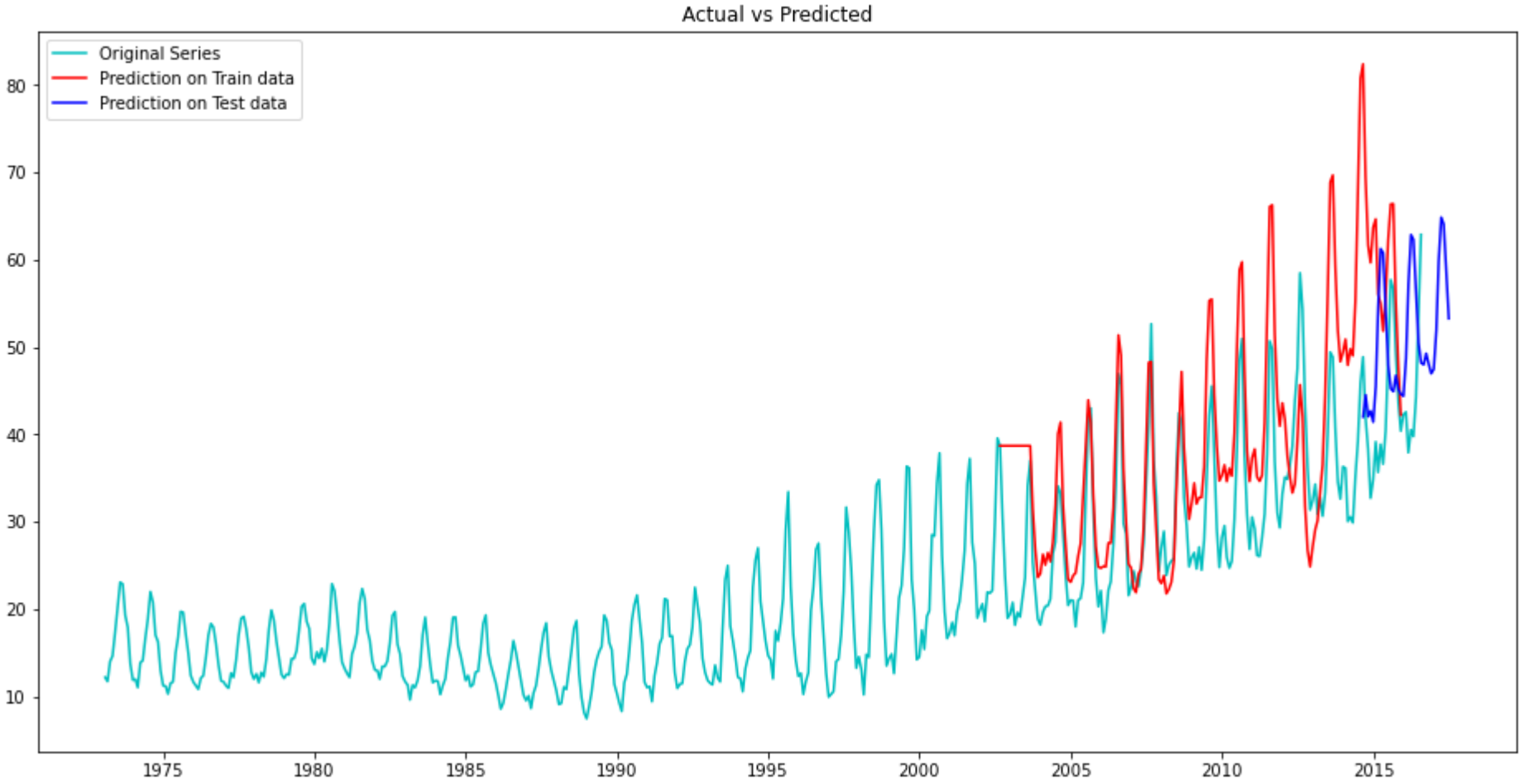
THANK YOU

APPENDIX

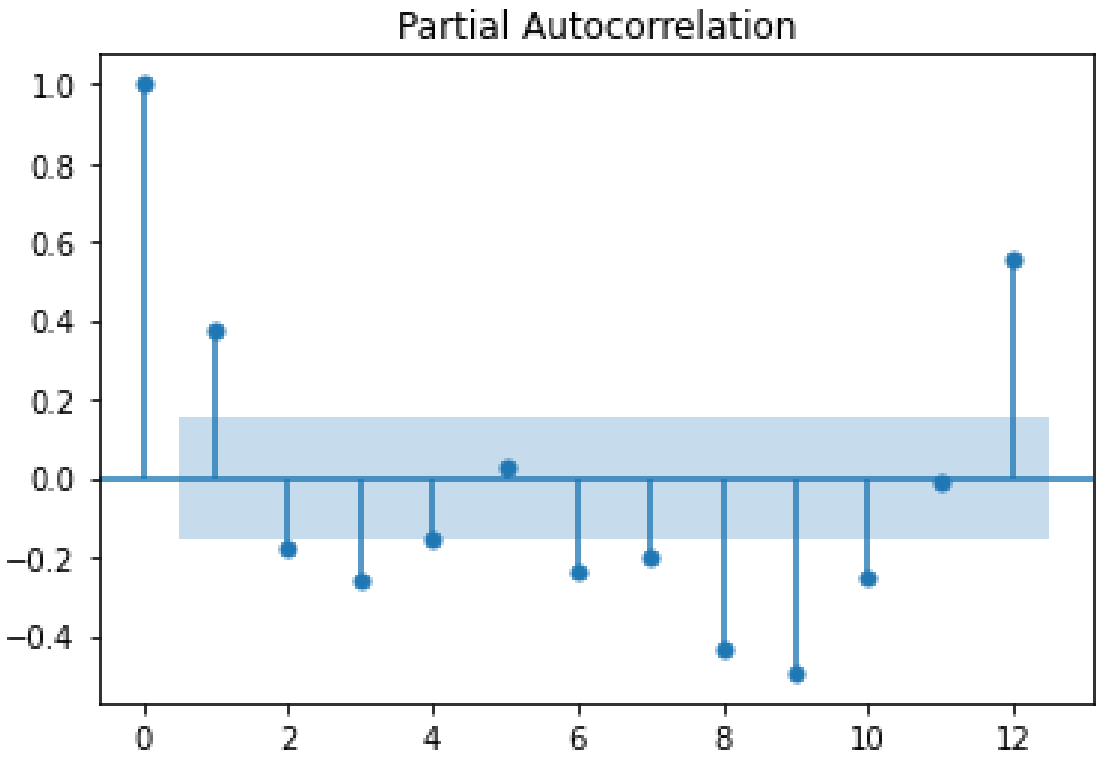
MODEL COMPARISON

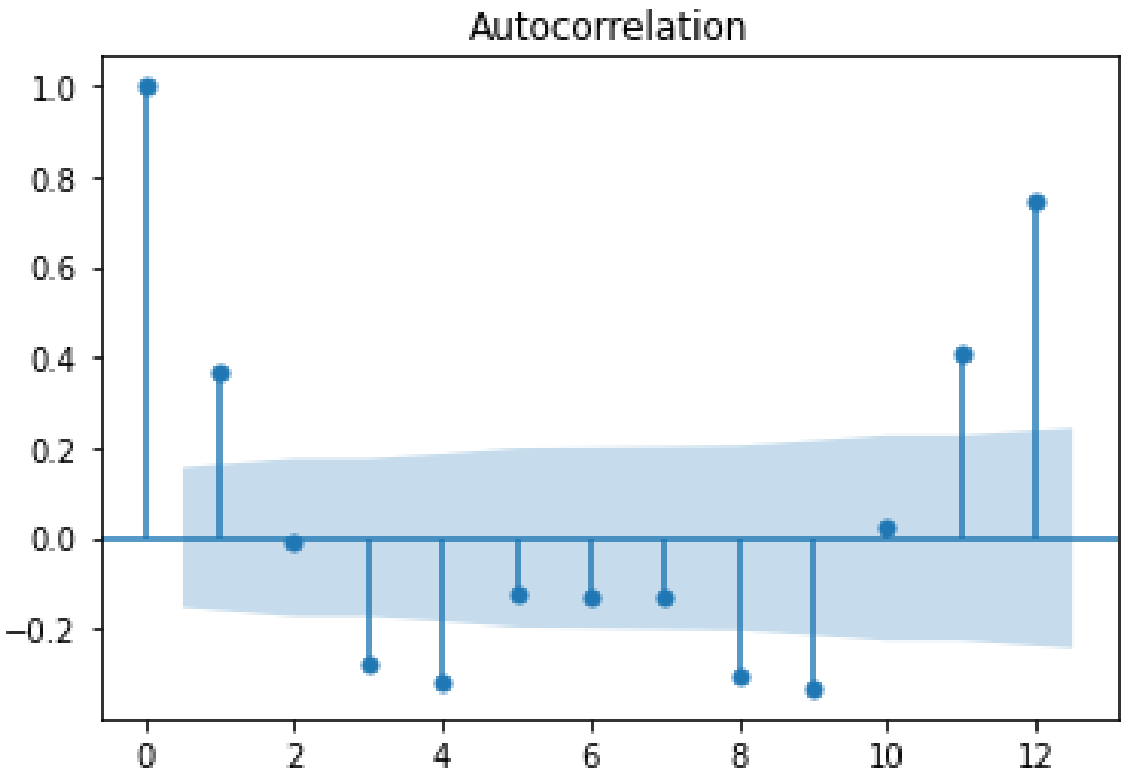
Model	AIC	RMSE (test data)
AR	-4.86	14.17
MA	-229.00	43.95
ARMA	-291.16	89.28
ARIMA	-306.28	114.15
SARIMAX	-308.35	31.30

PREDICTIONS ON TEST AND TRAIN DATA



SOLUTION CODE HIGHLIGHTS





```
from sklearn.metrics import mean_squared_error

#Importing AutoReg function to apply AR model
from statsmodels.tsa.ar_model import AutoReg
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plt.figure(figsize=(16,8))
model_AR = AutoReg(df_shift, lags=12) #Using number of lags as 12
results_AR = model_AR.fit()
plt.plot(df_shift)
predict = results_AR.predict(start=0,end=len(df_shift)-1)
predict = predict.fillna(0) #Converting NaN values to 0
plt.plot(predict, color='red')
plt.title('AR Model - RMSE: %.4f'% mean_squared_error(predict,df_shift['Co2_emissions'], squared=False))  #Calculating rmse
plt.show()
#Code here
```

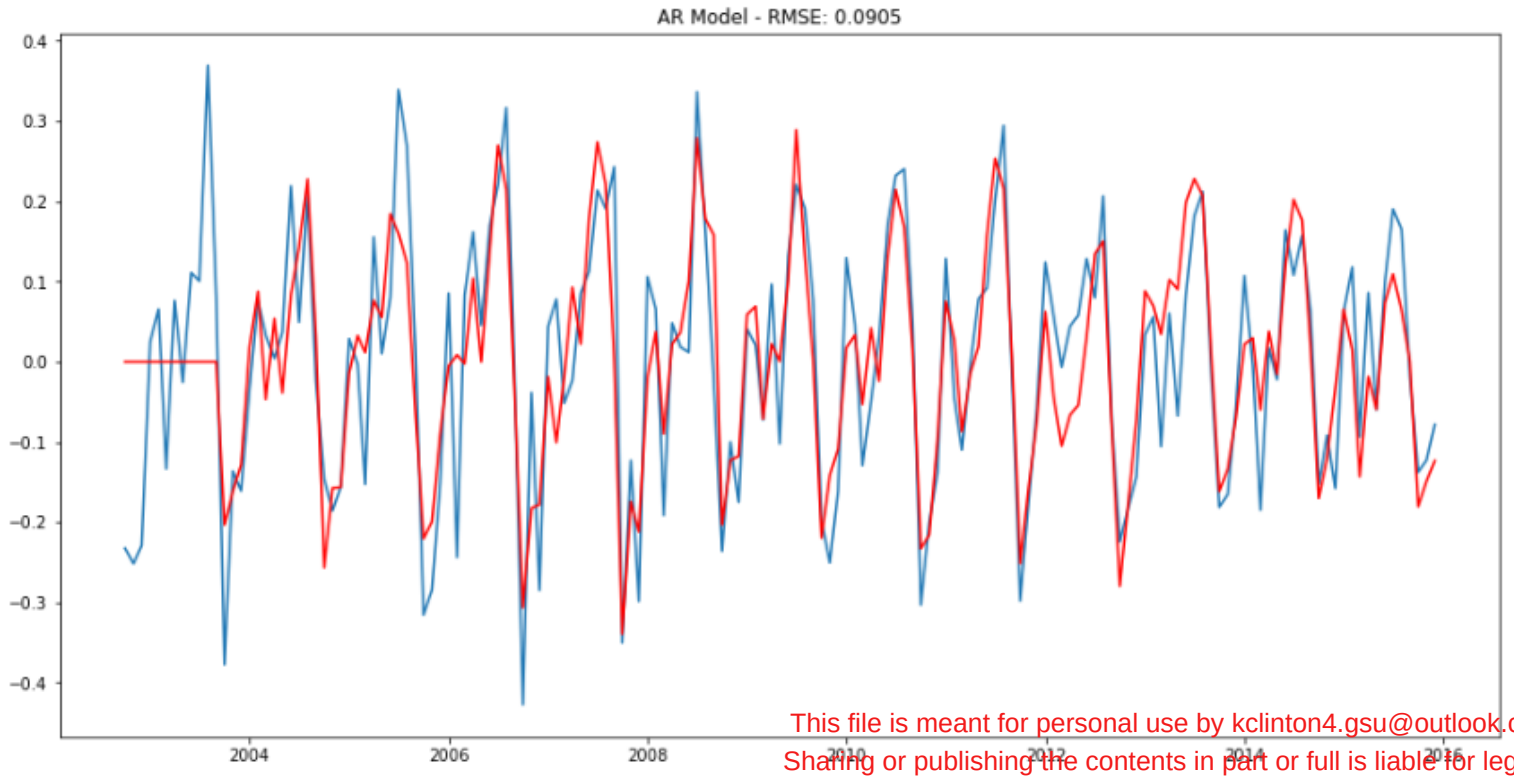

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