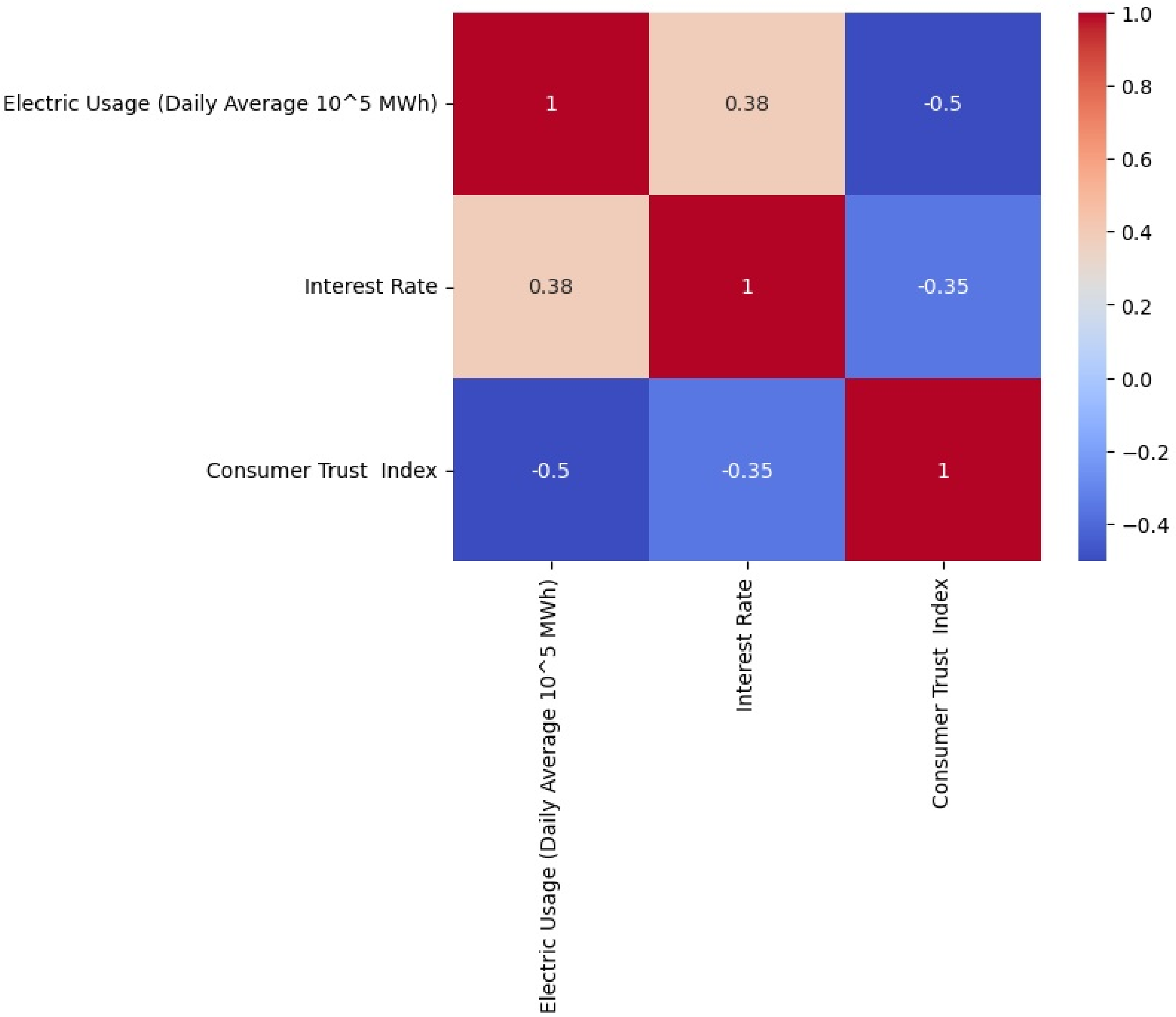
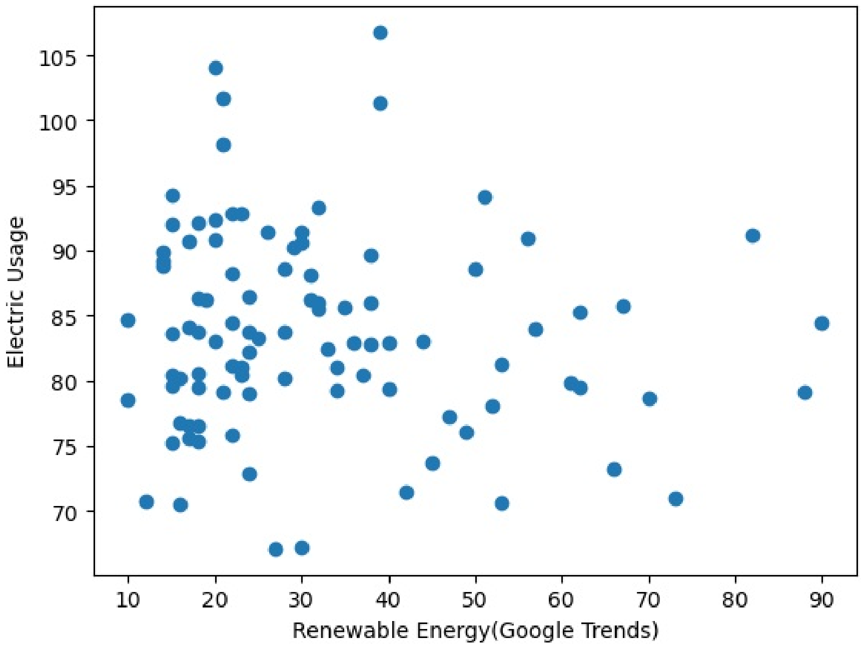
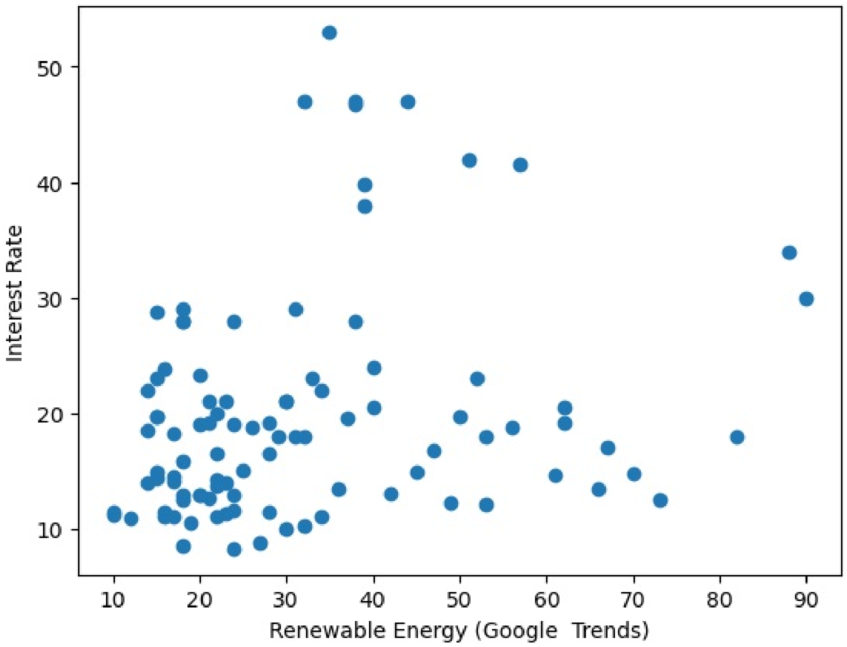
Hüseyin Kızıltaş 2020402165 The aim of the work is to detect the relation of "Daily Electric Usage" with "Interest Rates" "Consumer Trust Index" and Google Trends values of keywords "Renewable Energy", "Energy Savings", "Electricity Bills"

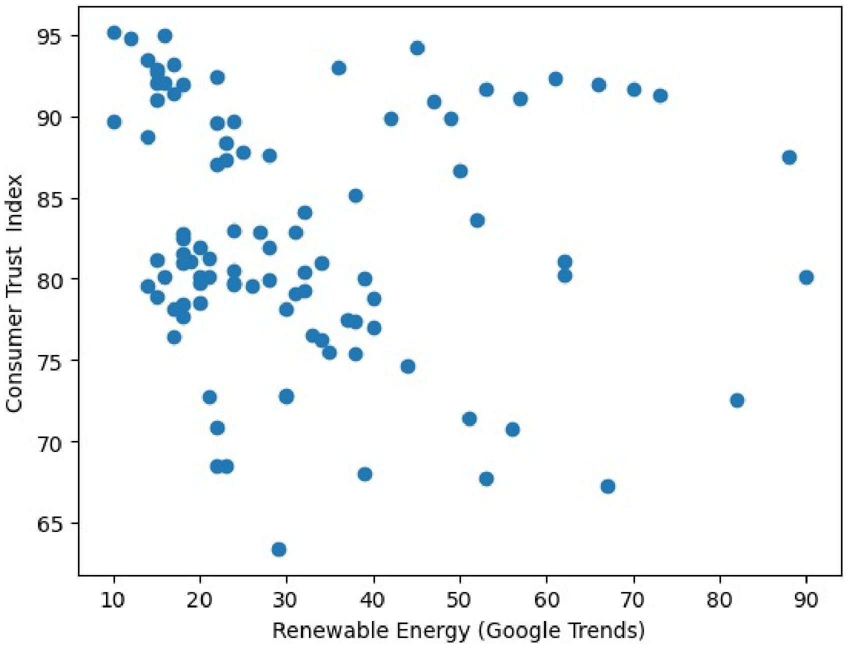
In [ ]:

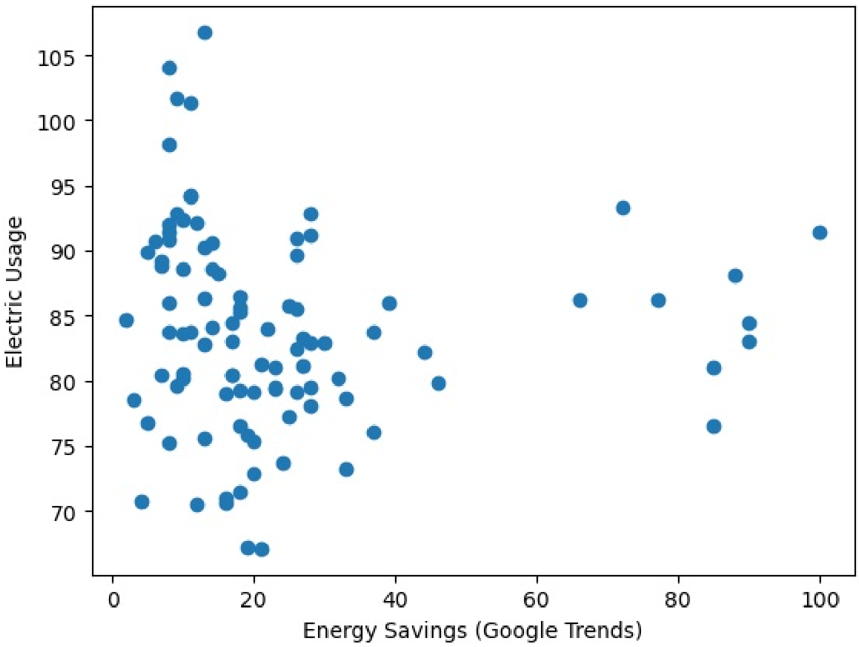
```python
import pandas as pd
import seaborn as sns
import matplotlib.pyplot as plt
import scipy.stats as stats
import statsmodels.api as sm
import plotly.express as px

data = pd.read_csv('go.csv')

data['Tarih'] = pd.to_datetime(data['Tarih'])

data_long = pd.melt(data, id_vars='Tarih', var_name='Variable', value_name='Value')

fig = px.line(data_long, x='Tarih', y='Value', color='Variable', title='Time Series Plot for Each Variable')
fig.show()

corr_matrix = data.iloc[:, 1:4].corr()

sns.heatmap(corr_matrix, annot=True, cmap='coolwarm')
plt.show()


plt.scatter(data.iloc[:, 4], data.iloc[:, 1])
plt.xlabel("Renewable Energy(Google Trends)")
plt.ylabel("Electric Usage")
plt.show()

plt.scatter(data.iloc[:, 4], data.iloc[:, 2])
plt.xlabel("Renewable Energy (Google  Trends)")
plt.ylabel("Interest Rate")
plt.show()

plt.scatter(data.iloc[:, 4], data.iloc[:, 3])
plt.xlabel("Renewable Energy (Google Trends)")
plt.ylabel("Consumer Trust  Index")
plt.show()

plt.scatter(data.iloc[:, 5], data.iloc[:, 1])
plt.xlabel("Energy Savings (Google Trends)")
plt.ylabel("Electric Usage")
plt.show()

plt.scatter(data.iloc[:, 5], data.iloc[:, 2])
plt.xlabel("Energy Savings (Google  Trends)")
plt.ylabel("Interest Rate")
plt.show()

plt.scatter(data.iloc[:, 5], data.iloc[:, 3])
plt.xlabel("Energy Savings (Google Trends)")
plt.ylabel("Consumer Trust  Index")
plt.show()

plt.scatter(data.iloc[:, 6], data.iloc[:, 1])
plt.xlabel("Electricity Bills (Google Trends)")
plt.ylabel("Electric Usage")
plt.show()

plt.scatter(data.iloc[:, 6], data.iloc[:, 2])
plt.xlabel("Electricity Bills (Google  Trends)")
plt.ylabel("Interest Rate")
plt.show()

plt.scatter(data.iloc[:, 6], data.iloc[:, 3])
plt.xlabel("Electricity Bills (Google Trends)")
plt.ylabel("Consumer Trust  Index")
plt.show()
```

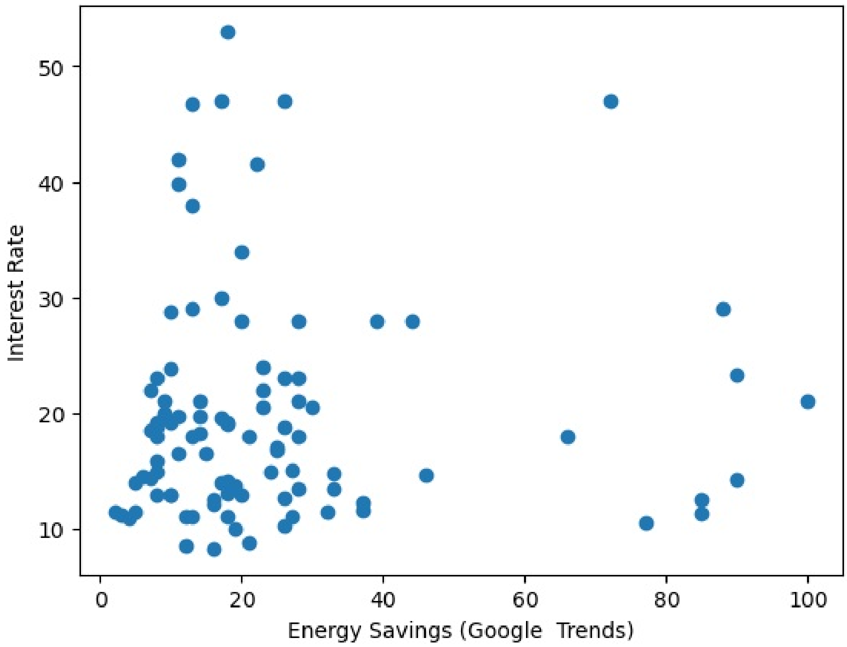

Electric Usage (Daily Average 10^5 MWh)
Interest Rate
Consumer Trust Index
1
0.38
-0.5
0.38
1
-0.35
-0.5
-0.35
1
1.0
0.8
0.6
0.4
0.2
0.0
−0.2
−0.4

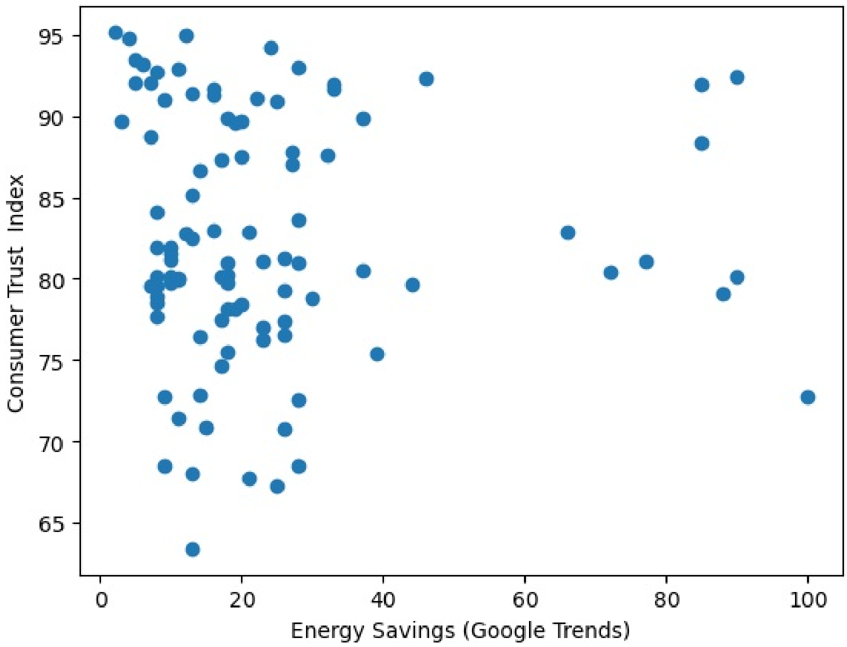

Electric Usage
Renewable Energy(Google Trends)
105
100
95
90
85
80
75
70
10
20
30
40
50
60
70
80
90

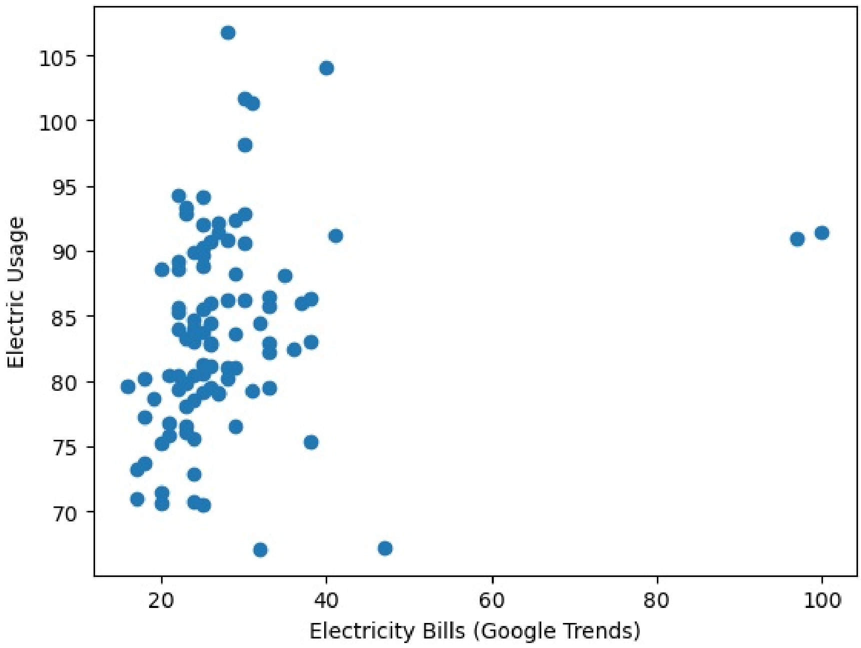

Interest Rate
10
20
30
40
50
10
20
30
40
50
60
70
80
90
Renewable Energy (Google Trends)

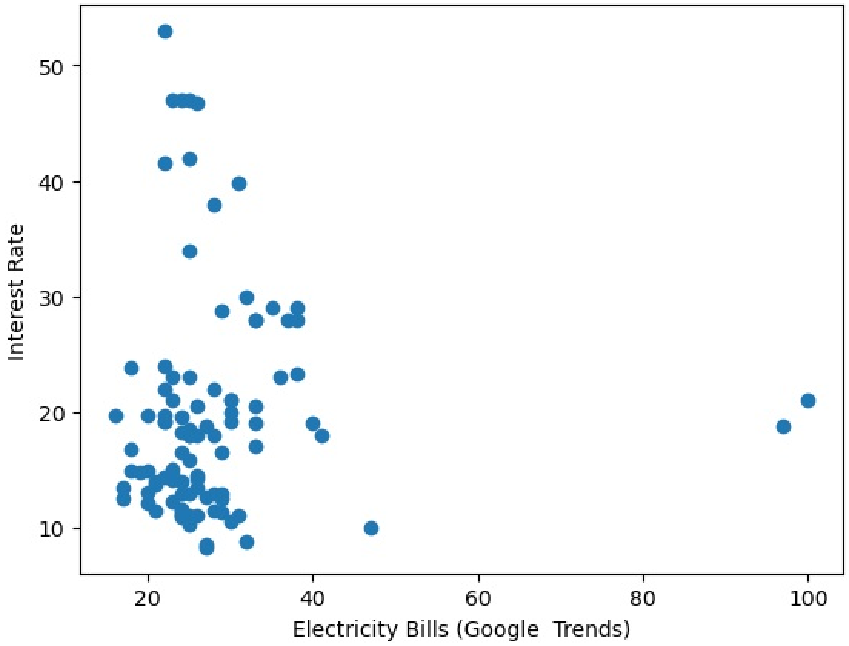

Consumer Trust Index
65
70
75
80
85
90
95
10
20
30
40
50
60
70
80
90
Renewable Energy (Google Trends)

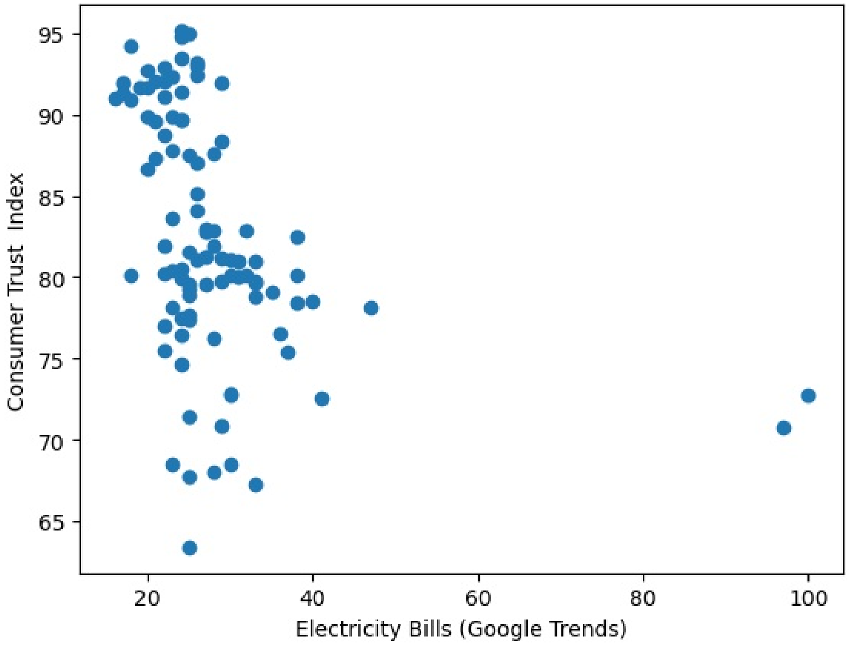

Electric Usage
70
75
80
85
90
95
100
105
0
20
40
60
80
100
Energy Savings (Google Trends)


Interest Rate
10
20
30
40
50
0
20
40
60
80
100
Energy Savings (Google Trends)


Consumer Trust Index
65
70
75
80
85
90
95
0
20
40
60
80
100
Energy Savings (Google Trends)


Electric Usage
70
75
80
85
90
95
100
105
20
40
60
80
100
Electricity Bills (Google Trends)





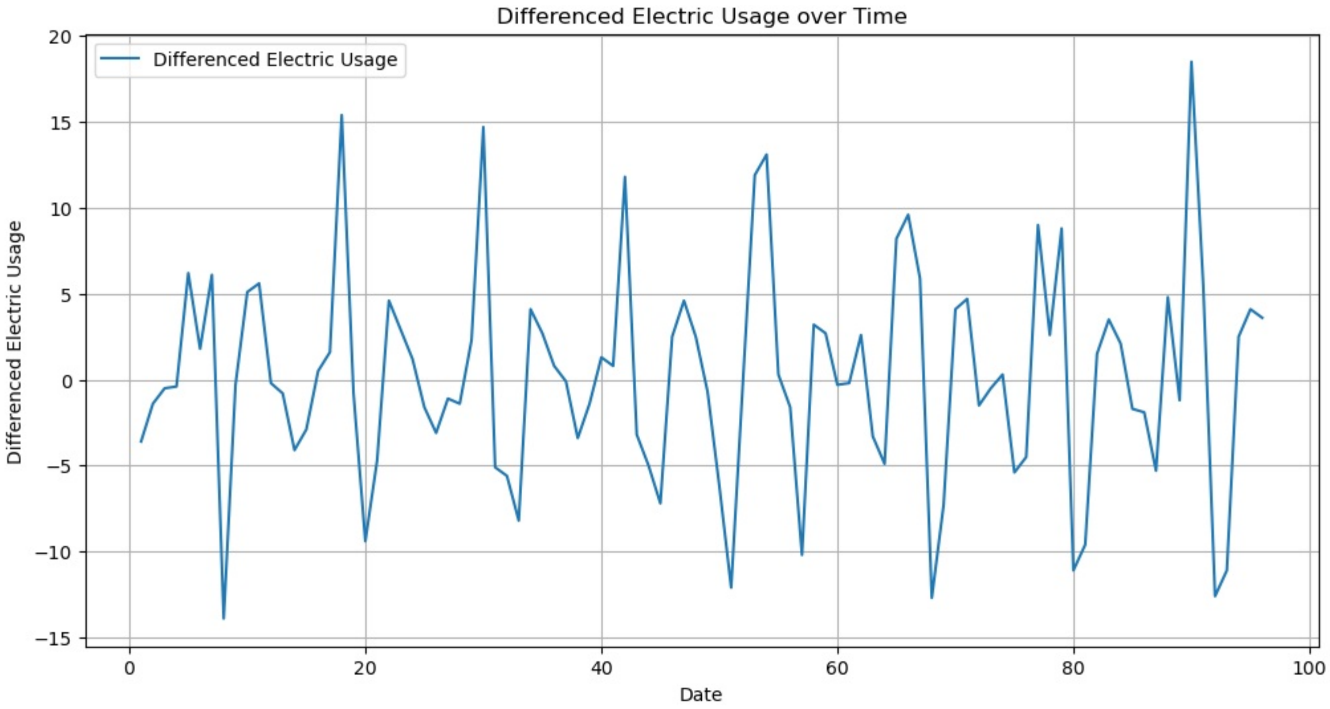
In [ ]:

```
from statsmodels.tsa.stattools import adfuller

def adf_test(timeseries):
    result = adfuller(timeseries, autolag='AIC')
    print('ADF Statistic:', result[0])
    print('p-value:', result[1])
    print('Critical Values:')
    for key, value in result[4].items():
        print(f'    {key}: {value}')

adf_test(data['Electric Usage (Daily Average 10^5 MWh)'])
```

```
ADF Statistic: -1.3727766424773402
p-value: 0.5952555362687779
Critical Values:
   1%: -3.510711795769895
   5%: -2.8966159448223734
   10%: -2.5854823866213152
```

In [ ]:

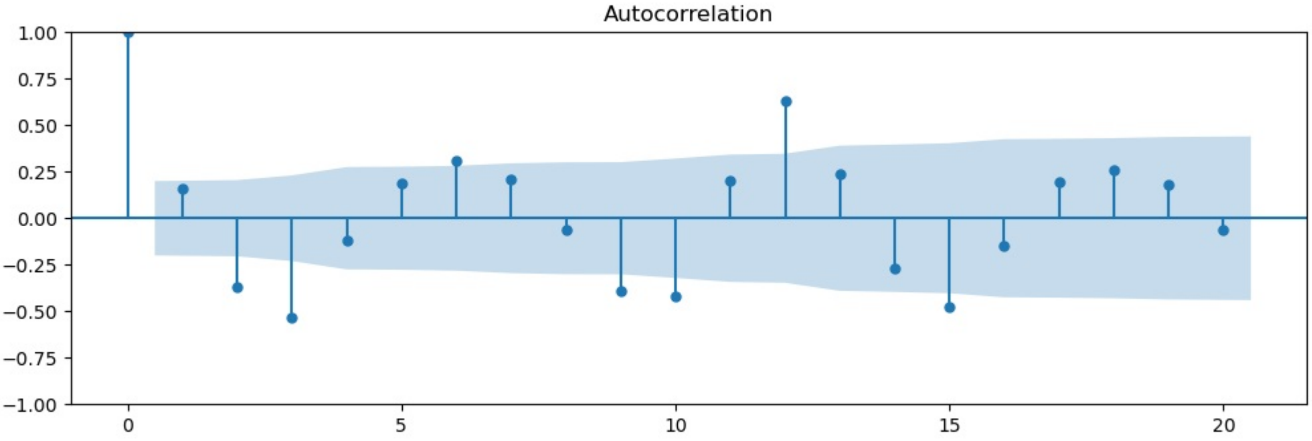
```
df_diff = data.diff().dropna()

plt.figure(figsize=(12, 6))
plt.plot(df_diff['Electric Usage (Daily Average 10^5 MWh)'], label='Differenced Electric Usage')
plt.title('Differenced Electric Usage over Time')
plt.xlabel('Date')
plt.ylabel('Differenced Electric Usage')
plt.grid(True)
plt.legend()
plt.show()

adf_test(df_diff['Electric Usage (Daily Average 10^5 MWh)'])
```

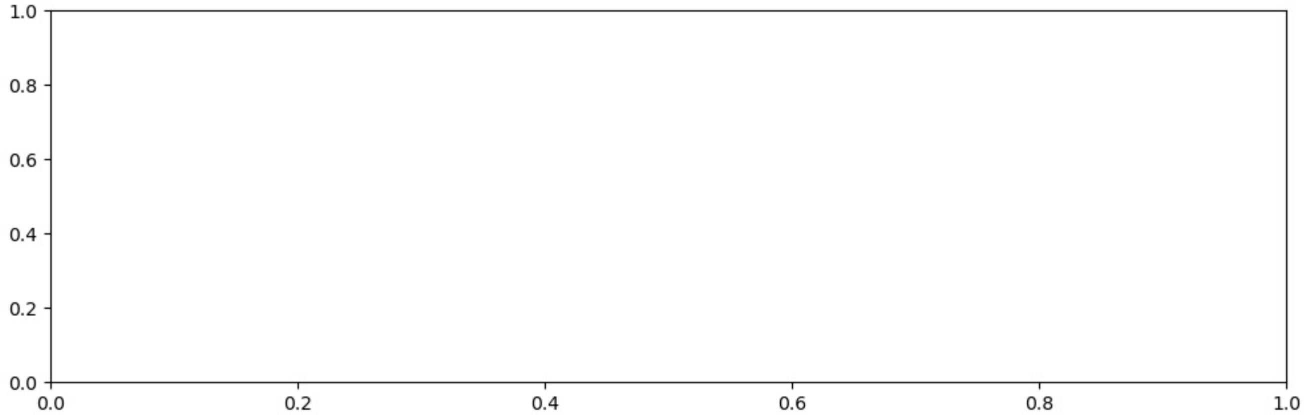


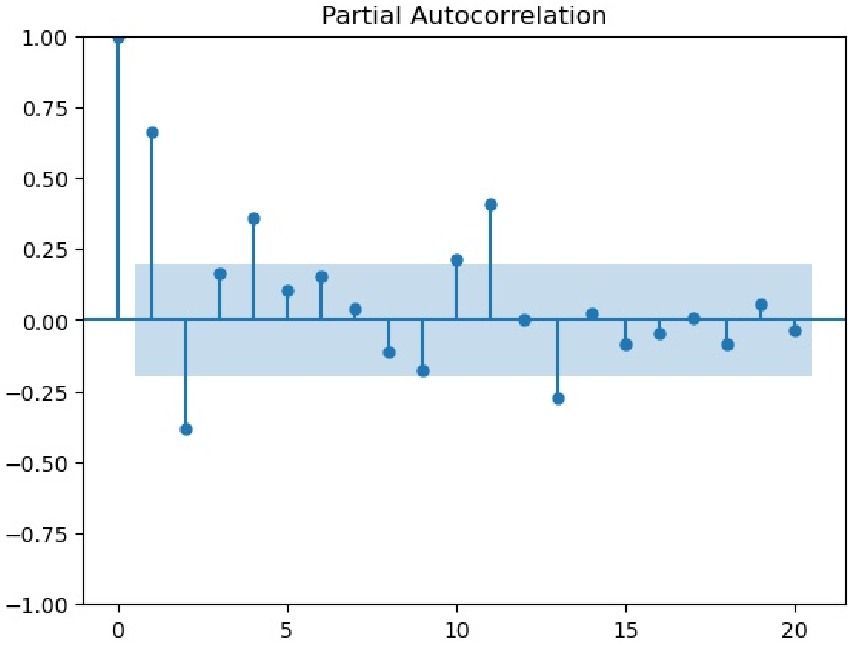
```
ADF Statistic: -3.4165814462345008
p-value: 0.010406432868434888
Critical Values:
   1%: -3.510711795769895
   5%: -2.8966159448223734
   10%: -2.5854823866213152
```

In [ ]:

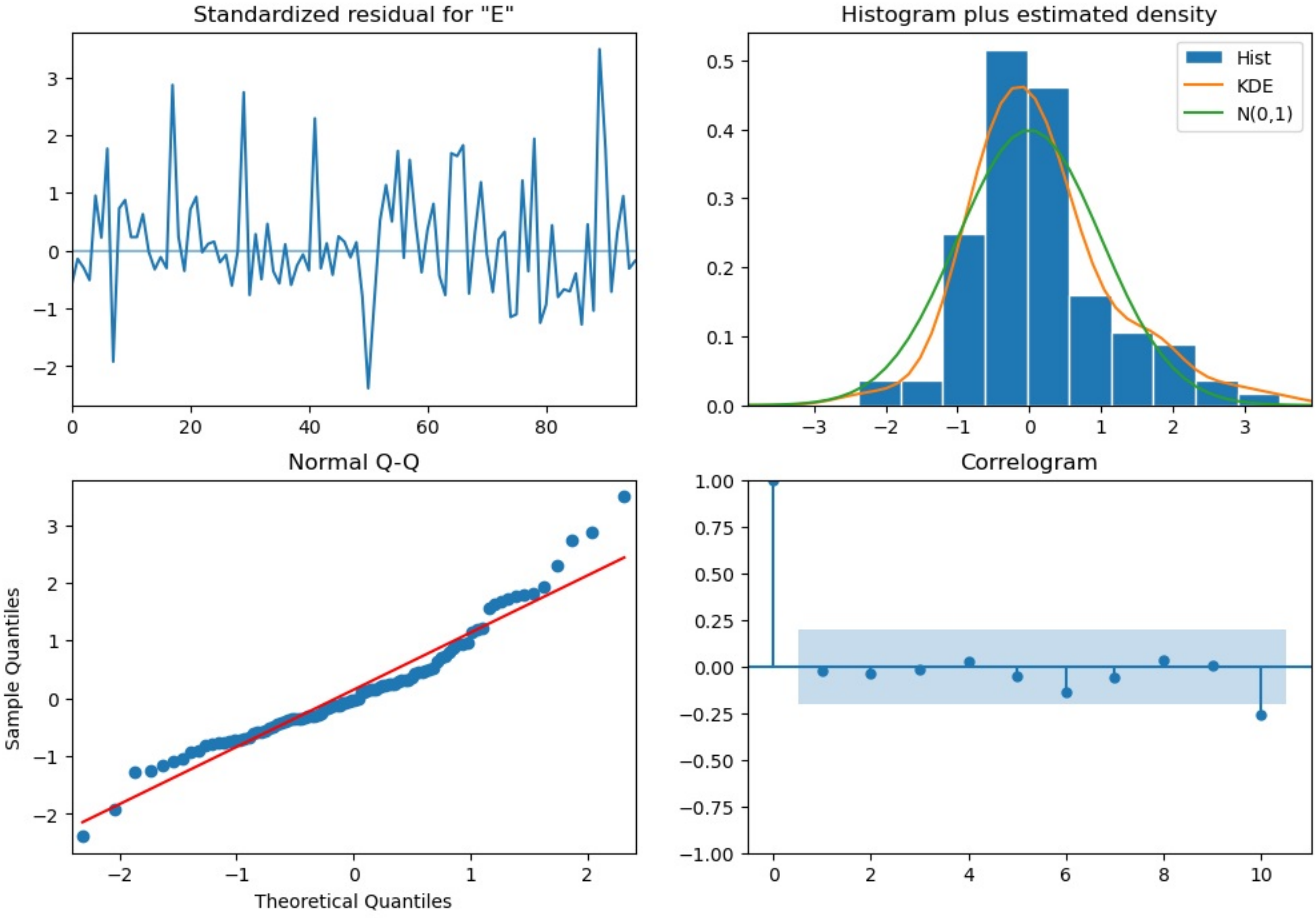
```
from statsmodels.graphics.tsaplots import plot_acf, plot_pacf
from statsmodels.tsa.arima.model import ARIMA
import pmdarima as pm
from statsmodels.graphics.tsaplots import plot_pacf

fig, (ax1, ax2) = plt.subplots(2, 1, figsize=(12, 8))
plot_acf(df_diff['Electric Usage (Daily Average 10^5 MWh)'], ax=ax1)
plot_pacf(data['Electric Usage (Daily Average 10^5 MWh)'], method='ywm')
plt.show()

model = ARIMA(data['Electric Usage (Daily Average 10^5 MWh)'], order=(4,1,2))
results = model.fit()

print(results.summary())

results.plot_diagnostics(figsize=(12, 8))
plt.show()

forecast = results.get_forecast(steps=12)
forecast_summary = forecast.summary_frame()
print(forecast_summary)
```


Autocorrelation
1.00
0.75
0.50
0.25
0.00
−0.25
−0.50
−0.75
−1.00
0
5
10
15
20


1.0
0.8
0.6
0.4
0.2
0.0
0.0
0.2
0.4
0.6
0.8
1.0


Partial Autocorrelation
1.00
0.75
0.50
0.25
0.00
−0.25
−0.50
−0.75
−1.00
0
5
10
15
20

```
                                           SARIMAX Results                                            
======================================================================================================
Dep. Variable:     Electric Usage (Daily Average 10^5 MWh)   No. Observations:                   97
Model:                                      ARIMA(4, 1, 2)   Log Likelihood                -284.181
Date:                                     Sat, 06 Apr 2024   AIC                            582.362
Time:                                             18:10:40   BIC                            600.313
Sample:                                                  0   HQIC                           589.618
                                                      - 97                                         
Covariance Type:                                       opg                                         
==============================================================================
                 coef    std err          z      P>|z|      [0.025      0.975]
------------------------------------------------------------------------------
ar.L1          0.0920      1.562      0.059      0.953      -2.969       3.153
ar.L2         -0.1148      0.793     -0.145      0.885      -1.669       1.440
ar.L3         -0.4673      0.637     -0.734      0.463      -1.715       0.781
ar.L4         -0.0296      0.484     -0.061      0.951      -0.979       0.919
ma.L1         -0.2640      1.547     -0.171      0.865      -3.297       2.769
ma.L2         -0.3679      1.062     -0.346      0.729      -2.449       1.713
sigma2        21.4165      2.744      7.805      0.000      16.039      26.795
===================================================================================
Ljung-Box (L1) (Q):                   0.06   Jarque-Bera (JB):                16.30
Prob(Q):                              0.80   Prob(JB):                         0.00
Heteroskedasticity (H):               1.51   Skew:                             0.80
Prob(H) (two-sided):                  0.25   Kurtosis:                         4.23
===================================================================================

Warnings:
[1] Covariance matrix calculated using the outer product of gradients (complex-step).
```



```
Electric Usage (Daily Average 10^5 MWh)       mean   mean_se  mean_ci_lower  \
97                                       93.067791  4.627799      83.997471   
98                                       90.946113  6.008319      79.170023   
99                                       88.973926  6.198791      76.824519   
100                                      89.037832  6.245018      76.797822   
101                                      90.268347  6.262600      77.993877   
102                                      91.358623  6.330013      78.952026   
103                                      91.346272  6.685591      78.242754   
104                                      90.643123  6.989103      76.944733   
105                                      90.033940  7.096055      76.125927   
106                                      90.032065  7.117342      76.082331   
107                                      90.430738  7.142381      76.431928   
108                                      90.773117  7.220824      76.620562   

Electric Usage (Daily Average 10^5 MWh)  mean_ci_upper  
97                                          102.138111  
98                                          102.722202  
99                                          101.123332  
100                                         101.277841  
101                                         102.542817  
102                                         103.765220  
103                                         104.449789  
104                                         104.341512  
105                                         103.941953  
106                                         103.981800  
107                                         104.429547  
108                                         104.925671  
```

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