NAAN MUTHALVAN

IBM COLLABARATE

ARTIFICIAL INTELLIGENCE

PROJECT TITLE

MEASURE ENERGY CONSUMPTION

NAME : PRAVEEN KUMAR M
DEPT & YEAR : CSE & III yr
REG.NO : 712221104014
COLLEGE : PARK COLLEGE OF ENGINEERING AND TECHNOLOGY

BUILDING MODEL FOR ENERGY PREDICTION

- Hence,we are going to build our prediction model algorithm for measure energy consumption.

- It consist the process of loading the dataset,data transformation,feature importance,train/test split,Visualize feature to target relationship,modeling,Forecast on Test,Outlier Analysis,Reviewing : Train/Test Split,Feature Horizon,Lag Features,Train Using Cross Validation,Fold Analysis,Retraining on all Data and Predicting Future.

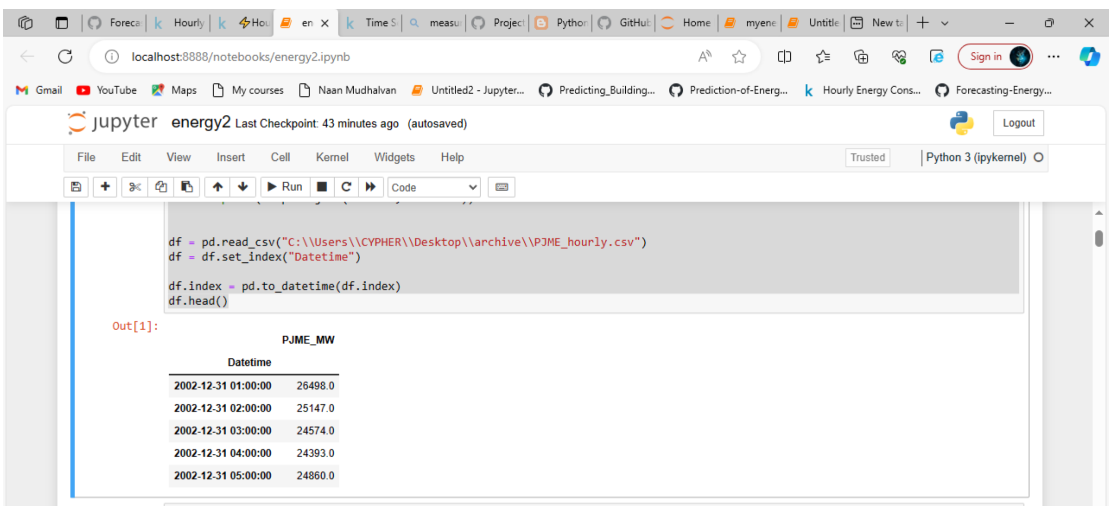
- Let we see the all process of building the model.

1. IMPORTING LIBRARIES AND DATA SET LOADING

CODE:

```
import numpy as np # linear algebra
import pandas as pd # data processing, CSV file I/O (e.g.
pd.read_csv)
import seaborn as sns
import matplotlib.pyplot as plt
import xgboost as xg


from sklearn.metrics import mean_squared_error

import os
for dirname, _, filenames in os.walk('/kaggle/input'):
    for filename in filenames:
        print(os.path.join(dirname, filename))


df =
pd.read_csv("C:\\Users\\CYPHER\\Desktop\\archive\\PJME_hourl
y.csv")
df = df.set_index("Datetime")

df.index = pd.to_datetime(df.index)
df.head()
```

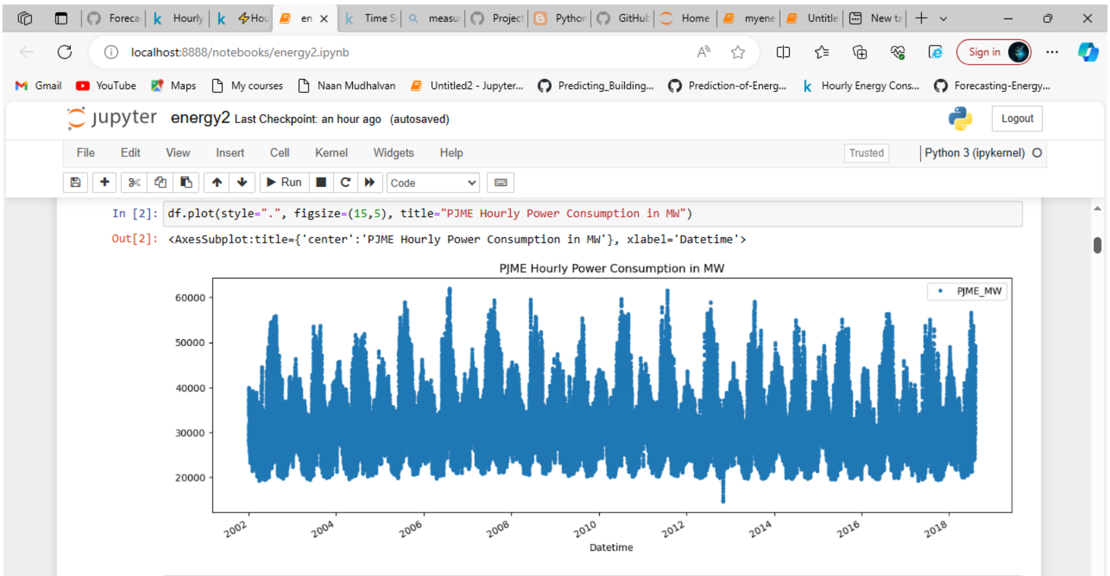
O/P:



2. TRAIN TEST SPLIT

CODE :

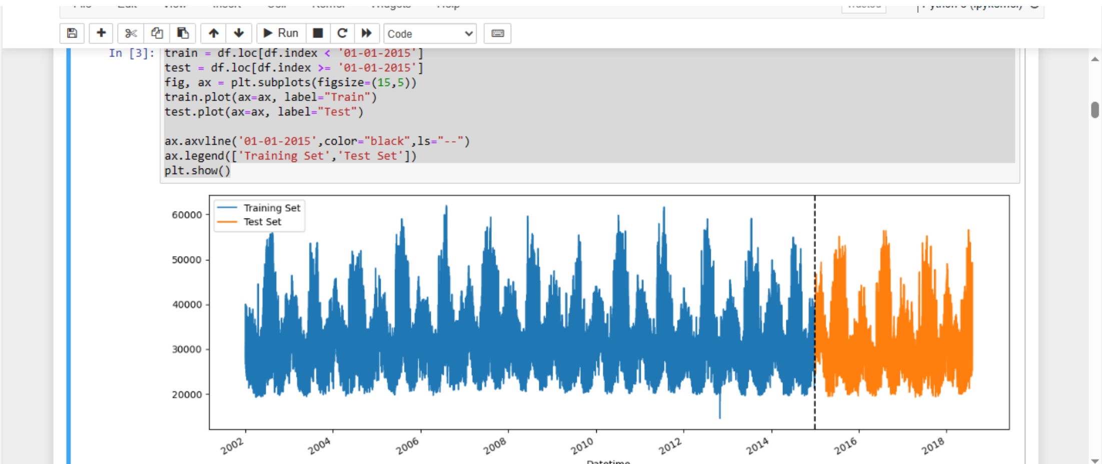
df.plot(style=".", figsize=(15,5), title="PJME Hourly Power Consumption in MW")



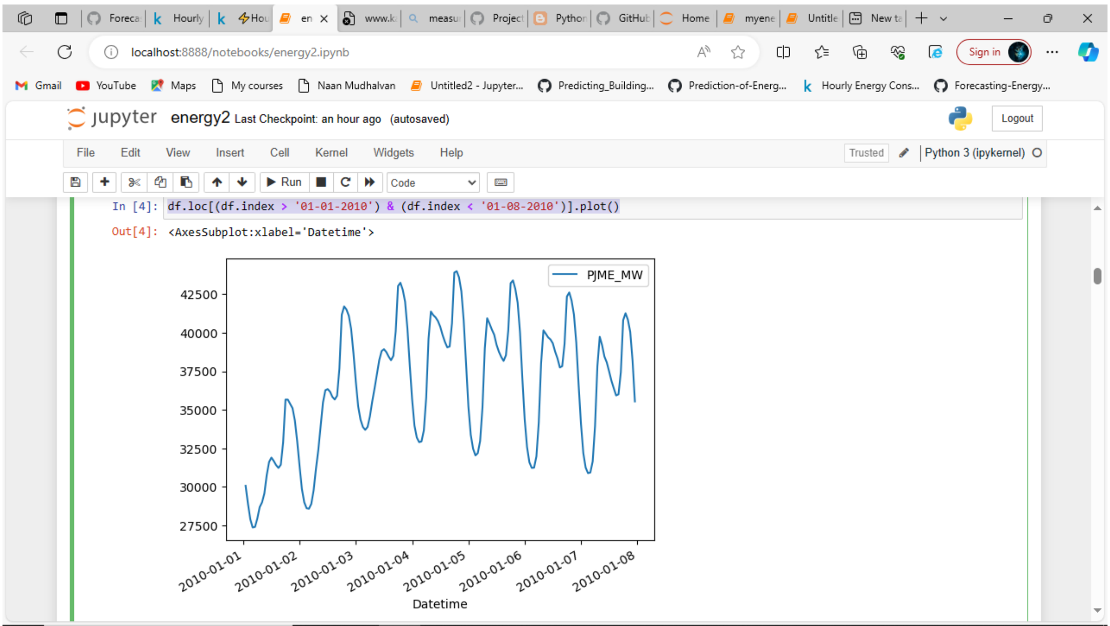
train = df.loc[df.index < '01-01-2015']
test = df.loc[df.index >= '01-01-2015']
fig, ax = plt.subplots(figsize=(15,5))
train.plot(ax=ax, label="Train")
test.plot(ax=ax, label="Test")

ax.axvline('01-01-2015',color="black",ls="--")

ax.legend(['Training Set','Test Set'])
plt.show()



```
df.loc[(df.index > '01-01-2010') & (df.index < '01-08-2010')].plot()
```



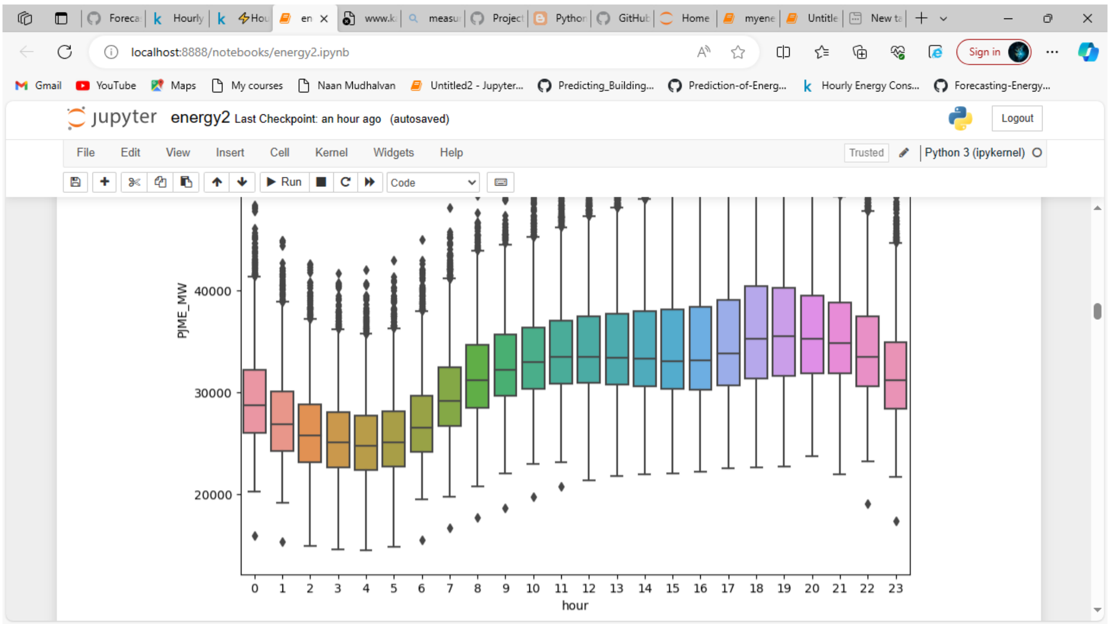
3. FEATURE CREATION

```
def create_time_series_features(dataframe):
   df = dataframe.copy()
   df['hour'] = df.index.hour
   df['dayofweek'] = df.index.dayofweek
   df['quarter'] = df.index.quarter
   df['month'] = df.index.month
   df['year'] = df.index.year
   df['dayofyear'] = df.index.dayofyear

  return df


df = create_time_series_features(df)
```

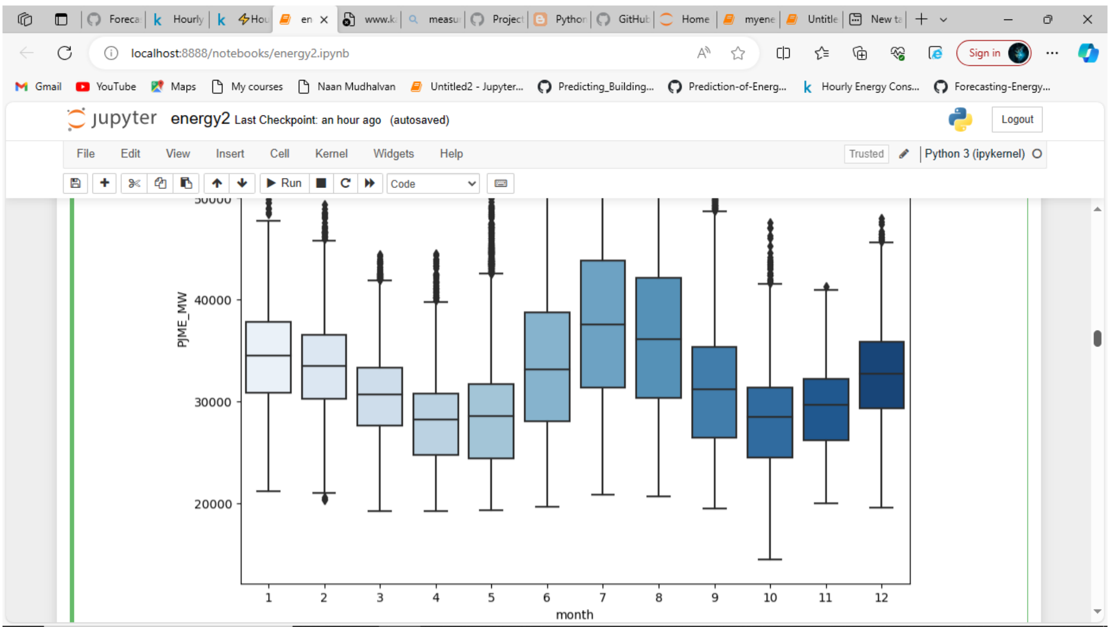
4. VISUALIZE FEATURE TO TARGET RELATIONSHIP

```
fig, ax = plt.subplots(figsize=(10,8))
sns.boxplot(data=df, x="hour",y="PJME_MW")
```

```
ax.set_title("MW By Hour")
plt.show()
```

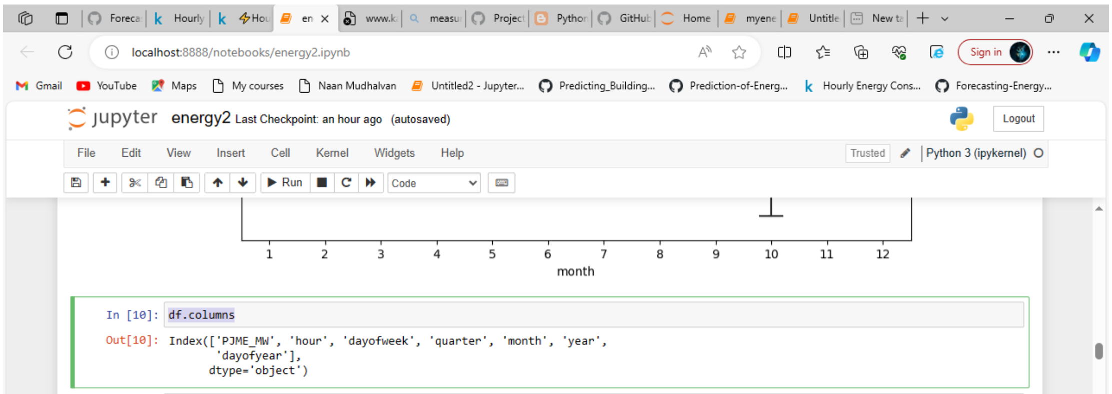



```
fig, ax = plt.subplots(figsize=(10,8))
sns.boxplot(data=df, x="month",y="PJME_MW",palette="Blues")
ax.set_title("MW By Month")
plt.show()
```

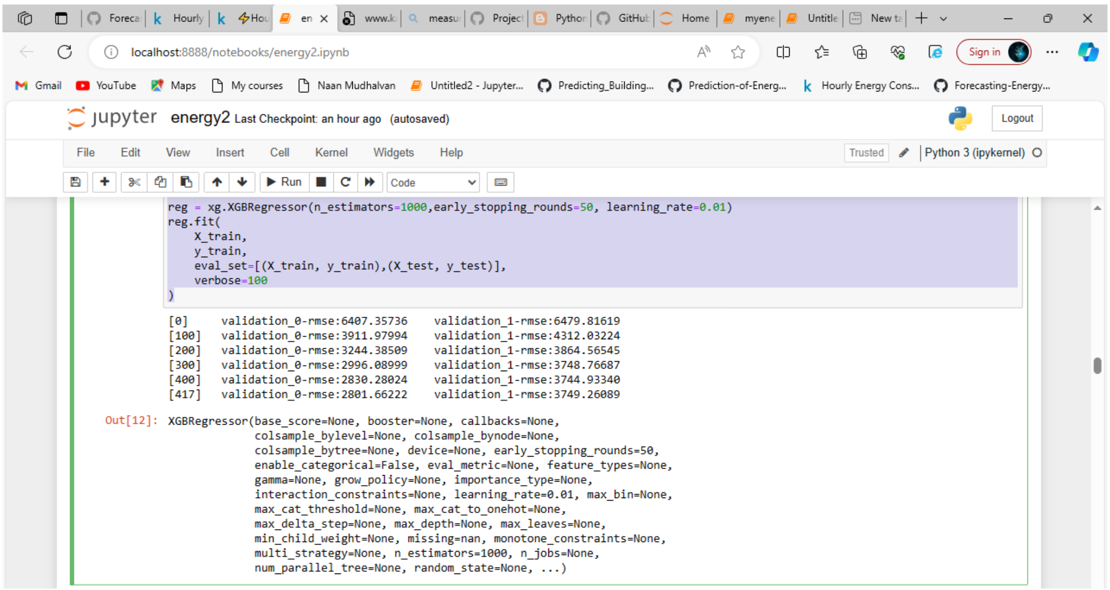


5. MODELING

df.columns

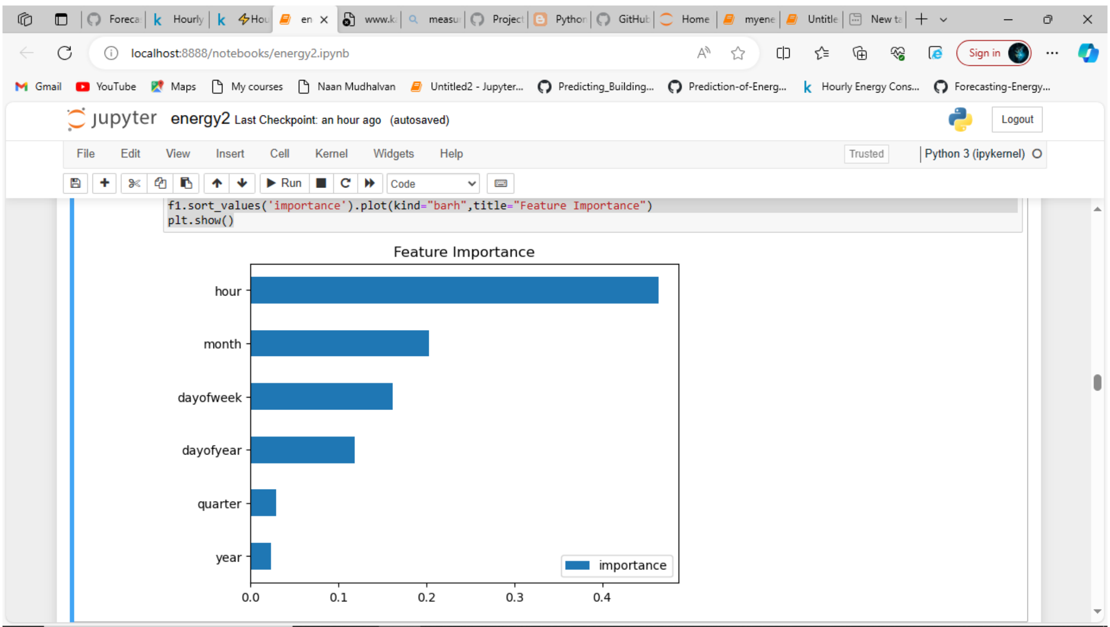



```
FEATURES = ['hour', 'dayofweek', 'quarter', 'month', 'year',
    'dayofyear']

OUTPUT = ['PJME_MW']

train = create_time_series_features(train)
test = create_time_series_features(test)
X_train = train[FEATURES]
y_train = train[OUTPUT]

X_test = test[FEATURES]
y_test = test[OUTPUT]



reg =
xg.XGBRegressor(n_estimators=1000,early_stopping_roun
ds=50, learning_rate=0.01)
reg.fit(
    X_train,
    y_train,
    eval_set=[(X_train, y_train),(X_test, y_test)],
    verbose=100
)
```



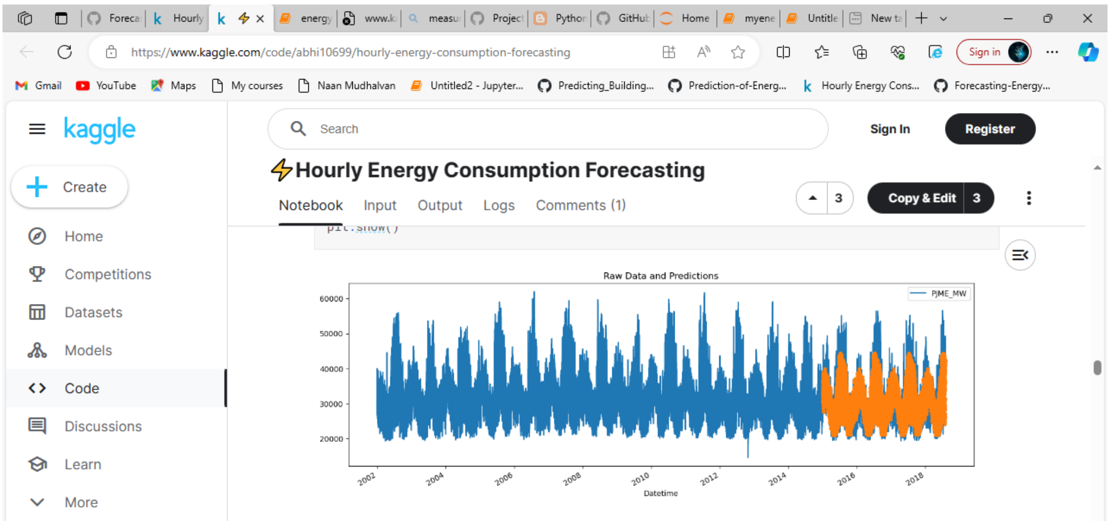
6.FEATURE IMPORTANCE

f1 = pd.DataFrame(data=reg.feature_importances_, index=reg.feature_names_in_, columns=['importance'])
f1.sort_values('importance').plot(kind="barh",title="Feature Importance")
plt.show()

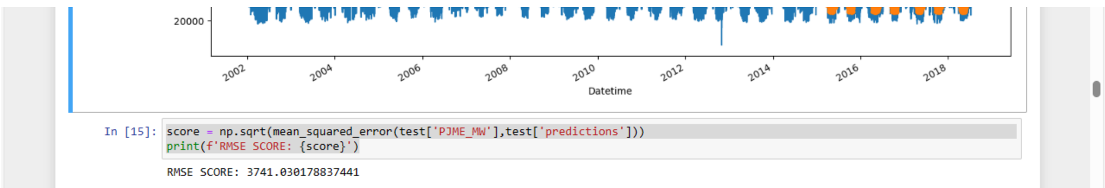


7.FEATURE FORECAST ON TEST

test['predictions'] = reg.predict(X_test)
df = df.merge(test[['predictions']],
how='left',left_index=True, right_index=True)
ax = df[['PJME_MW']].plot(figsize=(15,5))
df['predictions'].plot(ax=ax, style=".")
ax.set_title("Raw Data and Predictions")
plt.show()

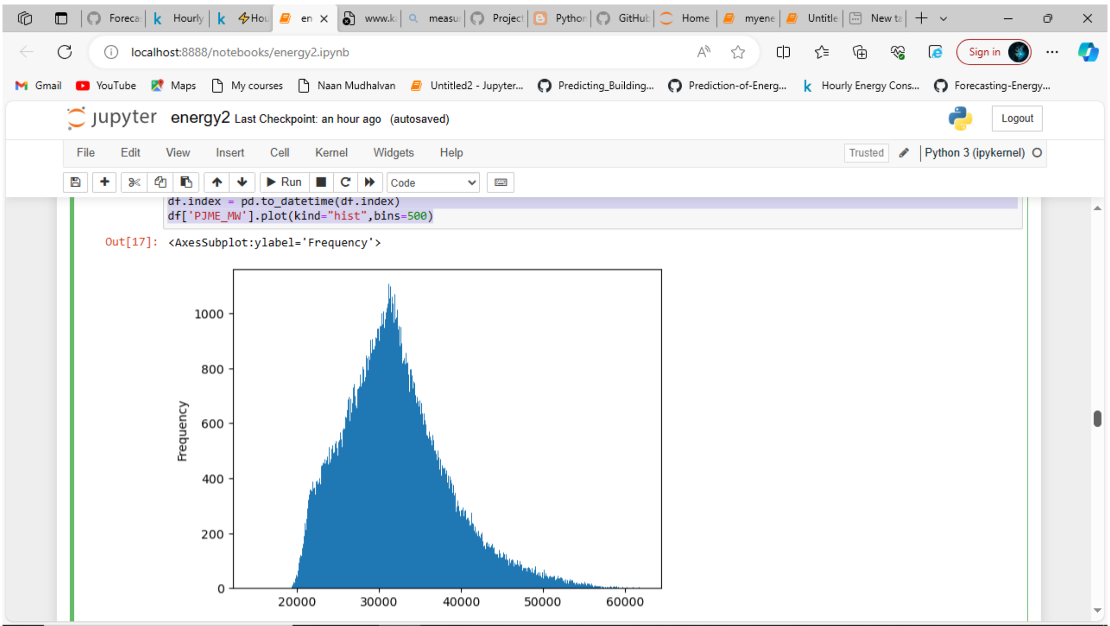


score =
np.sqrt(mean_squared_error(test['PJME_MW'],test['predict
ions']))
print(f'RMSE SCORE: {score}')



8. OUTLIER ANALYSIS

```
df =
pd.read_csv("C:\\Users\\CYPHER\\Desktop\\archive\\PJ
ME_hourly.csv")
df = df.set_index("Datetime")

df.index = pd.to_datetime(df.index)
df['PJME_MW'].plot(kind="hist",bins=500)
```

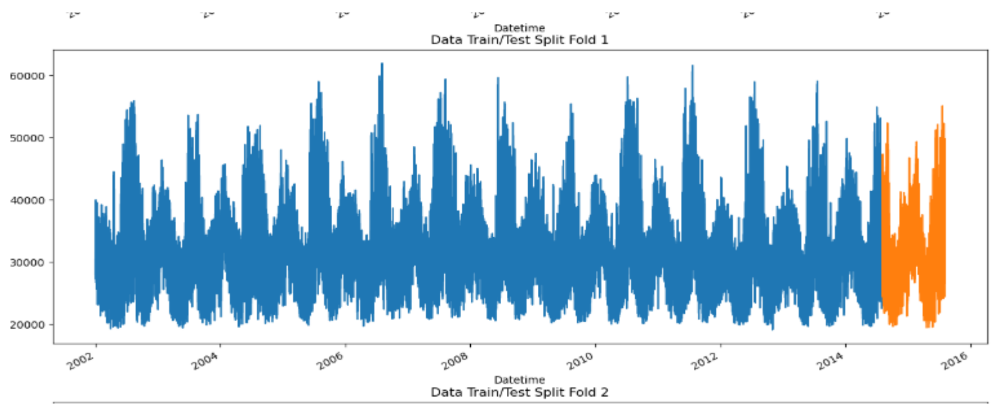


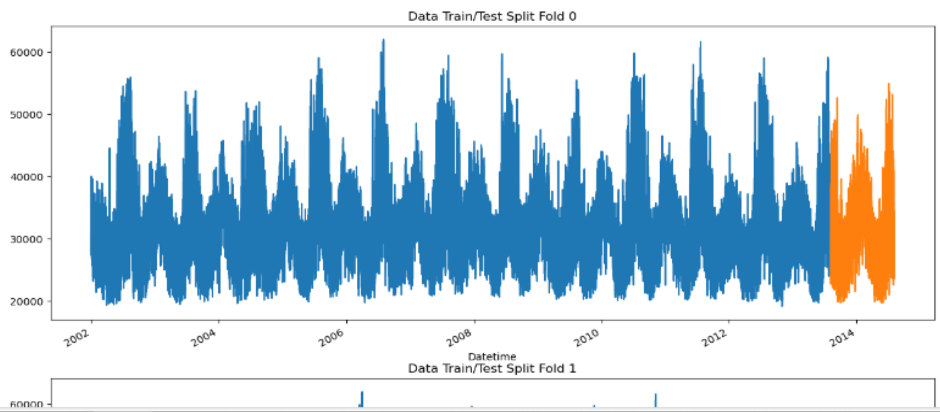

```
df = df.query('PJME_MW > 19_000').copy()
```

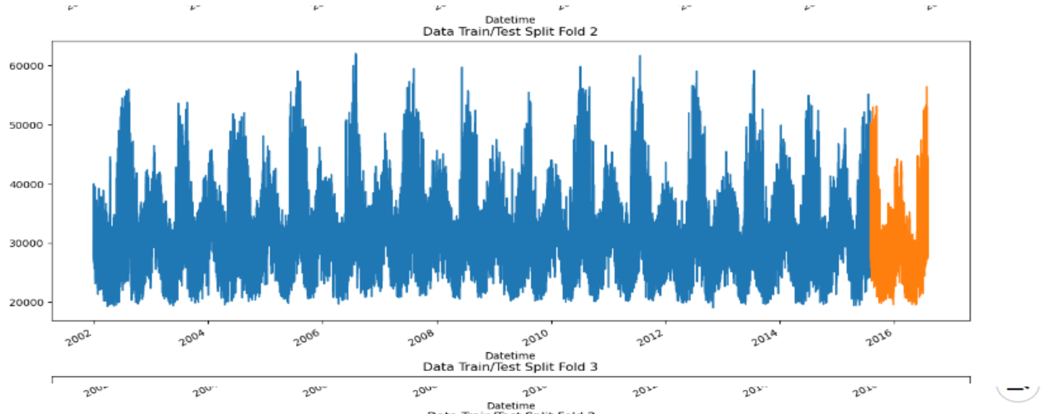
9. REVIEWING TRAIN AND TEST SPLIT

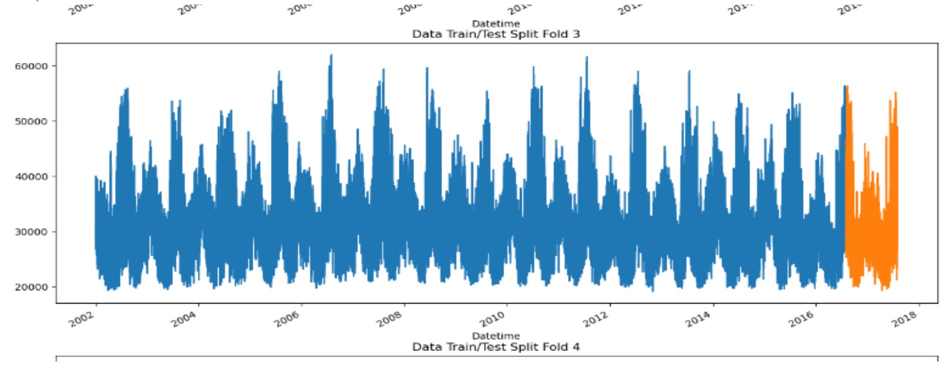
```
 from sklearn.model_selection import TimeSeriesSplit
tss = TimeSeriesSplit(n_splits=5,
test_size=24*365*1,gap=24)
df = df.sort_index()
fig, axs = plt.subplots(5,1,figsize=(15,35))

fold = 0
```

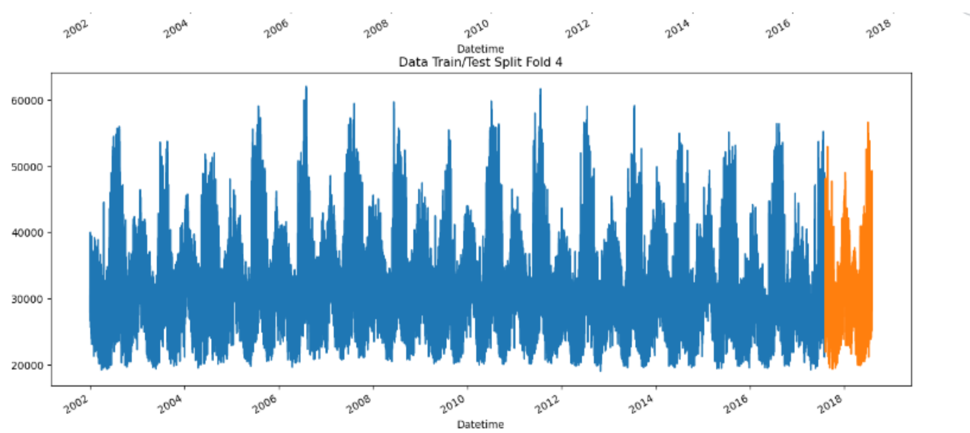
```
for train_idx, val_idx in tss.split(df):

    train = df.iloc[train_idx]
    test = df.iloc[val_idx]

    train['PJME_MW'].plot(
        ax=axs[fold],
        label="Training Set",
        title=f"Data Train/Test Split Fold {fold}"
    )
    test['PJME_MW'].plot(
        ax=axs[fold],
        label="Test Set",
    )

    fold += 1
```






Datetime
Data Train/Test Split Fold 2
60000
50000
40000
30000
20000
2002
2004
2006
2008
2010
2012
2014
2016
Datetime
Data Train/Test Split Fold 3


Datetime
Data Train/Test Split Fold 3
60000
50000
40000
30000
20000
2002
2004
2006
2008
2010
2012
2014
2016
2018
Datetime
Data Train/Test Split Fold 4

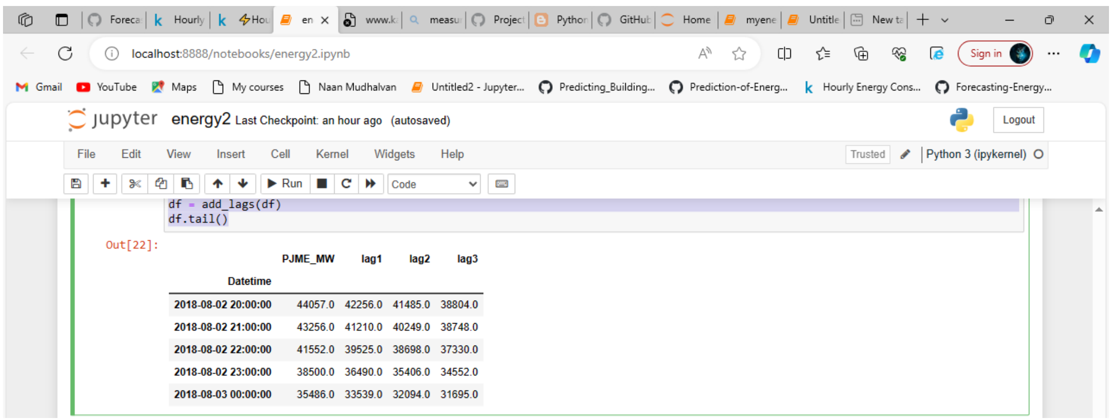

2002
2004
2006
2008
2010
2012
2014
2016
2018
Datetime
Data Train/Test Split Fold 4
60000
50000
40000
30000
20000
2002
2004
2006
2008
2010
2012
2014
2016
2018
Datetime

10. FEATURE HORIZON AND LAG FEATURES

```
df = create_time_series_features(df)
```

```
target_map = df['PJME_MW'].to_dict()
def add_lags(dframe):
    df = dframe.copy()
    df['lag1'] = (df.index - pd.Timedelta('364 days')).map(target_map)
    df['lag2'] = (df.index - pd.Timedelta('728 days')).map(target_map)
    df['lag3'] = (df.index - pd.Timedelta('1092 days')).map(target_map)

    return df
```

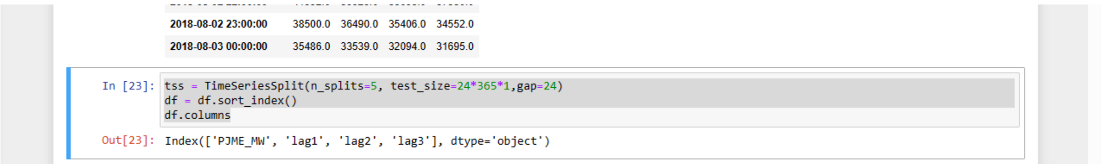
```
df = add_lags(df)
df.tail()
```



Datetime	PJME_MW	lag1	lag2	lag3
2018-08-02 20:00:00	44057.0	42256.0	41485.0	38804.0
2018-08-02 21:00:00	43256.0	41210.0	40249.0	38748.0
2018-08-02 22:00:00	41552.0	39525.0	38698.0	37330.0
2018-08-02 23:00:00	38500.0	36490.0	35406.0	34552.0
2018-08-03 00:00:00	35486.0	33539.0	32094.0	31695.0

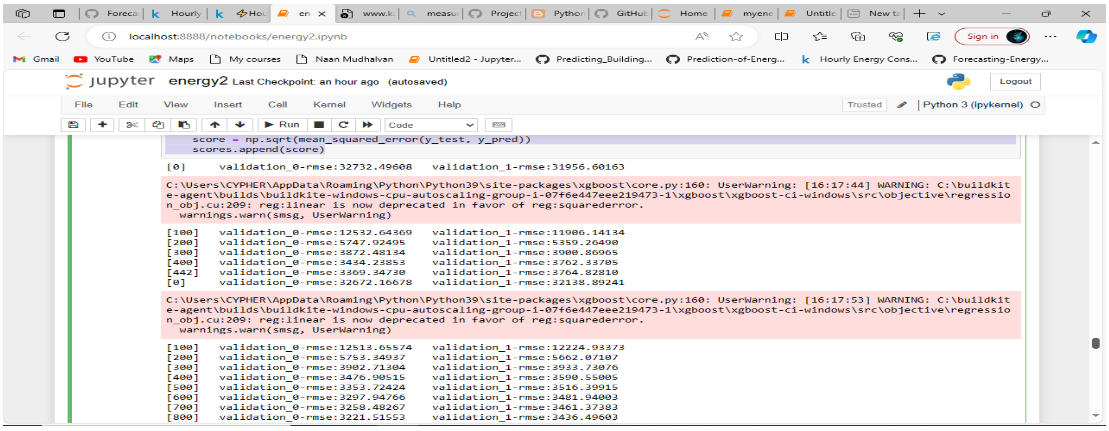
11. TRAIN USING CROSS VALIDATION

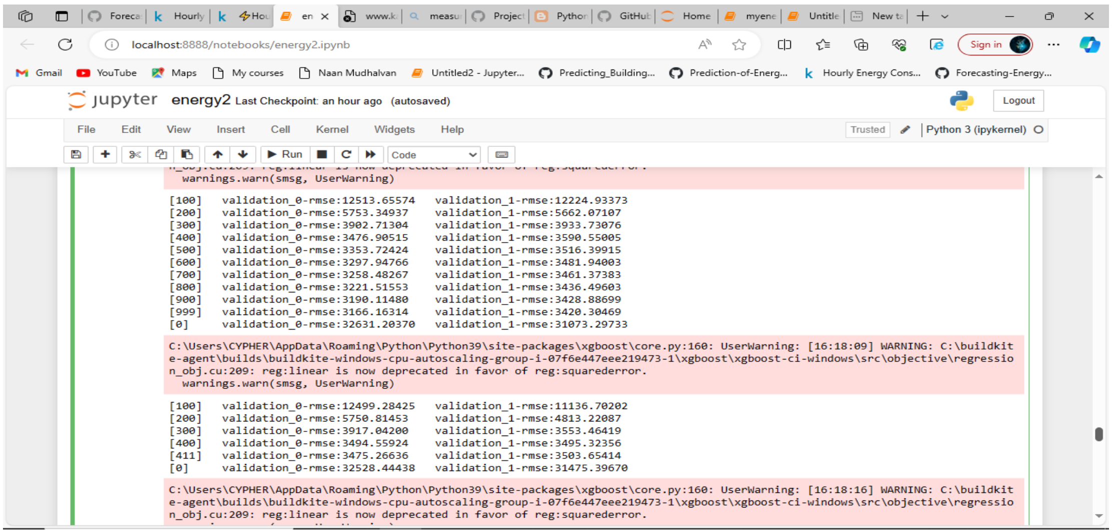
```
tss = TimeSeriesSplit(n_splits=5,
test_size=24*365*1,gap=24)
df = df.sort_index()
df.columns
```

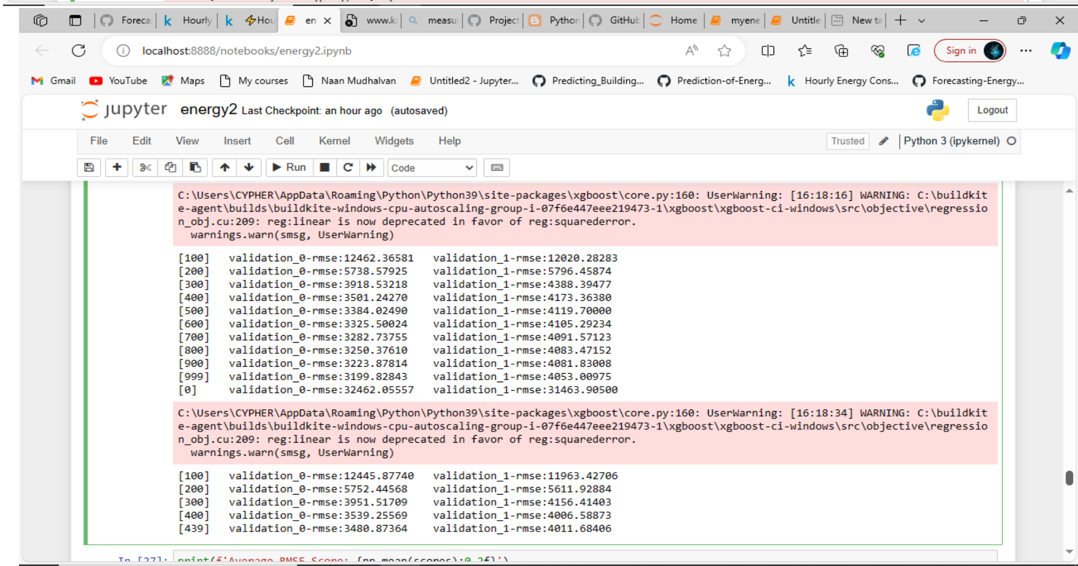



```
fold = 0
preds = []
scores = []

for train_idx, val_idx in tss.split(df):
    train = df.iloc[train_idx]
    test = df.iloc[val_idx]

    train = create_time_series_features(train)
    test = create_time_series_features(test)

    FEATURES = ['hour', 'dayofweek', 'quarter', 'month', 'year',
'dayofyear',
       'lag1', 'lag2', 'lag3']

    OUTPUT = 'PJME_MW'

    OUTPUT = 'PJME_MW'
```

```
X_train = train[FEATURES]
y_train = train[OUTPUT]

X_test = test[FEATURES]
y_test = test[OUTPUT]
reg = xg.XGBRegressor(
    base_score=0.5,
    booster='gbtree',
    n_estimators=1000,
    early_stopping_rounds=50,
    objective='reg:linear',
    max_depth=3,
    learning_rate=0.01
)

reg.fit(
    X_train,
    y_train,
    eval_set=[(X_train, y_train),(X_test, y_test)],
    verbose=100
)

y_pred = reg.predict(X_test)
preds.append(y_pred)
score = np.sqrt(mean_squared_error(y_test, y_pred))
scores.append(score)
```

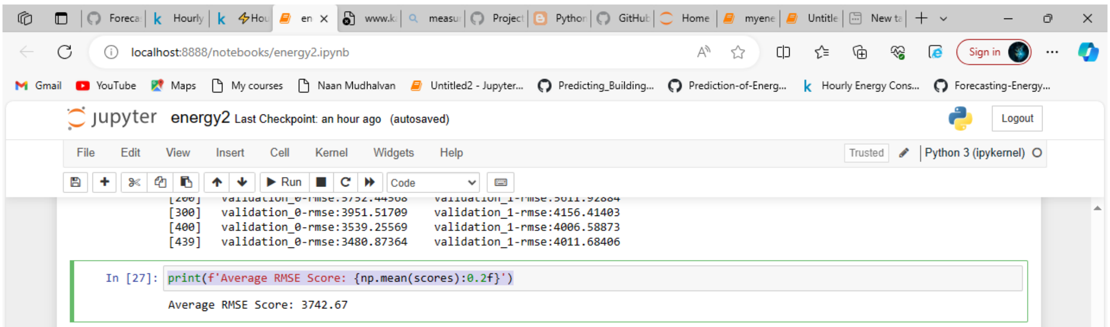

localhost:8888/notebooks/energy2.ipynb
jupyter energy2 Last Checkpoint: an hour ago (autosaved)
File Edit View Insert Cell Kernel Widgets Help
Trusted
Python 3 (ipykernel)
score = np.sqrt(mean_squared_error(y_test, y_pred))
scores.append(score)
[0] validation_0-rmse:32732.49608 validation_1-rmse:31956.60163
C:\Users\CYPHER\AppData\Roaming\Python\Python39\site-packages\xgboost\core.py:160: UserWarning: [16:17:44] WARNING: C:\buildkite-agent\builds\buildkite-windows-cpu-autoscaling-group-i-07f6e447eee219473-1\xgboost\xgboost-ci-windows\src\objective\regression_obj.cu:209: reg:linear is now deprecated in favor of reg:squarederror.
warnings.warn(smsg, UserWarning)
[100] validation_0-rmse:12532.64369 validation_1-rmse:11906.14134
[200] validation_0-rmse:5747.92495 validation_1-rmse:5359.26490
[300] validation_0-rmse:3872.48134 validation_1-rmse:3900.86965
[400] validation_0-rmse:3434.23853 validation_1-rmse:3762.33705
[442] validation_0-rmse:3369.34730 validation_1-rmse:3764.82810
[0] validation_0-rmse:32672.16678 validation_1-rmse:32138.89241
C:\Users\CYPHER\AppData\Roaming\Python\Python39\site-packages\xgboost\core.py:160: UserWarning: [16:17:53] WARNING: C:\buildkite-agent\builds\buildkite-windows-cpu-autoscaling-group-i-07f6e447eee219473-1\xgboost\xgboost-ci-windows\src\objective\regression_obj.cu:209: reg:linear is now deprecated in favor of reg:squarederror.
warnings.warn(smsg, UserWarning)
[100] validation_0-rmse:12513.65574 validation_1-rmse:12224.93373
[200] validation_0-rmse:5753.34937 validation_1-rmse:5662.07107
[300] validation_0-rmse:3902.71304 validation_1-rmse:3933.73076
[400] validation_0-rmse:3476.90515 validation_1-rmse:3590.55005
[500] validation_0-rmse:3353.72424 validation_1-rmse:3516.39915
[600] validation_0-rmse:3297.94766 validation_1-rmse:3481.94003
[700] validation_0-rmse:3258.48267 validation_1-rmse:3461.37383
[800] validation_0-rmse:3221.51553 validation_1-rmse:3436.49603


localhost:8888/notebooks/energy2.ipynb
jupyter energy2 Last Checkpoint: an hour ago (autosaved)
File Edit View Insert Cell Kernel Widgets Help
Trusted
Python 3 (ipykernel)
warnings.warn(smsg, UserWarning)
[100] validation_0-rmse:12513.65574 validation_1-rmse:12224.93373
[200] validation_0-rmse:5753.34937 validation_1-rmse:5662.07107
[300] validation_0-rmse:3902.71304 validation_1-rmse:3933.73076
[400] validation_0-rmse:3476.90515 validation_1-rmse:3590.55005
[500] validation_0-rmse:3353.72424 validation_1-rmse:3516.39915
[600] validation_0-rmse:3297.94766 validation_1-rmse:3481.94003
[700] validation_0-rmse:3258.48267 validation_1-rmse:3461.37383
[800] validation_0-rmse:3221.51553 validation_1-rmse:3436.49603
[900] validation_0-rmse:3190.11480 validation_1-rmse:3428.88699
[999] validation_0-rmse:3166.16314 validation_1-rmse:3420.30469
[0] validation_0-rmse:32631.20370 validation_1-rmse:31073.29733
C:\Users\CYPHER\AppData\Roaming\Python\Python39\site-packages\xgboost\core.py:160: UserWarning: [16:18:09] WARNING: C:\buildkite-agent\builds\buildkite-windows-cpu-autoscaling-group-i-07f6e447eee219473-1\xgboost\xgboost-ci-windows\src\objective\regression_obj.cu:209: reg:linear is now deprecated in favor of reg:squarederror.
warnings.warn(smsg, UserWarning)
[100] validation_0-rmse:12499.28425 validation_1-rmse:11136.70202
[200] validation_0-rmse:5750.81453 validation_1-rmse:4813.22087
[300] validation_0-rmse:3917.04200 validation_1-rmse:3553.46419
[400] validation_0-rmse:3494.55924 validation_1-rmse:3495.32356
[411] validation_0-rmse:3475.26636 validation_1-rmse:3503.65414
[0] validation_0-rmse:32528.44438 validation_1-rmse:31475.39670
C:\Users\CYPHER\AppData\Roaming\Python\Python39\site-packages\xgboost\core.py:160: UserWarning: [16:18:16] WARNING: C:\buildkite-agent\builds\buildkite-windows-cpu-autoscaling-group-i-07f6e447eee219473-1\xgboost\xgboost-ci-windows\src\objective\regression_obj.cu:209: reg:linear is now deprecated in favor of reg:squarederror.


localhost:8888/notebooks/energy2.ipynb
jupyter energy2 Last Checkpoint: an hour ago (autosaved)
File Edit View Insert Cell Kernel Widgets Help
Trusted
Python 3 (ipykernel)
C:\Users\CYPHER\AppData\Roaming\Python\Python39\site-packages\xgboost\core.py:160: UserWarning: [16:18:16] WARNING: C:\buildkite-agent\builds\buildkite-windows-cpu-autoscaling-group-i-07f6e447eee219473-1\xgboost\xgboost-ci-windows\src\objective\regression_obj.cu:209: reg:linear is now deprecated in favor of reg:squarederror.
warnings.warn(smsg, UserWarning)
[100] validation_0-rmse:12462.36581 validation_1-rmse:12020.28283
[200] validation_0-rmse:5738.57925 validation_1-rmse:5796.45874
[300] validation_0-rmse:3918.53218 validation_1-rmse:4388.39477
[400] validation_0-rmse:3501.24270 validation_1-rmse:4173.36380
[500] validation_0-rmse:3384.02490 validation_1-rmse:4119.70000
[600] validation_0-rmse:3325.50024 validation_1-rmse:4105.29234
[700] validation_0-rmse:3282.73755 validation_1-rmse:4091.57123
[800] validation_0-rmse:3250.37610 validation_1-rmse:4083.47152
[900] validation_0-rmse:3223.87814 validation_1-rmse:4081.83008
[999] validation_0-rmse:3199.82843 validation_1-rmse:4053.00975
[0] validation_0-rmse:32462.05557 validation_1-rmse:31463.90500
C:\Users\CYPHER\AppData\Roaming\Python\Python39\site-packages\xgboost\core.py:160: UserWarning: [16:18:34] WARNING: C:\buildkite-agent\builds\buildkite-windows-cpu-autoscaling-group-i-07f6e447eee219473-1\xgboost\xgboost-ci-windows\src\objective\regression_obj.cu:209: reg:linear is now deprecated in favor of reg:squarederror.
warnings.warn(smsg, UserWarning)
[100] validation_0-rmse:12445.87740 validation_1-rmse:11963.42706
[200] validation_0-rmse:5752.44568 validation_1-rmse:5611.92884
[300] validation_0-rmse:3951.51709 validation_1-rmse:4156.41403
[400] validation_0-rmse:3539.25569 validation_1-rmse:4006.58873
[439] validation_0-rmse:3480.87364 validation_1-rmse:4011.68406

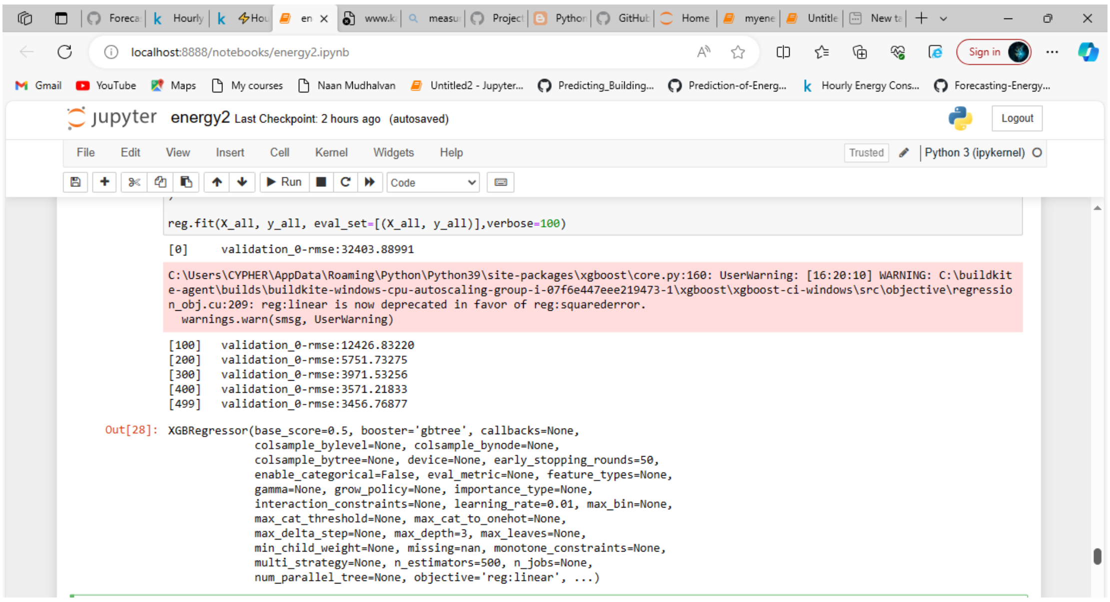
12.FOLD ANALYSIS & RETRAINING ON ALL DATA

```
print(f'Average RMSE Score: {np.mean(scores):0.2f}')
```



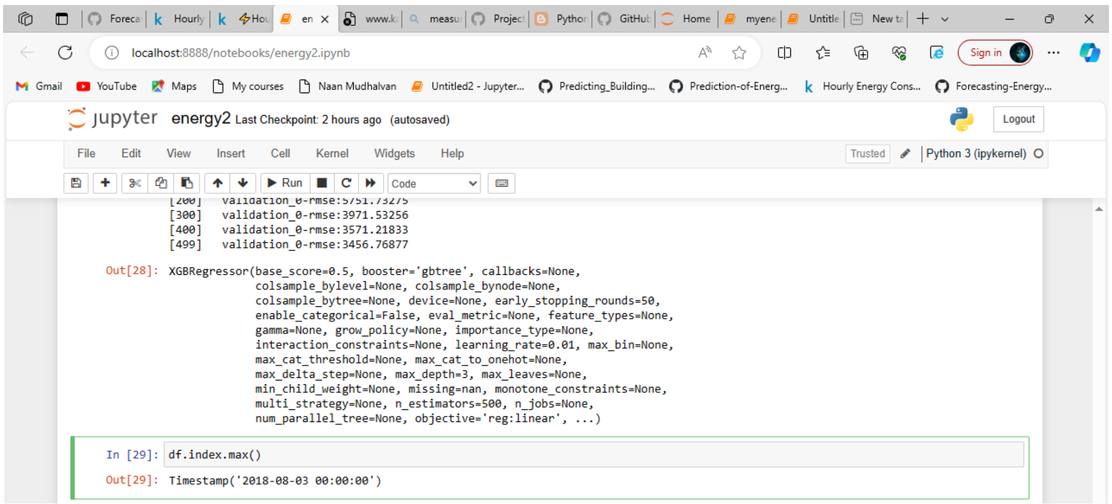

```
df = create_time_series_features(df)

FEATURES = ['hour', 'dayofweek', 'quarter', 'month', 'year', 'dayofyear',
      'lag1', 'lag2', 'lag3']

OUTPUT = 'PJME_MW'

X_all = df[FEATURES]
y_all = df[OUTPUT]

reg = xg.XGBRegressor(
   base_score=0.5,
```

```
    booster='gbtree',
    n_estimators=500,
    early_stopping_rounds=50,
    objective='reg:linear',
    max_depth=3,
    learning_rate=0.01
)

reg.fit(X_all, y_all, eval_set=[(X_all, y_all)],verbose=100)
```



13.PREDICTING FUTURE

df.index.max()



```
future = pd.date_range('2018-08-03','2019-08-03',freq='1h')
future_df = pd.DataFrame(index=future)

future_df['isFuture'] = True

df['isFuture'] = False

df_and_future = pd.concat([df, future_df])

df_and_future = create_time_series_features(df_and_future)
df_and_future = add_lags(df_and_future)
future_w_features = df_and_future.query('isFuture').copy()
future_w_features['pred'] =
reg.predict(future_w_features[FEATURES])
future_w_features['pred'].plot(
    figsize=(10,5),
    ms=1,
    lw=1,
    title="Future Predictions"
)

plt.show()
```