In [129]:

```
'''

Colour Code:

Demand (lines are solid)
price (lines are dashdotted)

Electrical :
Residential : Green(g), marker=o
Commercial : Red(r), marker=^
Industrial : Blue(b), marker=s


Natural Gas:
Residential : cyan(c), marker=o
Commercial : magenta(m), marker=^
Industrial : yellow(y), marker=s

NatGasEPP: black, marker=o

'''
```

Out[129]:

```
'\n\nColour Code:\n\nDemand (lines are solid)\nprice (lines are dashdotte
d)\n\nElectrical :\nResidential : Green(g), marker=o\nCommercial : Red(r),
marker=^\nIndustrial : Blue(b), marker=s\n\n\nNatural Gas: \nResidential :
cyan(c), marker=o\nCommercial : magenta(m), marker=^\nIndustrial : yellow
(y), marker=s\n\nNatGasEPP: black, marker=o\n\n'
```

In [130]:

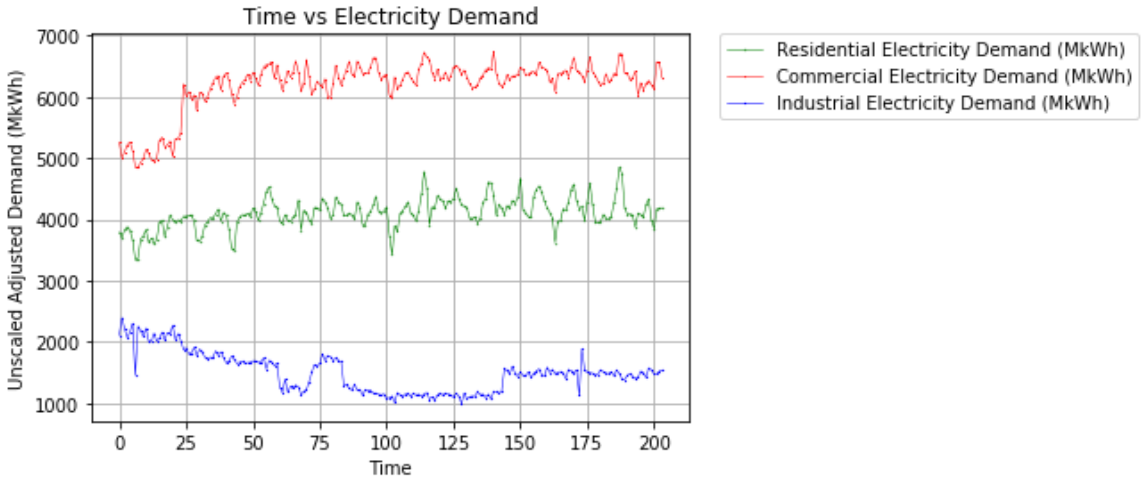
```
import pandas as pd
import matplotlib.pyplot as plt
import numpy as np
import seaborn as sns
import matplotlib.patches as mpatches
from scipy.stats import norm
from sklearn.preprocessing import StandardScaler
import warnings
warnings.filterwarnings("ignore")
```

In [131]:

```
data_scaled=pd.read_csv('CNG.csv')
data_unscaled=pd.read_csv('CNG.csv')
Month=data_scaled.iloc[:,0]
Year=data_scaled.iloc[:,1]
columns=data_scaled.columns
scaler=StandardScaler()                ##### Standardization: z = (x - u) / s
scaler.fit(data_scaled)
data_scaled=pd.DataFrame(scaler.transform(data_scaled))
data_scaled.columns=columns
data_scaled['Month']=Month
data_scaled['Year']=Year
```

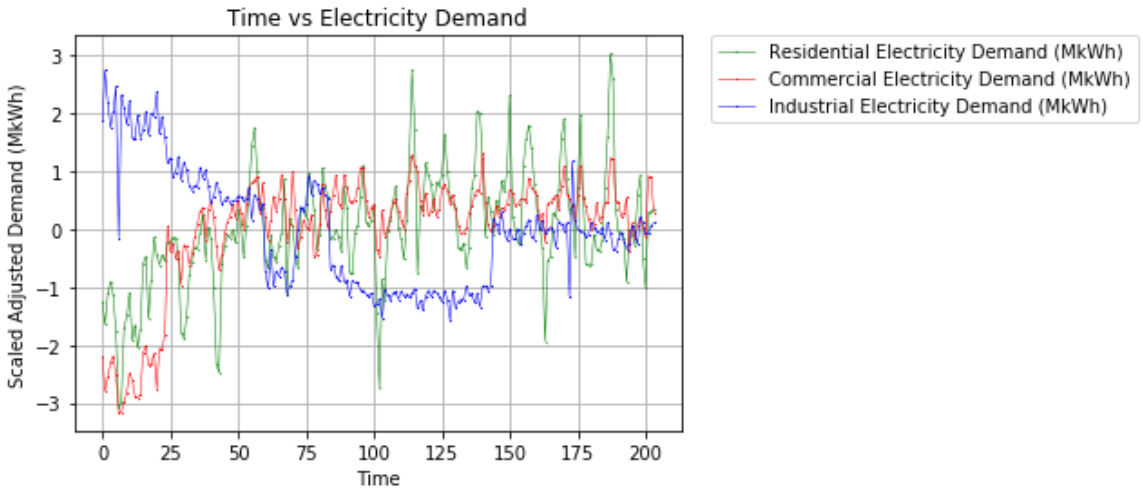
In [132]:

```
plt.plot(range(data.shape[0]),data_unscaled['Residential Electricity Demand (MkWh)'][::
-1],color='g',marker='o',linestyle='solid', linewidth=0.5, markersize=0.3)
plt.plot(range(data.shape[0]),data_unscaled['Commercial Electricity Demand (MkWh)'][::-
1],color='r',marker='^',linestyle='solid', linewidth=0.5, markersize=0.3)
plt.plot(range(data.shape[0]),data_unscaled['Industrial Electricity Demand (MkWh)'][::-
1],color='b',marker='s',linestyle='solid', linewidth=0.5, markersize=0.3)

patch1 = mpatches.Patch(color='g')
patch2 = mpatches.Patch(color='r')
patch3 = mpatches.Patch(color='b')

plt.legend(handles=[patch1,patch2,patch3])
plt.legend(bbox_to_anchor=(1.05, 1), loc=2, borderaxespad=0.)

title='Time vs Electricity Demand'
ylabel='Unscaled Adjusted Demand (MkWh)'
xlabel='Time'

plt.title(title)
plt.ylabel(ylabel)
plt.xlabel(xlabel)
plt.grid()
plt.savefig('Electricity_Demand_Over_Time_Unscaled.png',dpi=300,bbox_inches="tight")
plt.show()
```



In [133]:

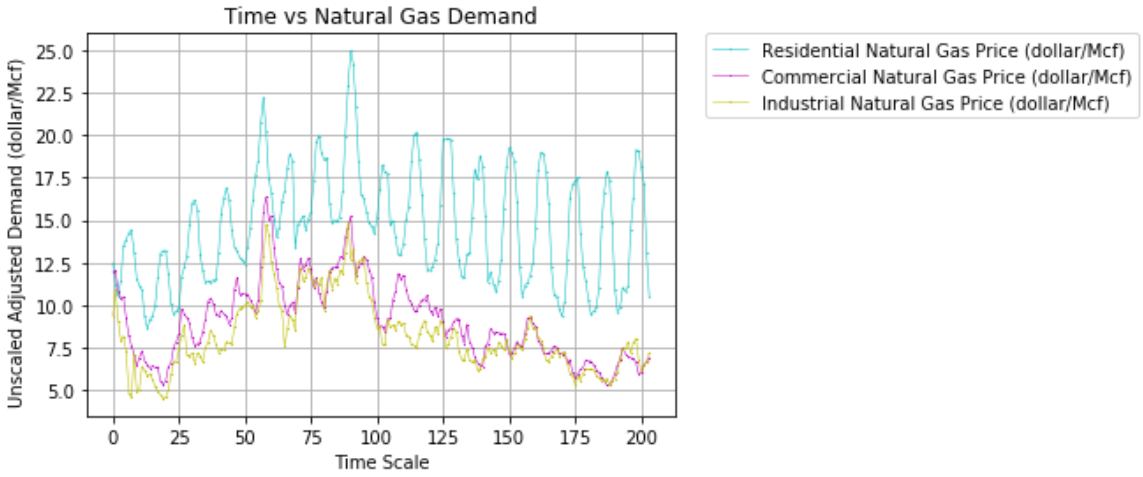
```
plt.plot(range(data.shape[0]),data_scaled['Residential Electricity Demand (MkWh)'][::-1
],color='g',marker='o',linestyle='solid', linewidth=0.5, markersize=0.3)
plt.plot(range(data.shape[0]),data_scaled['Commercial Electricity Demand (MkWh)'][::-1
],color='r',marker='^',linestyle='solid', linewidth=0.5, markersize=0.3)
plt.plot(range(data.shape[0]),data_scaled['Industrial Electricity Demand (MkWh)'][::-1
],color='b',marker='s',linestyle='solid', linewidth=0.5, markersize=0.3)

patch1 = mpatches.Patch(color='g')
patch2 = mpatches.Patch(color='r')
patch3 = mpatches.Patch(color='b')

plt.legend(handles=[patch1,patch2,patch3])
plt.legend(bbox_to_anchor=(1.05, 1), loc=2, borderaxespad=0.)

title='Time vs Electricity Demand'
ylabel='Scaled Adjusted Demand (MkWh)'
xlabel='Time'

plt.title(title)
plt.ylabel(ylabel)
plt.xlabel(xlabel)
plt.grid()
plt.savefig('Electricity_Demand_Over_Time_Scaled.png',dpi=300,bbox_inches="tight")
plt.show()
```



In [ ]:

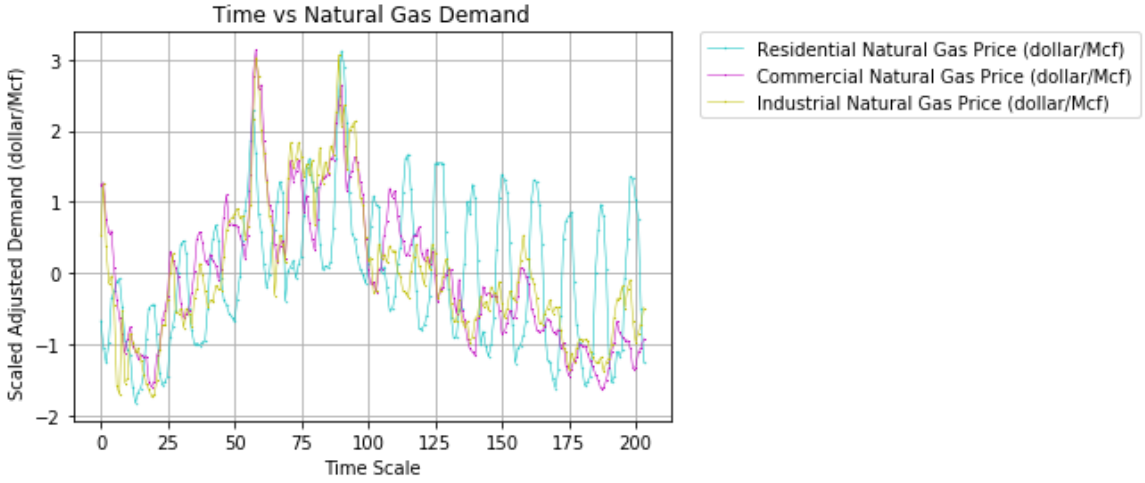
In [134]:

```
plt.plot(range(data.shape[0]),data_unscaled['Residential Natural Gas Price (dollar/Mc
f)'][::-1],color='c',marker='o',linestyle='solid', linewidth=0.5, markersize=0.3)
plt.plot(range(data.shape[0]),data_unscaled['Commercial Natural Gas Price (dollar/Mcf)'
][::-1],color='m',marker='^',linestyle='solid', linewidth=0.5, markersize=0.3)
plt.plot(range(data.shape[0]),data_unscaled['Industrial Natural Gas Price (dollar/Mcf)'
][::-1],color='y',marker='s',linestyle='solid', linewidth=0.5, markersize=0.3)
patch1 = mpatches.Patch(color='c')
patch2 = mpatches.Patch(color='m')
patch3 = mpatches.Patch(color='y')

plt.legend(handles=[patch1,patch2,patch3])
plt.legend(bbox_to_anchor=(1.05, 1), loc=2, borderaxespad=0.)

plt.title('Time vs Natural Gas Demand')
plt.ylabel('Unscaled Adjusted Demand (dollar/Mcf)  ')
plt.xlabel('Time Scale')
plt.grid()
plt.savefig('Natural_Gas_Demand_Over_Time_Unscaled.png',dpi=300,bbox_inches="tight")
plt.show()
```



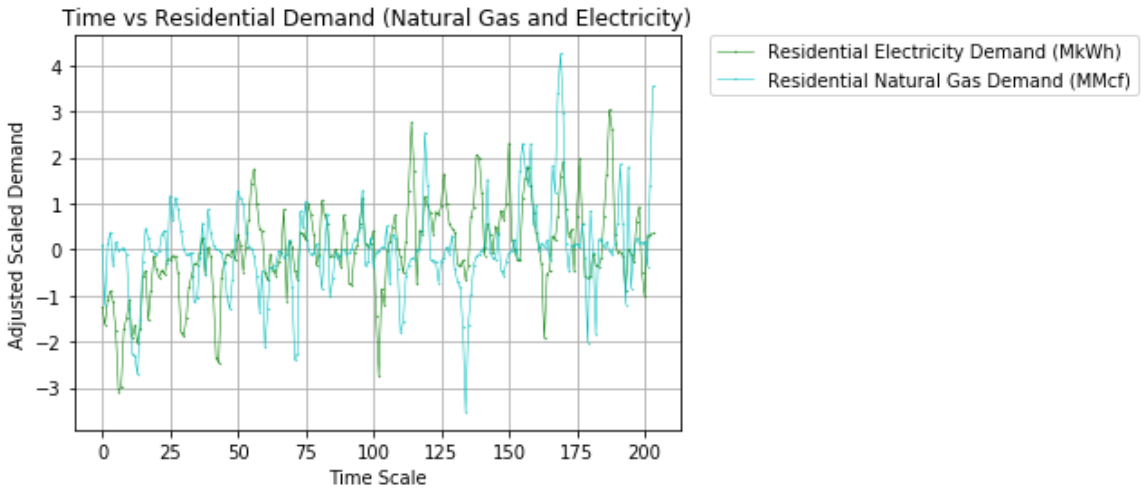
In [135]:

```
plt.plot(range(data.shape[0]),data_scaled['Residential Natural Gas Price (dollar/Mcf)']
[::-1],color='c',marker='o',linestyle='solid', linewidth=0.5, markersize=0.3)
plt.plot(range(data.shape[0]),data_scaled['Commercial Natural Gas Price (dollar/Mcf)']
[::-1],color='m',marker='^',linestyle='solid', linewidth=0.5, markersize=0.3)
plt.plot(range(data.shape[0]),data_scaled['Industrial Natural Gas Price (dollar/Mcf)']
[::-1],color='y',marker='s',linestyle='solid', linewidth=0.5, markersize=0.3)
patch1 = mpatches.Patch(color='c')
patch2 = mpatches.Patch(color='m')
patch3 = mpatches.Patch(color='y')

plt.legend(handles=[patch1,patch2,patch3])
plt.legend(bbox_to_anchor=(1.05, 1), loc=2, borderaxespad=0.)

plt.title('Time vs Natural Gas Demand')
plt.ylabel('Scaled Adjusted Demand (dollar/Mcf)  ')
plt.xlabel('Time Scale')
plt.grid()
plt.savefig('Natural_Gas_Demand_Over_Time_Scaled.png',dpi=300,bbox_inches="tight")
plt.show()
```



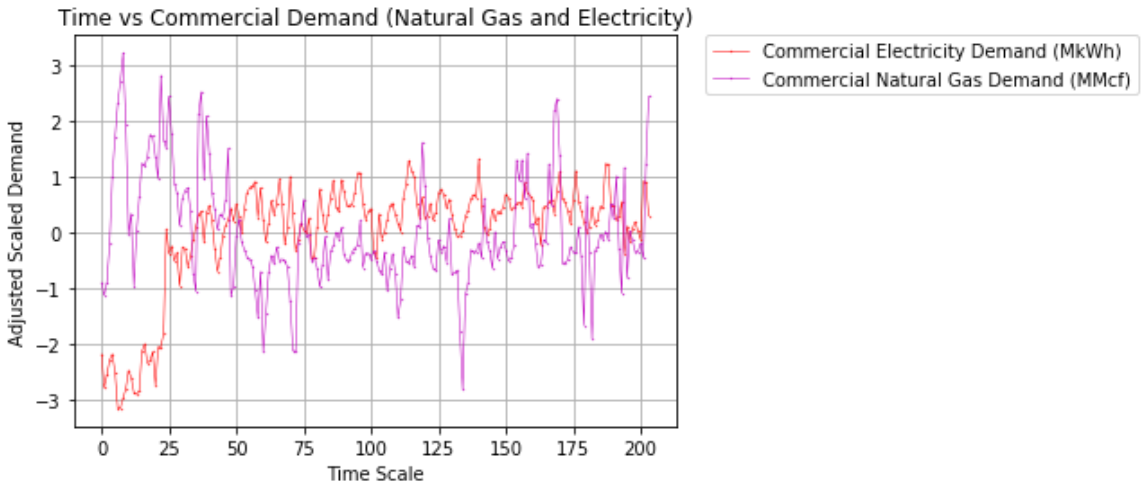
In [136]:

```
plt.plot(range(data.shape[0]),data_scaled['Residential Electricity Demand (MkWh)'][::-1
],color='g',marker='o',linestyle='solid', linewidth=0.5, markersize=0.3)
plt.plot(range(data.shape[0]),data_scaled['Residential Natural Gas Demand (MMcf)'][::-1
],color='c',marker='o',linestyle='solid', linewidth=0.5, markersize=0.3)
patch1 = mpatches.Patch(color='g')
patch2 = mpatches.Patch(color='c')

plt.legend(handles=[patch1,patch2])
plt.legend(bbox_to_anchor=(1.05, 1), loc=2, borderaxespad=0.)

plt.title('Time vs Residential Demand (Natural Gas and Electricity)')
plt.ylabel('Adjusted Scaled Demand')
plt.xlabel('Time Scale')
plt.grid()
plt.savefig('Residential_Demand_NG_Electricity_scaled.png',dpi=300,bbox_inches="tight")
plt.show()
```



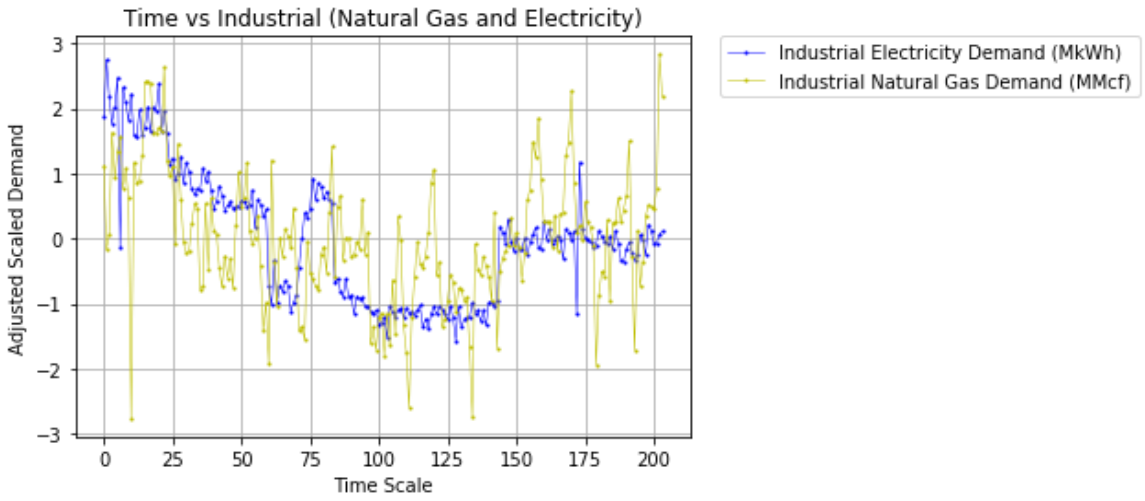
In [137]:

```
plt.plot(range(data.shape[0]),data_scaled['Commercial Electricity Demand (MkWh)'][::-1
],color='r',marker='o',linestyle='solid', linewidth=0.5, markersize=0.3)
plt.plot(range(data.shape[0]),data_scaled['Commercial Natural Gas Demand (MMcf)'][::-1
],color='m',marker='o',linestyle='solid', linewidth=0.5, markersize=0.3)
patch1 = mpatches.Patch(color='r')
patch2 = mpatches.Patch(color='m')

plt.legend(handles=[patch1,patch2])
plt.legend(bbox_to_anchor=(1.05, 1), loc=2, borderaxespad=0.)

plt.title('Time vs Commercial Demand (Natural Gas and Electricity)')
plt.ylabel('Adjusted Scaled Demand')
plt.xlabel('Time Scale')
plt.grid()
plt.savefig('Commercial_Demand_NG_Electricity_scaled.png',dpi=300,bbox_inches="tight")
plt.show()
```



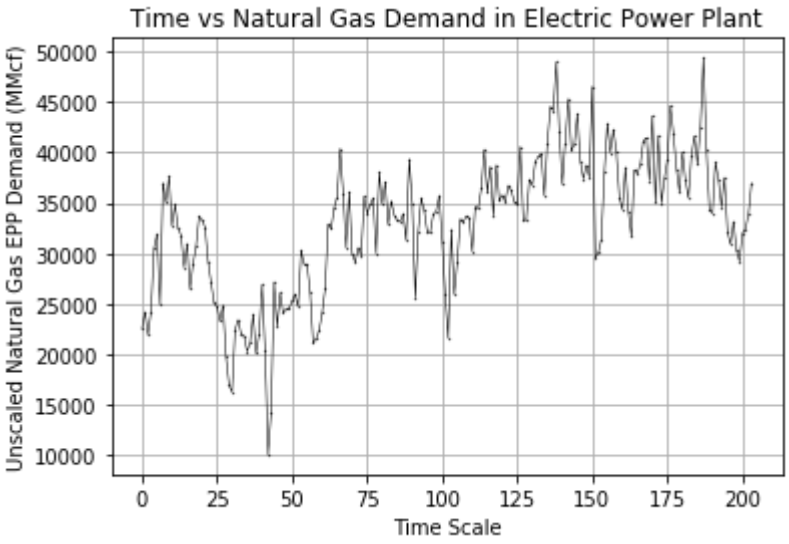
In [138]:

```
plt.plot(range(data.shape[0]),data['Industrial Electricity Demand (MkWh)'][::-1],color=
'b',marker='s',linestyle='solid', linewidth=0.5, markersize=1)
plt.plot(range(data.shape[0]),data['Industrial Natural Gas Demand (MMcf)'][::-1],color=
'y',marker='s',linestyle='solid', linewidth=0.5, markersize=1)
patch1 = mpatches.Patch(color='b')
patch2 = mpatches.Patch(color='y')

plt.legend(handles=[patch1,patch2])
plt.legend(bbox_to_anchor=(1.05, 1), loc=2, borderaxespad=0.)

plt.title('Time vs Industrial (Natural Gas and Electricity)')
plt.ylabel('Adjusted Scaled Demand')
plt.xlabel('Time Scale')
plt.grid()
plt.savefig('Industrial_Demand_NG_Electricity_scaled.png',dpi=300,bbox_inches="tight")
plt.show()
```



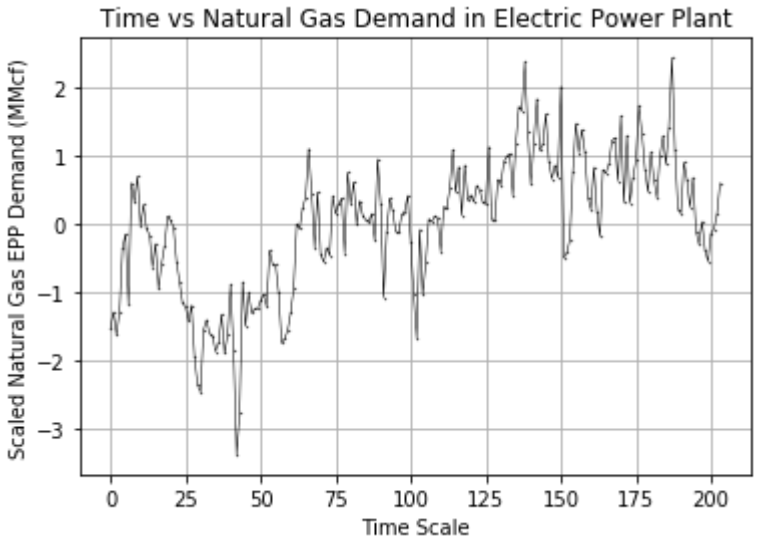
In [139]:

```
plt.plot(range(data.shape[0]),data_unscaled['Natural Gas EPP Demand (MMcf)'][::-1],colo
r='black',marker='o',linestyle='solid', linewidth=0.5, markersize=0.3)
plt.title('Time vs Natural Gas Demand in Electric Power Plant')
plt.ylabel('Unscaled Natural Gas EPP Demand (MMcf)')
plt.xlabel('Time Scale')
plt.grid()
plt.savefig('Natural_Gas_Demand_Electric_Power_Plant_Unscaled.png',dpi=300,bbox_inches=
"tight")
plt.show()
```



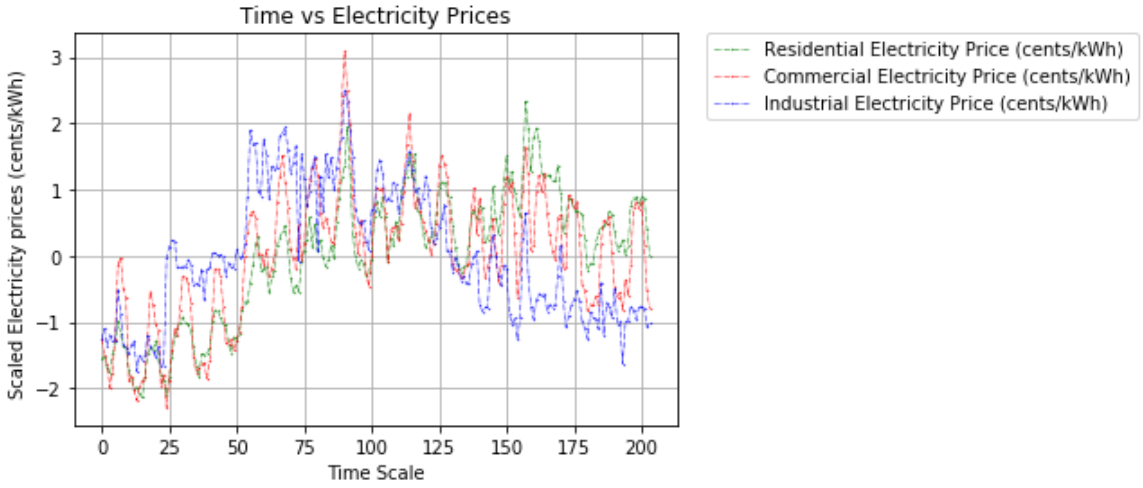
In [140]:

```
plt.plot(range(data.shape[0]),data_scaled['Natural Gas EPP Demand (MMcf)'][::-1],color=
'black',marker='o',linestyle='solid', linewidth=0.5, markersize=0.3)
plt.title('Time vs Natural Gas Demand in Electric Power Plant')
plt.ylabel('Scaled Natural Gas EPP Demand (MMcf)')
plt.xlabel('Time Scale')
plt.grid()
plt.savefig('Natural_Gas_Demand_Electric_Power_Plant_Scaled.png',dpi=300,bbox_inches="t
ight")
plt.show()
```



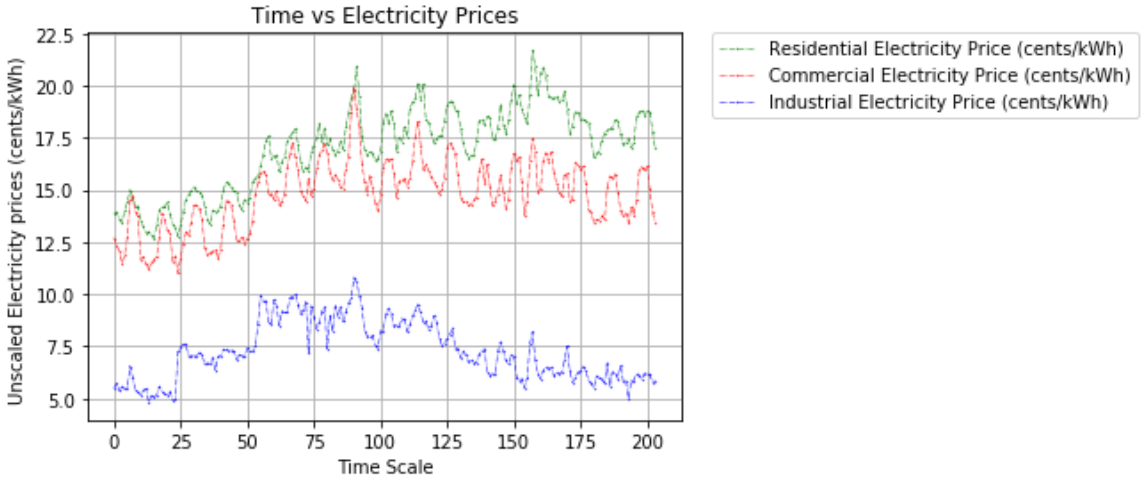
In [141]:

```
plt.plot(range(data.shape[0]),data_scaled['Residential Electricity Price (cents/kWh)']
[::-1],color='green',marker='o',linestyle='-.', linewidth=0.5, markersize=0.3)
plt.plot(range(data.shape[0]),data_scaled['Commercial Electricity Price (cents/kWh)']
[::-1],color='red',marker='o',linestyle='-.', linewidth=0.5, markersize=0.3)
plt.plot(range(data.shape[0]),data_scaled['Industrial Electricity Price (cents/kWh)']
[::-1],color='blue',marker='o',linestyle='-.', linewidth=0.5, markersize=0.3)

green_patch = mpatches.Patch(color='green')
red_patch = mpatches.Patch(color='red')
blue_patch = mpatches.Patch(color='blue')

plt.legend(handles=[red_patch,green_patch,blue_patch])
plt.legend(bbox_to_anchor=(1.05, 1), loc=2, borderaxespad=0.)

plt.title('Time vs Electricity Prices')
plt.ylabel('Scaled Electricity prices (cents/kWh) ')
plt.xlabel('Time Scale')
plt.grid()
plt.savefig('Electricity_Prices_over_time_Scaled.png',dpi=300,bbox_inches="tight")
plt.show()
```



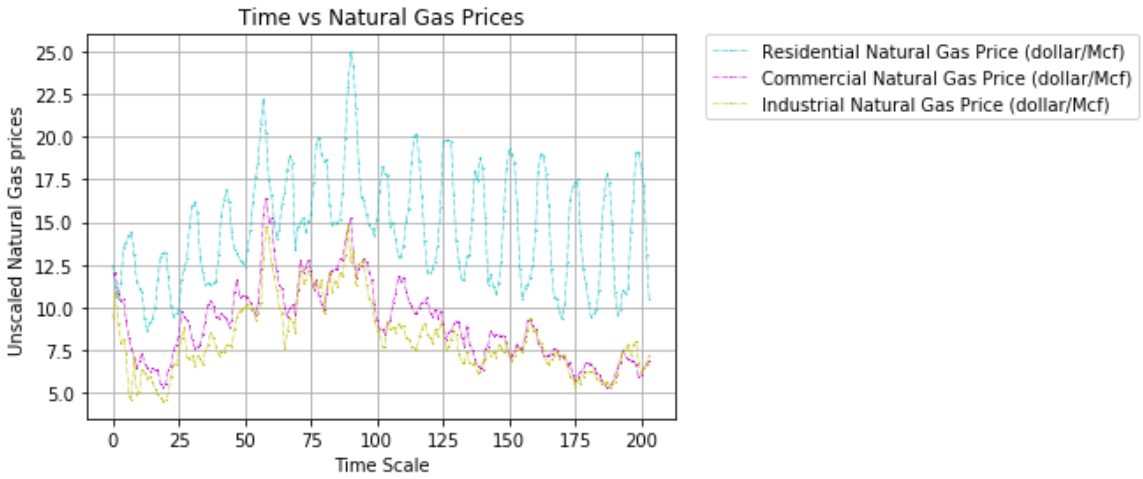
In [142]:

```
plt.plot(range(data.shape[0]),data_unscaled['Residential Electricity Price (cents/kWh)'
][::-1],color='green',marker='o',linestyle='-.', linewidth=0.5, markersize=0.3)
plt.plot(range(data.shape[0]),data_unscaled['Commercial Electricity Price (cents/kWh)']
[::-1],color='red',marker='o',linestyle='-.', linewidth=0.5, markersize=0.3)
plt.plot(range(data.shape[0]),data_unscaled['Industrial Electricity Price (cents/kWh)']
[::-1],color='blue',marker='o',linestyle='-.', linewidth=0.5, markersize=0.3)

green_patch = mpatches.Patch(color='green')
red_patch = mpatches.Patch(color='red')
blue_patch = mpatches.Patch(color='blue')

plt.legend(handles=[red_patch,green_patch,blue_patch])
plt.legend(bbox_to_anchor=(1.05, 1), loc=2, borderaxespad=0.)

plt.title('Time vs Electricity Prices')
plt.ylabel('Unscaled Electricity prices (cents/kWh) ')
plt.xlabel('Time Scale')
plt.grid()
plt.savefig('Electricity_Prices_over_time_unscaled.png',dpi=300,bbox_inches="tight")
plt.show()
```



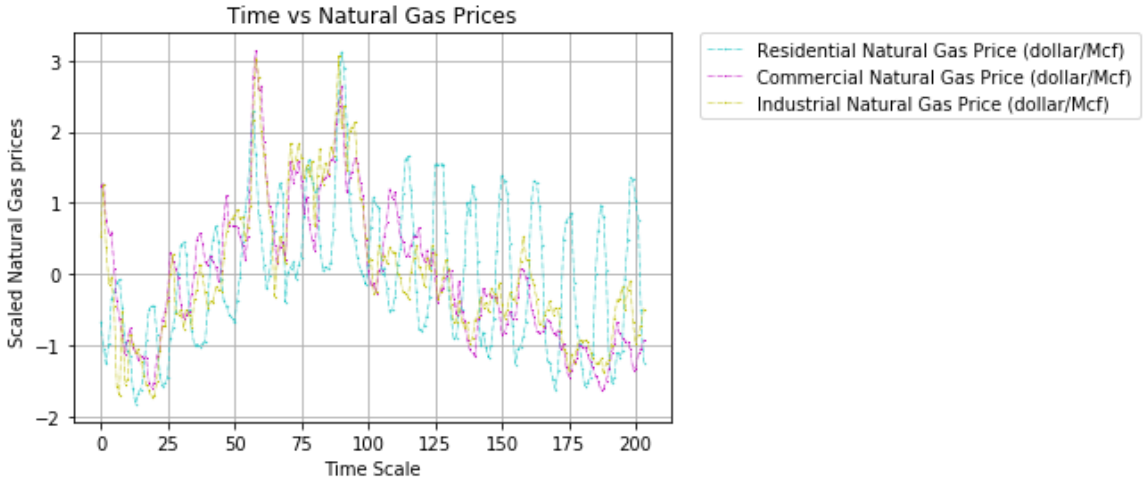
In [143]:

```
plt.plot(range(data.shape[0]),data_unscaled['Residential Natural Gas Price (dollar/Mc
f)'][::-1],color='c',marker='o',linestyle='-.', linewidth=0.5, markersize=0.3)
plt.plot(range(data.shape[0]),data_unscaled['Commercial Natural Gas Price (dollar/Mcf)'
][::-1],color='m',marker='^',linestyle='-.', linewidth=0.5, markersize=0.3)
plt.plot(range(data.shape[0]),data_unscaled['Industrial Natural Gas Price (dollar/Mcf)'
][::-1],color='y',marker='s',linestyle='-.', linewidth=0.5, markersize=0.3)

patch1 = mpatches.Patch(color='green')
patch2 = mpatches.Patch(color='red')
patch3 = mpatches.Patch(color='blue')

plt.legend(handles=[patch1,patch2,patch3])
plt.legend(bbox_to_anchor=(1.05, 1), loc=2, borderaxespad=0.)

plt.title('Time vs Natural Gas Prices')
plt.ylabel('Unscaled Natural Gas prices ')
plt.xlabel('Time Scale')
plt.grid()
plt.savefig('Natural_Gas_Prices_over_time_unscaled.png',dpi=300,bbox_inches="tight")
plt.show()
```



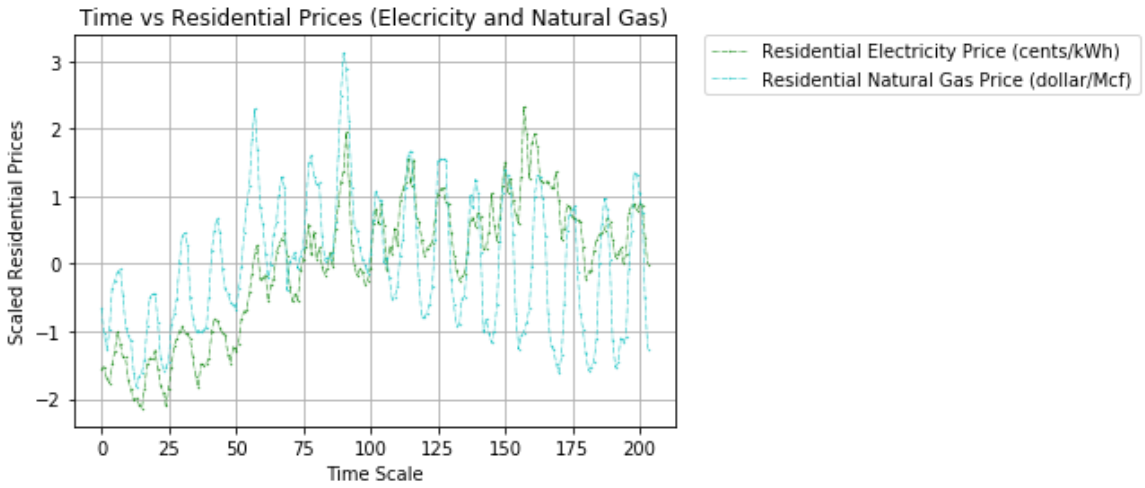
In [144]:

```
plt.plot(range(data.shape[0]),data_scaled['Residential Natural Gas Price (dollar/Mcf)']
[::-1],color='c',marker='o',linestyle='-.', linewidth=0.5, markersize=0.3)
plt.plot(range(data.shape[0]),data_scaled['Commercial Natural Gas Price (dollar/Mcf)']
[::-1],color='m',marker='^',linestyle='-.', linewidth=0.5, markersize=0.3)
plt.plot(range(data.shape[0]),data_scaled['Industrial Natural Gas Price (dollar/Mcf)']
[::-1],color='y',marker='s',linestyle='-.', linewidth=0.5, markersize=0.3)

patch1 = mpatches.Patch(color='green')
patch2 = mpatches.Patch(color='red')
patch3 = mpatches.Patch(color='blue')

plt.legend(handles=[patch1,patch2,patch3])
plt.legend(bbox_to_anchor=(1.05, 1), loc=2, borderaxespad=0.)

plt.title('Time vs Natural Gas Prices')
plt.ylabel('Scaled Natural Gas prices ')
plt.xlabel('Time Scale')
plt.grid()
plt.savefig('Natural_Gas_Prices_over_time_Scaled.png',dpi=300,bbox_inches="tight")
plt.show()
```



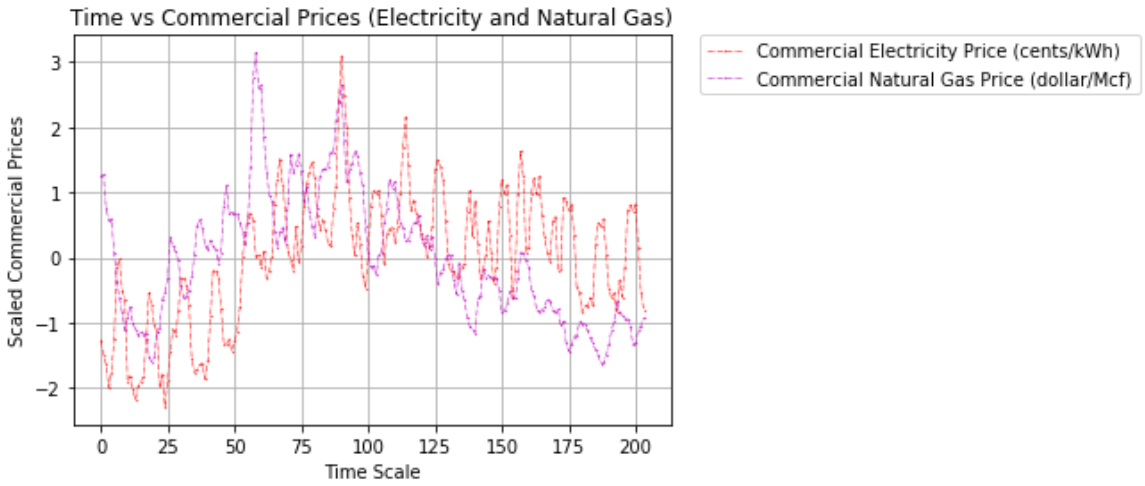
In [145]:

```
plt.plot(range(data.shape[0]),data_scaled['Residential Electricity Price (cents/kWh)']
[::-1],color='g',marker='o',linestyle='-.', linewidth=0.5, markersize=0.3)
plt.plot(range(data.shape[0]),data_scaled['Residential Natural Gas Price (dollar/Mcf)']
[::-1],color='c',marker='o',linestyle='-.', linewidth=0.5, markersize=0.3)
patch1 = mpatches.Patch(color='g')
patch2 = mpatches.Patch(color='c')

plt.legend(handles=[patch1,patch2])
plt.legend(bbox_to_anchor=(1.05, 1), loc=2, borderaxespad=0.)

plt.title('Time vs Residential Prices (Elecricity and Natural Gas)')
plt.ylabel('Scaled Residential Prices')
plt.xlabel('Time Scale')
plt.grid()
plt.savefig('Residential_Prices_over_time_Scaled.png',dpi=300,bbox_inches="tight")
plt.show()
```



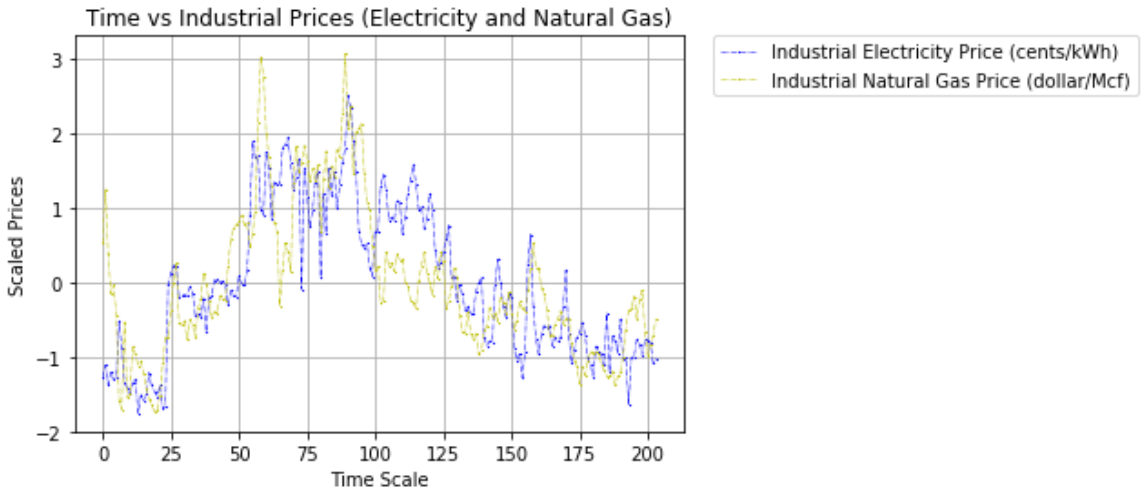
In [146]:

```
plt.plot(range(data.shape[0]),data_scaled['Commercial Electricity Price (cents/kWh)']
[::-1],color='r',marker='o',linestyle='-.', linewidth=0.5, markersize=0.3)
plt.plot(range(data.shape[0]),data_scaled['Commercial Natural Gas Price (dollar/Mcf)']
[::-1],color='m',marker='o',linestyle='-.', linewidth=0.5, markersize=0.3)
patch1 = mpatches.Patch(color='r')
patch2 = mpatches.Patch(color='m')

plt.legend(handles=[patch1,patch2])
plt.legend(bbox_to_anchor=(1.05, 1), loc=2, borderaxespad=0.)

plt.title('Time vs Commercial Prices (Electricity and Natural Gas)')
plt.ylabel('Scaled Commercial Prices')
plt.xlabel('Time Scale')
plt.grid()
plt.savefig('Commercial_Prices_over_time_Scaled.png',dpi=300,bbox_inches="tight")
plt.show()
```



In [147]:

```
plt.plot(range(data.shape[0]),data_scaled['Industrial Electricity Price (cents/kWh)']
[::-1],color='b',marker='s',linestyle='-.', linewidth=0.5, markersize=0.3)
plt.plot(range(data.shape[0]),data_scaled['Industrial Natural Gas Price (dollar/Mcf)']
[::-1],color='y',marker='s',linestyle='-.', linewidth=0.5, markersize=0.3)
patch1 = mpatches.Patch(color='b')
patch2 = mpatches.Patch(color='y')

plt.legend(handles=[patch1,patch2])
plt.legend(bbox_to_anchor=(1.05, 1), loc=2, borderaxespad=0.)

plt.title('Time vs Industrial Prices (Electricity and Natural Gas)')
plt.ylabel('Scaled Prices')
plt.xlabel('Time Scale')
plt.grid()
plt.savefig('Industrial_Prices_over_time_Scaled.png',dpi=300,bbox_inches="tight")
plt.show()
```



In [148]:

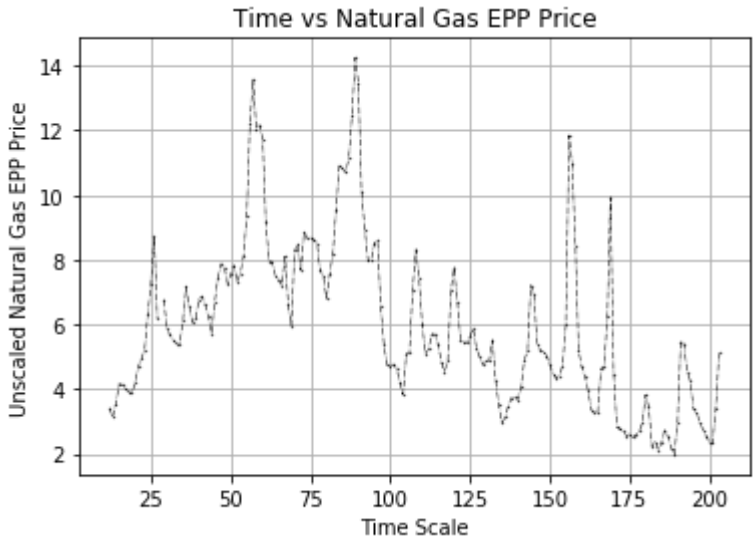
```
data_scaled.keys()
```

Out[148]:

```
Index(['Month', 'Year', 'Residential Electricity Demand (MkWh)',
       'Commercial Electricity Demand (MkWh)',
       'Industrial Electricity Demand (MkWh)',
       'Residential Natural Gas Demand (MMcf)',
       'Commercial Natural Gas Demand (MMcf)',
       'Industrial Natural Gas Demand (MMcf)', 'Natural Gas EPP Demand (MM
cf)',
       'Residential Electricity Price (cents/kWh)',
       'Commercial Electricity Price (cents/kWh)',
       'Industrial Electricity Price (cents/kWh)',
       'Residential Natural Gas Price (dollar/Mcf)',
       'Commercial Natural Gas Price (dollar/Mcf)',
       'Industrial Natural Gas Price (dollar/Mcf)',
       'Natural Gas Price EPP (dollar/Mcf)', 'CDSD', 'CLDD', 'DP01', 'DP1
0',
       'DSND', 'DSNW', 'DT00', 'DT32', 'DX32', 'DX70', 'DX90', 'EMNT', 'EM
SD',
       'EMSN', 'EMXP', 'EMXT', 'HDSD', 'HTDD', 'PRCP', 'SNOW', 'TAVG', 'TM
AX',
       'TMIN', 'WDF2', 'WDF5', 'WSF2', 'WSF5', 'DEWP', 'SNDP', 'VISIB',
       'PRCP.1', 'GUST', 'WDSP', 'RH', 'MXSPD', 'STP', 'SLP',
       'Unemployment Rate', 'Real GDP', 'Utilities Real GDP by State',
       'Population'],
      dtype='object')
```

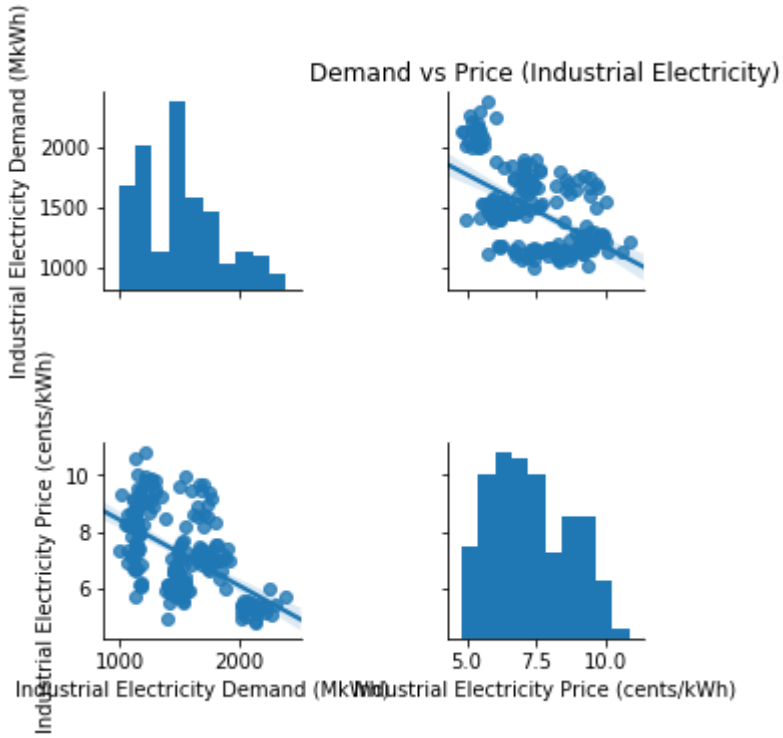
In [149]:

```
plt.plot(range(data.shape[0]),data_unscaled['Natural Gas Price EPP (dollar/Mcf)'][::-1
],color='black',marker='o',linestyle='-.', linewidth=0.5, markersize=0.3)
plt.title('Time vs Natural Gas EPP Price')
plt.ylabel('Unscaled Natural Gas EPP Price')
plt.xlabel('Time Scale')
plt.grid()
plt.savefig('Natural_Gas_Prices_EPP_over_time_Scaled.png',dpi=300,bbox_inches="tight")
plt.show()
```



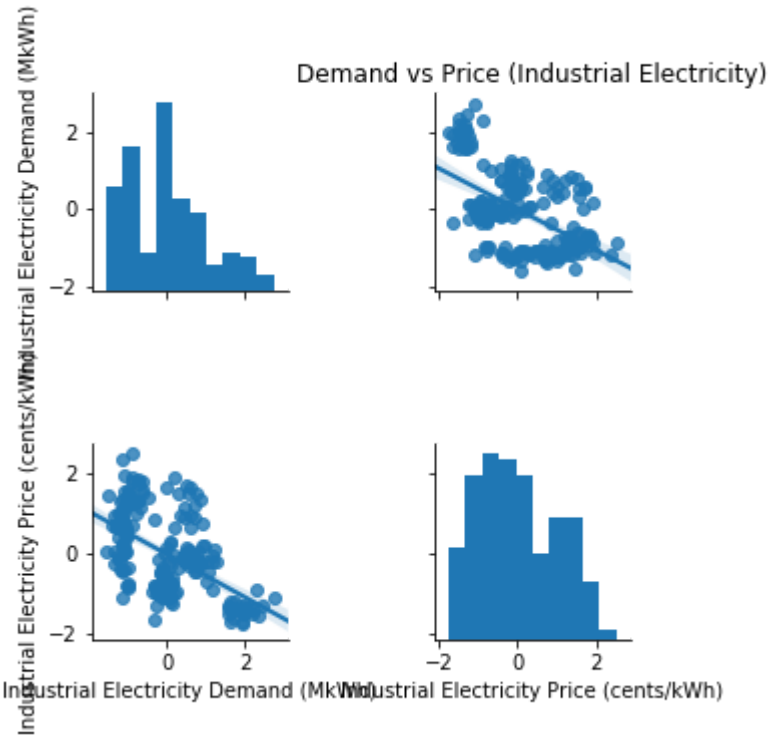
In [150]:

```
sns.pairplot(data_unscaled[['Industrial Electricity Demand (MkWh)','Industrial Electric
ity Price (cents/kWh)']],kind='reg')
plt.title('Demand vs Price (Industrial Electricity)')
plt.savefig('Unscaled_Demand_vs_Price_Industrial_Electrcity.png',dpi=300,bbox_inches="t
ight")
plt.show()
```



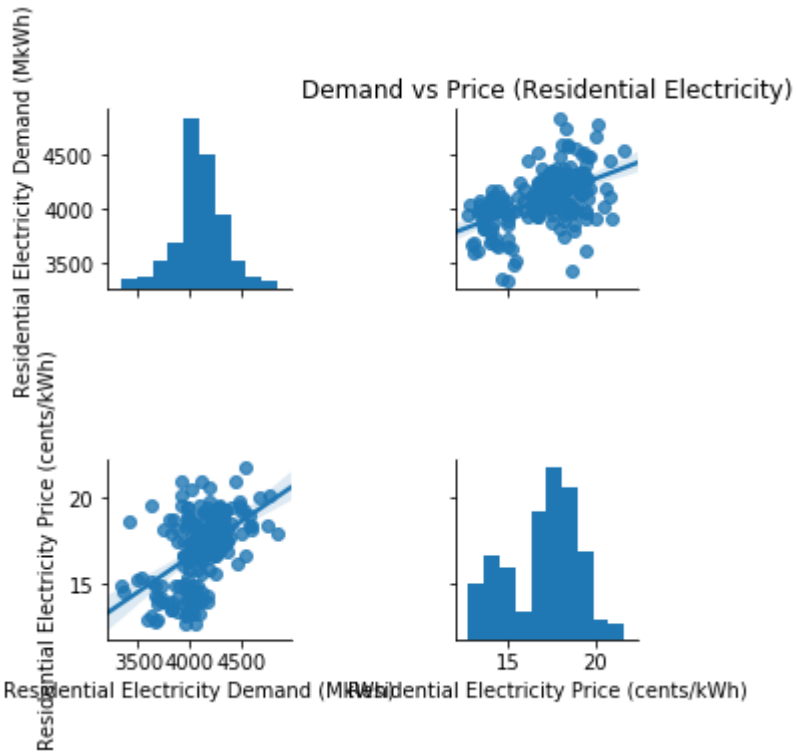
In [151]:

```
sns.pairplot(data_scaled[['Industrial Electricity Demand (MkWh)','Industrial Electricit
y Price (cents/kWh)']],kind='reg')
plt.title('Demand vs Price (Industrial Electricity)')
plt.savefig('Scaled_Demand_vs_Price_Industrial_Electrcity.png',dpi=300,bbox_inches="tig
ht")
plt.show()
```



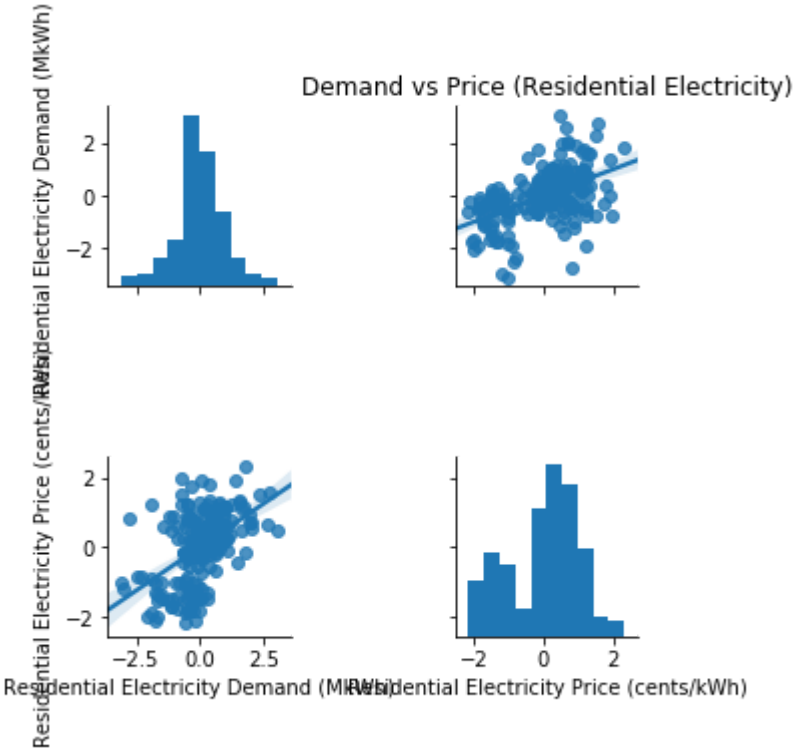
In [152]:

```
sns.pairplot(data_unscaled[['Residential Electricity Demand (MkWh)','Residential Electr
icity Price (cents/kWh)']],kind='reg')
plt.title('Demand vs Price (Residential Electricity)')
plt.savefig('Unscaled_Demand_vs_Price_Residential_Electrcity.png',dpi=300,bbox_inches=
"tight")
plt.show()
```



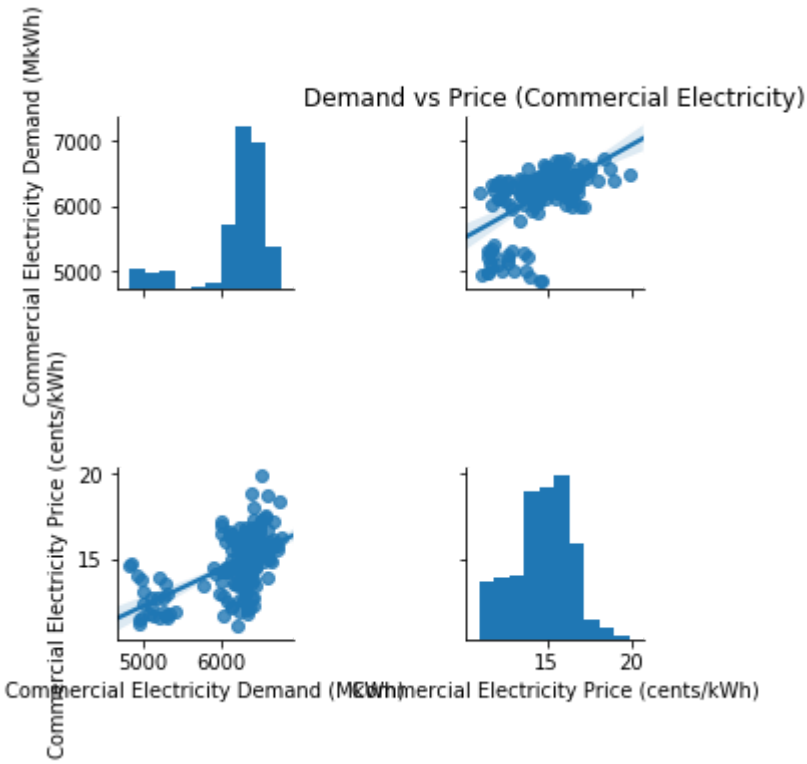
In [153]:

```
sns.pairplot(data_scaled[['Residential Electricity Demand (MkWh)','Residential Electric
ity Price (cents/kWh)']],kind='reg')
plt.title('Demand vs Price (Residential Electricity)')
plt.savefig('Scaled_Demand_vs_Price_Residential_Electrcity.png',dpi=300,bbox_inches="ti
ght")
plt.show()
```



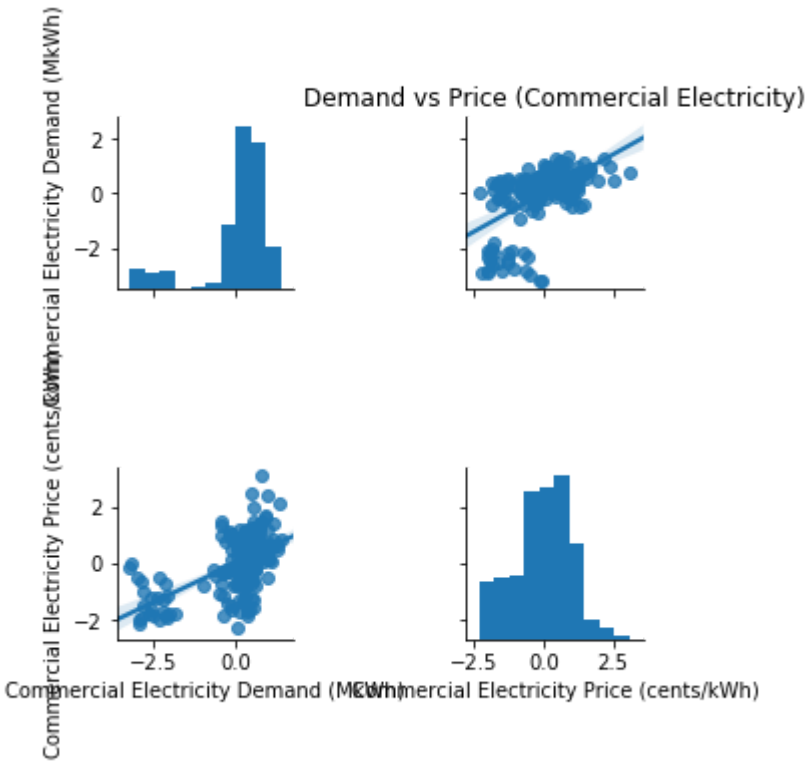
In [154]:

```
sns.pairplot(data_unscaled[['Commercial Electricity Demand (MkWh)','Commercial Electric
ity Price (cents/kWh)']],kind='reg')
plt.title('Demand vs Price (Commercial Electricity)')
plt.savefig('Unscaled_Demand_vs_Price_Commercial_Electrcity.png',dpi=300,bbox_inches="t
ight")
plt.show()
```



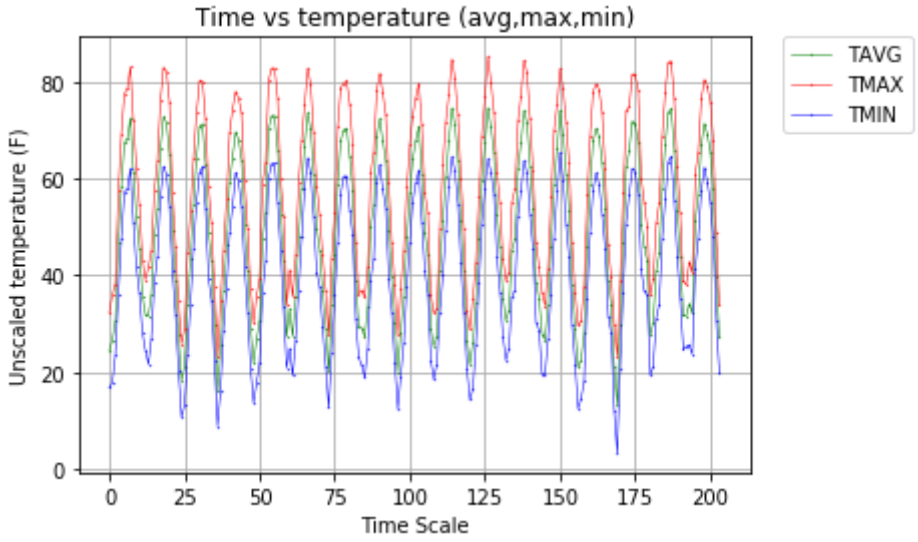
In [155]:

```
sns.pairplot(data_scaled[['Commercial Electricity Demand (MkWh)','Commercial Electricit
y Price (cents/kWh)']],kind='reg')
plt.title('Demand vs Price (Commercial Electricity)')
plt.savefig('scaled_Demand_vs_Price_Commercial_Electrcity.png',dpi=300,bbox_inches="tig
ht")
plt.show()
```



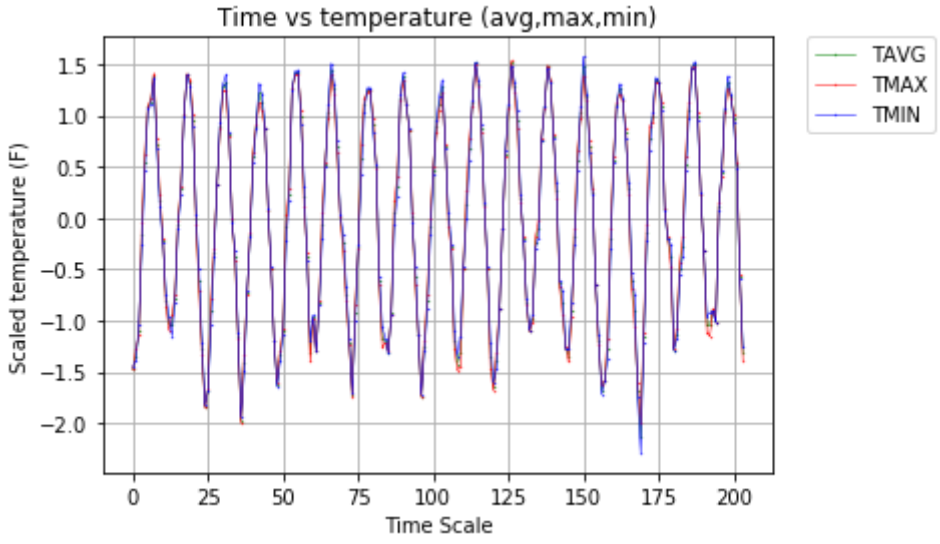
In [156]:

```
plt.plot(range(data.shape[0]),data_unscaled['TAVG'][::-1],color='green',marker='o',line
style='solid', linewidth=0.5, markersize=0.3)
plt.plot(range(data.shape[0]),data_unscaled['TMAX'][::-1],color='red',marker='o',linest
yle='solid', linewidth=0.5, markersize=0.3)
plt.plot(range(data.shape[0]),data_unscaled['TMIN'][::-1],color='blue',marker='o',lines
tyle='solid', linewidth=0.5, markersize=0.3)
green_patch = mpatches.Patch(color='green', label='TAVG')
red_patch = mpatches.Patch(color='red', label='TMAX')
blue_patch = mpatches.Patch(color='blue', label='TMIN')

plt.legend(handles=[red_patch,green_patch,blue_patch])
plt.legend(bbox_to_anchor=(1.05, 1), loc=2, borderaxespad=0.)

plt.title('Time vs temperature (avg,max,min)')
plt.ylabel('Unscaled temperature (F)')
plt.xlabel('Time Scale')
plt.grid()
plt.savefig('Unscaled_Temperatures_over_Time.png',dpi=300,bbox_inches="tight")
plt.show()
```



In [157]:

```
plt.plot(range(data.shape[0]),data_scaled['TAVG'][::-1],color='green',marker='o',linest
yle='solid', linewidth=0.5, markersize=0.3)
plt.plot(range(data.shape[0]),data_scaled['TMAX'][::-1],color='red',marker='o',linestyl
e='solid', linewidth=0.5, markersize=0.3)
plt.plot(range(data.shape[0]),data_scaled['TMIN'][::-1],color='blue',marker='o',linesty
le='solid', linewidth=0.5, markersize=0.3)
green_patch = mpatches.Patch(color='green', label='TAVG')
red_patch = mpatches.Patch(color='red', label='TMAX')
blue_patch = mpatches.Patch(color='blue', label='TMIN')

plt.legend(handles=[red_patch,green_patch,blue_patch])
plt.legend(bbox_to_anchor=(1.05, 1), loc=2, borderaxespad=0.)

plt.title('Time vs temperature (avg,max,min)')
plt.ylabel('Scaled temperature (F)')
plt.xlabel('Time Scale')
plt.grid()
plt.savefig('scaled_Temperatures_over_Time.png',dpi=300,bbox_inches="tight")
plt.show()
```



In [158]:

```
plt.plot(range(data.shape[0]),data_unscaled['STP'][::-1],color='green',marker='o',lines
tyle='solid', linewidth=0.5, markersize=0.3)
plt.plot(range(data.shape[0]),data_unscaled['SLP'][::-1],color='red',marker='v',linesty
le='dashed', linewidth=0.5, markersize=0.3)

plt.title('Time vs STP,SLP')
plt.ylabel('Unscaled (STP and SLP) in Pa')
plt.xlabel('Time Scale')
plt.savefig('Unscaled_STP_SLP_over_Time.png',dpi=300,bbox_inches="tight")
plt.show()
```

In [159]:

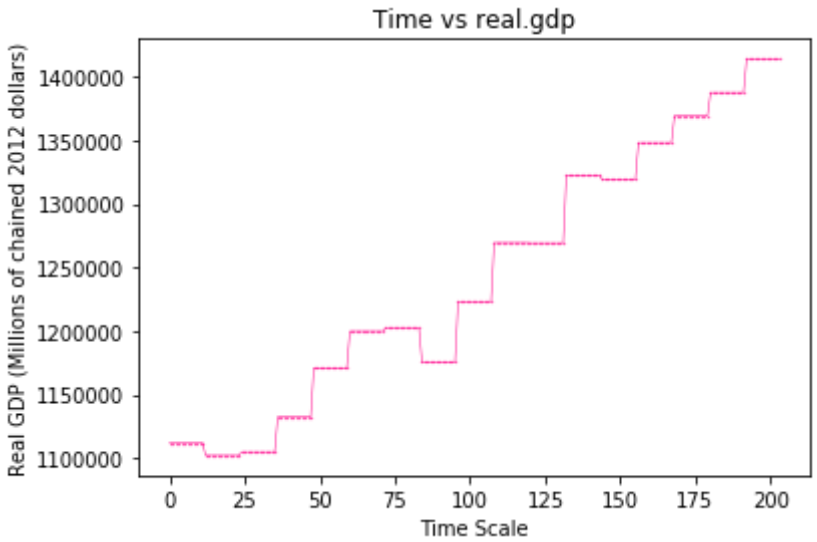
```
data_scaled.keys()
```

Out[159]:

```
Index(['Month', 'Year', 'Residential Electricity Demand (MkWh)',
       'Commercial Electricity Demand (MkWh)',
       'Industrial Electricity Demand (MkWh)',
       'Residential Natural Gas Demand (MMcf)',
       'Commercial Natural Gas Demand (MMcf)',
       'Industrial Natural Gas Demand (MMcf)', 'Natural Gas EPP Demand (MM
cf)',
       'Residential Electricity Price (cents/kWh)',
       'Commercial Electricity Price (cents/kWh)',
       'Industrial Electricity Price (cents/kWh)',
       'Residential Natural Gas Price (dollar/Mcf)',
       'Commercial Natural Gas Price (dollar/Mcf)',
       'Industrial Natural Gas Price (dollar/Mcf)',
       'Natural Gas Price EPP (dollar/Mcf)', 'CDSD', 'CLDD', 'DP01', 'DP1
0',
       'DSND', 'DSNW', 'DT00', 'DT32', 'DX32', 'DX70', 'DX90', 'EMNT', 'EM
SD',
       'EMSN', 'EMXP', 'EMXT', 'HDSD', 'HTDD', 'PRCP', 'SNOW', 'TAVG', 'TM
AX',
       'TMIN', 'WDF2', 'WDF5', 'WSF2', 'WSF5', 'DEWP', 'SNDP', 'VISIB',
       'PRCP.1', 'GUST', 'WDSP', 'RH', 'MXSPD', 'STP', 'SLP',
       'Unemployment Rate', 'Real GDP', 'Utilities Real GDP by State',
       'Population'],
      dtype='object')
```

In [160]:

```
plt.plot(range(data.shape[0]),data_unscaled['Real GDP'][::-1],color='deeppink',marker=
'o',linestyle='solid', linewidth=0.5, markersize=0.3)
plt.title('Time vs real.gdp')
plt.ylabel('Real GDP (Millions of chained 2012 dollars)')
plt.xlabel('Time Scale')
plt.savefig('unscaled_real_gdp_over_Time.png',dpi=300,bbox_inches="tight")
plt.show()
```



In [161]:

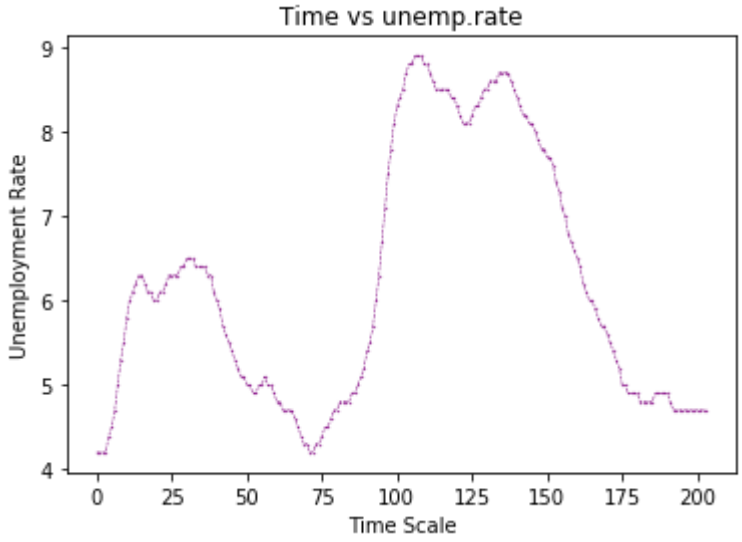
```
data.keys()
```

Out[161]:

```
Index(['Month', 'Year', 'Residential Electricity Demand (MkWh)',
       'Commercial Electricity Demand (MkWh)',
       'Industrial Electricity Demand (MkWh)',
       'Residential Natural Gas Demand (MMcf)',
       'Commercial Natural Gas Demand (MMcf)',
       'Industrial Natural Gas Demand (MMcf)', 'Natural Gas EPP Demand (MM
cf)',
       'Residential Electricity Price (cents/kWh)',
       'Commercial Electricity Price (cents/kWh)',
       'Industrial Electricity Price (cents/kWh)',
       'Residential Natural Gas Price (dollar/Mcf)',
       'Commercial Natural Gas Price (dollar/Mcf)',
       'Industrial Natural Gas Price (dollar/Mcf)',
       'Natural Gas Price EPP (dollar/Mcf)', 'CDSD', 'CLDD', 'DP01', 'DP1
0',
       'DSND', 'DSNW', 'DT00', 'DT32', 'DX32', 'DX70', 'DX90', 'EMNT', 'EM
SD',
       'EMSN', 'EMXP', 'EMXT', 'HDSD', 'HTDD', 'PRCP', 'SNOW', 'TAVG', 'TM
AX',
       'TMIN', 'WDF2', 'WDF5', 'WSF2', 'WSF5', 'DEWP', 'SNDP', 'VISIB',
       'PRCP.1', 'GUST', 'WDSP', 'RH', 'MXSPD', 'STP', 'SLP',
       'Unemployment Rate', 'Real GDP', 'Utilities Real GDP by State',
       'Population'],
      dtype='object')
```

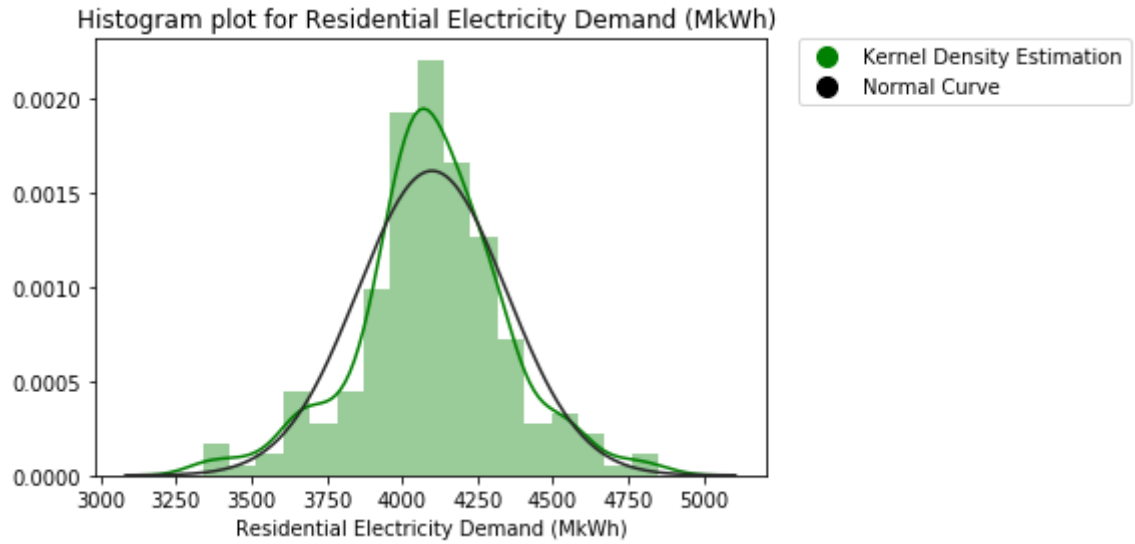
In [162]:

```
plt.plot(range(data.shape[0]),data_unscaled['Unemployment Rate'][::-1],color='purple',m
arker='o',linestyle='dashed', linewidth=0.5, markersize=0.3)

plt.title('Time vs unemp.rate')
plt.ylabel('Unemployment Rate')
plt.xlabel('Time Scale')
plt.savefig('unscaled_Unemployment_rate_over_Time.png',dpi=300,bbox_inches="tight")
plt.show()
```



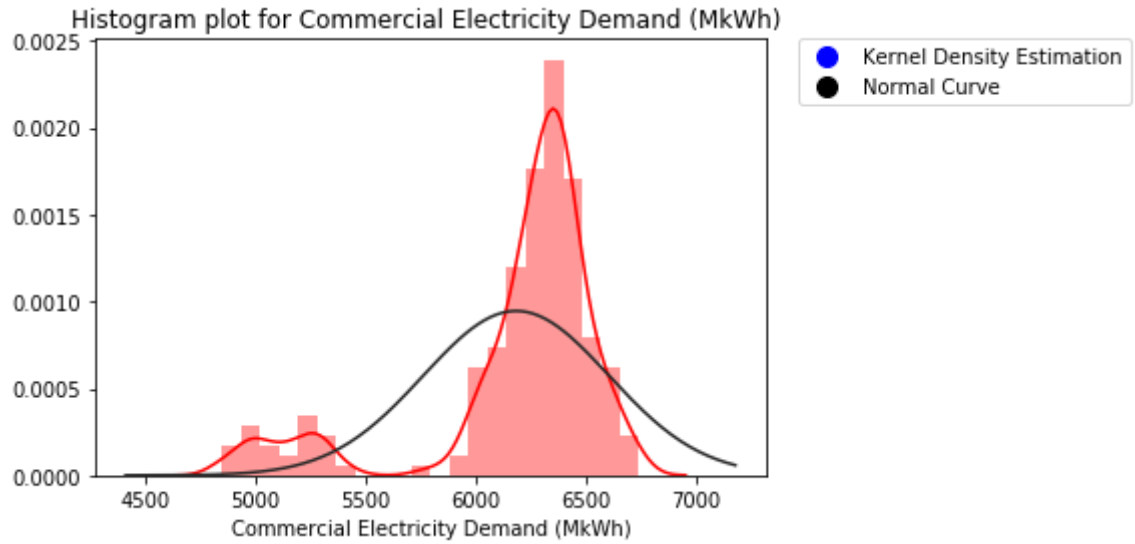
In [163]:

```
sns.distplot(data_unscaled['Residential Electricity Demand (MkWh)'],fit=norm,color='gre
en')
plt.title('Histogram plot for Residential Electricity Demand (MkWh) ')
colors = ["g", "black"]
texts = ["Kernel Density Estimation", "Normal Curve"]
patches = [ plt.plot([],[], marker="o", ms=10, ls="", mec=None, color=colors[i],
            label="{:s}".format(texts[i]) )[0]  for i in range(len(texts)) ]
plt.legend(bbox_to_anchor=(1.05, 1), loc=2, borderaxespad=0.)
plt.savefig('Distribution_Residential_Electricity_Demand_Unscaled.png',dpi=300,bbox_inc
hes="tight")
```



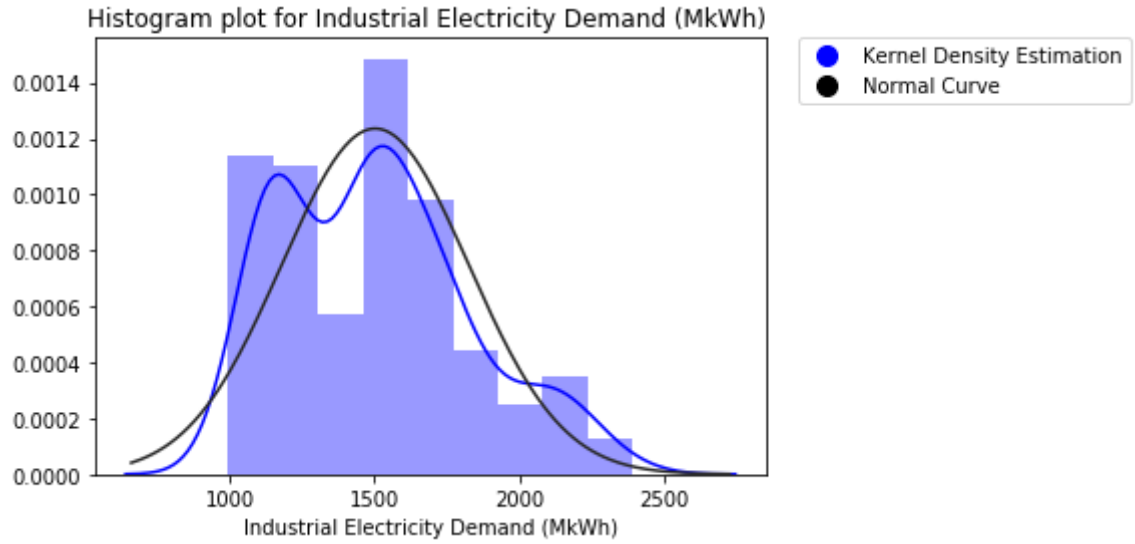
In [164]:

```
sns.distplot(data_unscaled['Commercial Electricity Demand (MkWh)'],fit=norm,color='red'
)
plt.title('Histogram plot for Commercial Electricity Demand (MkWh) ')
colors = ["blue", "black"]
texts = ["Kernel Density Estimation", "Normal Curve"]
patches = [ plt.plot([],[], marker="o", ms=10, ls="", mec=None, color=colors[i],
            label="{:s}".format(texts[i]) )[0]  for i in range(len(texts)) ]
plt.legend(bbox_to_anchor=(1.05, 1), loc=2, borderaxespad=0.)
plt.savefig('Distribution_Commercial_Electricity_Demand_Unscaled.png',dpi=300,bbox_inch
es="tight")
```



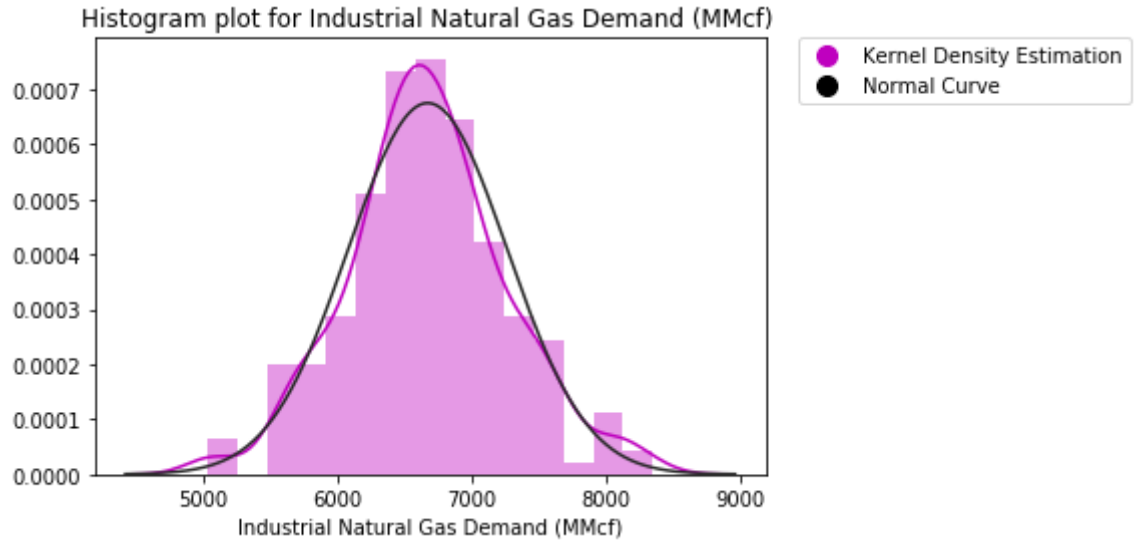
In [165]:

```
sns.distplot(data_unscaled['Industrial Electricity Demand (MkWh)'],fit=norm,color='blu
e')
plt.title('Histogram plot for Industrial Electricity Demand (MkWh) ')
colors = ["blue", "black"]
texts = ["Kernel Density Estimation", "Normal Curve"]
patches = [ plt.plot([],[], marker="o", ms=10, ls="", mec=None, color=colors[i],
            label="{:s}".format(texts[i]) )[0]  for i in range(len(texts)) ]
plt.legend(bbox_to_anchor=(1.05, 1), loc=2, borderaxespad=0.)
plt.savefig('Distribution_Industrial_Electricity_Demand_Unscaled.png',dpi=300,bbox_inch
es="tight")
```



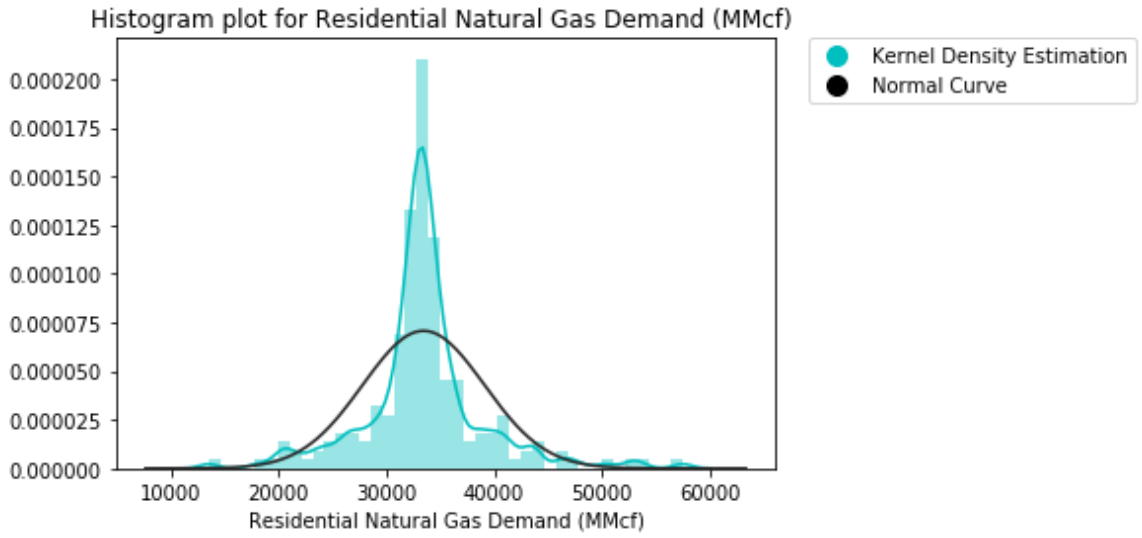
In [166]:

```
sns.distplot(data_unscaled['Industrial Natural Gas Demand (MMcf)'],fit=norm,color='m')
plt.title('Histogram plot for Industrial Natural Gas Demand (MMcf) ')
colors = ["m", "black"]
texts = ["Kernel Density Estimation", "Normal Curve"]
patches = [ plt.plot([],[], marker="o", ms=10, ls="", mec=None, color=colors[i],
            label="{:s}".format(texts[i]) )[0]  for i in range(len(texts)) ]
plt.legend(bbox_to_anchor=(1.05, 1), loc=2, borderaxespad=0.)
plt.savefig('Distribution_Industrial_Natural_Gas_Demand_Unscaled.png',dpi=300,bbox_inch
es="tight")
```



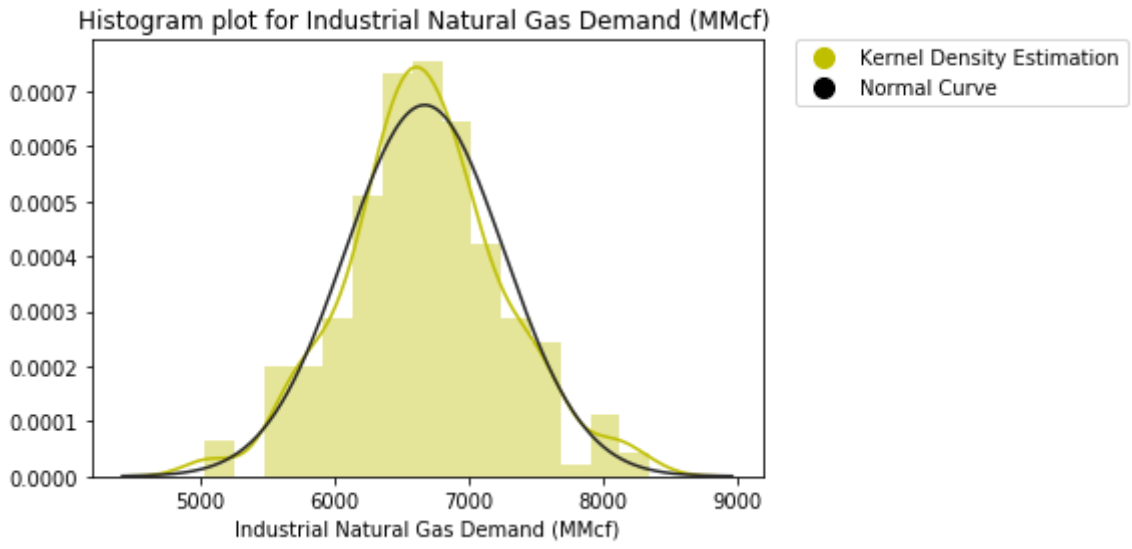
In [167]:

```
sns.distplot(data_unscaled['Residential Natural Gas Demand (MMcf)'],fit=norm,color='c')
plt.title('Histogram plot for Residential Natural Gas Demand (MMcf) ')
colors = ["c", "black"]
texts = ["Kernel Density Estimation", "Normal Curve"]
patches = [ plt.plot([],[], marker="o", ms=10, ls="", mec=None, color=colors[i],
            label="{:s}".format(texts[i]) )[0]  for i in range(len(texts)) ]
plt.legend(bbox_to_anchor=(1.05, 1), loc=2, borderaxespad=0.)
plt.savefig('Distribution_Residential_Natural_Gas_Demand_Unscaled.png',dpi=300,bbox_inc
hes="tight")
```



In [168]:

```
sns.distplot(data_unscaled['Industrial Natural Gas Demand (MMcf)'],fit=norm,color='y')
plt.title('Histogram plot for Industrial Natural Gas Demand (MMcf) ')
colors = ["y", "black"]
texts = ["Kernel Density Estimation", "Normal Curve"]
patches = [ plt.plot([],[], marker="o", ms=10, ls="", mec=None, color=colors[i],
            label="{:s}".format(texts[i]) )[0]  for i in range(len(texts)) ]
plt.legend(bbox_to_anchor=(1.05, 1), loc=2, borderaxespad=0.)
plt.savefig('Distribution_Industrial_Natural_Gas_Demand_Unscaled.png',dpi=300,bbox_inch
es="tight")
```



In [169]:

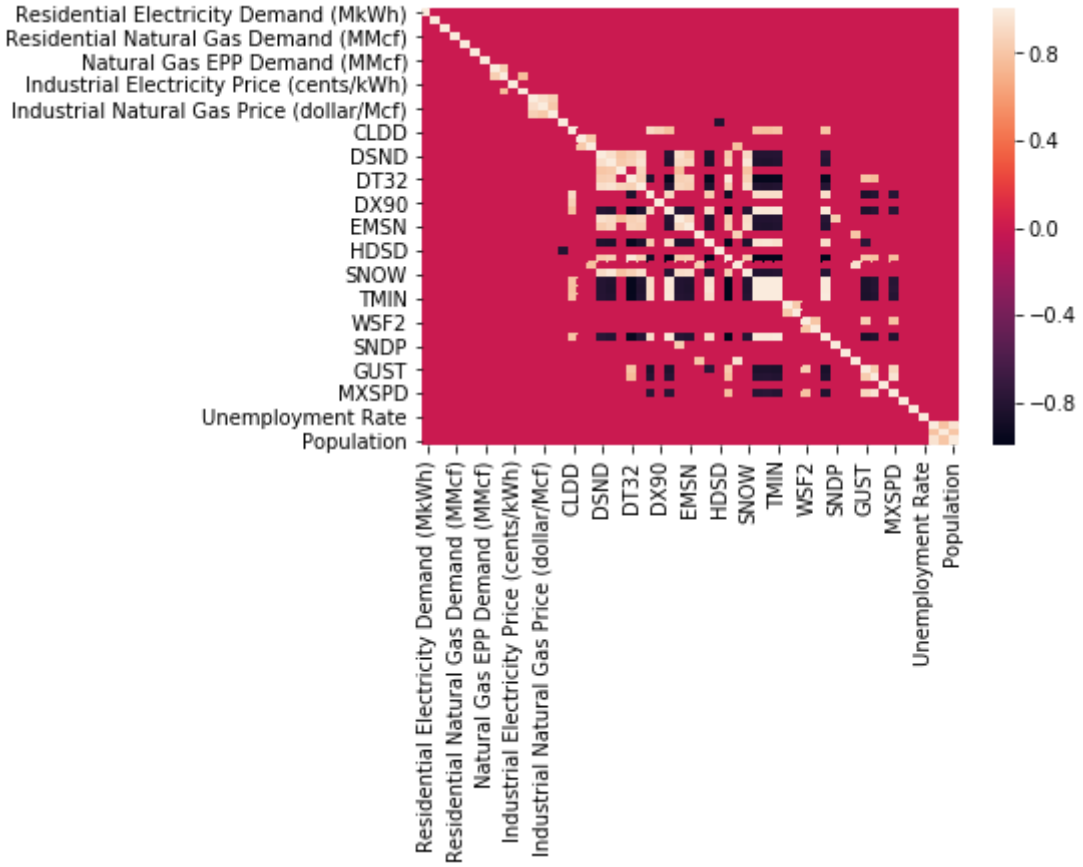
```
threshold=0.75
corrmat=data_unscaled.iloc[:,2:].corr().values
corrmat[(np.logical_and(corrmat<=threshold, corrmat>=-threshold))]=0
corrmat=pd.DataFrame(corrmat)
corrmat.columns=data_unscaled.iloc[:,2:].columns
corrmat.index=corrmat.columns
```

In [170]:

```
sns.heatmap(corrmat)
```

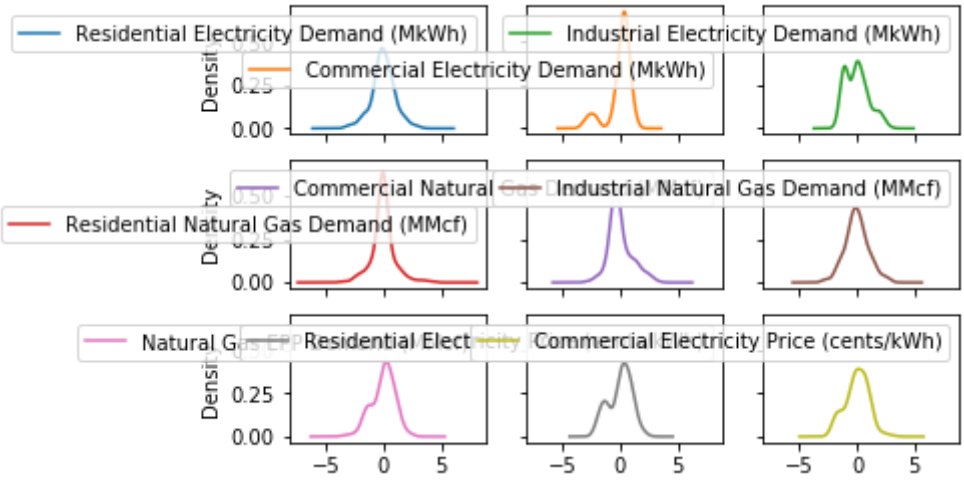
Out[170]:

```
<matplotlib.axes._subplots.AxesSubplot at 0x1eac25c5ac8>
```



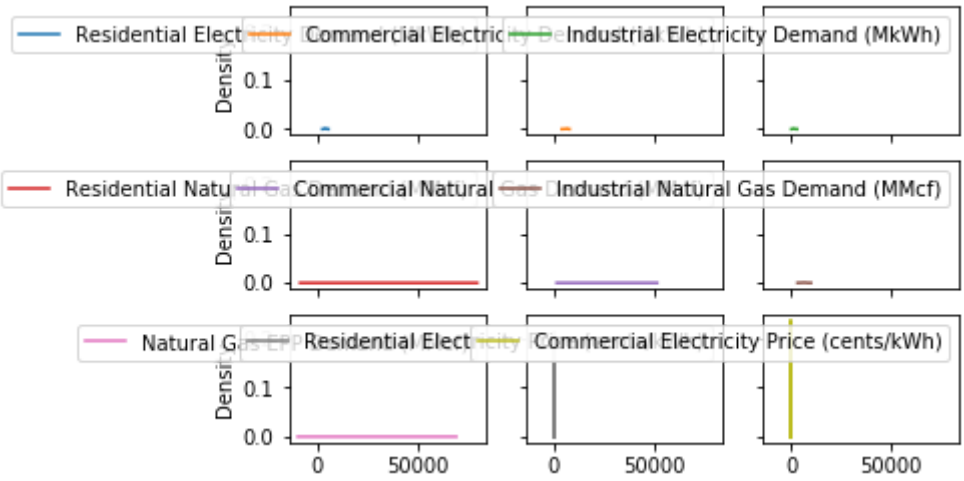
In [171]:

```
data_scaled.iloc[:,2:11].plot(kind='density', subplots=True,layout=(3,3), sharex=True,s
harey=True)
plt.savefig('scaled_Distributions_Prototype.png',dpi=300,bbox_inches="tight")
plt.show()
```



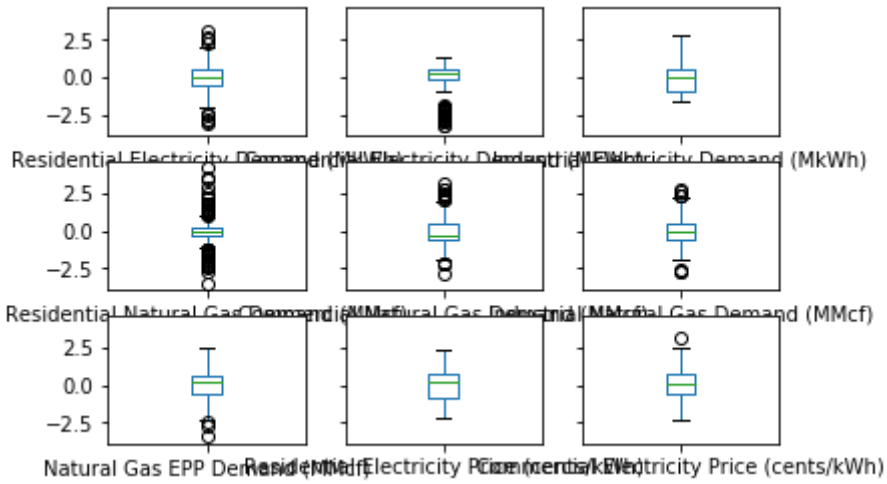
In [172]:

```
data_unscaled.iloc[:,2:11].plot(kind='density', subplots=True,layout=(3,3), sharex=True
,sharey=True)
plt.savefig('Uncaled_Distributions_Prototype.png',dpi=300,bbox_inches="tight")
plt.show()
```



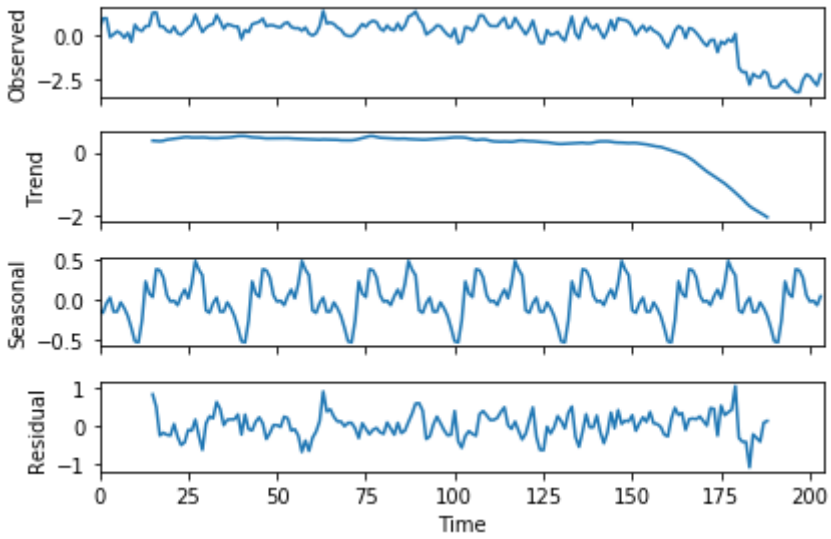
In [173]:

```
data.iloc[:,2:11].plot(kind='box', subplots=True, layout=(3,3), sharex=True, sharey=Tru
e)
plt.show()
```



In [175]:

```
from statsmodels.tsa.seasonal import seasonal_decompose
result = seasonal_decompose(data.iloc[:,3].values, model='additive', freq=30)
result.plot()
plt.savefig('Decomposition_Example.png',dpi=300)
plt.show()
```



In [ ]:

```

```

In [ ]:

```

```