TrainingTask

May 14, 2024

[2]:
```
import warnings
warnings.filterwarnings("ignore")
```

[3]:
```
import pandas as pd
```

[8]:
```
weather = pd.read_csv("power-laws-forecasting-energy-consumption-weather.csv",␣
 ↪sep=";", parse_dates=['Timestamp'])
consumption =pd.
 ↪read_csv("power-laws-forecasting-energy-consumption-training-data.csv",␣
 ↪sep=";", parse_dates=['Timestamp'])

site_id = 6

weather_on_site = weather.query(f"SiteId == {site_id}")
weather_on_site = weather_on_site.sort_values("Timestamp")

consumption_on_site = consumption[consumption["SiteId"] == site_id]
consumption_on_site = consumption_on_site.sort_values("Timestamp")

weather_on_site.to_csv(f"site_{site_id}_weather.csv", sep=";", index=False)
consumption_on_site.to_csv(f"site_{site_id}_consumption.csv", sep=";",␣
 ↪index=False)
```

[11]:
```
consumption.to_csv(f"site_{site_id}_consumption_edit.csv", sep=";", index=False)
```

[21]:
```
def fahr_to_celsius(temp_fahr):
    """Convert Fahrenheit to Celsius

    Return Celsius conversion of input"""
    temp_celsius = (temp_fahr - 32) * 5 / 9
    return temp_celsius
```

[22]:
```
##consumption_edit1["Temperature_C"] =␣
 ↪fahr_to_celsius(consumption_edit1["Temperature"])
```

[23]:
```
#consumption_edit1
```

[25]:
```
import pandas
import datetime

site_id = 6

weather = pandas.read_csv(f"site_{site_id}_weather.csv", sep=";",␣
 ↪parse_dates=['Timestamp'])
consumption = pandas.read_csv(f"site_{site_id}_consumption.csv", sep=";",␣
 ↪parse_dates=['Timestamp'])

def datetime_to_epoch(d1):
    """
    January 1st, 1970 at 00:00:00 UTC is referred to as the Unix epoch
    :param d1: input date
    :return: seconds since unix epoch
    """
    if not d1.tzinfo:
        raise ValueError("date is missing timezone information")

    d2 = datetime.datetime(1970, 1, 1, tzinfo=datetime.timezone.utc)
    time_delta = d1 - d2
    ts = int(time_delta.total_seconds())
    return ts

def to_unix_epoch(row):
    return datetime_to_epoch(row["Timestamp"])

weather = weather[weather["Distance"] < 8]

weather["UnixTS"] = weather.apply(to_unix_epoch, axis=1)
consumption["UnixTS"] = consumption.apply(to_unix_epoch, axis=1)

def convert_to_celisus(f):
    return (f - 32) / 1.8

def find_closest_temperature_at_ts(row):
    timestamp = row["UnixTS"]
    loc = weather["UnixTS"].searchsorted(timestamp)

    return weather.iloc[loc]["Temperature"]


    if loc < len(weather)-1:
        c0 = weather.iloc[ loc ]
        c1 = weather.iloc[ loc+1 ]
        distance = c1["UnixTS"] - c0["UnixTS"]
        alpha = (timestamp - c0["UnixTS"]) / distance
```

```
        t0 = weather.iloc[loc]["Temperature"]
        t1 = weather.iloc[loc+1]["Temperature"]
        return convert_to_celisus((1-alpha) * t0 + alpha * t1)

    return convert_to_celisus(weather.iloc[loc]["Temperature"])

consumption["Temperature"] = consumption.apply(find_closest_temperature_at_ts,␣
 ↪axis=1)

weather.to_csv(f"site_{site_id}_weather_post.csv", sep=";", index=False)
consumption.to_csv(f"site_{site_id}_consumption_post.csv", sep=";", index=False)
```

[26]:
```
weather
```

[26]:

	Timestamp	Temperature	Distance	SiteId	UnixTS
0	2013-01-01 13:00:00+00:00	21.7	7.611766	6	1357045200
4	2013-01-01 16:00:00+00:00	22.4	7.611766	6	1357056000
9	2013-01-01 19:00:00+00:00	20.5	7.611766	6	1357066800
13	2013-01-01 22:00:00+00:00	16.0	7.611766	6	1357077600
17	2013-01-02 01:00:00+00:00	15.0	7.611766	6	1357088400
…	…	…	…	…	…
95756	2017-12-30 22:00:00+00:00	17.8	7.611766	6	1514671200
95764	2017-12-31 01:00:00+00:00	16.2	7.611766	6	1514682000
95771	2017-12-31 04:00:00+00:00	14.9	7.611766	6	1514692800
95777	2017-12-31 07:00:00+00:00	15.4	7.611766	6	1514703600
95785	2017-12-31 10:00:00+00:00	20.4	7.611766	6	1514714400

[14415 rows x 5 columns]

[27]:
```
consumption
```

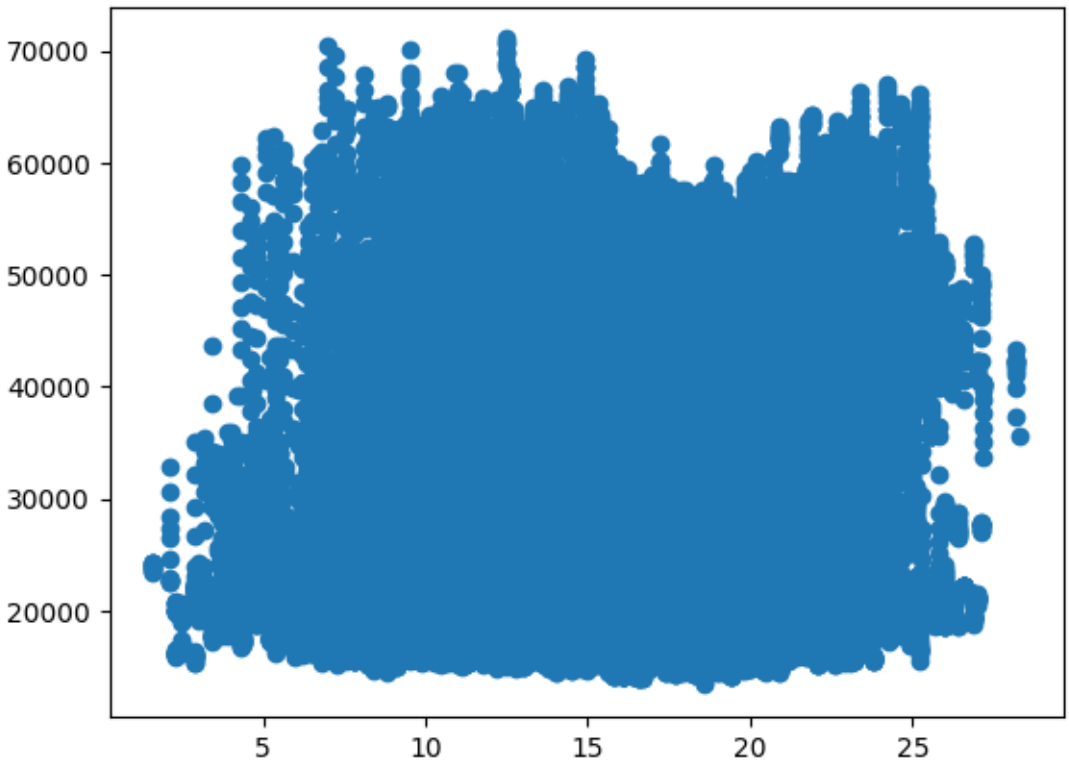
[27]:

	obs_id	SiteId	Timestamp	ForecastId	Value	\
0	1231308	6	2013-01-01 01:00:00+00:00	43	25108.373290	
1	1855136	6	2013-01-01 01:15:00+00:00	43	25062.047878	
2	5379308	6	2013-01-01 01:30:00+00:00	43	25015.722466	
3	1204858	6	2013-01-01 01:45:00+00:00	43	24969.397055	
4	167176	6	2013-01-01 02:00:00+00:00	43	24923.071643	
…	…	…	…	…	…	
140739	2522602	6	2017-10-23 01:45:00+00:00	188	15935.941719	
140740	7671789	6	2017-10-23 02:00:00+00:00	188	15935.941719	
140741	184978	6	2017-10-23 02:15:00+00:00	188	15565.338424	
140742	1399957	6	2017-10-23 02:30:00+00:00	188	15194.735128	
140743	4821512	6	2017-10-23 02:45:00+00:00	188	15380.036776	

	UnixTS	Temperature
0	1357002000	21.7
1	1357002900	21.7

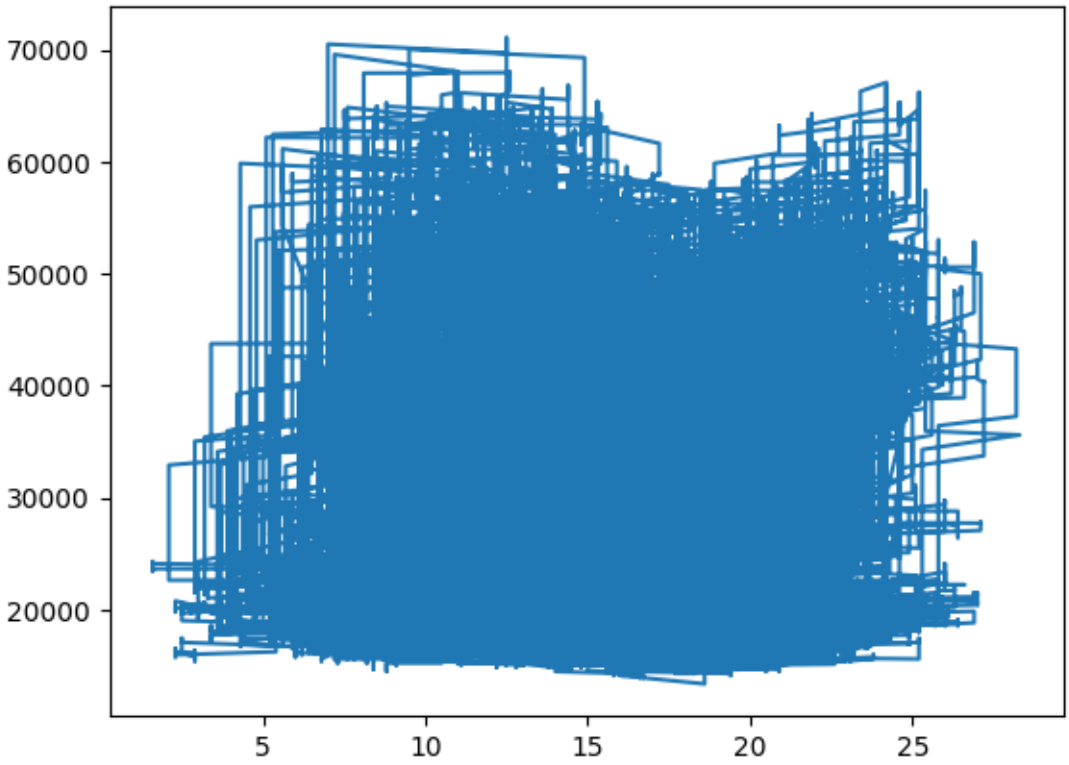
```
2        1357003800          21.7
3        1357004700          21.7
4        1357005600          21.7
…              …             …
140739   1508723100          12.9
140740   1508724000          12.9
140741   1508724900          12.9
140742   1508725800          12.9
140743   1508726700          12.9

[140744 rows x 7 columns]
```

[28]:
```
import matplotlib.pyplot as plt

plt.scatter(consumption.iloc[:,6],consumption.iloc[:,4])
plt.show()
```



[29]:
```
import matplotlib.pyplot as plt

plt.plot(consumption['Temperature'],consumption['Value'])
```

[29]:
```
[<matplotlib.lines.Line2D at 0x24585e1aa90>]
```

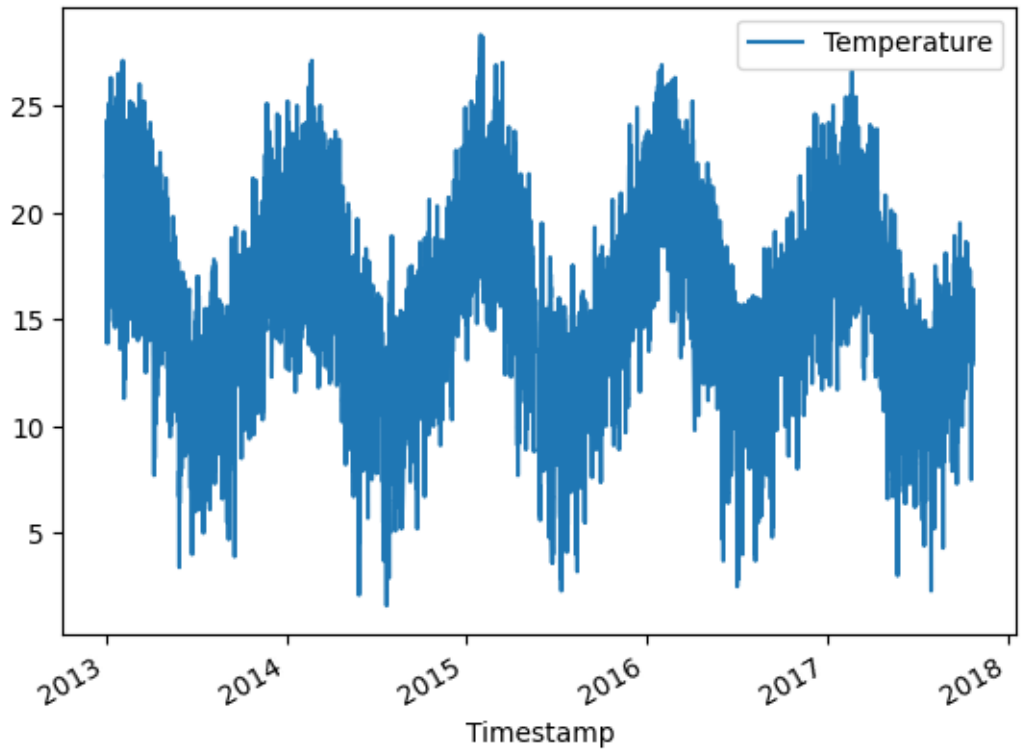


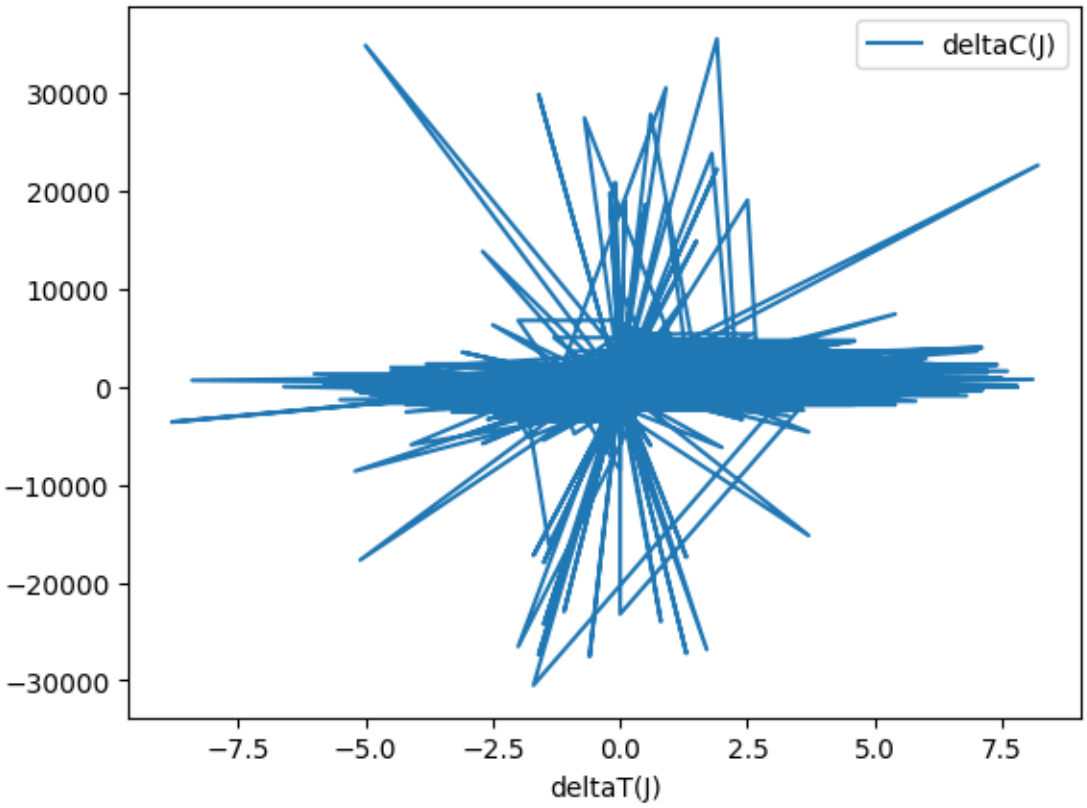
[31]:
```
import matplotlib.pyplot as plt

site_id = 6

weather = pd.read_csv(f"site_{site_id}_weather_post.csv", sep=";",␣
 ↪parse_dates=['Timestamp'])
consumption = pd.read_csv(f"site_{site_id}_consumption_post.csv", sep=";",␣
 ↪parse_dates=['Timestamp'])

print(consumption["Timestamp"])
consumption.plot(x="Timestamp", y=["Temperature"])
#consumption.plot(x="Temperature", y="Value")

consumption["C(J)"] = consumption["Value"]
consumption["C(J-1)"] = consumption["Value"].shift(periods=1)

consumption["T(J)"] = consumption["Temperature"]
consumption["T(J-1)"] = consumption["Temperature"].shift(periods=1)

consumption = consumption.drop([0])

consumption["deltaT(J)"] = consumption["T(J)"] - consumption["T(J-1)"]
```

```
consumption["deltaC(J)"] = consumption["C(J)"] - consumption["C(J-1)"]

figure2 = consumption.plot(x="deltaT(J)", y="deltaC(J)")
plt.figure().show()

#weather = pandas.read_csv(f"site_{site_id}_weather.csv", sep=";",␣
 ↪parse_dates=['Timestamp'])

print(consumption.head(100))
print(consumption["Temperature"].max())
```

```
0         2013-01-01 01:00:00+00:00
1         2013-01-01 01:15:00+00:00
2         2013-01-01 01:30:00+00:00
3         2013-01-01 01:45:00+00:00
4         2013-01-01 02:00:00+00:00
                     …
140739    2017-10-23 01:45:00+00:00
140740    2017-10-23 02:00:00+00:00
140741    2017-10-23 02:15:00+00:00
140742    2017-10-23 02:30:00+00:00
140743    2017-10-23 02:45:00+00:00
Name: Timestamp, Length: 140744, dtype: datetime64[ns, UTC]
      obs_id  SiteId                 Timestamp  ForecastId         Value  \
1    1855136       6 2013-01-01 01:15:00+00:00          43  25062.047878
2    5379308       6 2013-01-01 01:30:00+00:00          43  25015.722466
3    1204858       6 2013-01-01 01:45:00+00:00          43  24969.397055
4     167176       6 2013-01-01 02:00:00+00:00          43  24923.071643
5    1417840       6 2013-01-01 02:15:00+00:00          43  24992.559760
..       …     …                         …         …           …
96   4414228       6 2013-01-02 01:00:00+00:00          43  25201.024114
97   7679920       6 2013-01-02 01:15:00+00:00          43  24946.234349
98   3636173       6 2013-01-02 01:30:00+00:00          43  24691.444583
99   2507416       6 2013-01-02 01:45:00+00:00          43  24784.095407
100  4975213       6 2013-01-02 02:00:00+00:00          43  24876.746231

         UnixTS  Temperature          C(J)        C(J-1)  T(J)  T(J-1)  \
1    1357002900         21.7  25062.047878  25108.373290  21.7    21.7
2    1357003800         21.7  25015.722466  25062.047878  21.7    21.7
3    1357004700         21.7  24969.397055  25015.722466  21.7    21.7
4    1357005600         21.7  24923.071643  24969.397055  21.7    21.7
5    1357006500         21.7  24992.559760  24923.071643  21.7    21.7
..          …           …           …           …   …     …
96   1357088400         15.0  25201.024114  25177.861408  15.0    15.0
97   1357089300         13.9  24946.234349  25201.024114  13.9    15.0
98   1357090200         13.9  24691.444583  24946.234349  13.9    13.9
99   1357091100         13.9  24784.095407  24691.444583  13.9    13.9
100  1357092000         13.9  24876.746231  24784.095407  13.9    13.9
```

```
     deltaT(J)   deltaC(J)
1          0.0  -46.325412
2          0.0  -46.325412
3          0.0  -46.325412
4          0.0  -46.325412
5          0.0   69.488118
..         …          …
96         0.0   23.162706
97        -1.1 -254.789766
98         0.0 -254.789766
99         0.0   92.650824
100        0.0   92.650824

[100 rows x 13 columns]
28.3
```

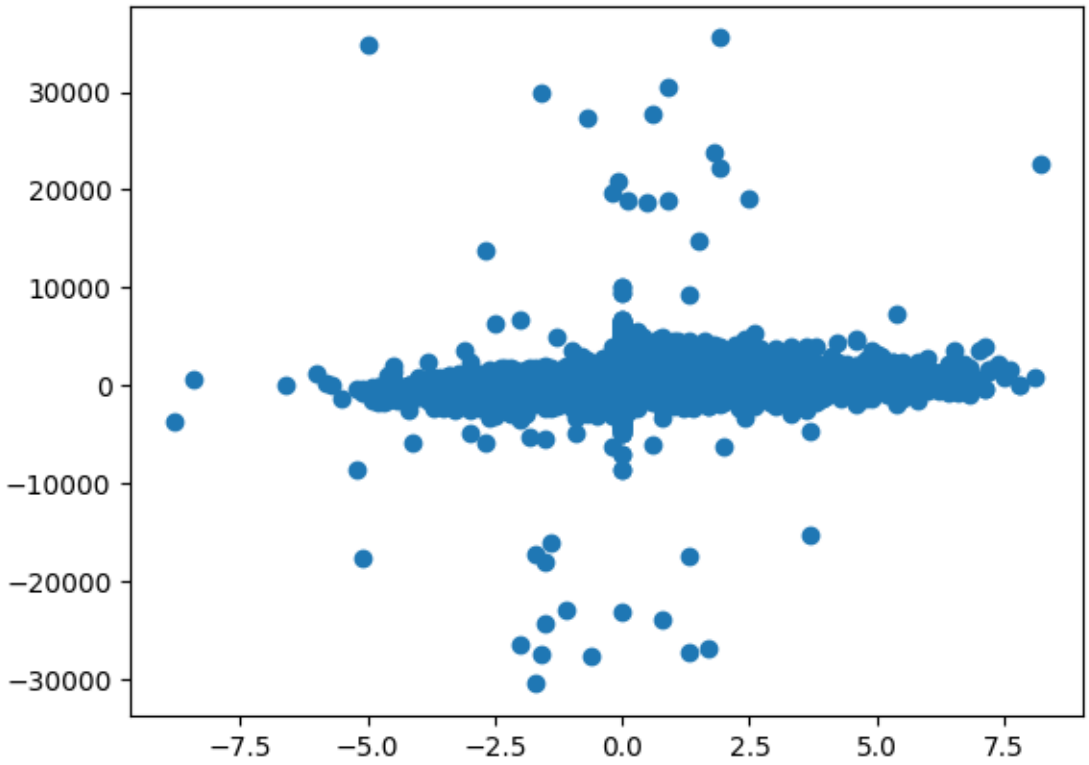





```
<Figure size 640x480 with 0 Axes>
```

[32]:
```
plt.scatter(x=consumption["deltaT(J)"], y=consumption["deltaC(J)"])
```

[32]:
```
<matplotlib.collections.PathCollection at 0x24585e1add0>
```



[33]:
```
DataForRegression=consumption[["deltaT(J)","deltaC(J)"]]
DataForRegression['deltaC(J-1)']=DataForRegression['deltaC(J)'].shift(1)
DataForRegressionb=DataForRegression.dropna(axis=1)
DataForRegression.head(7)
```

[33]:

	deltaT(J)	deltaC(J)	deltaC(J-1)
1	0.0	-46.325412	NaN
2	0.0	-46.325412	-46.325412
3	0.0	-46.325412	-46.325412
4	0.0	-46.325412	-46.325412
5	0.0	69.488118	-46.325412
6	0.0	69.488118	69.488118
7	0.0	185.301648	69.488118

[34]:
```
DataForRegression['deltaT(J-1)']=DataForRegression['deltaT(J)'].shift(1)
DataForRegressionb=DataForRegression.dropna(axis=1)
```

[35]:
```
DataForRegression1=  DataForRegression.drop([1])
```

[36]:
```
DataForRegression1
```

[36]:
```
         deltaT(J)   deltaC(J)  deltaC(J-1)  deltaT(J-1)
2              0.0  -46.325412   -46.325412          0.0
3              0.0  -46.325412   -46.325412          0.0
4              0.0  -46.325412   -46.325412          0.0
5              0.0   69.488118   -46.325412          0.0
6              0.0   69.488118    69.488118          0.0
…              …          …           …           …
140739         0.0    0.000000  -185.301648          0.0
140740         0.0    0.000000     0.000000          0.0
140741         0.0 -370.603296     0.000000          0.0
140742         0.0 -370.603296  -370.603296          0.0
140743         0.0  185.301648  -370.603296          0.0

[140742 rows x 4 columns]
```

[37]:
```
DataForRegression1=DataForRegression1.dropna()
```

[38]:
```
y=DataForRegression1["deltaC(J)"]
```

[39]:
```
y
```

[39]:
```
2         -46.325412
3         -46.325412
4         -46.325412
5          69.488118
6          69.488118
              …
140739      0.000000
140740      0.000000
140741   -370.603296
140742   -370.603296
140743    185.301648
Name: deltaC(J), Length: 139615, dtype: float64
```

[40]:
```
x=DataForRegression1.drop(DataForRegression1.columns[[1]], axis=1)
```

[41]:
```
x
```

[41]:
```
         deltaT(J)  deltaC(J-1)  deltaT(J-1)
2              0.0   -46.325412          0.0
3              0.0   -46.325412          0.0
4              0.0   -46.325412          0.0
5              0.0   -46.325412          0.0
6              0.0    69.488118          0.0
…              …           …           …
140739         0.0  -185.301648          0.0
140740         0.0     0.000000          0.0
140741         0.0     0.000000          0.0
```

```
140742        0.0  -370.603296          0.0
140743        0.0  -370.603296          0.0

[139615 rows x 3 columns]
```

[46]:
```
x[x.isna().any(axis=1)]
```

[46]:
```
Empty DataFrame
Columns: [deltaT(J), deltaC(J-1), deltaT(J-1)]
Index: []
```

[47]:
```
y[y.isna()]
```

[47]:
```
Series([], Name: deltaC(J), dtype: float64)
```

[48]:
```
from sklearn import datasets, linear_model
from sklearn.metrics import mean_squared_error, r2_score, mean_absolute_error
```

[49]:
```
regr = linear_model.LinearRegression(fit_intercept=False)
```

[50]:
```
regr.fit(x, y)
```

[50]:
```
LinearRegression(fit_intercept=False)
```

[51]:
```
y_pred = regr.predict(x)
```

[52]:
```
# The coefficients
print("Coefficients: \n", regr.coef_)
# The mean squared error
print("Mean squared error: %.2f" % mean_squared_error(y, y_pred))
# The coefficient of determination: 1 is perfect prediction
print("Coefficient of determination: %.2f" % r2_score(y, y_pred))
```

```
Coefficients:
 [19.63788156  0.60809605 39.06437609]
Mean squared error: 519609.02
Coefficient of determination: 0.37
```

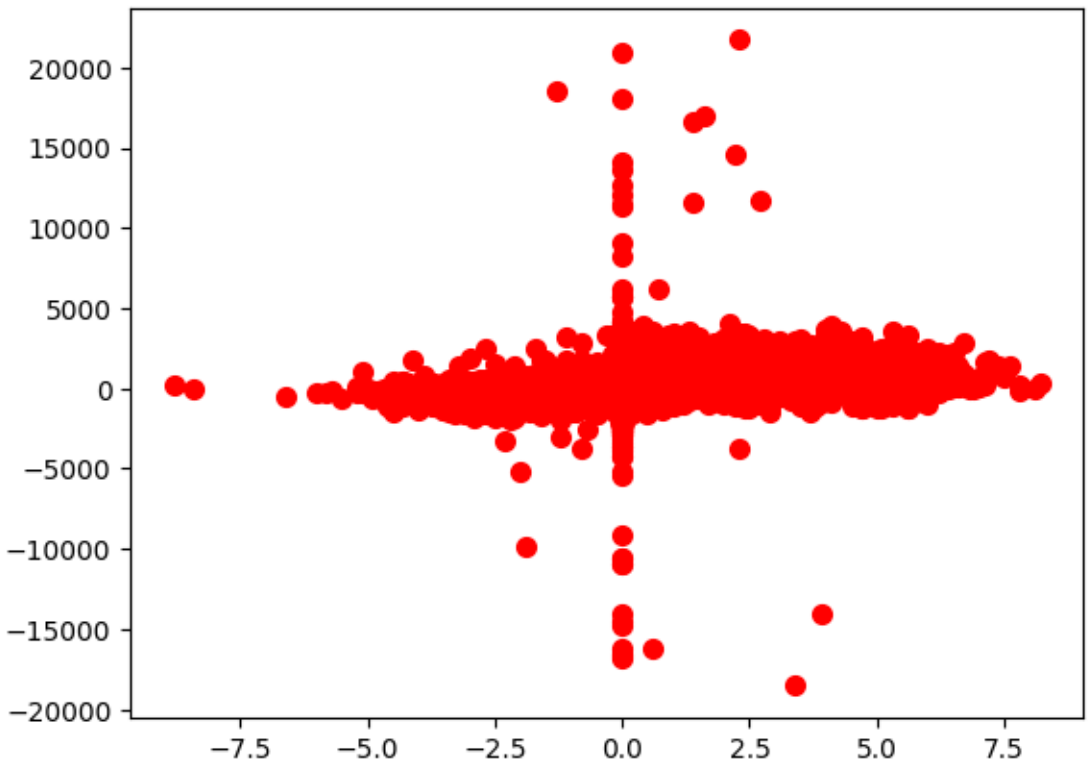
[53]:
```
regr.intercept_
```

[53]:
```
0.0
```

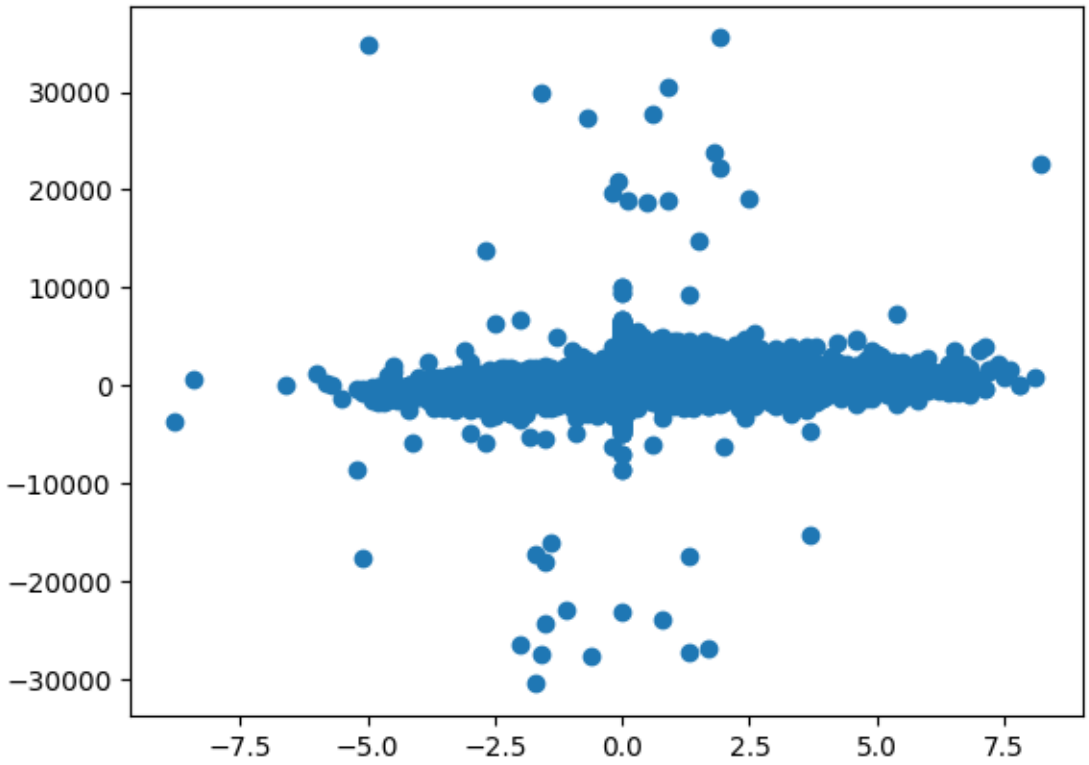
[54]:
```
r2_score(y,y_pred)
```

[54]:
```
0.3745178118185988
```

[55]:
```
#plt.scatter(x, y,  color='gray')
plt.scatter(x['deltaT(J)'], y_pred, color='red', linewidth=2)
plt.show()
```

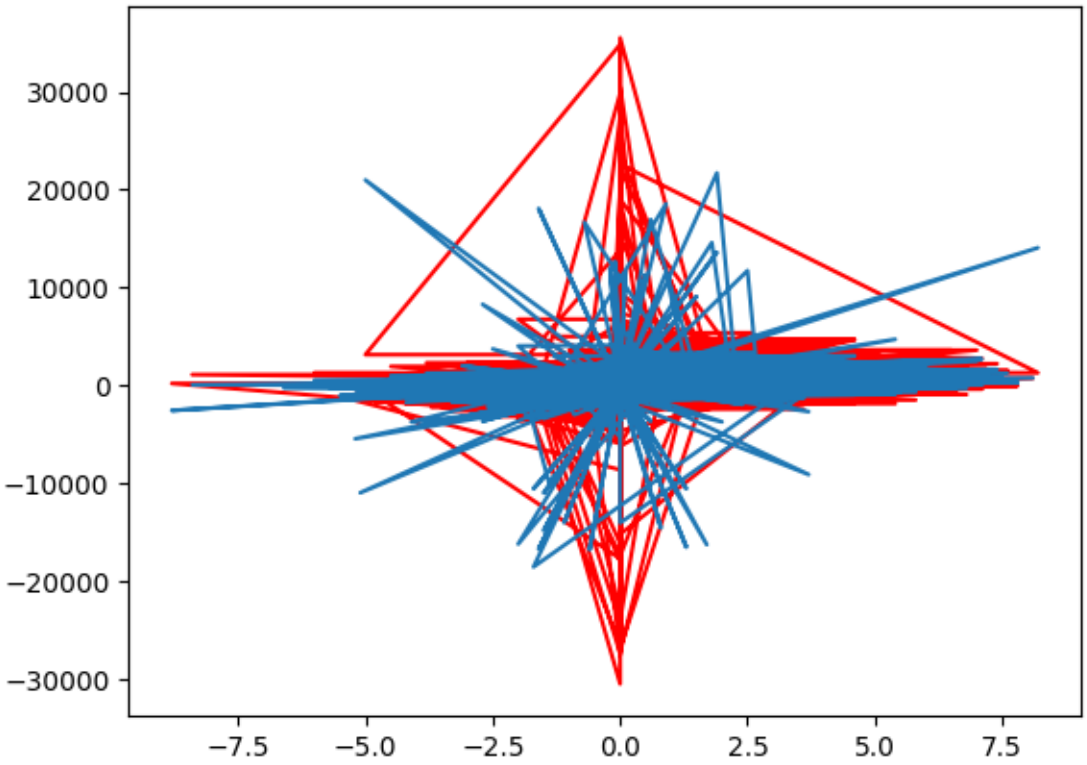


[56]:
```
plt.scatter(x['deltaT(J)'], y)
plt.show()
```



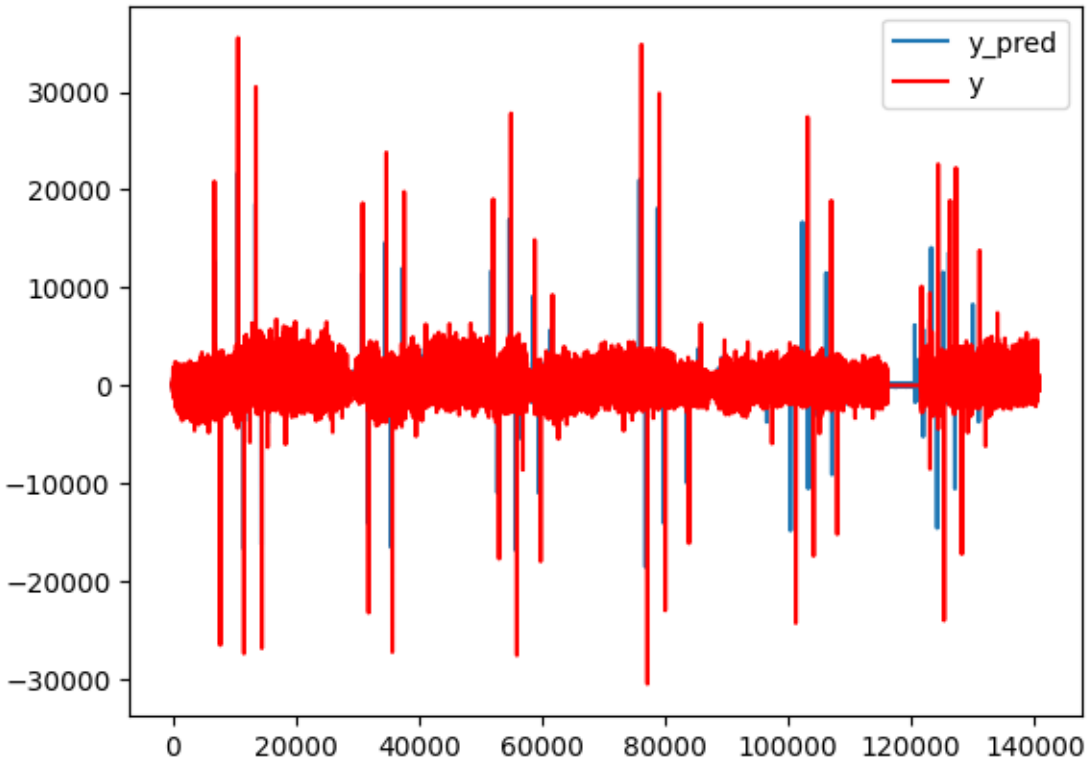
[57]:
```
plt.plot(x['deltaT(J-1)'],y,'r', x['deltaT(J-1)'], y_pred)
```

[57]:
```
[<matplotlib.lines.Line2D at 0x24587e4c690>,
 <matplotlib.lines.Line2D at 0x24587f42ad0>]
```



[58]:
```
plt.plot(y_pred)
plt.plot(y,'r')
plt.legend(['y_pred', 'y'])
```

[58]: <matplotlib.legend.Legend at 0x24587f85c10>



[59]:
```
import numpy as np
DataafterRegression=pd.concat([x,pd.DataFrame(np.matrix.
  ↪transpose(y_pred),columns=['DeltaC_pred'])], ignore_index=True, axis=1)
```

[60]:
```
DataafterRegression=x
```

[61]:
```
DataafterRegression["DeltaC_pred"]=np.matrix.transpose(y_pred)
DataafterRegression["DeltaC_pred"]=DataafterRegression["DeltaC_pred"].shift(-1)
```

[62]:
```
DataafterRegression["DeltaC(J)"]=y
```

[63]:
```
print(DataafterRegression)
```

```
        deltaT(J)  deltaC(J-1)  deltaT(J-1)  DeltaC_pred   DeltaC(J)
2             0.0   -46.325412          0.0    -28.17030  -46.325412
3             0.0   -46.325412          0.0    -28.17030  -46.325412
4             0.0   -46.325412          0.0    -28.17030  -46.325412
5             0.0   -46.325412          0.0     42.25545   69.488118
6             0.0    69.488118          0.0     42.25545   69.488118
…             …           …            …           …          …
140739        0.0  -185.301648          0.0      0.00000    0.000000
140740        0.0     0.000000          0.0      0.00000    0.000000
140741        0.0     0.000000          0.0   -225.36240 -370.603296
```

```
140742         0.0  -370.603296           0.0   -225.36240 -370.603296
140743         0.0  -370.603296           0.0          NaN  185.301648

[139615 rows x 5 columns]
```

[ ]:

[64]:
```
#DataafterRegression1=pd.concat(DataafterRegression)
#DataafterRegression1[~DataafterRegression1.index.duplicated()].sort_index()
```

[65]:
```
DataafterRegression
```

[65]:
```
         deltaT(J)  deltaC(J-1)  deltaT(J-1)  DeltaC_pred   DeltaC(J)
2              0.0   -46.325412          0.0    -28.17030  -46.325412
3              0.0   -46.325412          0.0    -28.17030  -46.325412
4              0.0   -46.325412          0.0    -28.17030  -46.325412
5              0.0   -46.325412          0.0     42.25545   69.488118
6              0.0    69.488118          0.0     42.25545   69.488118
…              …           …           …           …          …
140739         0.0  -185.301648          0.0      0.00000    0.000000
140740         0.0     0.000000          0.0      0.00000    0.000000
140741         0.0     0.000000          0.0   -225.36240 -370.603296
140742         0.0  -370.603296          0.0   -225.36240 -370.603296
140743         0.0  -370.603296          0.0          NaN  185.301648

[139615 rows x 5 columns]
```

[66]:
```
DataafterRegression1=DataafterRegression.dropna()
```

[67]:
```
DataafterRegression1
```

[67]:
```
         deltaT(J)  deltaC(J-1)  deltaT(J-1)  DeltaC_pred   DeltaC(J)
2              0.0   -46.325412          0.0    -28.17030  -46.325412
3              0.0   -46.325412          0.0    -28.17030  -46.325412
4              0.0   -46.325412          0.0    -28.17030  -46.325412
5              0.0   -46.325412          0.0     42.25545   69.488118
6              0.0    69.488118          0.0     42.25545   69.488118
…              …           …           …           …          …
140738         0.0  -185.301648         -0.1   -112.68120 -185.301648
140739         0.0  -185.301648          0.0      0.00000    0.000000
140740         0.0     0.000000          0.0      0.00000    0.000000
140741         0.0     0.000000          0.0   -225.36240 -370.603296
140742         0.0  -370.603296          0.0   -225.36240 -370.603296

[139614 rows x 5 columns]
```

[68]:
```
#consumption["deltaT(J)"] = consumption["T(J)"] - consumption["T(J-1)"]
#consumption["deltaC(J)"] = consumption["C(J)"] - consumption["C(J-1)"]
```

```
DataafterRegression1["T(J)"]=DataafterRegression1["deltaT(J)"]+consumption["T(J-1)"]
DataafterRegression1["C_pred(J)"]=DataafterRegression1["DeltaC_pred"]+consumption["C(J-1)"]
DataafterRegression1["C(J)"]=DataafterRegression1["DeltaC(J)"]+consumption["C(J-1)"]
```

[69]:
```
DataafterRegression1
```

[69]:

	deltaT(J)	deltaC(J-1)	deltaT(J-1)	DeltaC_pred	DeltaC(J)	T(J)	\
2	0.0	-46.325412	0.0	-28.17030	-46.325412	21.7	
3	0.0	-46.325412	0.0	-28.17030	-46.325412	21.7	
4	0.0	-46.325412	0.0	-28.17030	-46.325412	21.7	
5	0.0	-46.325412	0.0	42.25545	69.488118	21.7	
6	0.0	69.488118	0.0	42.25545	69.488118	21.7	
…	…	…	…	…	…	…	
140738	0.0	-185.301648	-0.1	-112.68120	-185.301648	12.9	
140739	0.0	-185.301648	0.0	0.00000	0.000000	12.9	
140740	0.0	0.000000	0.0	0.00000	0.000000	12.9	
140741	0.0	0.000000	0.0	-225.36240	-370.603296	12.9	
140742	0.0	-370.603296	0.0	-225.36240	-370.603296	12.9	

	C_pred(J)	C(J)
2	25033.877578	25015.722466
3	24987.552166	24969.397055
4	24941.226755	24923.071643
5	24965.327093	24992.559760
6	25034.815210	25062.047878
…	…	…
140738	16008.562167	15935.941719
140739	15935.941719	15935.941719
140740	15935.941719	15935.941719
140741	15710.579319	15565.338424
140742	15339.976024	15194.735128

[139614 rows x 8 columns]

[70]:
```
DataafterRegression1["Timestamp"]=consumption["Timestamp"]
```

[71]:
```
DataafterRegression1
```

[71]:

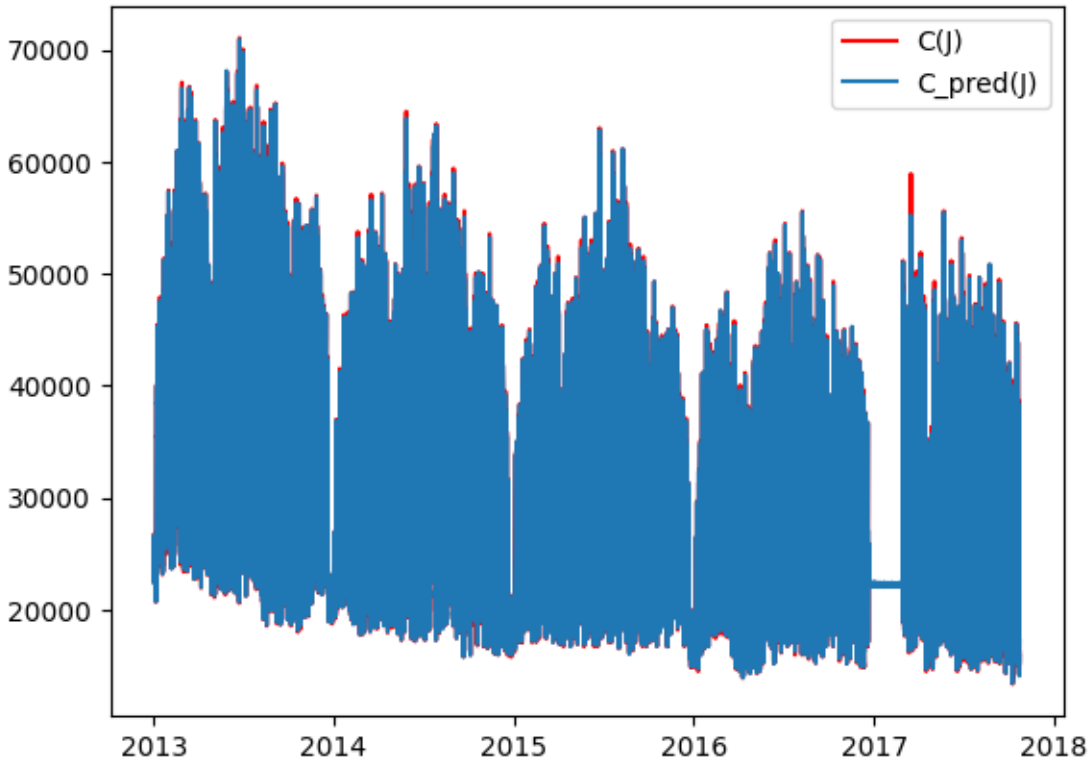
	deltaT(J)	deltaC(J-1)	deltaT(J-1)	DeltaC_pred	DeltaC(J)	T(J)	\
2	0.0	-46.325412	0.0	-28.17030	-46.325412	21.7	
3	0.0	-46.325412	0.0	-28.17030	-46.325412	21.7	
4	0.0	-46.325412	0.0	-28.17030	-46.325412	21.7	
5	0.0	-46.325412	0.0	42.25545	69.488118	21.7	
6	0.0	69.488118	0.0	42.25545	69.488118	21.7	
…	…	…	…	…	…	…	
140738	0.0	-185.301648	-0.1	-112.68120	-185.301648	12.9	
140739	0.0	-185.301648	0.0	0.00000	0.000000	12.9	

```
140740        0.0     0.000000          0.0      0.00000    0.000000  12.9
140741        0.0     0.000000          0.0   -225.36240 -370.603296  12.9
140742        0.0  -370.603296          0.0   -225.36240 -370.603296  12.9

           C_pred(J)          C(J)                 Timestamp
2       25033.877578  25015.722466 2013-01-01 01:30:00+00:00
3       24987.552166  24969.397055 2013-01-01 01:45:00+00:00
4       24941.226755  24923.071643 2013-01-01 02:00:00+00:00
5       24965.327093  24992.559760 2013-01-01 02:15:00+00:00
6       25034.815210  25062.047878 2013-01-01 02:30:00+00:00
…                ...           ...                       ...
140738  16008.562167  15935.941719 2017-10-23 01:30:00+00:00
140739  15935.941719  15935.941719 2017-10-23 01:45:00+00:00
140740  15935.941719  15935.941719 2017-10-23 02:00:00+00:00
140741  15710.579319  15565.338424 2017-10-23 02:15:00+00:00
140742  15339.976024  15194.735128 2017-10-23 02:30:00+00:00

[139614 rows x 9 columns]
```

[72]:
```
#plt.plot(DataafterRegression1['T(J)'],DataafterRegression1['C(J)'])#,'r',␣
 ↪x['deltaT(J-1)'], y_pred)
```

[73]:
```
#DataafterRegression1.plot(x="Timestamp", y=["C(J)"])
#DataafterRegression1.plot(x="Timestamp", y=["C_pred(J)"])



plt.
 ↪plot(DataafterRegression1["Timestamp"],DataafterRegression1["C(J)"],'r',DataafterRegression
#plt.plot(y,'r')
plt.legend(['C(J)', 'C_pred(J)'])
```

[73]:
```
<matplotlib.legend.Legend at 0x24588aa4d90>
```



[74]:
```
mean_squared_error(y_true=DataafterRegression1["C(J)"],y_pred=DataafterRegression1["C_pred(J)"
```

[74]: 126194.47226763415

[75]:
```
mean_absolute_error(y_true=DataafterRegression1["C(J)"],y_pred=DataafterRegression1["C_pred(J)
```

[75]: 202.81542538599072

[76]:
```
def mean_absolute_percentage_error(y_true, y_pred):
    """Calculates MAPE given y_true and y_pred"""
    y_true, y_pred = np.array(y_true), np.array(y_pred)
    return np.mean(np.abs((y_true - y_pred) / y_true)) * 100

mean_absolute_percentage_error(y_true=DataafterRegression1["C(J)"],y_pred=DataafterRegression1
```

[76]: 0.6936105037179624

[77]:
```
consumption1 =pd.read_csv("power-laws-forecasting-energy-consumption-test-data.
↪csv", sep=";", parse_dates=['Timestamp'])

site_id = 6
```

```
consumption_on_site = consumption[consumption["SiteId"] == site_id]
consumption_on_site = consumption_on_site.sort_values("Timestamp")

consumption_on_site.to_csv(f"site_{site_id}_consumption1.csv", sep=";",␣
 ↪index=False)
```

[88]:
```
import datetime

site_id = 6

consumption1 = pd.read_csv(f"site_{site_id}_consumption1.csv", sep=";",␣
 ↪parse_dates=['Timestamp'])

def datetime_to_epoch(d1):
    """
    January 1st, 1970 at 00:00:00 UTC is referred to as the Unix epoch
    :param d1: input date
    :return: seconds since unix epoch
    """
    if not d1.tzinfo:
        raise ValueError("date is missing timezone information")

    d2 = datetime.datetime(1970, 1, 1, tzinfo=datetime.timezone.utc)
    time_delta = d1 - d2
    ts = int(time_delta.total_seconds())
    return ts

def to_unix_epoch(row):
    return datetime_to_epoch(row["Timestamp"])

weather = weather[weather["Distance"] < 8]

weather["UnixTS"] = weather.apply(to_unix_epoch, axis=1)
consumption1["UnixTS"] = consumption1.apply(to_unix_epoch, axis=1)

def find_closest_temperature_at_ts(row):
    timestamp = row["UnixTS"]
    loc = weather["UnixTS"].searchsorted(timestamp)
    if loc < len(weather)-1:
        c0 = weather.iloc[ loc ]
        c1 = weather.iloc[ loc+1 ]
        distance = c1["UnixTS"] - c0["UnixTS"]
        #print("YO... ", distance)
        alpha = (timestamp - c0["UnixTS"]) / distance
        t0 = weather.iloc[loc]["Temperature"]
        t1 = weather.iloc[loc+1]["Temperature"]
        return (1-alpha) * t0 + alpha * t1
```

```
    return weather.iloc[loc]["Temperature"]

consumption1["Temperature"] = consumption1.
 ↪apply(find_closest_temperature_at_ts, axis=1)
#print(consumption1.head(50))
```

[89]:
```
consumption1
```

[89]:

	obs_id	SiteId	Timestamp	ForecastId	Value	\
0	1855136	6	2013-01-01 01:15:00+00:00	43	25062.047878	
1	5379308	6	2013-01-01 01:30:00+00:00	43	25015.722466	
2	1204858	6	2013-01-01 01:45:00+00:00	43	24969.397055	
3	167176	6	2013-01-01 02:00:00+00:00	43	24923.071643	
4	1417840	6	2013-01-01 02:15:00+00:00	43	24992.559760	
…	…	…	…	…	…	
140738	2522602	6	2017-10-23 01:45:00+00:00	188	15935.941719	
140739	7671789	6	2017-10-23 02:00:00+00:00	188	15935.941719	
140740	184978	6	2017-10-23 02:15:00+00:00	188	15565.338424	
140741	1399957	6	2017-10-23 02:30:00+00:00	188	15194.735128	
140742	4821512	6	2017-10-23 02:45:00+00:00	188	15380.036776	

	UnixTS	Temperature	C(J)	C(J-1)	T(J)	T(J-1)	\
0	1357002900	18.958333	25062.047878	25108.373290	21.7	21.7	
1	1357003800	19.016667	25015.722466	25062.047878	21.7	21.7	
2	1357004700	19.075000	24969.397055	25015.722466	21.7	21.7	
3	1357005600	19.133333	24923.071643	24969.397055	21.7	21.7	
4	1357006500	19.191667	24992.559760	24923.071643	21.7	21.7	
…	…	…	…	…	…	…	
140738	1508723100	12.900000	15935.941719	15935.941719	12.9	12.9	
140739	1508724000	12.900000	15935.941719	15935.941719	12.9	12.9	
140740	1508724900	12.900000	15565.338424	15935.941719	12.9	12.9	
140741	1508725800	12.900000	15194.735128	15565.338424	12.9	12.9	
140742	1508726700	12.900000	15380.036776	15194.735128	12.9	12.9	

	deltaT(J)	deltaC(J)
0	0.0	-46.325412
1	0.0	-46.325412
2	0.0	-46.325412
3	0.0	-46.325412
4	0.0	69.488118
…	…	…
140738	0.0	0.000000
140739	0.0	0.000000
140740	0.0	-370.603296
140741	0.0	-370.603296
140742	0.0	185.301648

```
[140743 rows x 13 columns]
```

[95]:
```
import pandas
import datetime

site_id = 6

weather = pandas.read_csv(f"site_{site_id}_weather.csv", sep=";",␣
 ↪parse_dates=['Timestamp'])
consumption1 = pandas.read_csv(f"site_{site_id}_consumption1.csv", sep=";",␣
 ↪parse_dates=['Timestamp'])

def datetime_to_epoch(d1):
    """
    January 1st, 1970 at 00:00:00 UTC is referred to as the Unix epoch
    :param d1: input date
    :return: seconds since unix epoch
    """
    if not d1.tzinfo:
        raise ValueError("date is missing timezone information")

    d2 = datetime.datetime(1970, 1, 1, tzinfo=datetime.timezone.utc)
    time_delta = d1 - d2
    ts = int(time_delta.total_seconds())
    return ts

def to_unix_epoch(row):
    return datetime_to_epoch(row["Timestamp"])

weather = weather[weather["Distance"] < 8]

weather["UnixTS"] = weather.apply(to_unix_epoch, axis=1)
consumption1["UnixTS"] = consumption1.apply(to_unix_epoch, axis=1)

def convert_to_celisus(f):
    return (f - 32) / 1.8

def find_closest_temperature_at_ts(row):
    timestamp = row["UnixTS"]
    loc = weather["UnixTS"].searchsorted(timestamp)

    return weather.iloc[loc]["Temperature"]


    if loc < len(weather)-1:
        c0 = weather.iloc[ loc ]
```

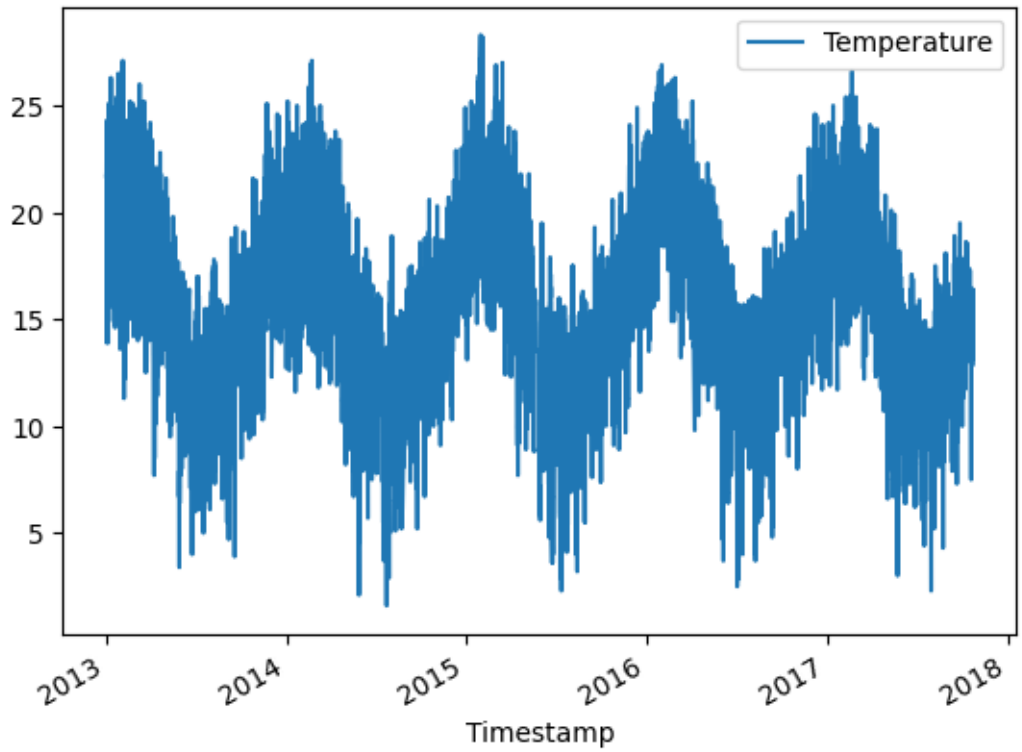
```
        c1 = weather.iloc[ loc+1 ]
        distance = c1["UnixTS"] - c0["UnixTS"]
        alpha = (timestamp - c0["UnixTS"]) / distance
        t0 = weather.iloc[loc]["Temperature"]
        t1 = weather.iloc[loc+1]["Temperature"]
        return convert_to_celisus((1-alpha) * t0 + alpha * t1)

    return convert_to_celisus(weather.iloc[loc]["Temperature"])

consumption1["Temperature"] = consumption1.
 ↪apply(find_closest_temperature_at_ts, axis=1)

weather.to_csv(f"site_{site_id}_weather_post.csv", sep=";", index=False)
consumption1.to_csv(f"site_{site_id}_consumption_post1.csv", sep=";",␣
 ↪index=False)
```

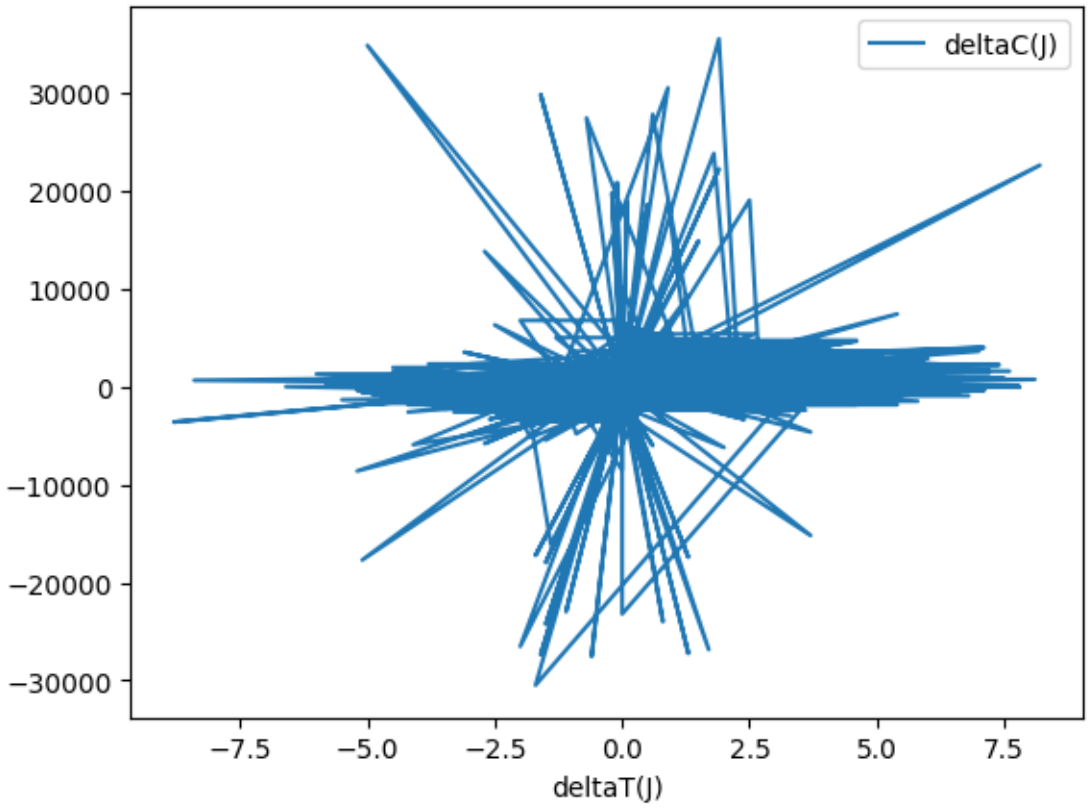
[96]:
```
import matplotlib.pyplot as plt

site_id = 6

weather = pd.read_csv(f"site_{site_id}_weather_post.csv", sep=";",␣
 ↪parse_dates=['Timestamp'])
consumption1 = pd.read_csv(f"site_{site_id}_consumption_post1.csv", sep=";",␣
 ↪parse_dates=['Timestamp'])

print(consumption1["Timestamp"])
consumption.plot(x="Timestamp", y=["Temperature"])
#consumption.plot(x="Temperature", y="Value")

consumption1["C(J)"] = consumption1["Value"]
consumption1["C(J-1)"] = consumption1["Value"].shift(periods=1)

consumption1["T(J)"] = consumption1["Temperature"]
consumption1["T(J-1)"] = consumption1["Temperature"].shift(periods=1)

consumption1 = consumption1.drop([0])

consumption1["deltaT(J)"] = consumption1["T(J)"] - consumption1["T(J-1)"]
consumption1["deltaC(J)"] = consumption1["C(J)"] - consumption1["C(J-1)"]

figure2 = consumption1.plot(x="deltaT(J)", y="deltaC(J)")
plt.figure().show()

#weather = pandas.read_csv(f"site_{site_id}_weather.csv", sep=";",␣
 ↪parse_dates=['Timestamp'])

print(consumption1.head(100))
```

```
print(consumption1["Temperature"].max())
```

```
0        2013-01-01 01:15:00+00:00
1        2013-01-01 01:30:00+00:00
2        2013-01-01 01:45:00+00:00
3        2013-01-01 02:00:00+00:00
4        2013-01-01 02:15:00+00:00
                    …
140738   2017-10-23 01:45:00+00:00
140739   2017-10-23 02:00:00+00:00
140740   2017-10-23 02:15:00+00:00
140741   2017-10-23 02:30:00+00:00
140742   2017-10-23 02:45:00+00:00
Name: Timestamp, Length: 140743, dtype: datetime64[ns, UTC]
      obs_id  SiteId                 Timestamp  ForecastId         Value  \
1    5379308       6 2013-01-01 01:30:00+00:00          43  25015.722466
2    1204858       6 2013-01-01 01:45:00+00:00          43  24969.397055
3     167176       6 2013-01-01 02:00:00+00:00          43  24923.071643
4    1417840       6 2013-01-01 02:15:00+00:00          43  24992.559760
5    6647355       6 2013-01-01 02:30:00+00:00          43  25062.047878
..       …     …                         …         …           …
96   7679920       6 2013-01-02 01:15:00+00:00          43  24946.234349
97   3636173       6 2013-01-02 01:30:00+00:00          43  24691.444583
98   2507416       6 2013-01-02 01:45:00+00:00          43  24784.095407
99   4975213       6 2013-01-02 02:00:00+00:00          43  24876.746231
100   194561       6 2013-01-02 02:15:00+00:00          43  25154.698702

         UnixTS  Temperature          C(J)        C(J-1)  T(J)  T(J-1)  \
1    1357003800         21.7  25015.722466  25062.047878  21.7    21.7
2    1357004700         21.7  24969.397055  25015.722466  21.7    21.7
3    1357005600         21.7  24923.071643  24969.397055  21.7    21.7
4    1357006500         21.7  24992.559760  24923.071643  21.7    21.7
5    1357007400         21.7  25062.047878  24992.559760  21.7    21.7
..          …           …           …           …   …     …
96   1357089300         13.9  24946.234349  25201.024114  13.9    15.0
97   1357090200         13.9  24691.444583  24946.234349  13.9    13.9
98   1357091100         13.9  24784.095407  24691.444583  13.9    13.9
99   1357092000         13.9  24876.746231  24784.095407  13.9    13.9
100  1357092900         13.9  25154.698702  24876.746231  13.9    13.9

     deltaT(J)   deltaC(J)
1          0.0  -46.325412
2          0.0  -46.325412
3          0.0  -46.325412
4          0.0   69.488118
5          0.0   69.488118
..         …         …
96        -1.1 -254.789766
```

```
97          0.0 -254.789766
98          0.0   92.650824
99          0.0   92.650824
100         0.0  277.952472

[100 rows x 13 columns]
28.3
```

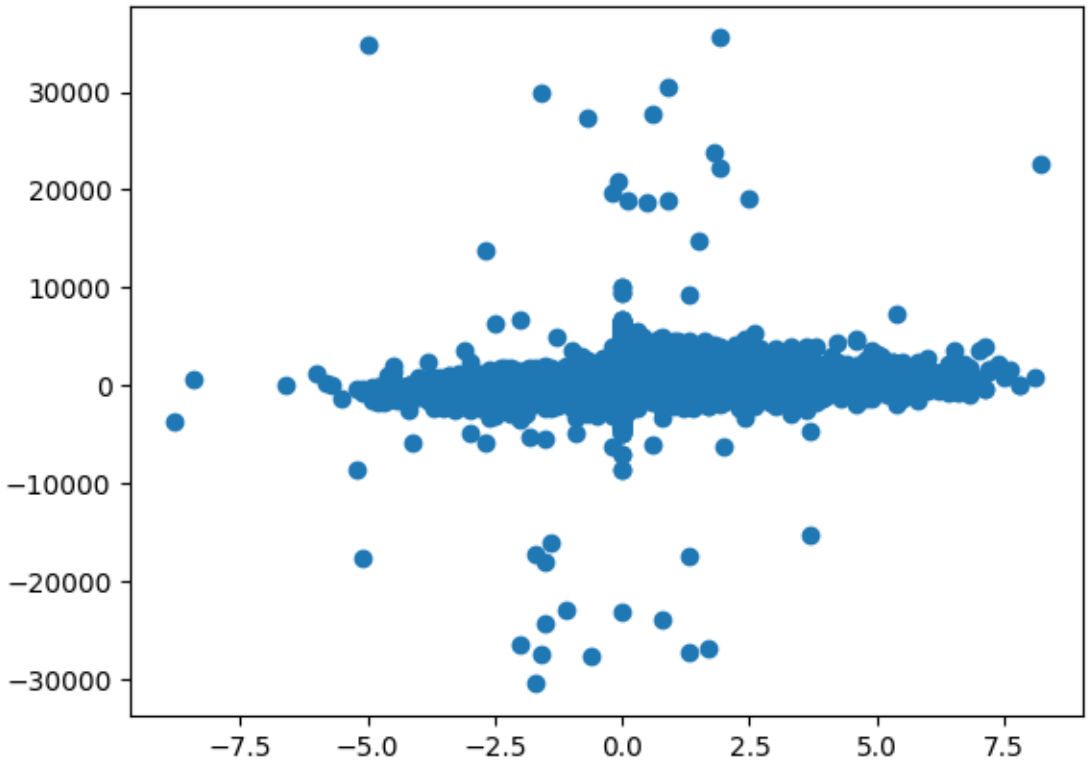





```
<Figure size 640x480 with 0 Axes>
```

[97]:
```
plt.scatter(x=consumption1["deltaT(J)"], y=consumption1["deltaC(J)"])
```

[97]:
```
<matplotlib.collections.PathCollection at 0x245857a0a10>
```



[98]:
```
DataForRegression_test=consumption1[["deltaT(J)","deltaC(J)"]]
DataForRegression_test['deltaC(J-1)']=DataForRegression_test['deltaC(J)'].
 ↪shift(1)
DataForRegressionb_test=DataForRegression_test.dropna(axis=1)
DataForRegression_test.head(7)
```

[98]:

	deltaT(J)	deltaC(J)	deltaC(J-1)
1	0.0	-46.325412	NaN
2	0.0	-46.325412	-46.325412
3	0.0	-46.325412	-46.325412
4	0.0	69.488118	-46.325412
5	0.0	69.488118	69.488118
6	0.0	185.301648	69.488118
7	0.0	185.301648	185.301648

[99]:
```
DataForRegression_test['deltaT(J-1)']=DataForRegression_test['deltaT(J)'].
 ↪shift(1)
DataForRegressionb_tes=DataForRegression_test.dropna(axis=1)
```

[100]:
```
DataForRegression1_test=  DataForRegression_test.drop([1])
```

[101]:
```
DataForRegression1_test
```

[101]:
```
        deltaT(J)   deltaC(J)  deltaC(J-1)  deltaT(J-1)
2             0.0  -46.325412   -46.325412          0.0
3             0.0  -46.325412   -46.325412          0.0
4             0.0   69.488118   -46.325412          0.0
5             0.0   69.488118    69.488118          0.0
6             0.0  185.301648    69.488118          0.0
…             …          …           …           …
140738        0.0    0.000000  -185.301648          0.0
140739        0.0    0.000000     0.000000          0.0
140740        0.0 -370.603296     0.000000          0.0
140741        0.0 -370.603296  -370.603296          0.0
140742        0.0  185.301648  -370.603296          0.0

[140741 rows x 4 columns]
```

[102]:
```
DataForRegression1_test=DataForRegression1_test.dropna()
```

[103]:
```
y_test=DataForRegression1_test["deltaC(J)"]
```

[104]:
```
y_test
```

[104]:
```
2         -46.325412
3         -46.325412
4          69.488118
5          69.488118
6         185.301648
             …
140738      0.000000
140739      0.000000
140740   -370.603296
140741   -370.603296
140742    185.301648
Name: deltaC(J), Length: 139614, dtype: float64
```

[105]:
```
x_test=DataForRegression1_test.drop(DataForRegression1_test.columns[[1]],␣
↪axis=1)
```

[106]:
```
x_test
```

[106]:
```
        deltaT(J)  deltaC(J-1)  deltaT(J-1)
2             0.0   -46.325412          0.0
3             0.0   -46.325412          0.0
4             0.0   -46.325412          0.0
5             0.0    69.488118          0.0
6             0.0    69.488118          0.0
…             …          …           …
140738        0.0  -185.301648          0.0
140739        0.0     0.000000          0.0
```

```
140740        0.0     0.000000          0.0
140741        0.0  -370.603296          0.0
140742        0.0  -370.603296          0.0

[139614 rows x 3 columns]
```

[107]:
```
x_test[x_test.isna().any(axis=1)]
```

[107]:
```
Empty DataFrame
Columns: [deltaT(J), deltaC(J-1), deltaT(J-1)]
Index: []
```

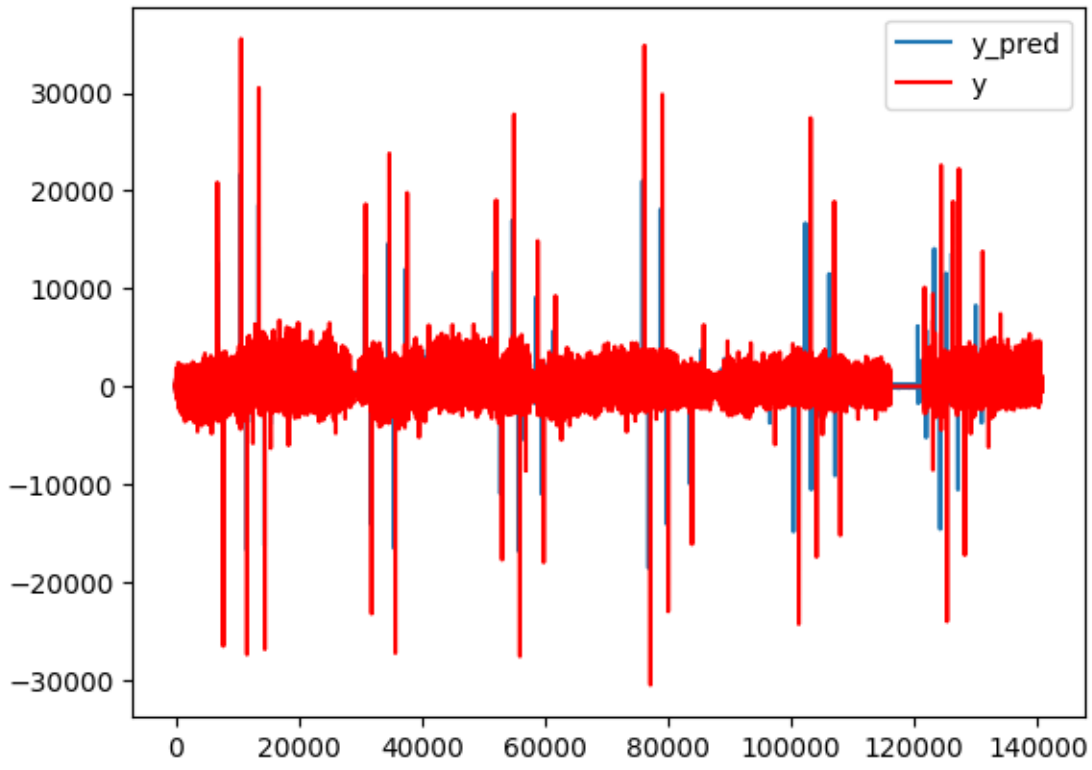
[108]:
```
y_test[y_test.isna()]
```

[108]:
```
Series([], Name: deltaC(J), dtype: float64)
```

[109]:
```
y_pred = regr.predict(x_test)
```

[110]:
```
plt.plot(y_pred)
plt.plot(y,'r')
plt.legend(['y_pred', 'y'])
```

[110]:
```
<matplotlib.legend.Legend at 0x245ceed9c50>
```



[111]:
```
import numpy as np
DataafterRegression_test=pd.concat([x,pd.DataFrame(np.matrix.
 ↪transpose(y_pred),columns=['DeltaC_pred_test'])], ignore_index=True, axis=1)

DataafterRegression_test=x_test

DataafterRegression_test["DeltaC_pred_test"]=np.matrix.transpose(y_pred)
DataafterRegression_test["DeltaC_pred_test"]=DataafterRegression_test["DeltaC_pred_test"].
 ↪shift(-1)

DataafterRegression_test["DeltaC(J)"]=y

print(DataafterRegression_test)

DataafterRegression_test

DataafterRegression1_test=DataafterRegression_test.dropna()

DataafterRegression1_test
```

```
        deltaT(J)  deltaC(J-1)  deltaT(J-1)  DeltaC_pred_test   DeltaC(J)
2             0.0   -46.325412          0.0         -28.17030  -46.325412
3             0.0   -46.325412          0.0         -28.17030  -46.325412
4             0.0   -46.325412          0.0          42.25545  -46.325412
5             0.0    69.488118          0.0          42.25545   69.488118
6             0.0    69.488118          0.0         112.68120   69.488118
…             …           …            …                …          …
140738        0.0  -185.301648          0.0           0.00000 -185.301648
140739        0.0     0.000000          0.0           0.00000    0.000000
140740        0.0     0.000000          0.0        -225.36240    0.000000
140741        0.0  -370.603296          0.0        -225.36240 -370.603296
140742        0.0  -370.603296          0.0               NaN -370.603296

[139614 rows x 5 columns]
```

[111]:
```
        deltaT(J)  deltaC(J-1)  deltaT(J-1)  DeltaC_pred_test   DeltaC(J)
2             0.0   -46.325412          0.0         -28.17030  -46.325412
3             0.0   -46.325412          0.0         -28.17030  -46.325412
4             0.0   -46.325412          0.0          42.25545  -46.325412
5             0.0    69.488118          0.0          42.25545   69.488118
6             0.0    69.488118          0.0         112.68120   69.488118
…             …           …            …                …          …
140737        0.0  -185.301648         -0.1        -112.68120 -185.301648
140738        0.0  -185.301648          0.0           0.00000 -185.301648
140739        0.0     0.000000          0.0           0.00000    0.000000
140740        0.0     0.000000          0.0        -225.36240    0.000000
```

```
140741        0.0  -370.603296          0.0        -225.36240 -370.603296

[139565 rows x 5 columns]
```

[ ]: