

WE_Final_part3

November 12, 2018

**

EE4211 Project -- Team name: WE

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Q3. Proposal Implementations:

** **

Data Analysis according to Weekdays and Weekends

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0.0.1 Brief Introduction: Firstly, generate hourly reading for each meter ID of the total 6 months and split the hourly reading result into weekdays and weekends. Secondly, we construct a vector containing three features for each meter ID. Then, we use K-means algorithm to divide those meters into three groups according to features. Last but not least, we propose a novel system with the help of GPS.

```
In [1]: import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
from datetime import datetime
import scipy.stats as stats
from sklearn import metrics
import random
from mpl_toolkits.mplot3d import Axes3D
from scipy.stats import chi2
from pandas import Series, DataFrame
```

0.0.2 1. Import csv data and split data in groups according to meter_ID

```
In [2]: data=pd.read_csv('dataport-export_gas_oct2015-mar2016.csv')
data_sort = data.sort_index(by=['dataid', 'localminute'])
data_sort.head()
```

C:\Users\dell\AppData\Roaming\Python\Python36\site-packages\ipykernel_launcher.py:2: FutureWarning

```
Out[2]:
```

		localminute	dataid	meter_value
83	2015-10-01	00:14:44-05	35	93470
244	2015-10-01	00:42:34-05	35	93470

723	2015-10-01 02:02:37-05	35	93470
790	2015-10-01 02:12:38-05	35	93470
829	2015-10-01 02:20:36-05	35	93470

```
In [3]: #preprocess datetime into the same format
date_time = []
for i in range(data_sort.shape[0]):
    date_time.append(data_sort['localminute'][i:i+1].values[0][:19])
month = np.zeros(data_sort.shape[0])
day = np.zeros(data_sort.shape[0])
hour = np.zeros(data_sort.shape[0])
for row in range(data_sort.shape[0]):
    month[row] = int(date_time[row][5:7])
    day[row] = int(date_time[row][8:10])
    hour[row] = int(date_time[row][11:13])
#extract month, day and hour respectively
data_sort['month'] = month
data_sort['day'] = day
data_sort['hour'] = hour
#select October to plot hourly meter readings
#df=data_sort[data_sort['month']==10]
#adjust the order of columns
df_month = data_sort[['dataid', 'localminute', 'month', 'day', 'hour', 'meter_value']]
#calculate the number of meters with readings in October
id_count = df_month['dataid'].value_counts()
print('number of meters:', len(id_count))
```

number of meters: 157

```
In [4]: meter = id_count.index
meter=meter.values
meter=np.sort(meter)
#print(meter)
```

0.03 2. Generate hourly reading for each meter ID of the total 6 months and save the results into the "Reault_full.csv" file.

```
In [5]: Result=np.zeros(4392)
my_month=[10,11,12,1,2,3]
month_num=[31,30,31,31,29,31]
for i in meter:
    print(i)
    meter_value = df_month[df_month['dataid']==i]
    result = np.zeros(4392)
    n=0
    for m in my_month:
        meter_value_month = meter_value[meter_value['month']==m]
        if meter_value_month.empty:
```

```

        continue
    for j in range(1,month_num[n]+1):
        meter_value_day = meter_value_month[meter_value_month['day']==j]
        if meter_value_day.empty:
            continue
        for k in range(24):
            meter_value_hour = meter_value_day[meter_value_day['hour']==k]
            if meter_value_hour.empty:
                continue
            #print((sum(month_num[0:n])+j-1)*24+k)
            result[(sum(month_num[0:n])+(j-1))*24+k]
            = int(meter_value_hour['meter_value'][0:1].values)
            #print(result)

        n=n+1
    vac = np.where(result == 0)[0]
    non_vac = np.nonzero(result)[0]
    left = non_vac[0]
    if 0 in vac:
        result[0]= result[left]
        vac = vac[1:]
    for num in vac:
        result[num]=result[num-1]
    Result=np.vstack((Result,result))
    print(Result)

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35

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 [ 93470. 93470. 93470. ... 104684. 104684. 104692.]
 [165674. 165674. 165674. ... 175070. 175070. 175070.]
 ...
 [122186. 122186. 122186. ... 138144. 138146. 138146.]

```

```

[158512. 158512. 158512. ... 179902. 179902. 179902.]
[ 33632. 33632. 33632. ... 39292. 39292. 39292.]]
9956
[[ 0. 0. 0. ... 0. 0. 0.]
 [ 93470. 93470. 93470. ... 104684. 104684. 104692.]
 [165674. 165674. 165674. ... 175070. 175070. 175070.]
 ...
 [158512. 158512. 158512. ... 179902. 179902. 179902.]
 [ 33632. 33632. 33632. ... 39292. 39292. 39292.]
 [ 95860. 95860. 95860. ... 107042. 107042. 107042.]]
9982
[[ 0. 0. 0. ... 0. 0. 0.]
 [ 93470. 93470. 93470. ... 104684. 104684. 104692.]
 [165674. 165674. 165674. ... 175070. 175070. 175070.]
 ...
 [ 33632. 33632. 33632. ... 39292. 39292. 39292.]
 [ 95860. 95860. 95860. ... 107042. 107042. 107042.]
 [105946. 105946. 105946. ... 119924. 119924. 119924.]]

```

```

In [6]: Result=np.delete(Result,0,0)
        np.savetxt(r'./Reault_full.csv',Result,fmt="%.8f", delimiter=',')

```

0.0.4 3. Split the hourly reading result into weekdays and weekends

Split the hourly reading result having generated above into two categories, weekdays and weekends, in terms of each meter ID. Then, we randomly choose two weekdays of each week in order to ensure the consistency of the data volume for weekends. And save them into "weekday.csv" and "weekend.csv" separately.

```

In [7]: weekend=[2,3]
        weekday=[1,5]
        for i in range(25):
            front_num=(i+1)*7
            a=2+front_num
            a=[a,a+1]
            index=random.sample([0,1,4,5,6], 2)
            b = [i+front_num for i in index]
            weekend=np.vstack((weekend,a))
            weekday=np.vstack((weekday,b))

        # mysample=np.concatenate((a,b),axis=0)
        # myseed=np.vstack((myseed,mysample))
        weekend=np.ravel(weekend)
        weekday=np.ravel(weekday)
        weekend=weekend.tolist()
        weekday=weekday.tolist()
        weekend.sort()
        weekday.sort()

```

```
print(weekend)
print(weekday)
```

```
[2, 3, 9, 10, 16, 17, 23, 24, 30, 31, 37, 38, 44, 45, 51, 52, 58, 59, 65, 66, 72, 73, 79, 80, 86, 87, 93, 94, 100, 101, 107, 108, 114, 115, 121, 122, 128, 129, 135, 136, 142, 143, 149, 150, 156, 157, 163, 164, 170, 171, 177, 178, 184, 185, 191, 192, 198, 199, 205, 206, 212, 213, 219, 220, 226, 227, 233, 234, 240, 241, 247, 248, 254, 255, 261, 262, 268, 269, 275, 276, 282, 283, 289, 290, 296, 297, 303, 304, 310, 311, 317, 318, 324, 325, 331, 332, 338, 339, 345, 346, 352, 353, 359, 360, 366, 367, 373, 374, 380, 381, 387, 388, 394, 395, 401, 402, 408, 409, 415, 416, 422, 423, 429, 430, 436, 437, 443, 444, 450, 451, 457, 458, 464, 465, 471, 472, 478, 479, 485, 486, 492, 493, 499, 500, 506, 507, 513, 514, 520, 521, 527, 528, 534, 535, 541, 542, 548, 549, 555, 556, 562, 563, 569, 570, 576, 577, 583, 584, 590, 591, 597, 598, 604, 605, 611, 612, 618, 619, 625, 626, 632, 633, 639, 640, 646, 647, 653, 654, 660, 661, 667, 668, 674, 675, 681, 682, 688, 689, 695, 696, 702, 703, 709, 710, 716, 717, 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1353, 1354, 1360, 1361, 1367, 1368, 1374, 1375, 1381, 1382, 1388, 1389, 1395, 1396, 1402, 1403, 1409, 1410, 1416, 1417, 1423, 1424, 1430, 1431, 1437, 1438, 1444, 1445, 1451, 1452, 1458, 1459, 1465, 1466, 1472, 1473, 1479, 1480, 1486, 1487, 1493, 1494, 1500, 1501, 1507, 1508, 1514, 1515, 1521, 1522, 1528, 1529, 1535, 1536, 1542, 1543, 1549, 1550, 1556, 1557, 1563, 1564, 1570, 1571, 1577, 1578, 1584, 1585, 1591, 1592, 1598, 1599, 1605, 1606, 1612, 1613, 1619, 1620, 1626, 1627, 1633, 1634, 1640, 1641, 1647, 1648, 1654, 1655, 1661, 1662, 1668, 1669, 1675, 1676, 1682, 1683, 1689, 1690, 1696, 1697, 1703, 1704, 1710, 1711, 1717, 1718, 1724, 1725, 1731, 1732, 1738, 1739, 1745, 1746, 1752, 1753, 1759, 1760, 1766, 1767, 1773, 1774, 1780, 1781, 1787, 1788, 1794, 1795, 1801, 1802, 1808, 1809, 1815, 1816, 1822, 1823, 1829, 1830, 1836, 1837, 1843, 1844, 1850, 1851, 1857, 1858, 1864, 1865, 1871, 1872, 1878, 1879, 1885, 1886, 1892, 1893, 1899, 1900, 1906, 1907, 1913, 1914, 1920, 1921, 1927, 1928, 1934, 1935, 1941, 1942, 1948, 1949, 1955, 1956, 1962, 1963, 1969, 1970, 1976, 1977, 1983, 1984, 1990, 1991, 1997, 1998, 2004, 2005, 2011, 2012, 2018, 2019, 2025, 2026, 2032, 2033, 2039, 2040, 2046, 2047, 2053, 2054, 2060, 2061, 2067, 2068, 2074, 2075, 2081, 2082, 2088, 2089, 2095, 2096, 2102, 2103, 2109, 2110, 2116, 2117, 2123, 2124, 2130, 2131, 2137, 2138, 2144, 2145, 2151, 2152, 2158, 2159, 2165, 2166, 2172, 2173, 2179, 2180, 2186, 2187, 2193, 2194, 2200, 2201, 2207, 2208, 2214, 2215, 2221, 2222, 2228, 2229, 2235, 2236, 2242, 2243, 2249, 2250, 2256, 2257, 2263, 2264, 2270, 2271, 2277, 2278, 2284, 2285, 2291, 2292, 2298, 2299, 2305, 2306, 2312, 2313, 2319, 2320, 2326, 2327, 2333, 2334, 2340, 2341, 2347, 2348, 2354, 2355, 2361, 2362, 2368, 2369, 2375, 2376, 2382, 2383, 2389, 2390, 2396, 2397, 2403, 2404, 2410, 2411, 2417, 2418, 2424, 2425, 2431, 2432, 2438, 2439, 2445, 2446, 2452, 2453, 2459, 2460, 2466, 2467, 2473, 2474, 2480, 2481, 2487, 2488, 2494, 2495, 2501, 2502, 2508, 2509, 2515, 2516, 2522, 2523, 2529, 2530, 2536, 2537, 2543, 2544, 2550, 2551, 2557, 2558, 2564, 2565, 2571, 2572, 2578, 2579, 2585, 2586, 2592, 2593, 2599, 2600, 2606, 2607, 2613, 2614, 2620, 2621, 2627, 2628, 2634, 2635, 2641, 2642, 2648, 2649, 2655, 2656, 2662, 2663, 2669, 2670, 2676, 2677, 2683, 2684, 2690, 2691, 2697, 2698, 2704, 2705, 2711, 2712, 2718, 2719, 2725, 2726, 2732, 2733, 2739, 2740, 2746, 2747, 2753, 2754, 2760, 2761, 2767, 2768, 2774, 2775, 2781, 2782, 2788, 2789, 2795, 2796, 2802, 2803, 2809, 2810, 2816, 2817, 2823, 2824, 2830, 2831, 2837, 2838, 2844, 2845, 2851, 2852, 2858, 2859, 2865, 2866, 2872, 2873, 2879, 2880, 2886, 2887, 2893, 2894, 2900, 2901, 2907, 2908, 2914, 2915, 2921, 2922, 2928, 2929, 2935, 2936, 2942, 2943, 2949, 2950, 2956, 2957, 2963, 2964, 2970, 2971, 2977, 2978, 2984, 2985, 2991, 2992, 2998, 2999, 3005, 3006, 3012, 3013, 3019, 3020, 3026, 3027, 3033, 3034, 3040, 3041, 3047, 3048, 3054, 3055, 3061, 3062, 3068, 3069, 3075, 3076, 3082, 3083, 3089, 3090, 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3677, 3678, 3684, 3685, 3691, 3692, 3698, 3699, 3705, 3706, 3712, 3713, 3719, 3720, 3726, 3727, 3733, 3734, 3740, 3741, 3747, 3748, 3754, 3755, 3761, 3762, 3768, 3769, 3775, 3776, 3782, 3783, 3789, 3790, 3796, 3797, 3803, 3804, 3810, 3811, 3817, 3818, 3824, 3825, 3831, 3832, 3838, 3839, 3845, 3846, 3852, 3853, 3859, 3860, 3866, 3867, 3873, 3874, 3880, 3881, 3887, 3888, 3894, 3895, 3901, 3902, 3908, 3909, 3915, 3916, 3922, 3923, 3929, 3930, 3936, 3937, 3943, 3944, 3950, 3951, 3957, 3958, 3964, 3965, 3971, 3972, 3978, 3979, 3985, 3986, 3992, 3993, 3999, 4000]
```

```
In [8]: Sample=np.zeros(24)
x=np.arange(0,24)
for i in weekend:
    sample=i*24+x
    #print(sample)
    Sample=np.vstack((Sample,sample))
Sample=np.delete(Sample,0,0)
Sample=Sample.astype(np.int)
Sample=np.ravel(Sample)
Sample=Sample.tolist()
Sample.sort()
equal_sample=Result[:,Sample]
# print(equal_sample)
# print(len(equal_sample))
# print(np.size(equal_sample))
esample=equal_sample
for i in range(157):
    esample[i,:]=equal_sample[i,:]-equal_sample[i,0]
#np.savetxt(r'./weekend.csv',esample,fmt="%.8f", delimiter=',')
```

```
In [9]: Sample=np.zeros(24)
x=np.arange(0,24)
for i in weekday:
    sample=i*24+x
    #print(sample)
    Sample=np.vstack((Sample,sample))
Sample=np.delete(Sample,0,0)
Sample=Sample.astype(np.int)
Sample=np.ravel(Sample)
Sample=Sample.tolist()
Sample.sort()
equal_sample=Result[:,Sample]
# print(equal_sample)
# print(len(equal_sample))
# print(np.size(equal_sample))
esample=equal_sample
for i in range(157):
    esample[i,:]=equal_sample[i,:]-equal_sample[i,0]
#np.savetxt(r'./weekday.csv',esample,fmt="%.8f", delimiter=',')
```

0.0.5 4.Construct feature vectors according to splitted data by weekdays and weekends:

According to the new data set above, We analyze a vector containing three features for each meter ID from different aspects, Euclidean Distance, normolized Euclidean Distance, Jensen-Shannon Divergence and Consumption Difference. First two are concerning the correlation of the distribution distance and the consumption trend for weekdays and weekends. The last one focus on the difference of the consumption between weekdays and weekends.

Euclidean distance: the "ordinary" straight-line distance between two points in Euclidean space. We use this metric to measure the difference of two curves by different daytypes for each meter.

Jensen-Shannon: as is shown, the curves representing meter_values in weekdays and weekends are not the distribution curve in the range of [0,1]. Hence, we do the normalization for the data with respect to the trend of the curve.

Consumption Difference: the average gas ammount in the whole 6 months. Through it we can compare the average consumption in weekdays and weekend.

```
In [10]: df_weekday=pd.read_csv('weekday.csv')
df_weekend=pd.read_csv('weekend.csv')
#df_weekday.head()
#df_weekend.head()
weekday = df_weekday.as_matrix()
weekend = df_weekend.as_matrix()

In [11]: ##### distribution distance
# normolization
def normalization(a,b):
    p = a/a.sum()
    q = b/b.sum()
    return p,q
    x_axis = [x for x in range(1248)]
    plt.figure(figsize=(15,4))
    plt.scatter(x_axis,p,s=0.1)
    plt.scatter(x_axis,q,s=0.1)

#
def euclidean(a,b):
    eu_distance = np.sqrt(np.sum(np.square(a - b)))
    return (eu_distance)

#jsJensen-Shannon
def js(p,q):
    M=(p+q)/2
    js_distance=0.5*stats.entropy(p, M)+0.5*stats.entropy(q, M)
    return (js_distance)

In [12]: data=pd.read_csv('dataport-export_gas_oct2015-mar2016.csv')
data_sort = data.sort_values(by=['dataid', 'localminute'])
meter = list(data_sort['dataid'])
```

```

l = list(set(meter))
l.sort()
data = {'meterid': l}
df_feature= DataFrame(data)
df_feature.head()

```

```

Out[12]:    meterid
0         35
1         44
2         77
3         94
4        114

```

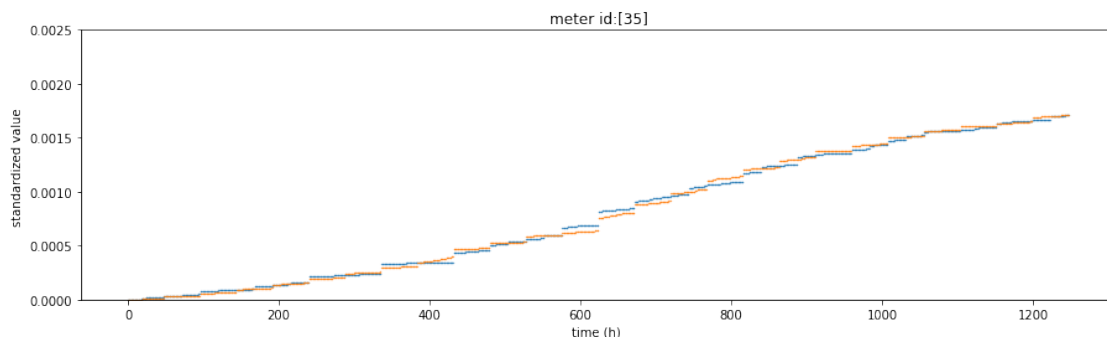
(1) Generate the features and show the result

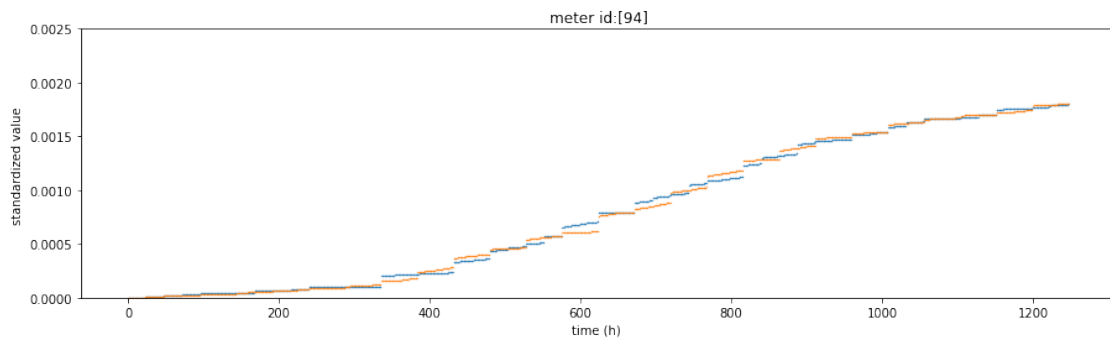
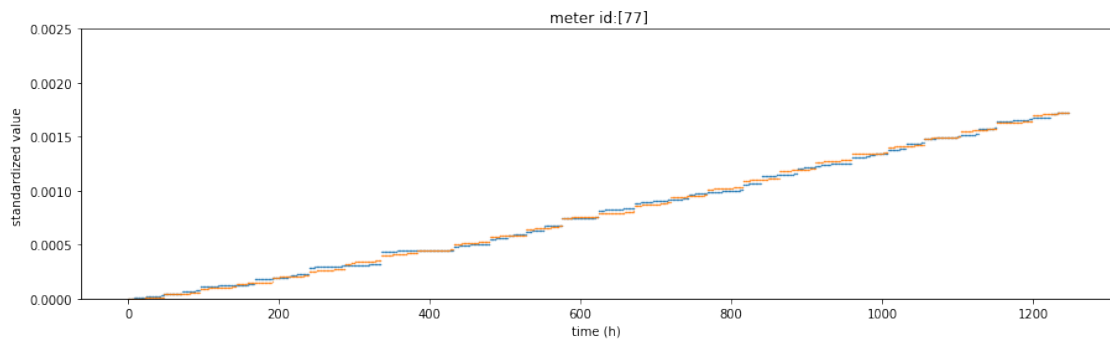
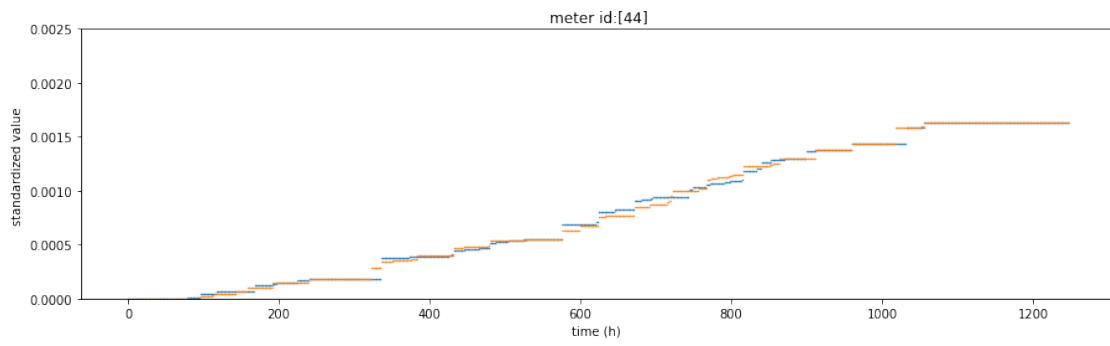
```

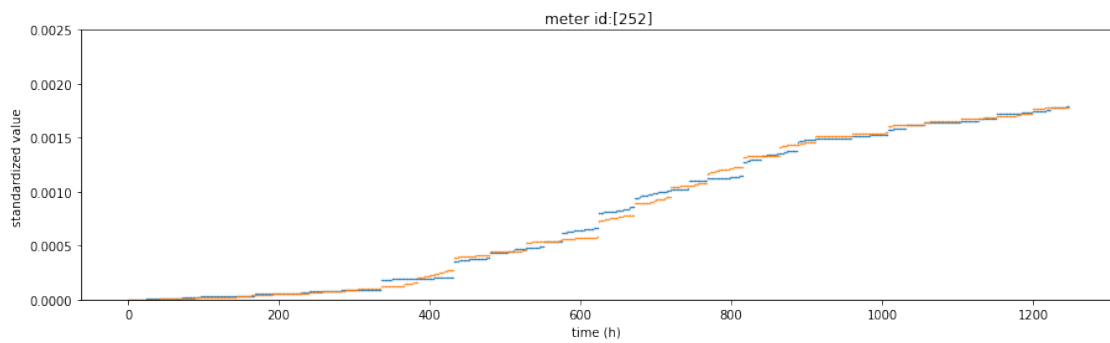
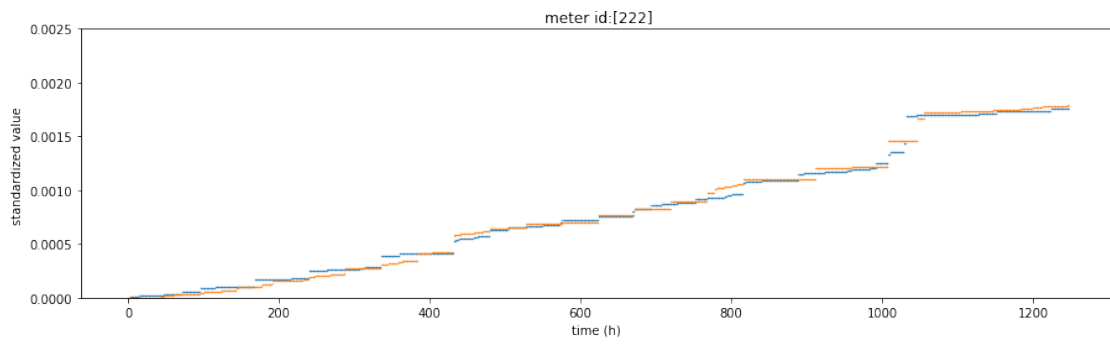
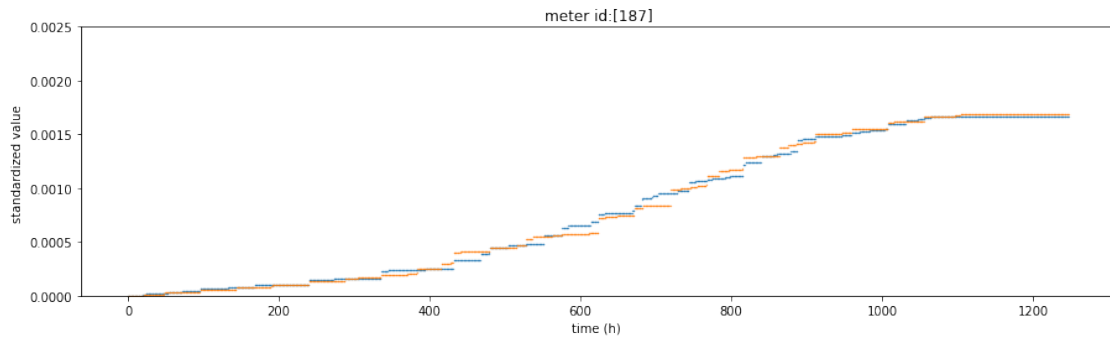
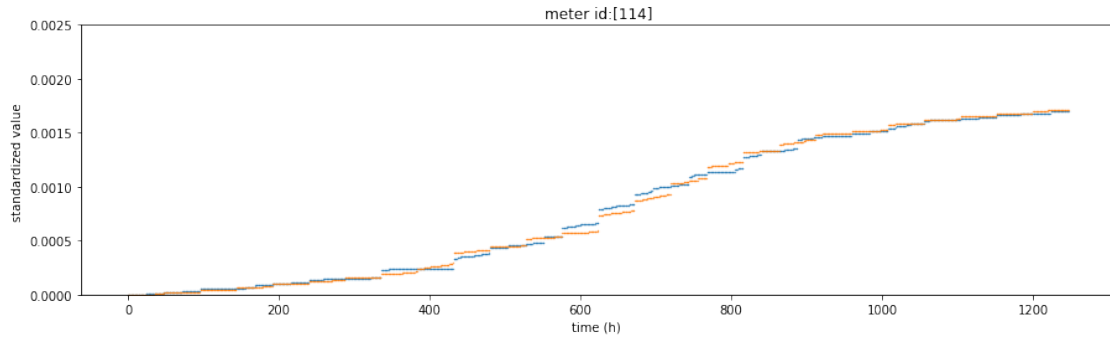
In [13]: # consumption difference
diff = []
for i in range(157):
    diff.append((weekday[i][-1]-weekend[i][-1])/52)
df_feature['cost_diff']= diff

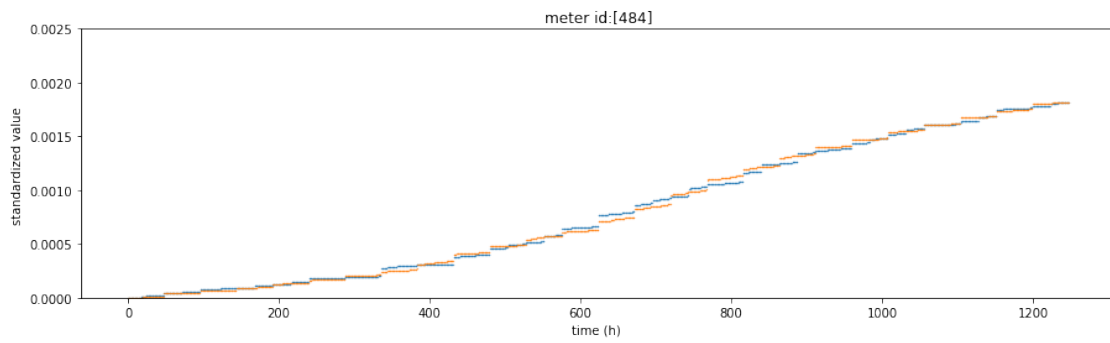
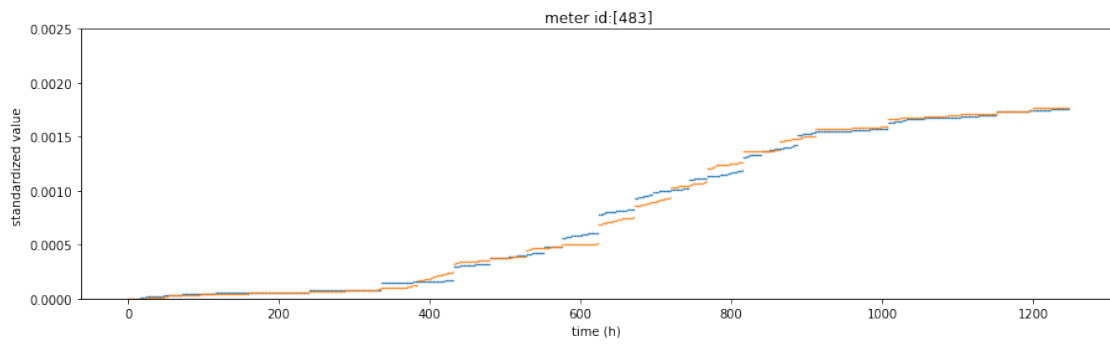
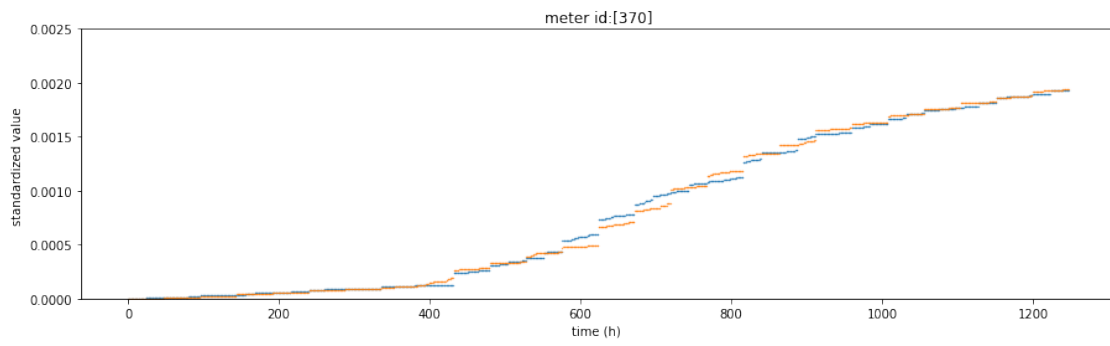
In [14]: w,x,y,z = [],[],[],[]
for i in range(157):
    a = weekday[i]
    b = weekend[i]
    p,q = normalization(a,b)
    w.append(euclidean(a,b))
    x.append(euclidean(p,q))
    z.append(js(p,q))
x_axis = [x for x in range(1248)]
plt.figure(figsize=(15,4))
plt.ylim (0,0.0025)
plt.scatter(x_axis,p,s=0.1)
plt.scatter(x_axis,q,s=0.1)
plt.xlabel('time (h) ')
plt.ylabel('standardized value ')
plt.title('meter id:'+ str(df_feature['meterid'][i:i+1].values))
plt.show()

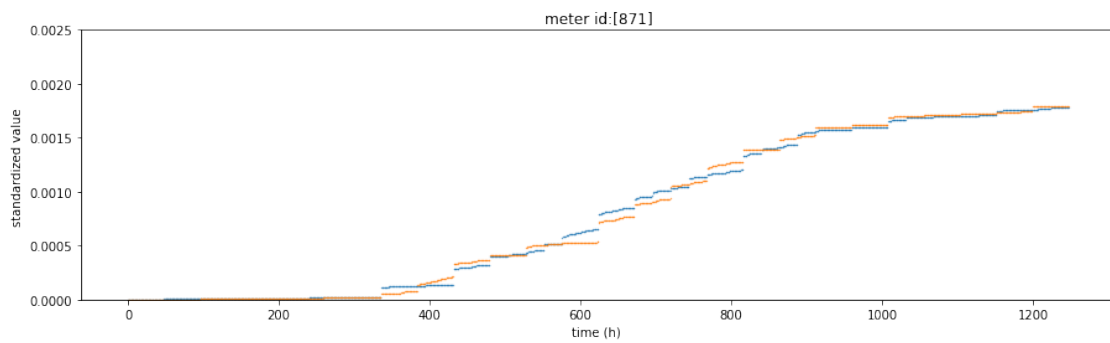
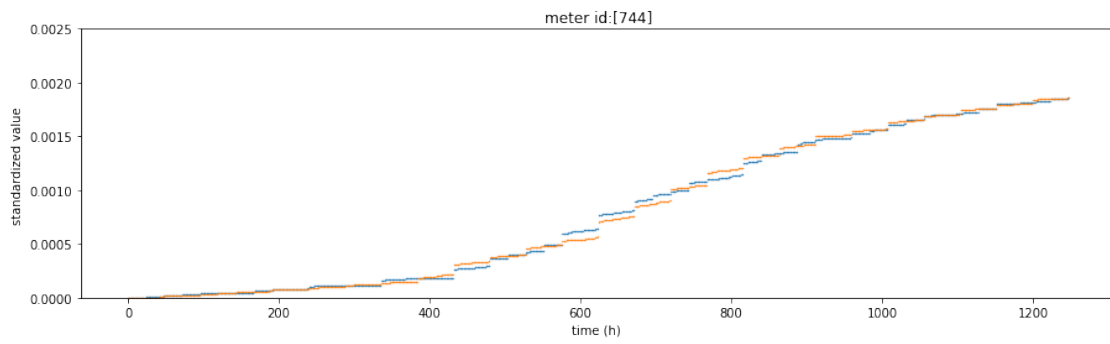
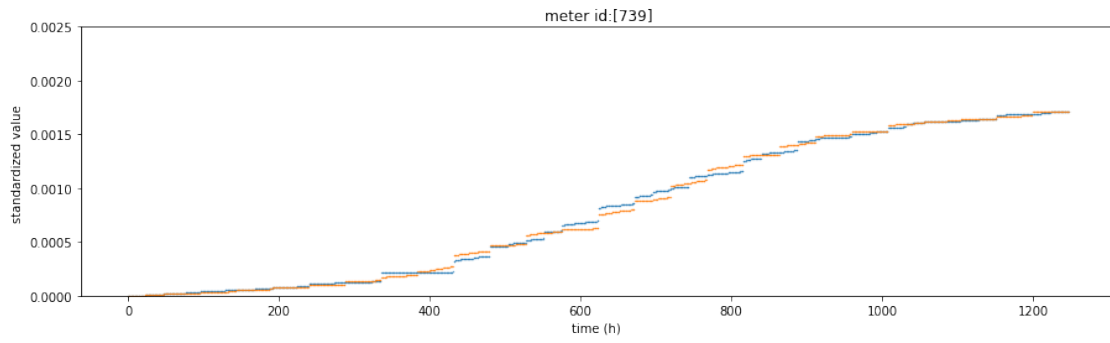
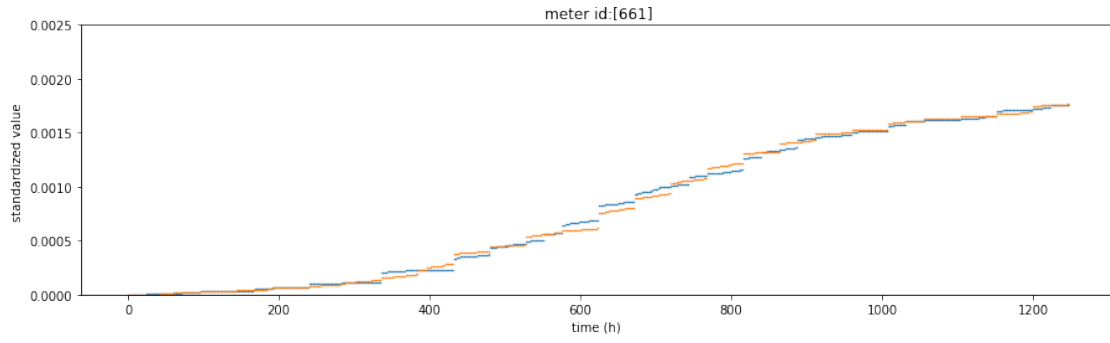
```

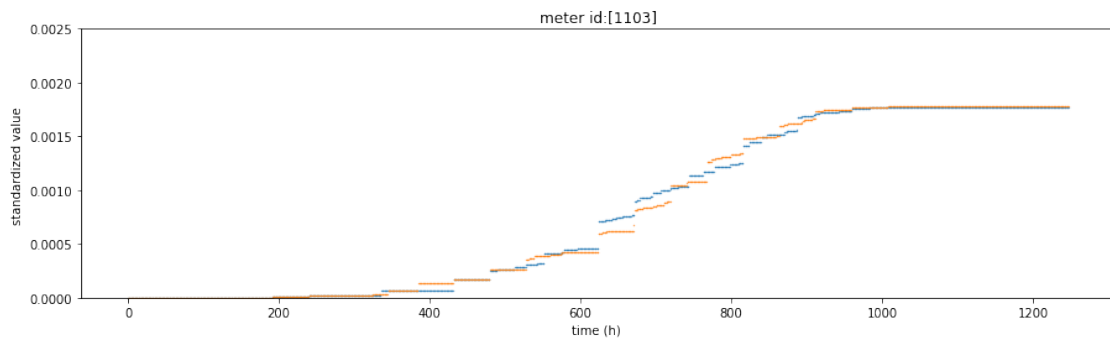
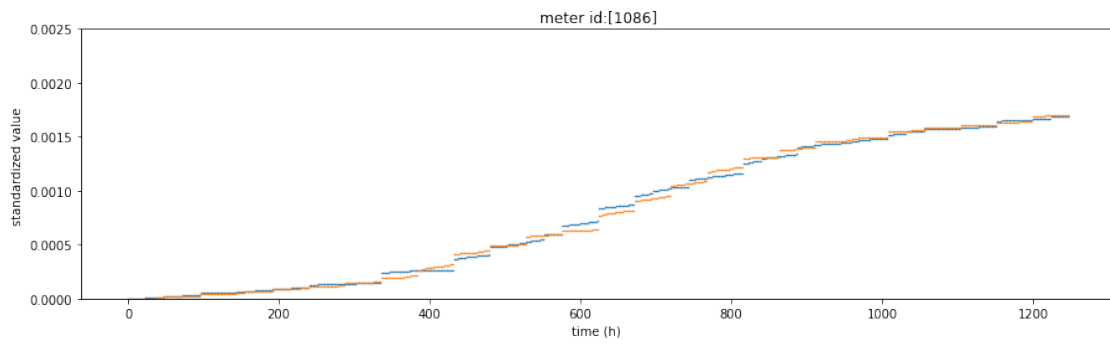
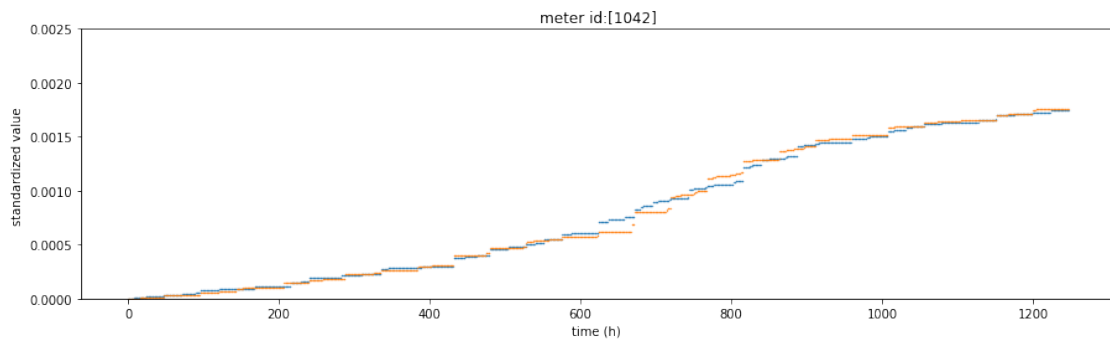


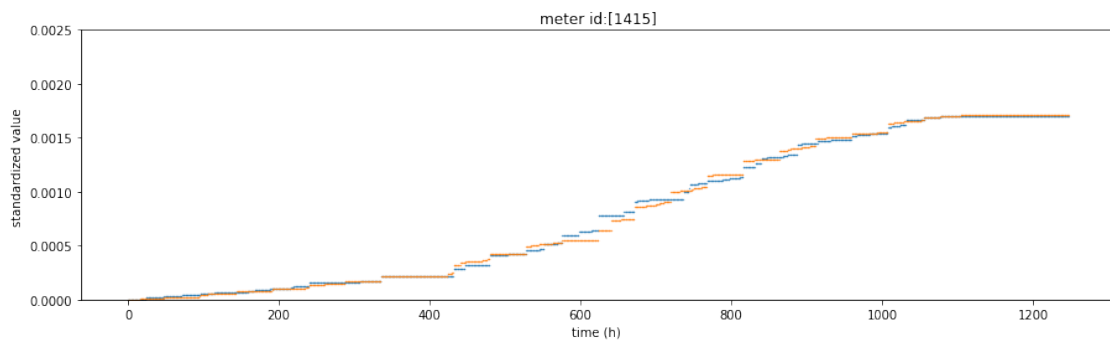
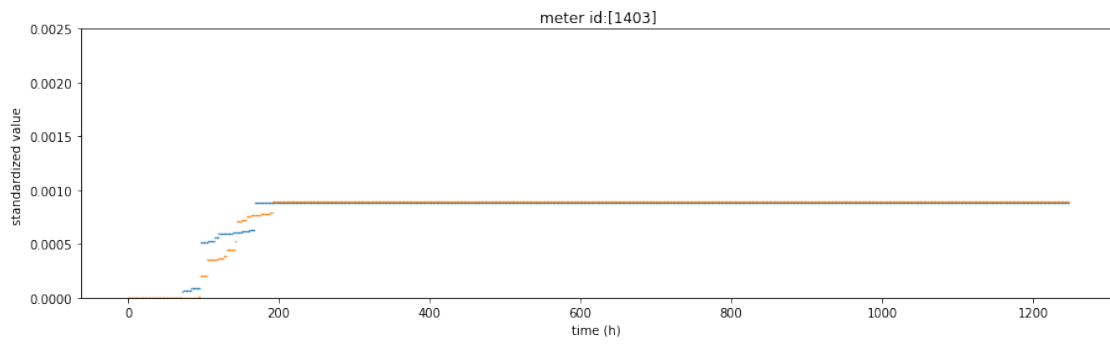
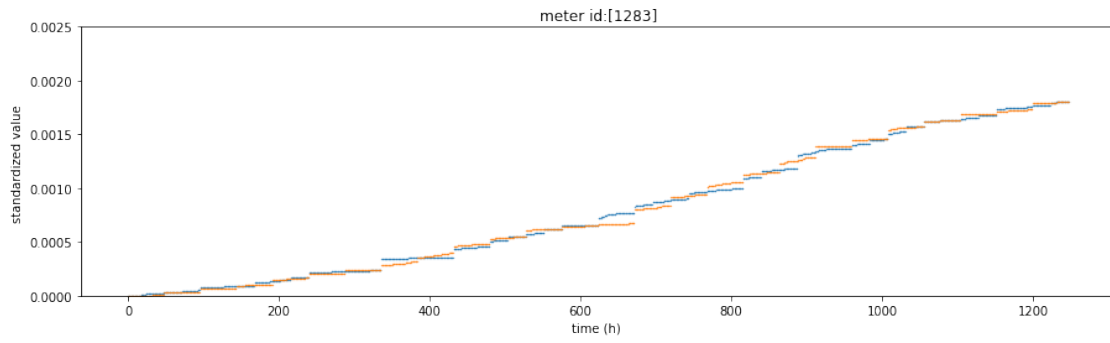
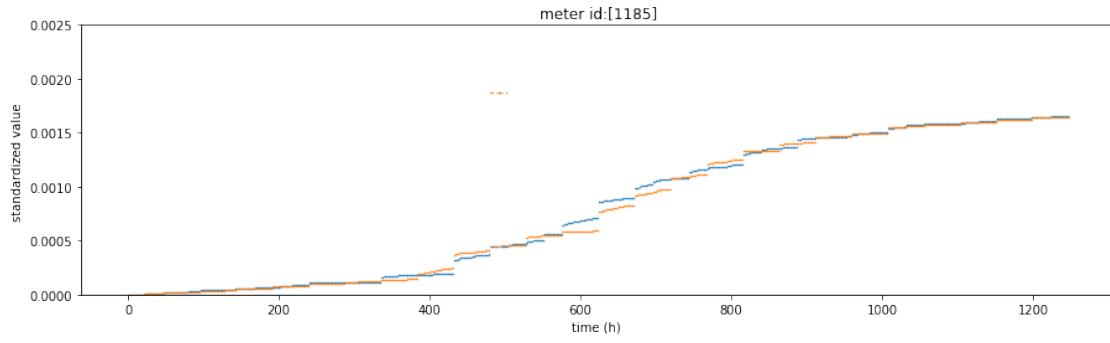


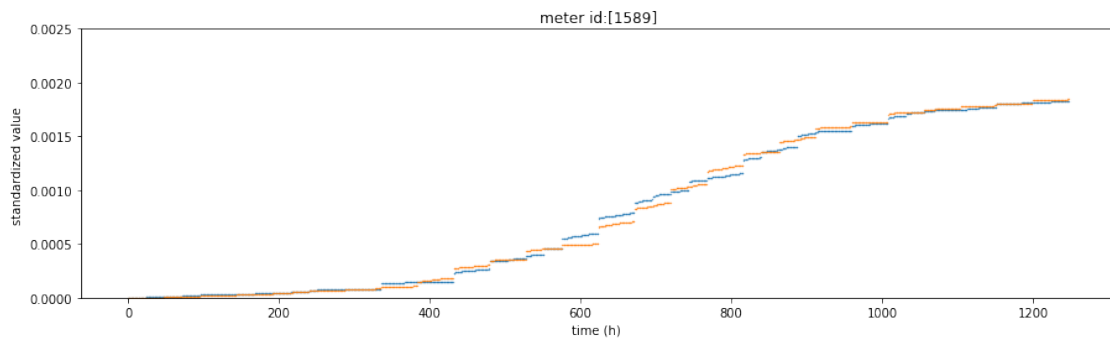
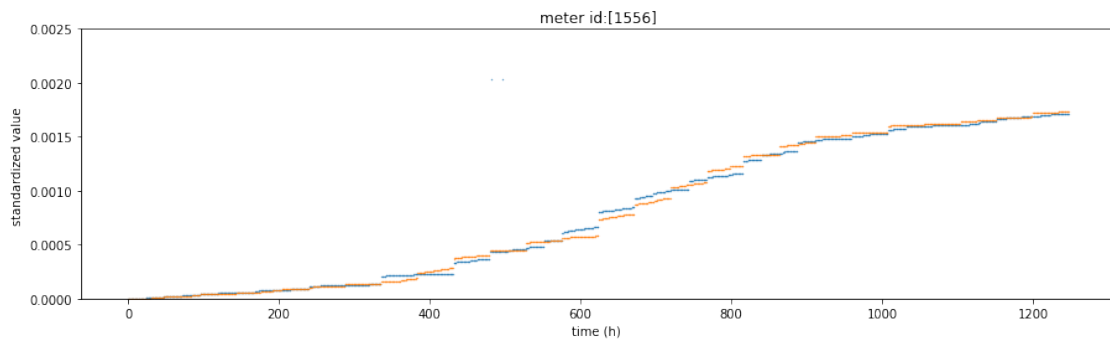
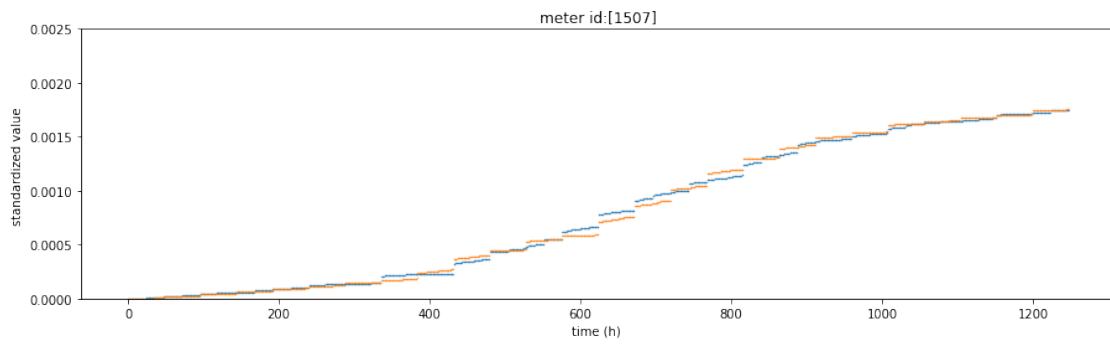


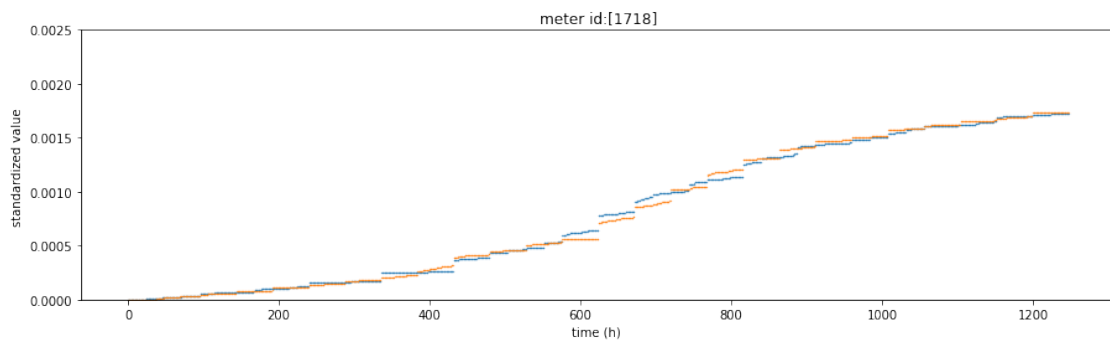
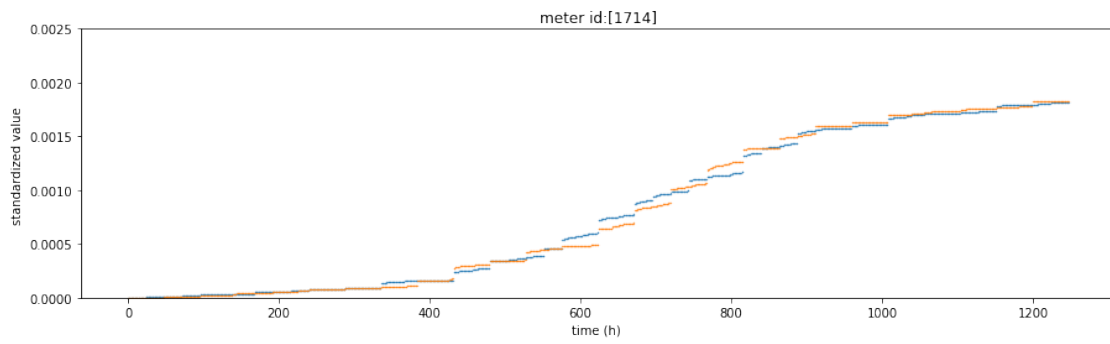
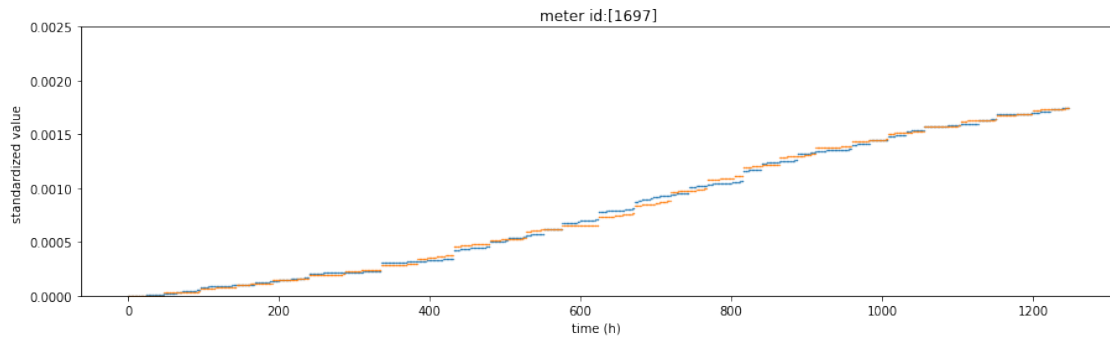
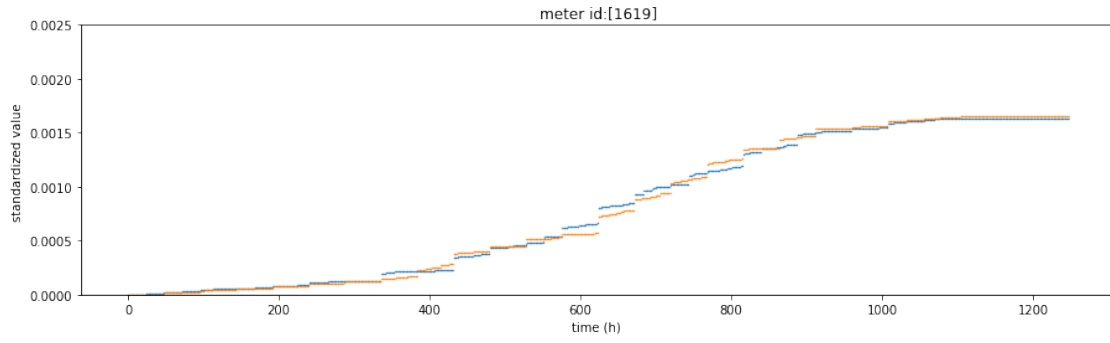


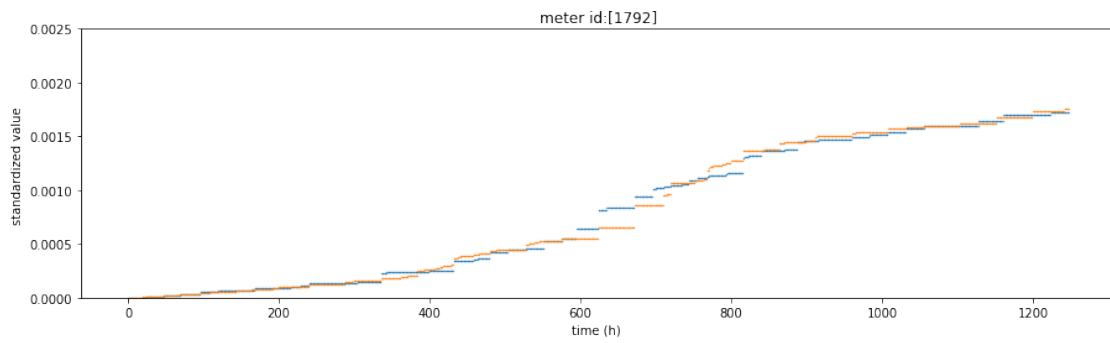
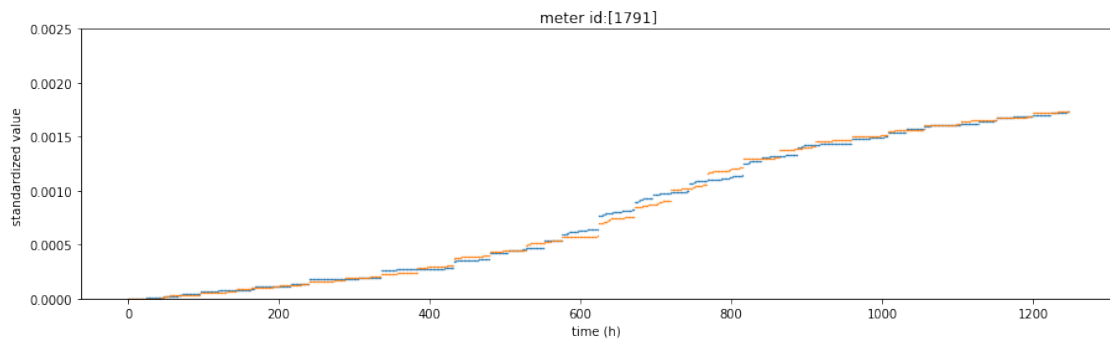
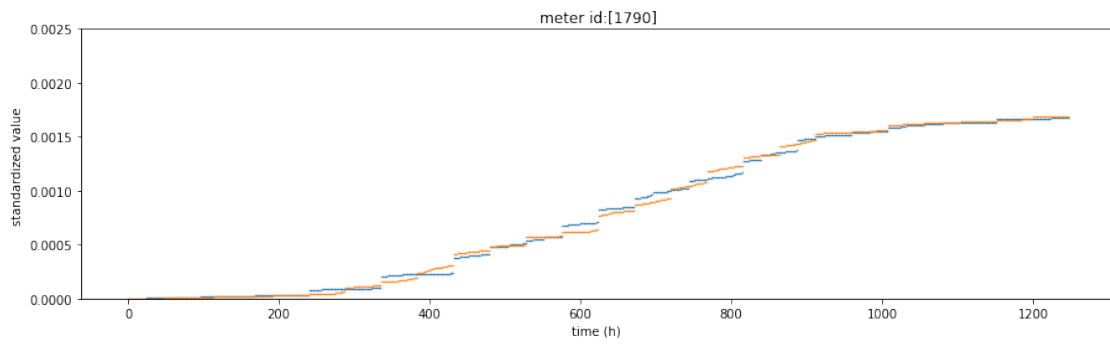


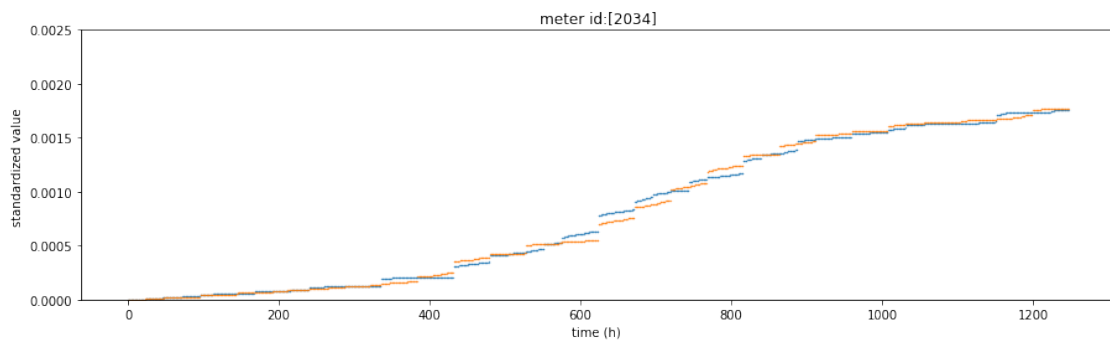
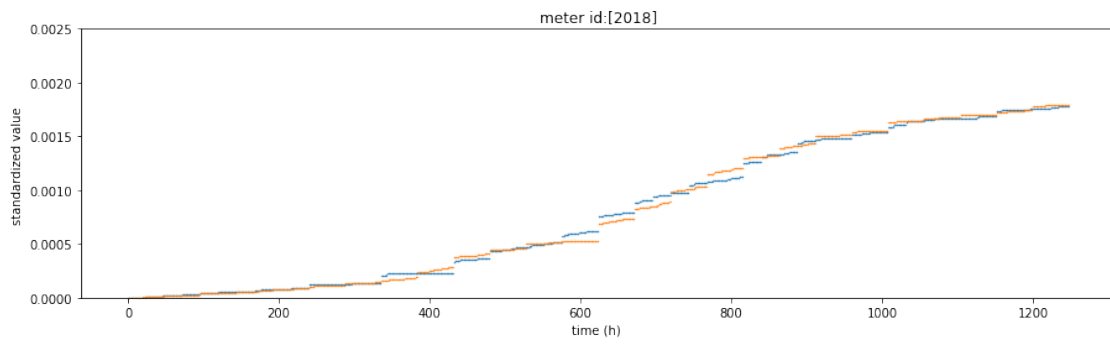
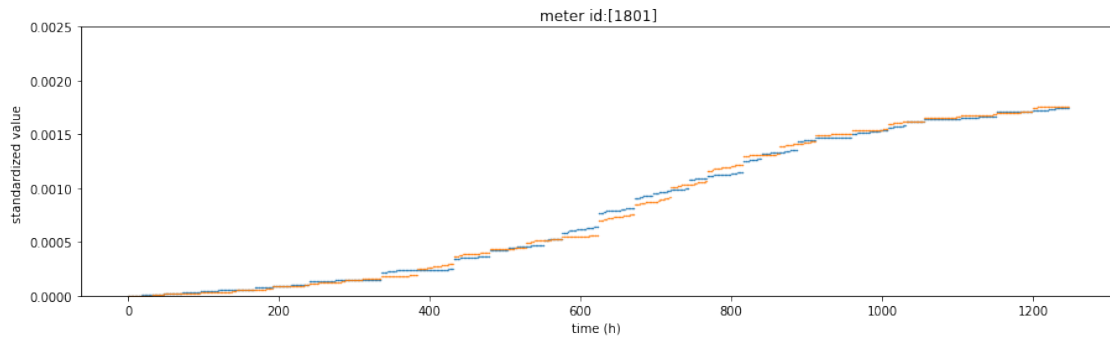
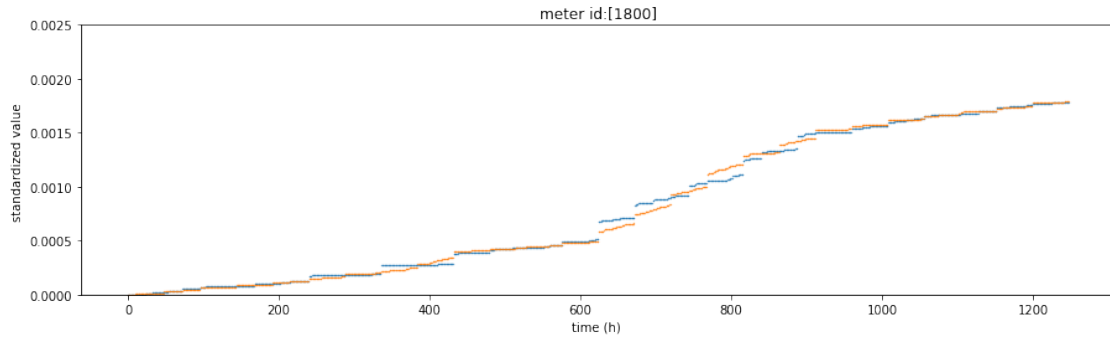


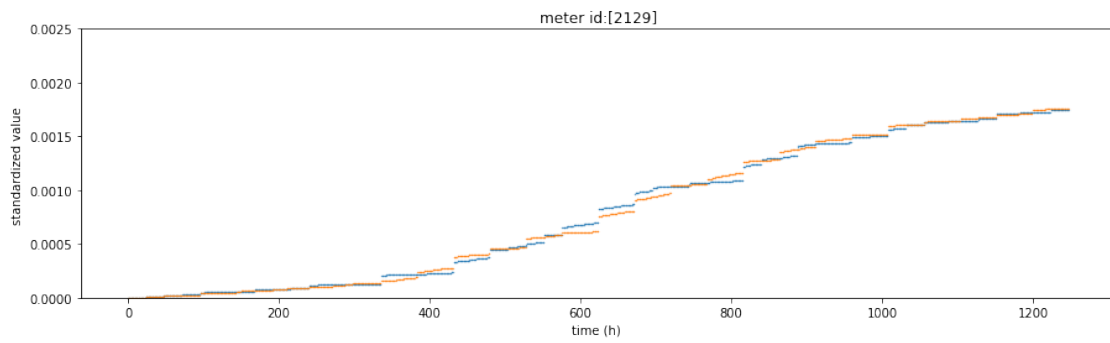
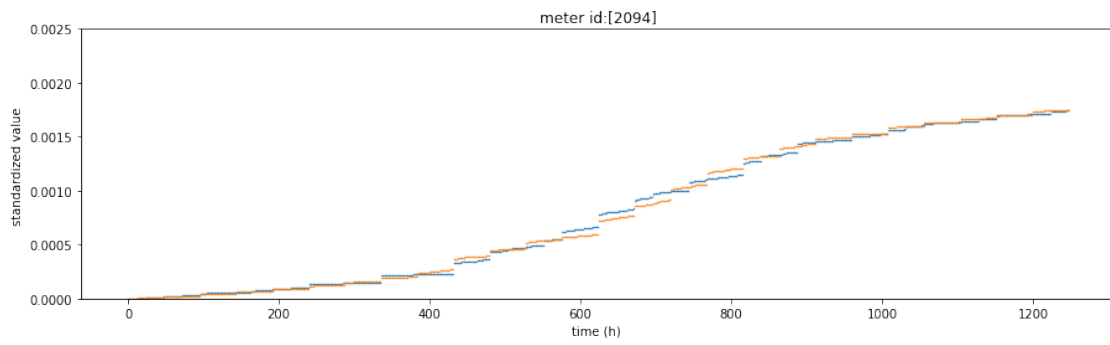
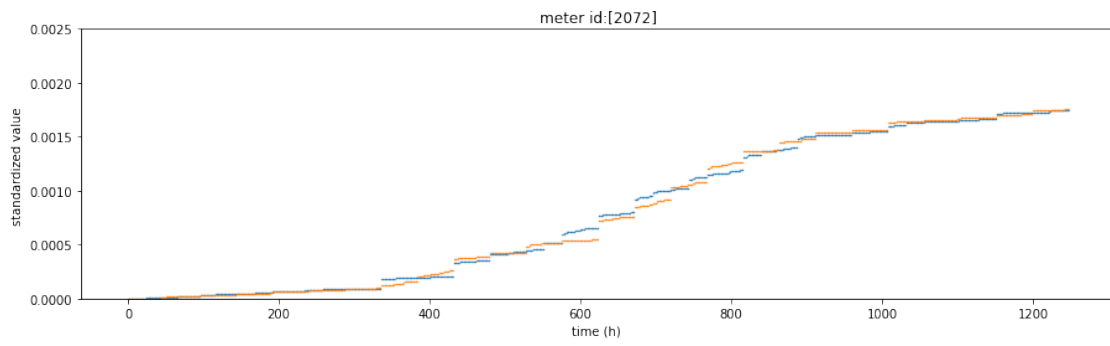


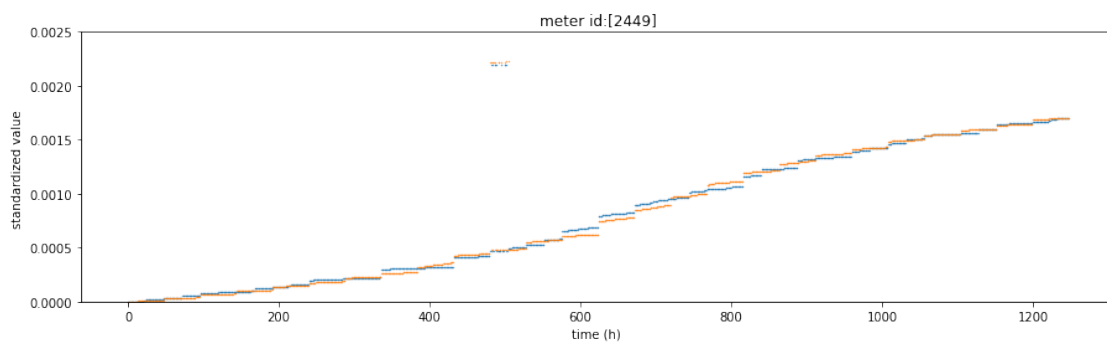
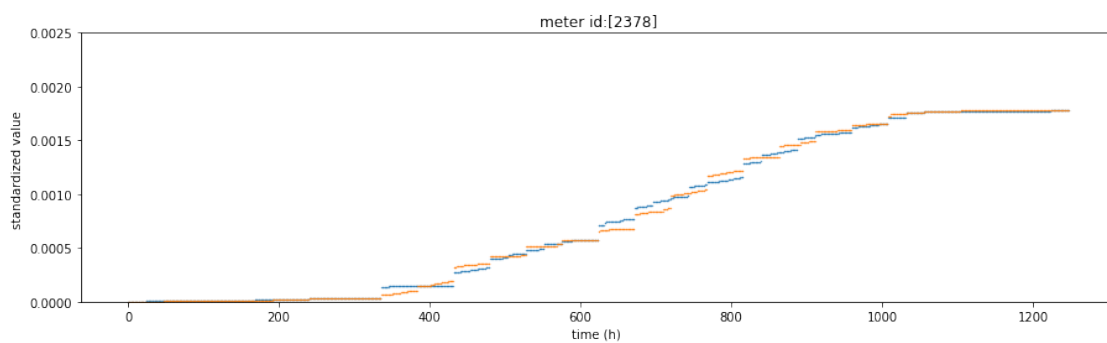
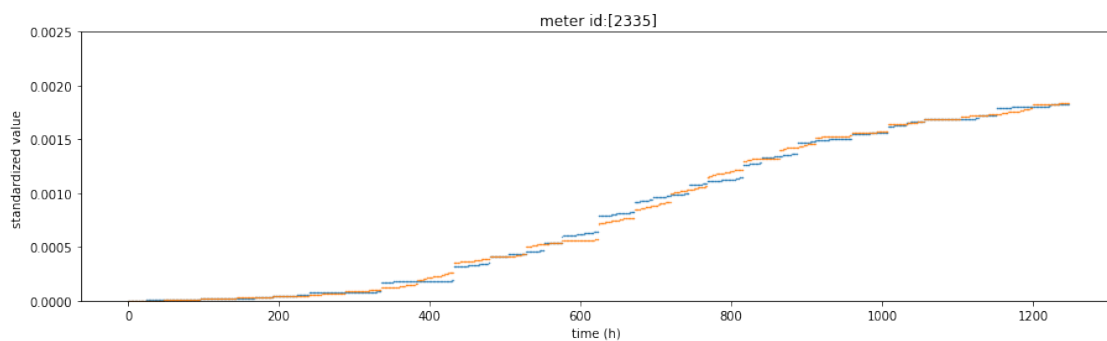
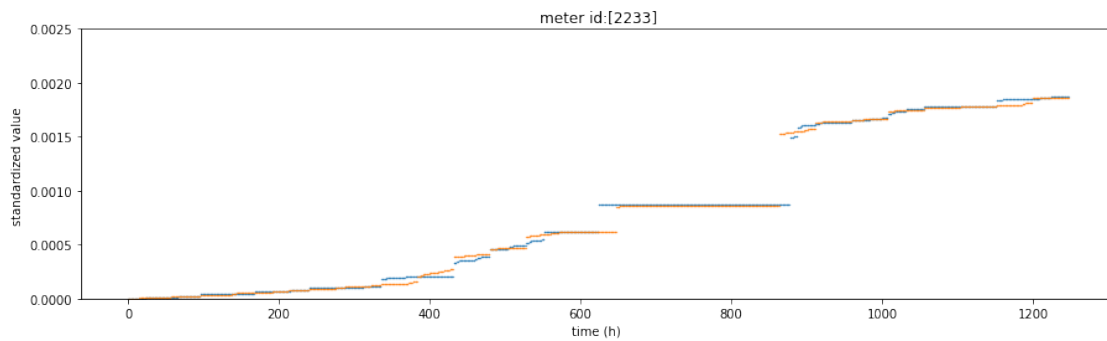


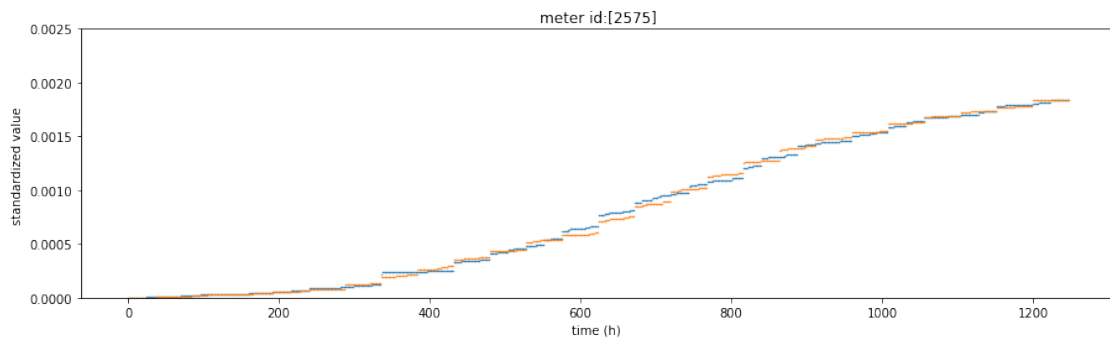
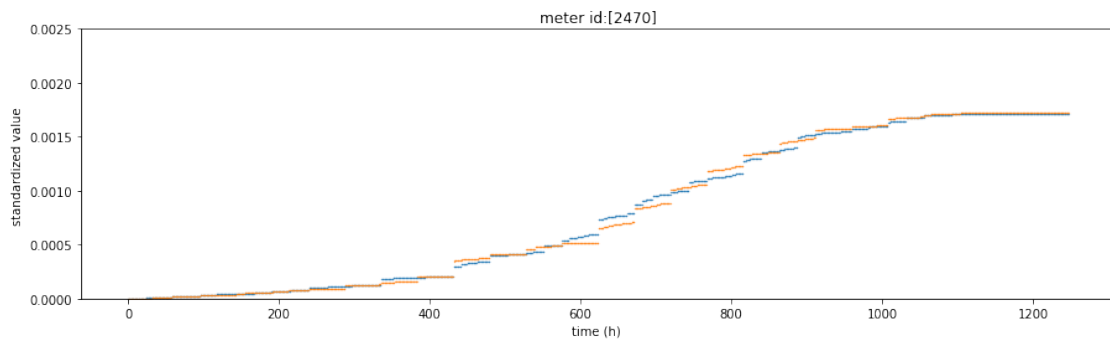
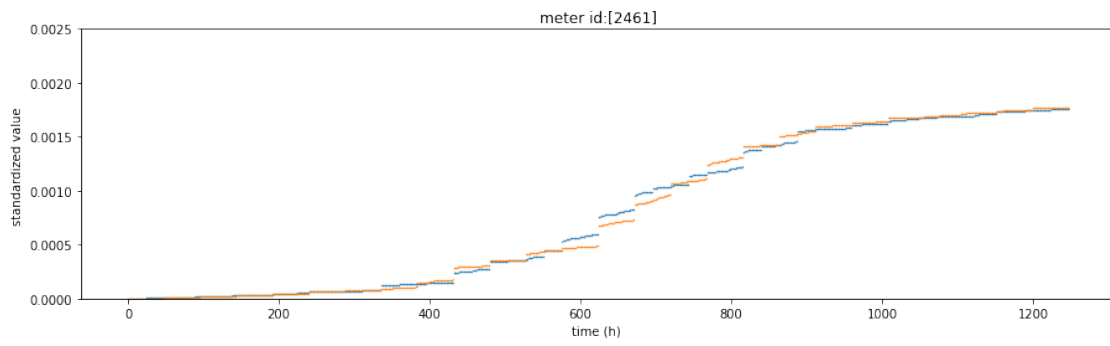


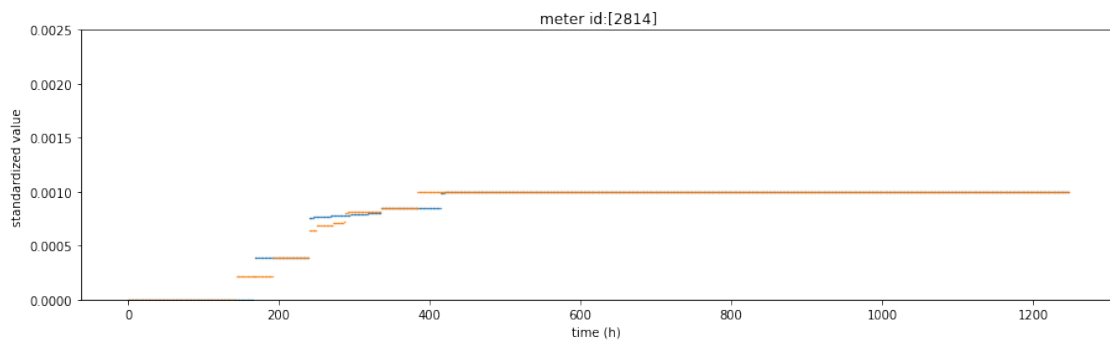
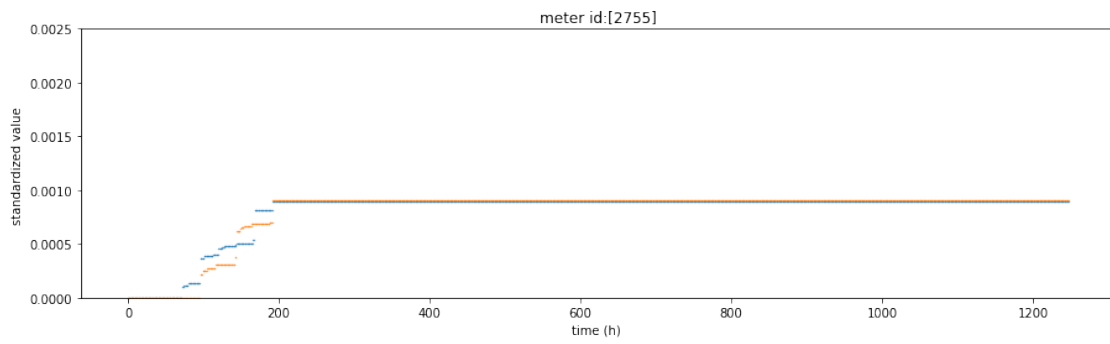
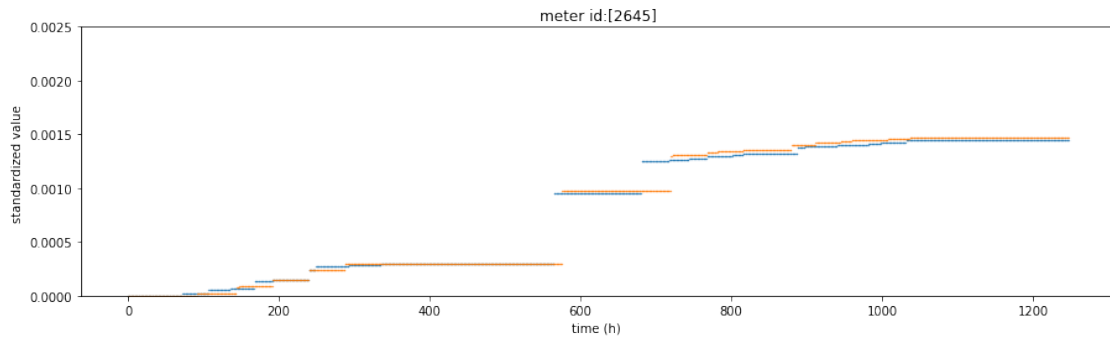
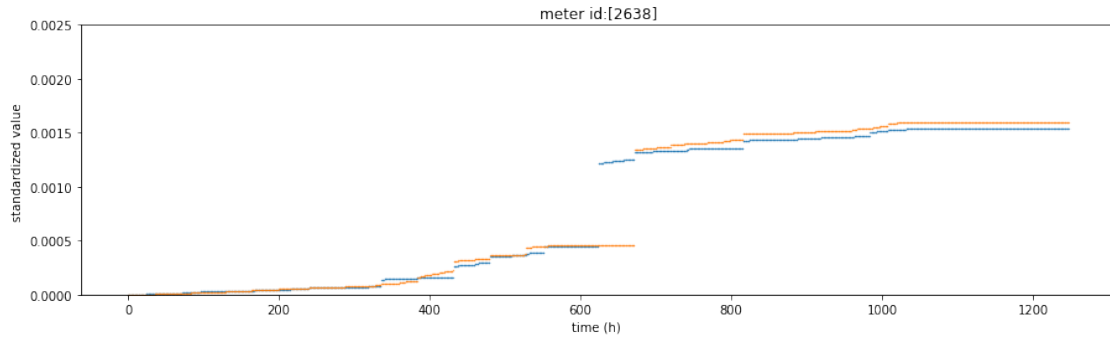


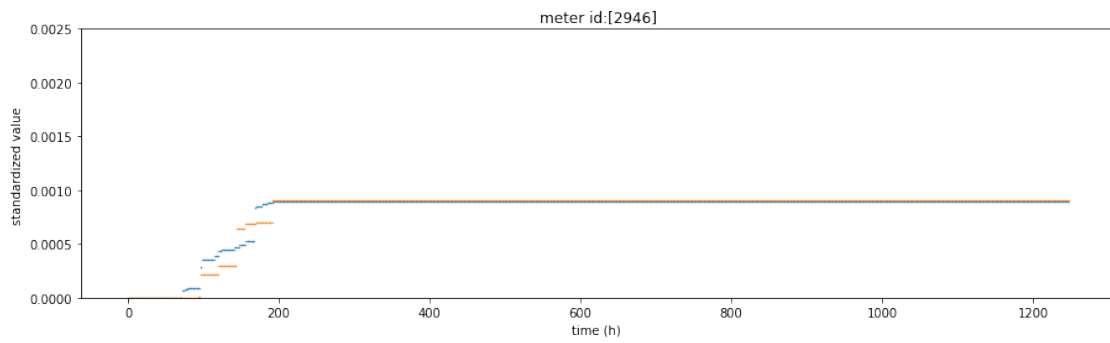
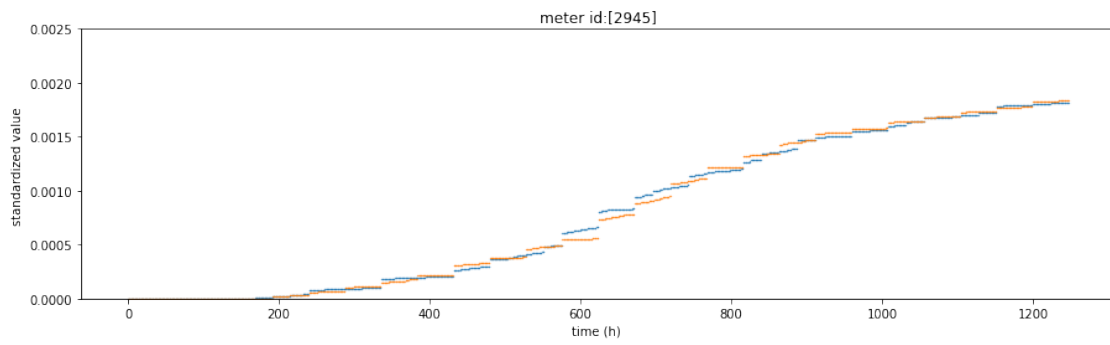
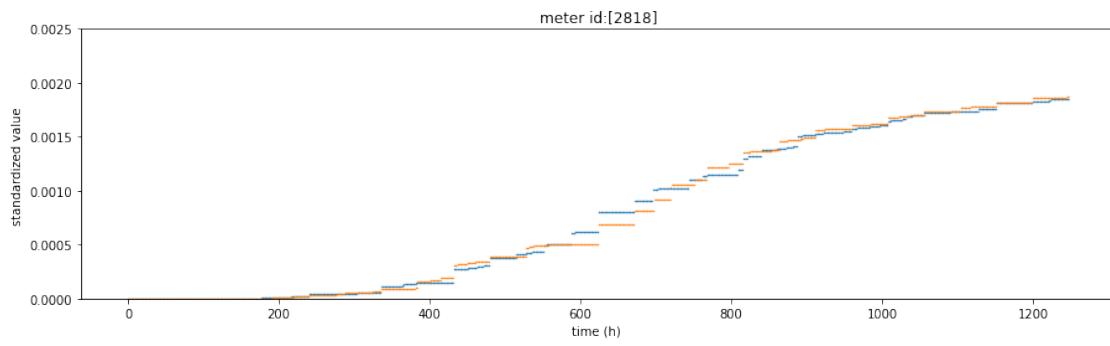


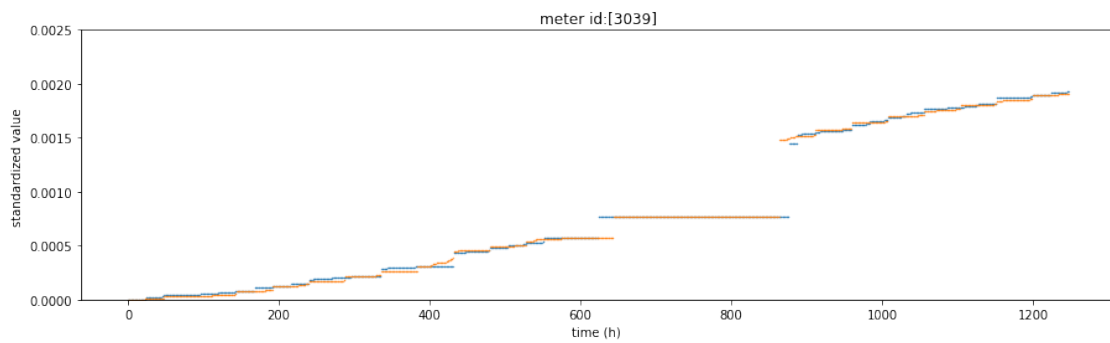
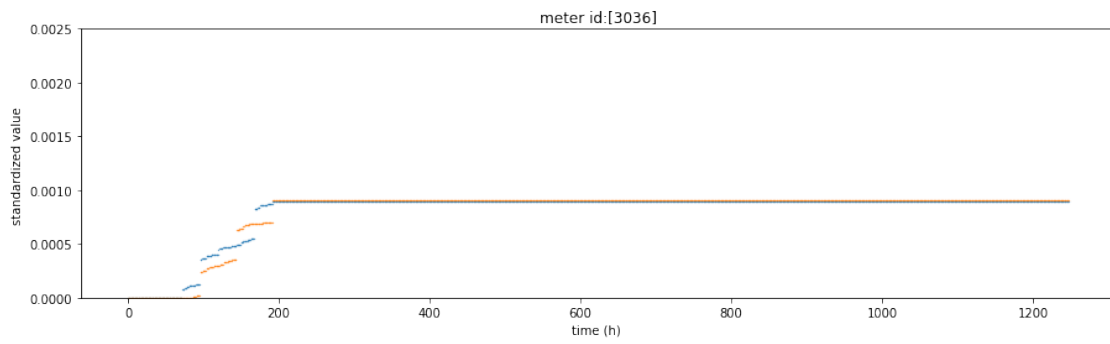
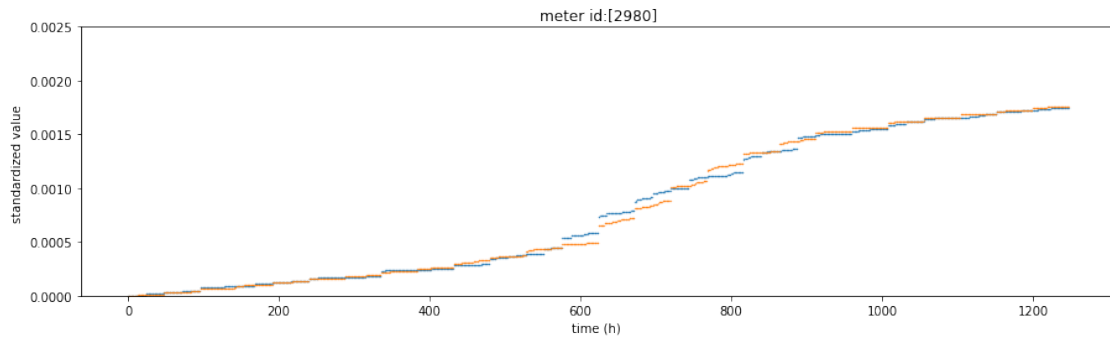
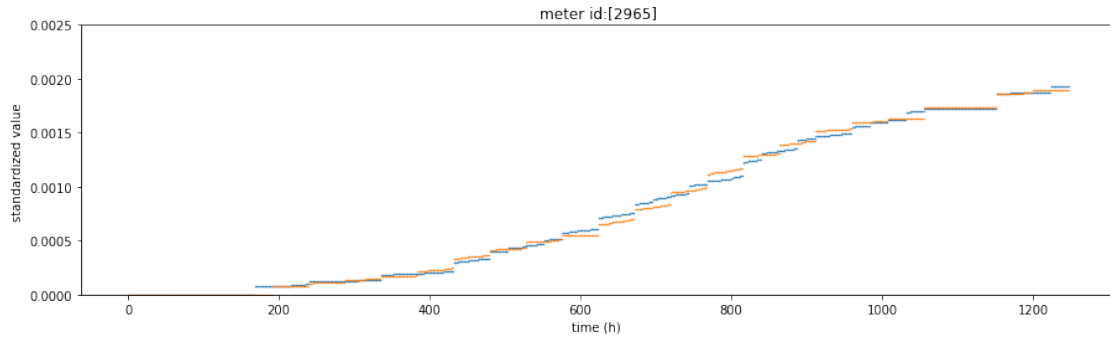


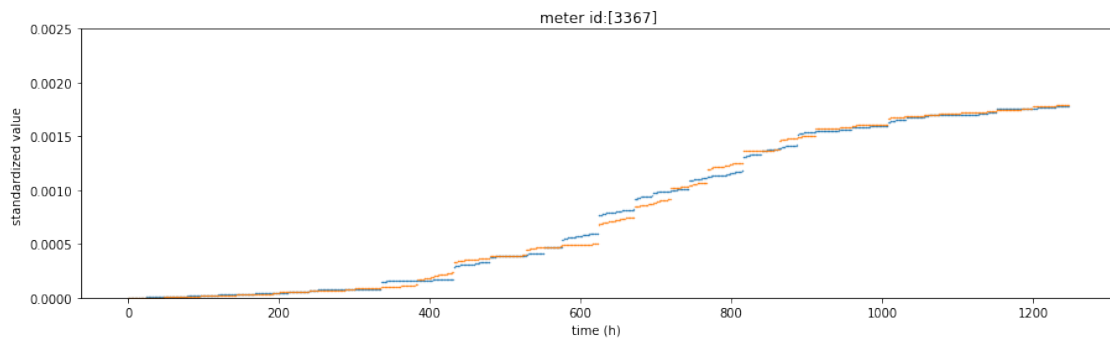
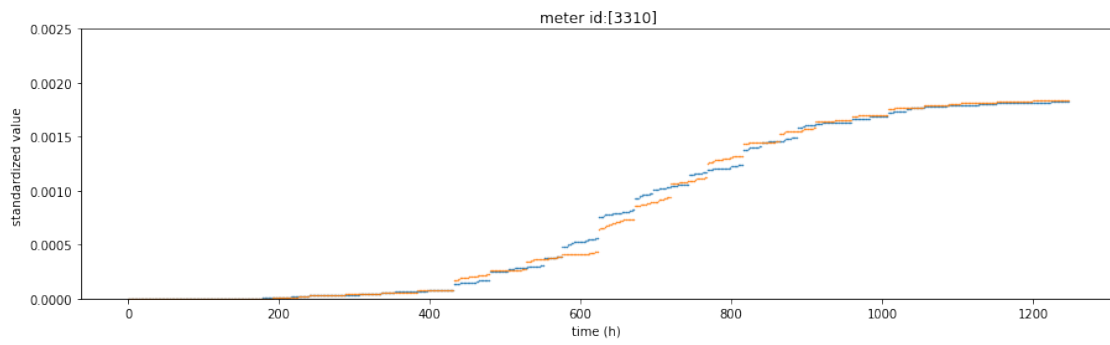
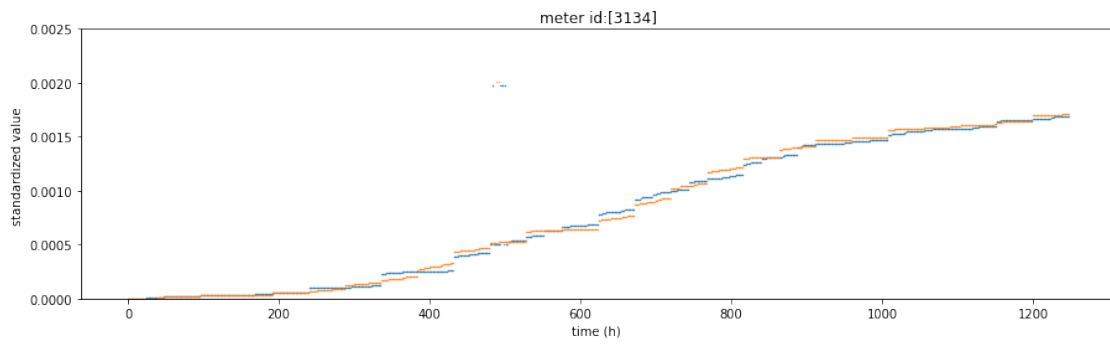


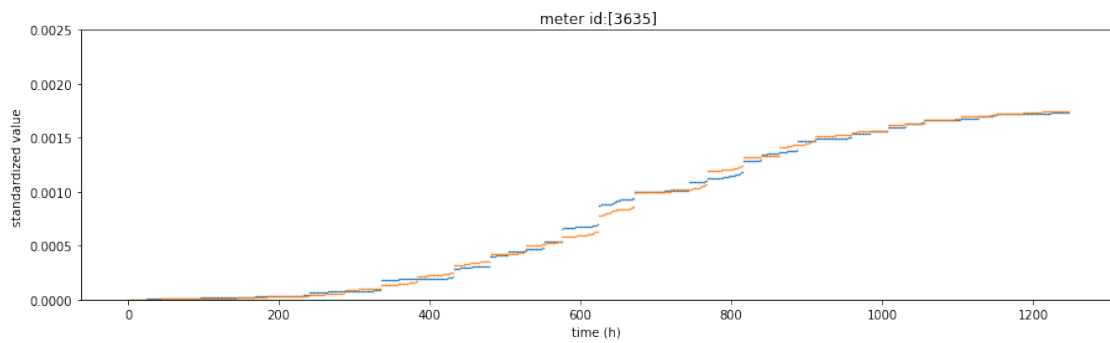
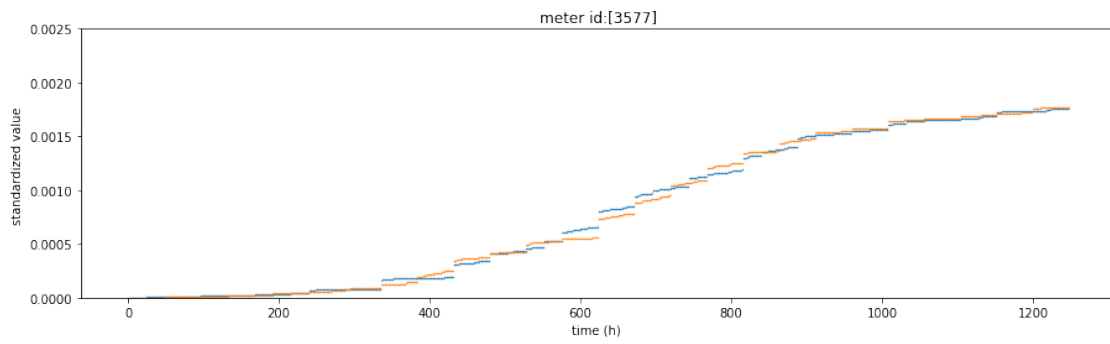
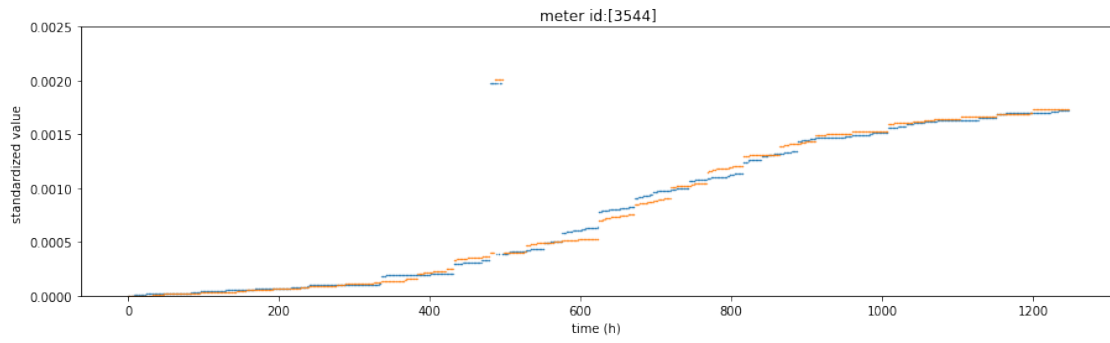
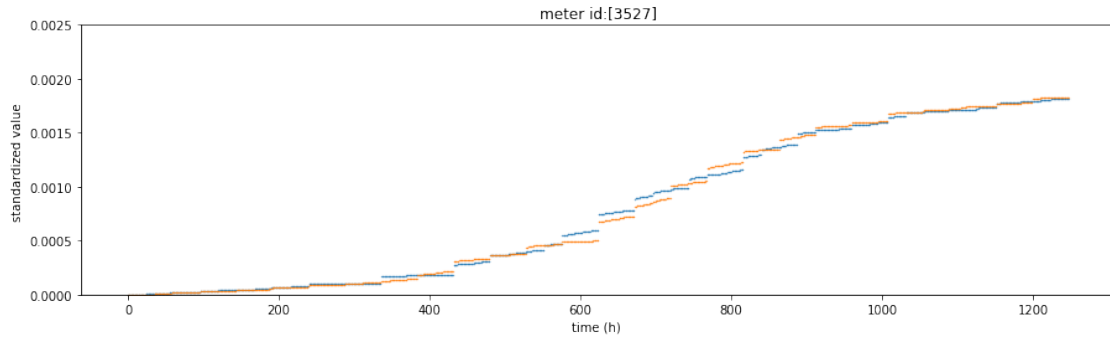


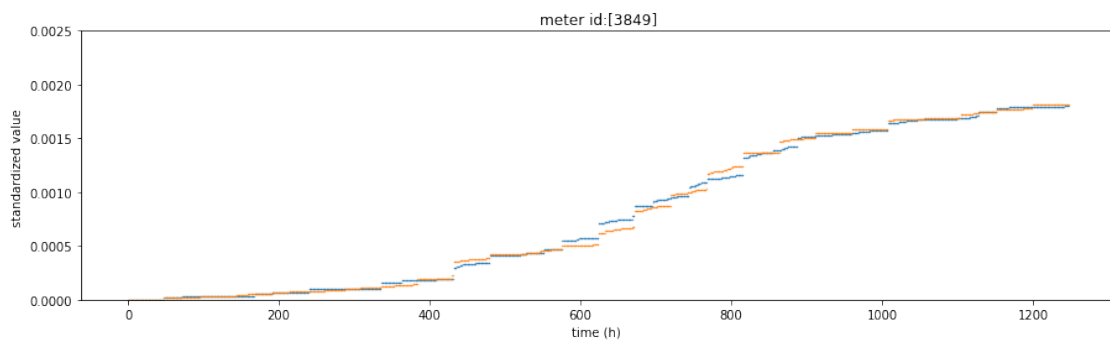
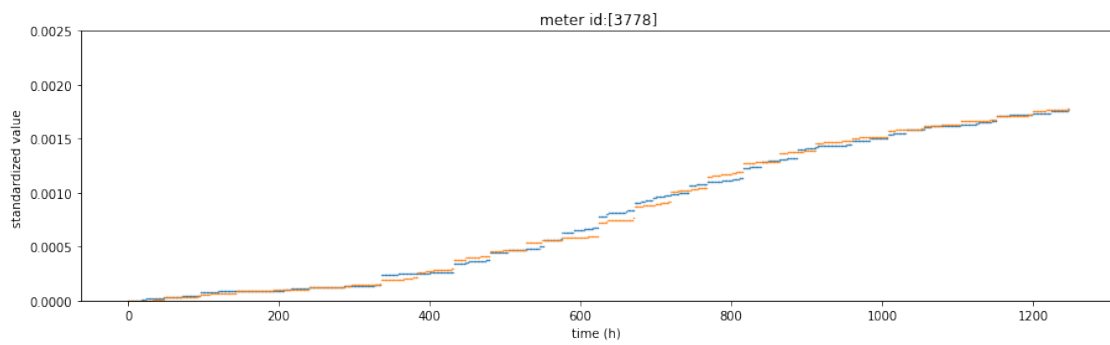
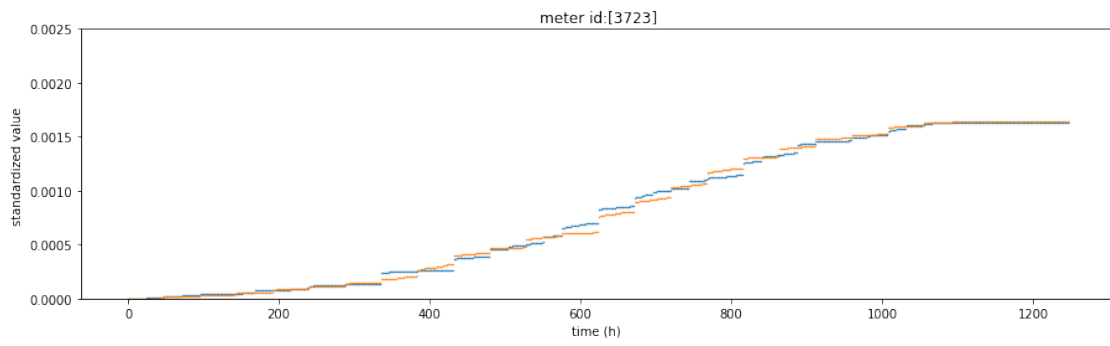


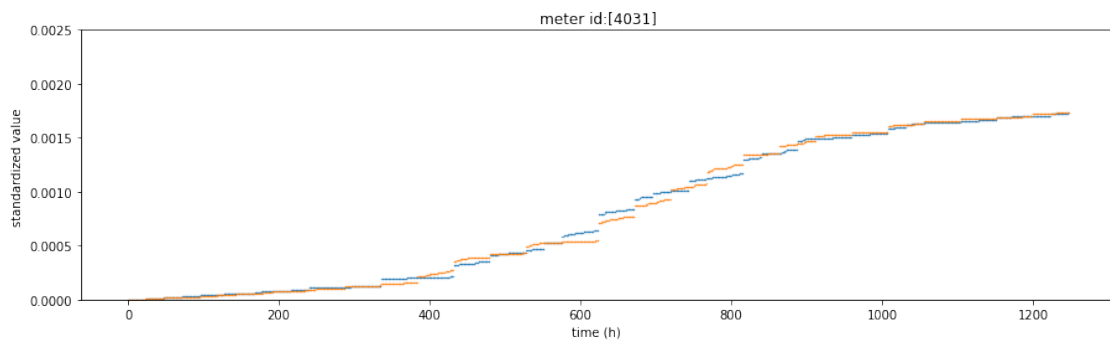
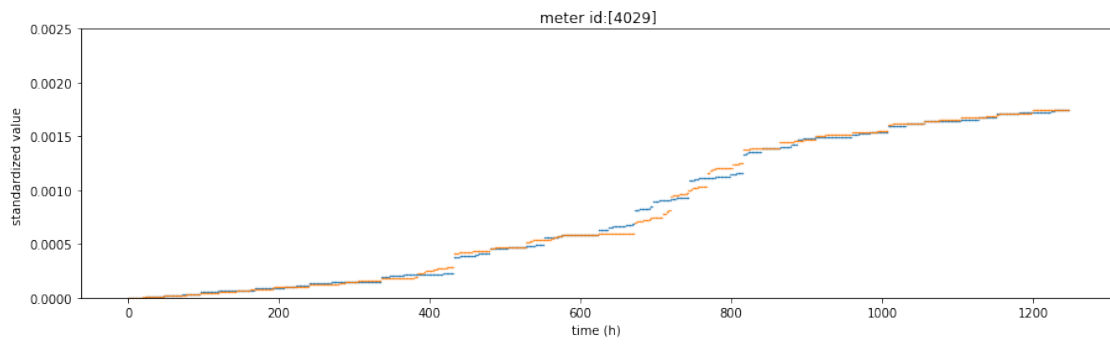
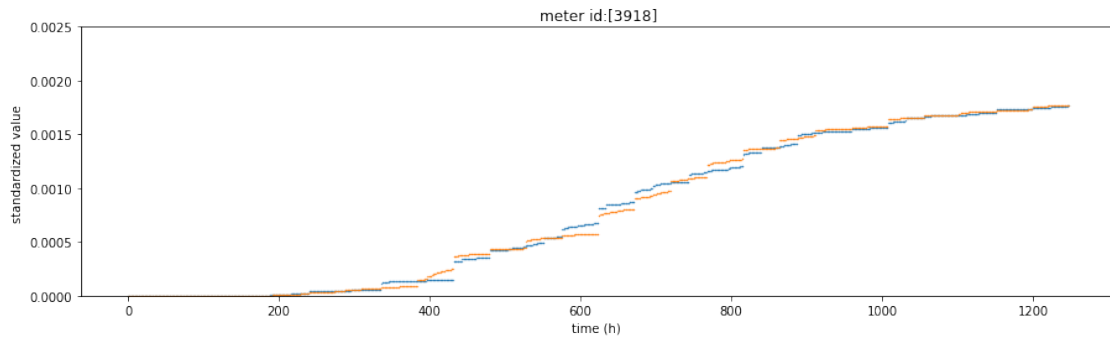
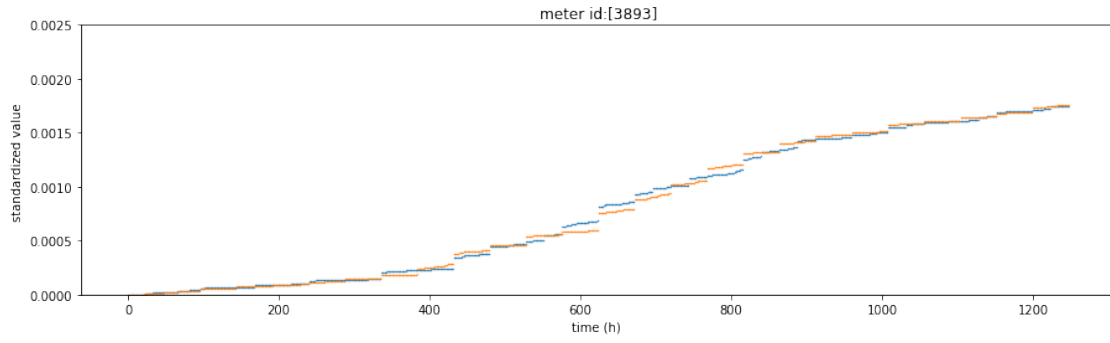


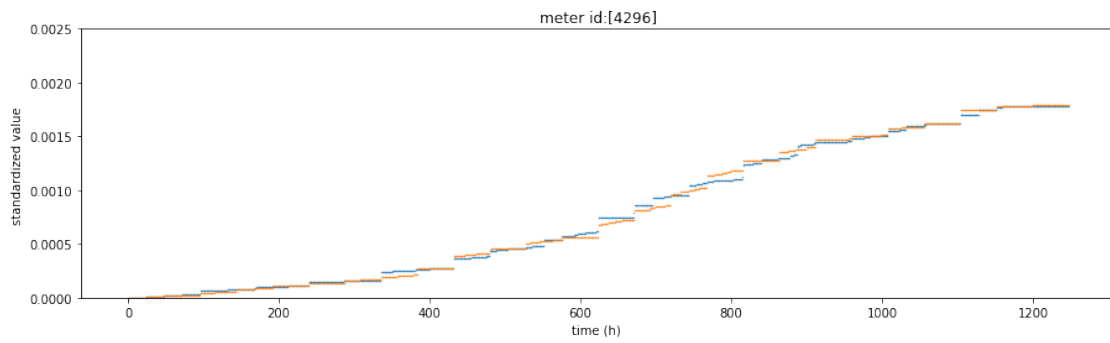
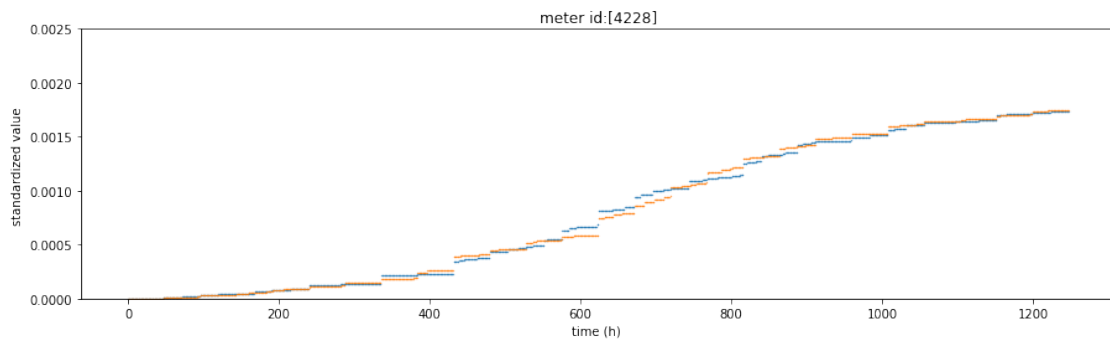
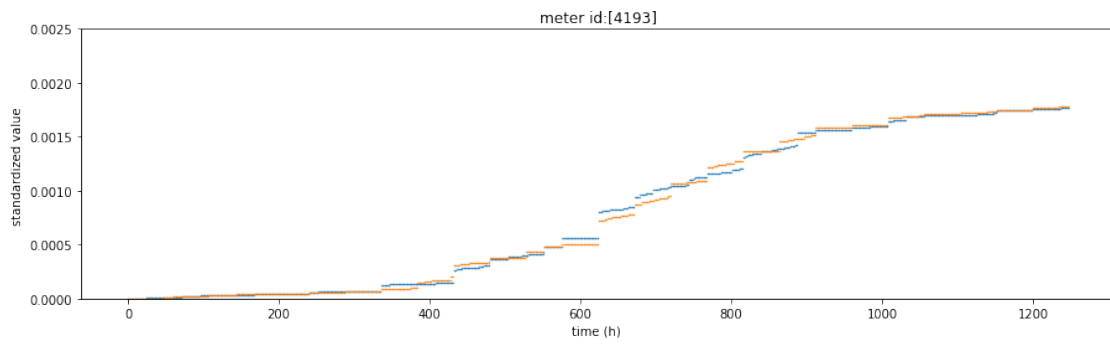


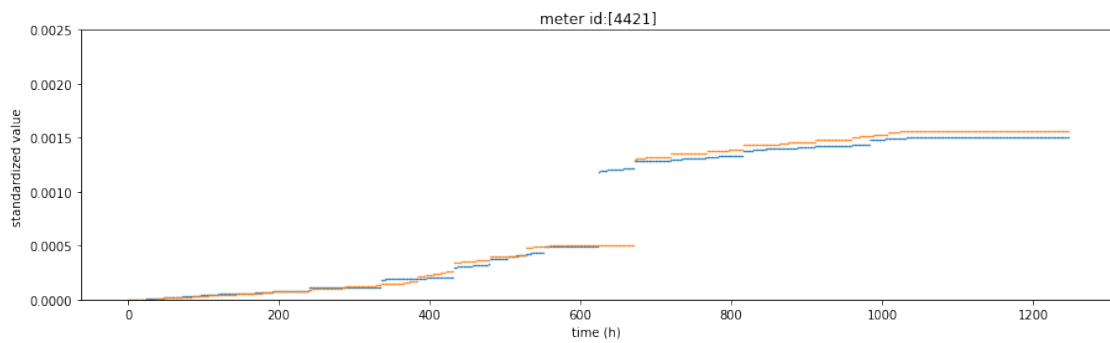
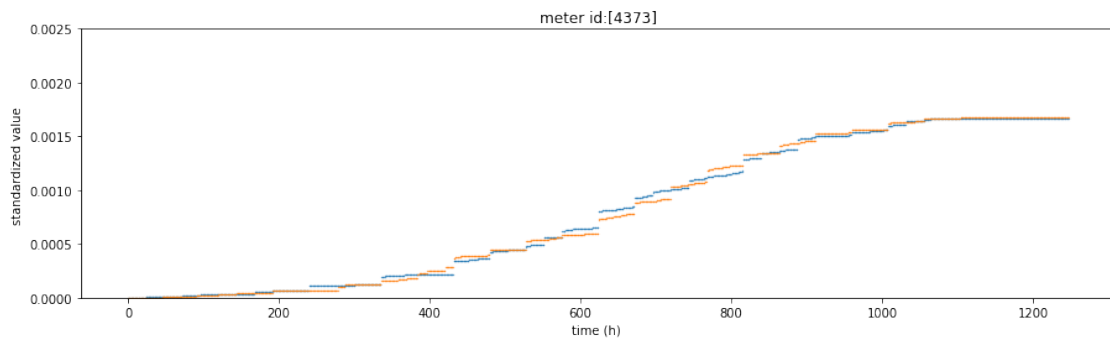
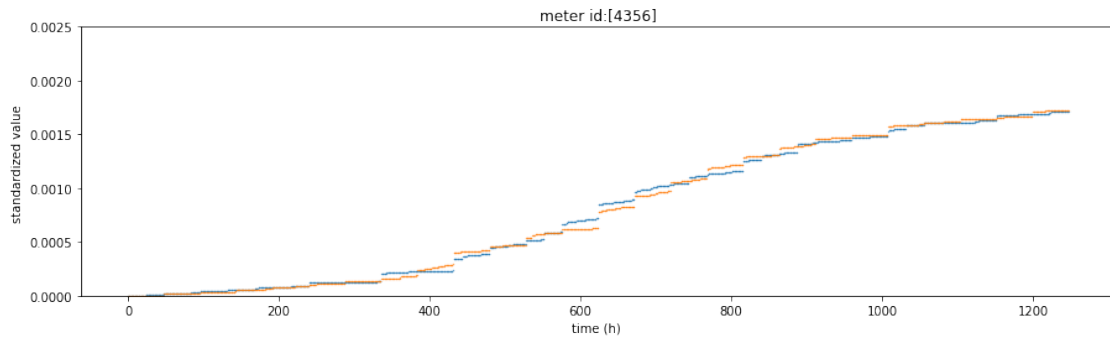
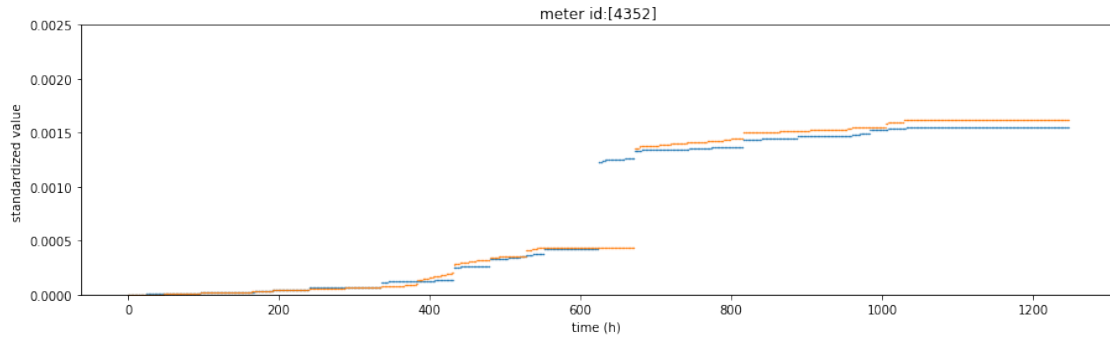


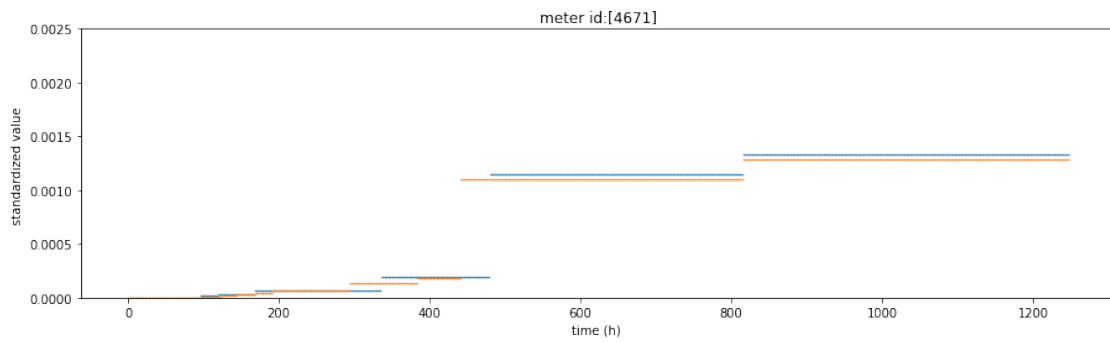
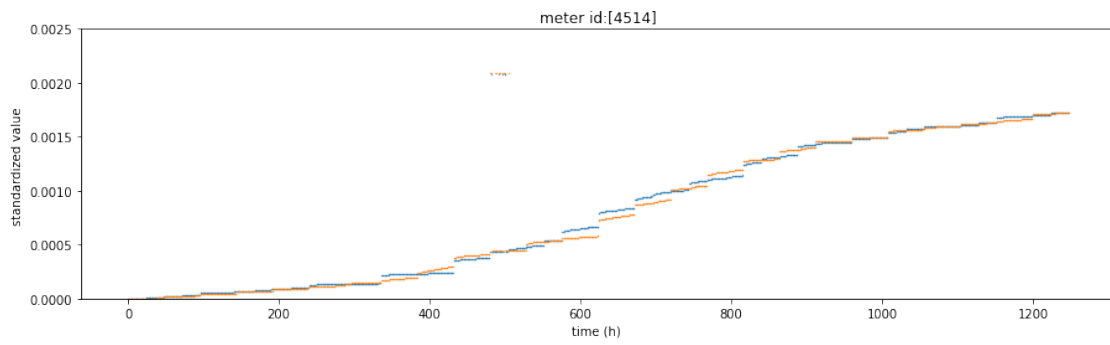
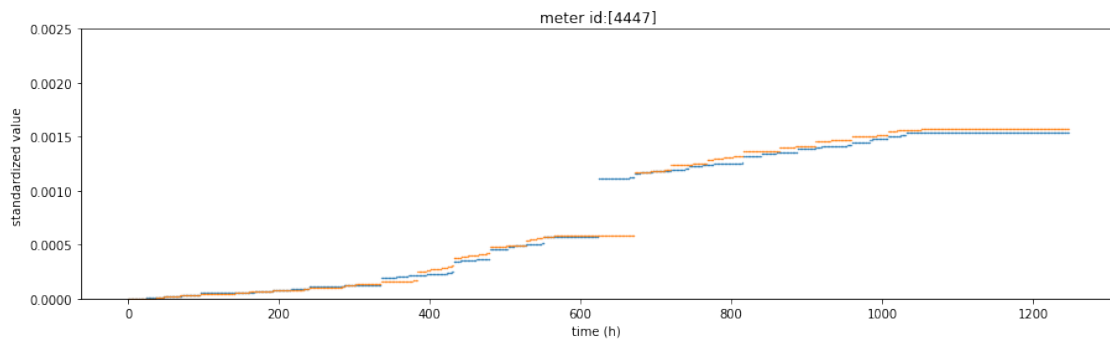


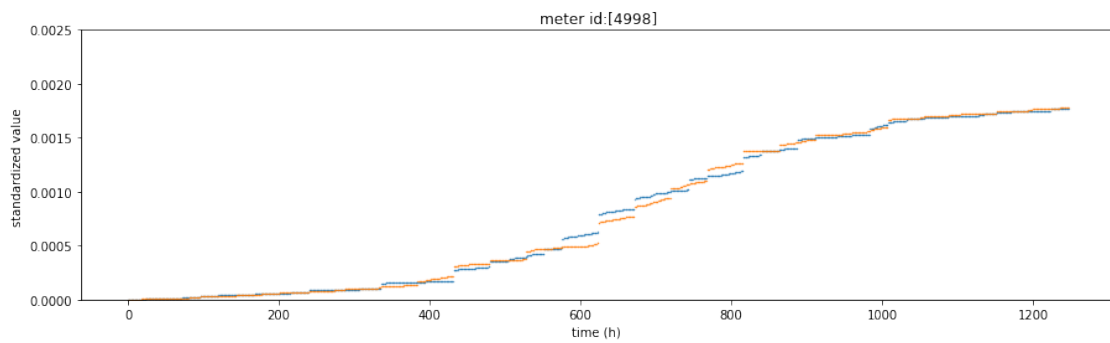
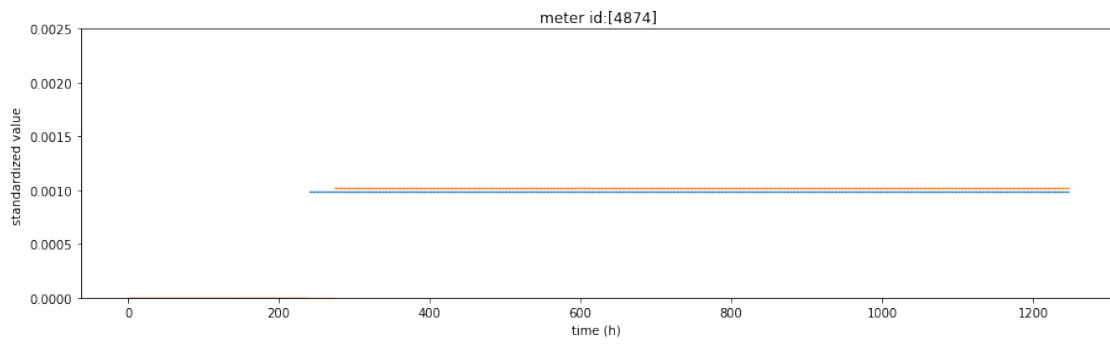
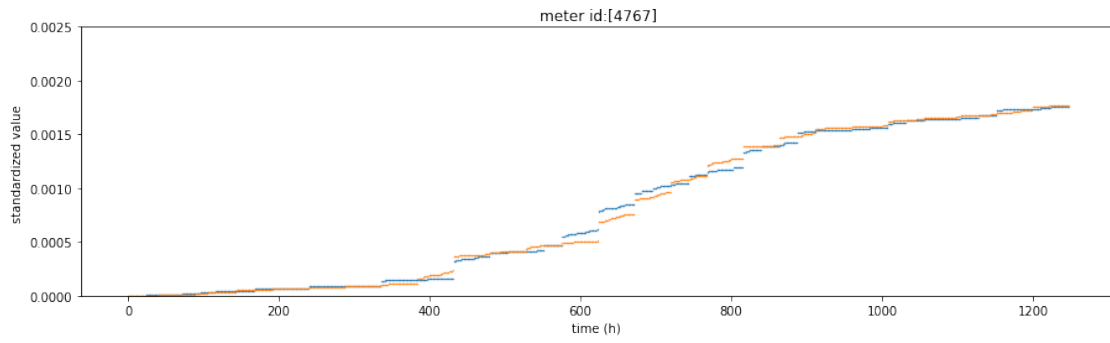
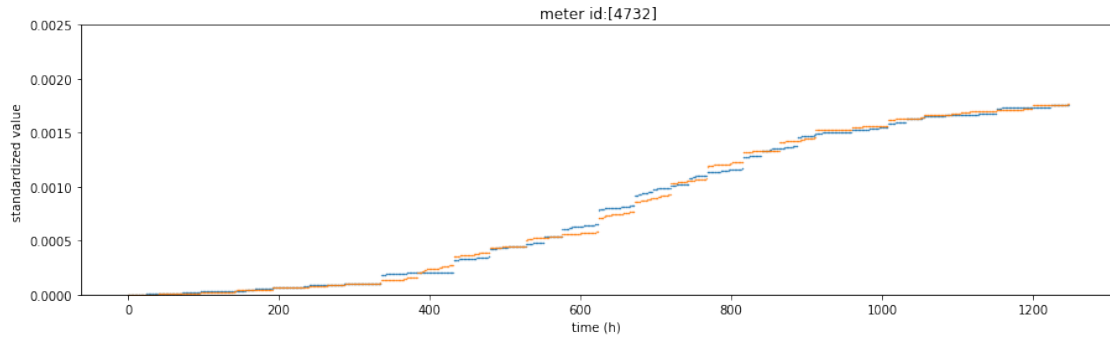


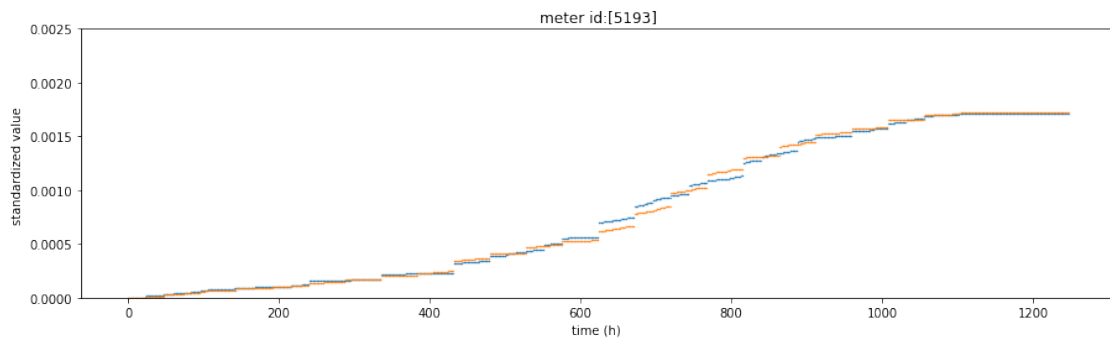
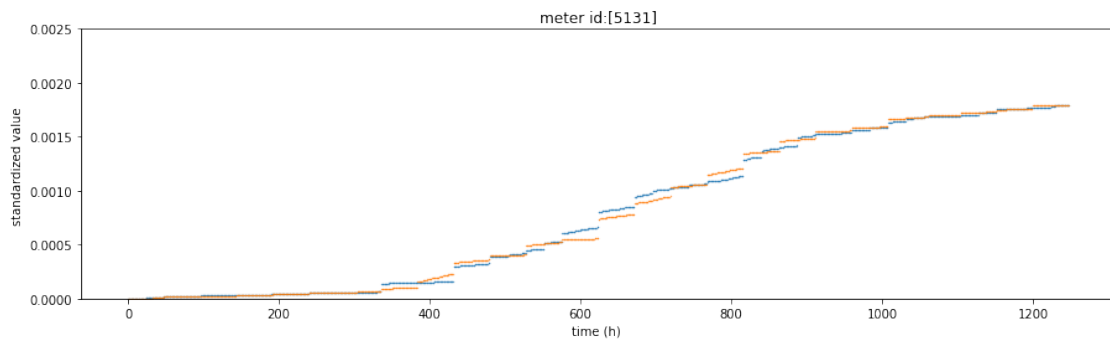
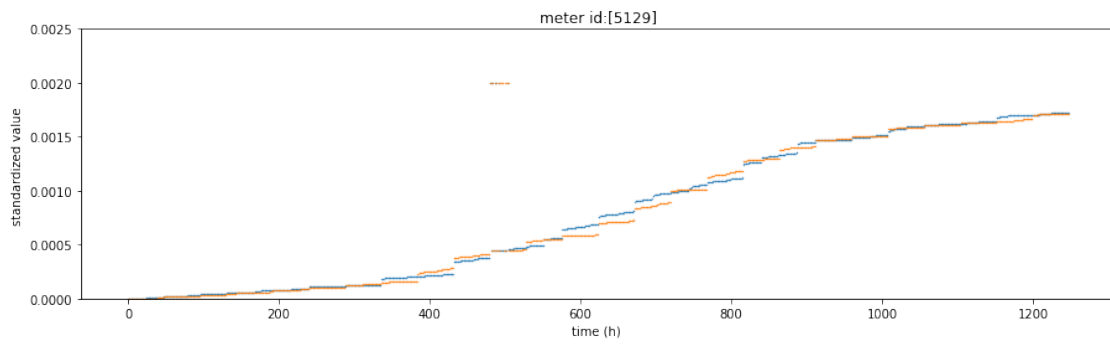


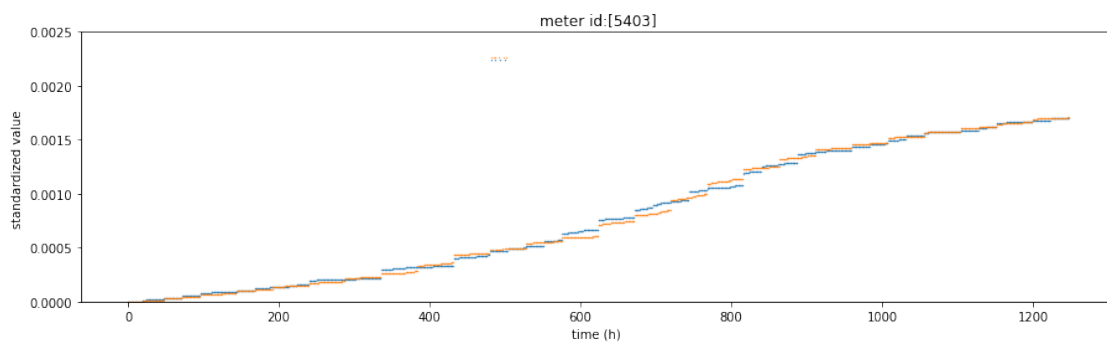
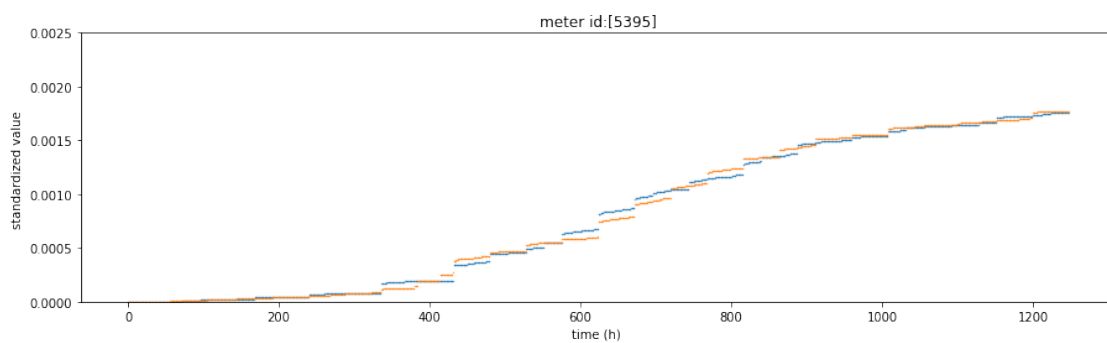
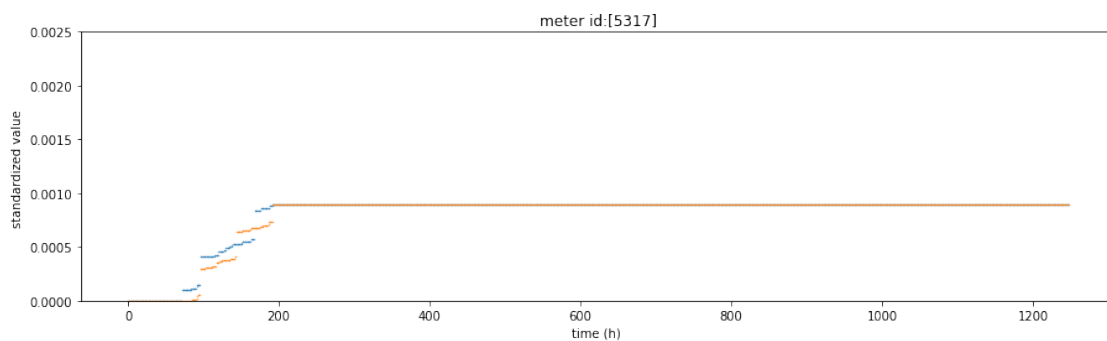
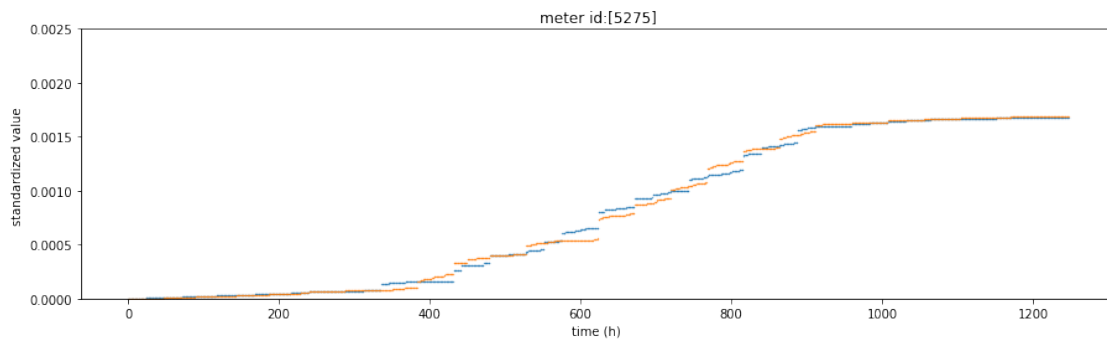


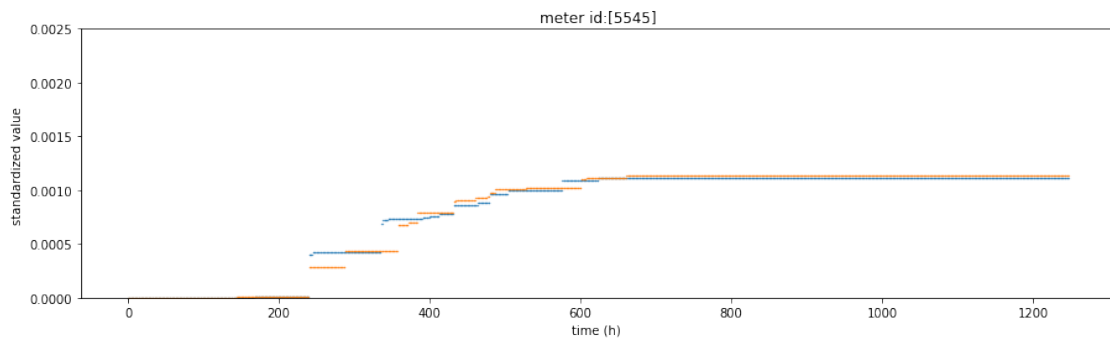
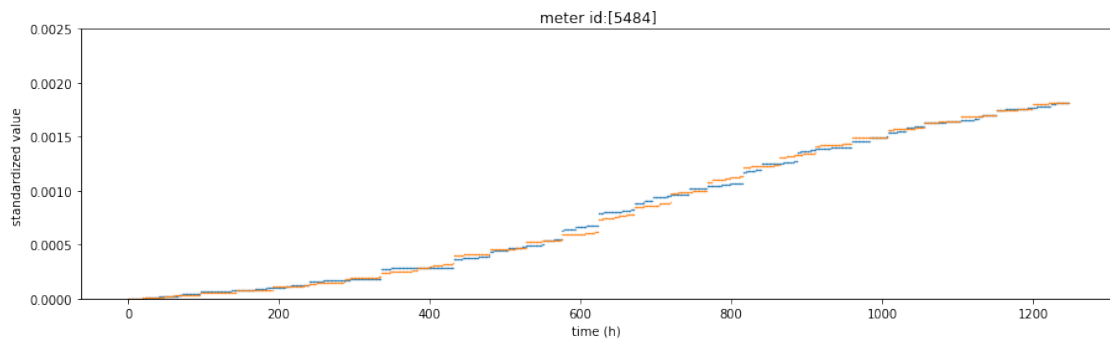
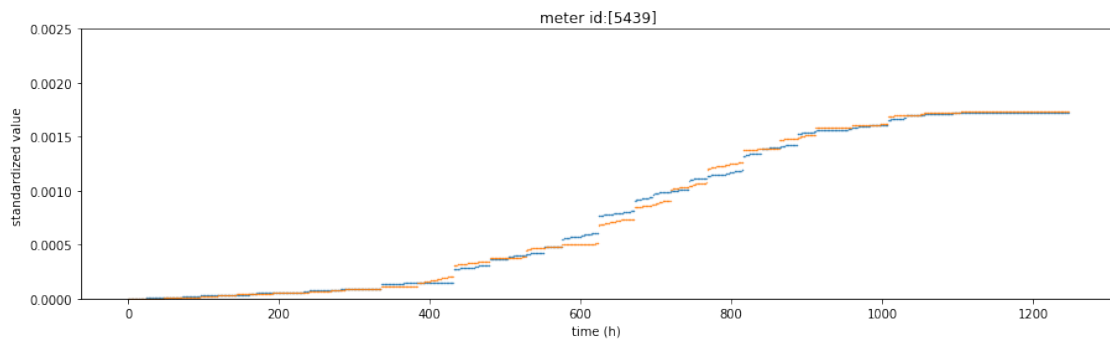


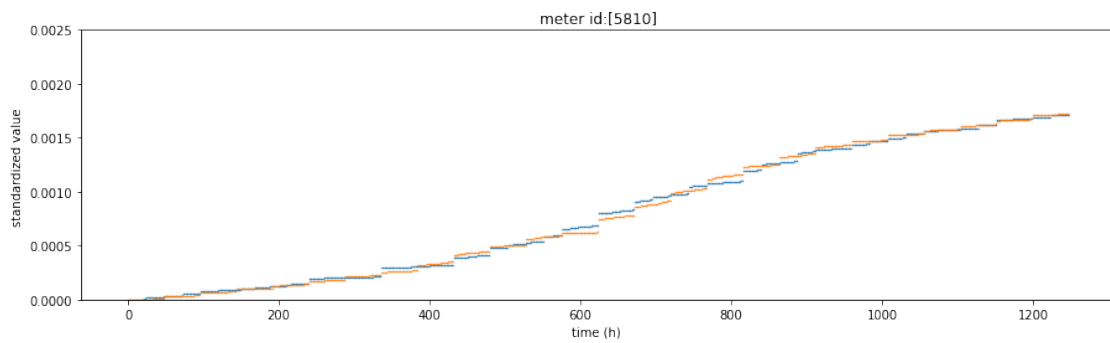
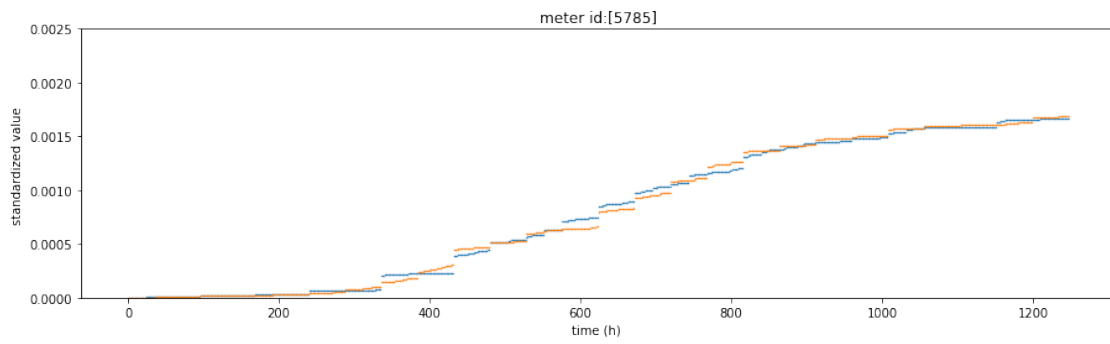
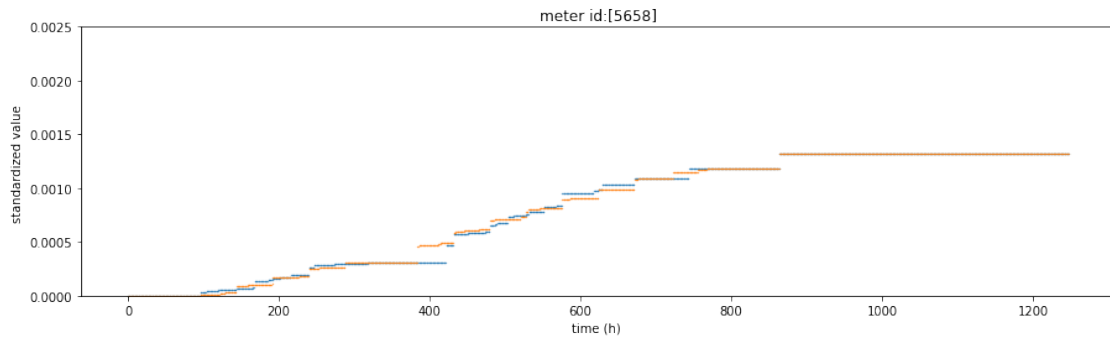
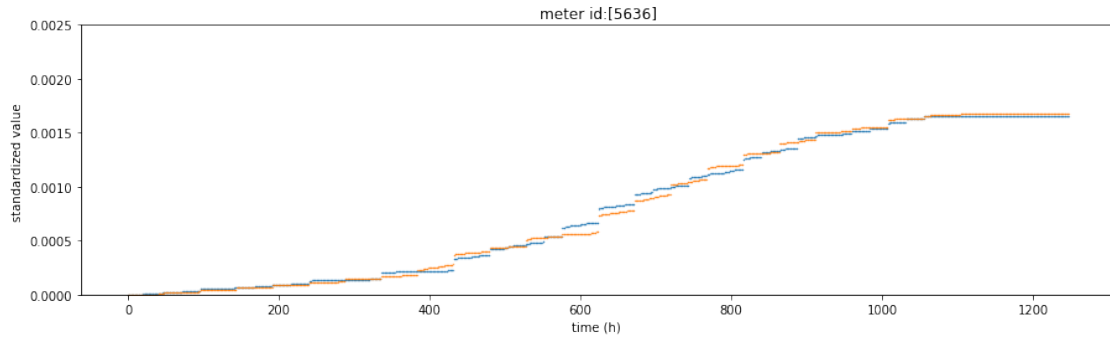


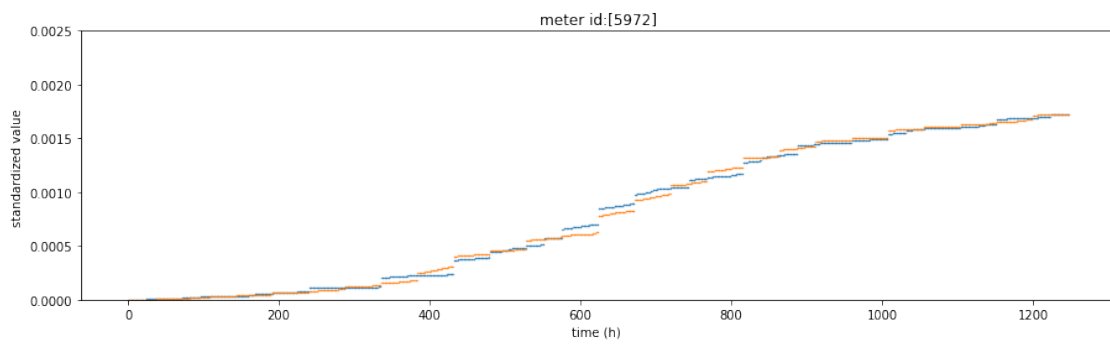
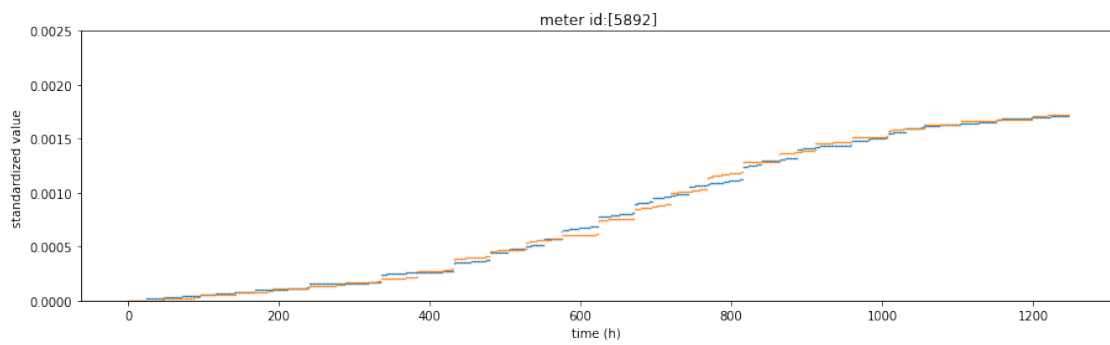
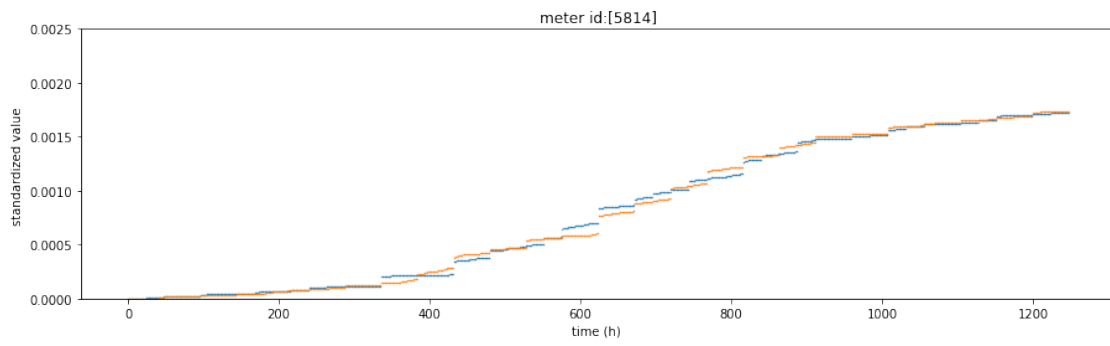


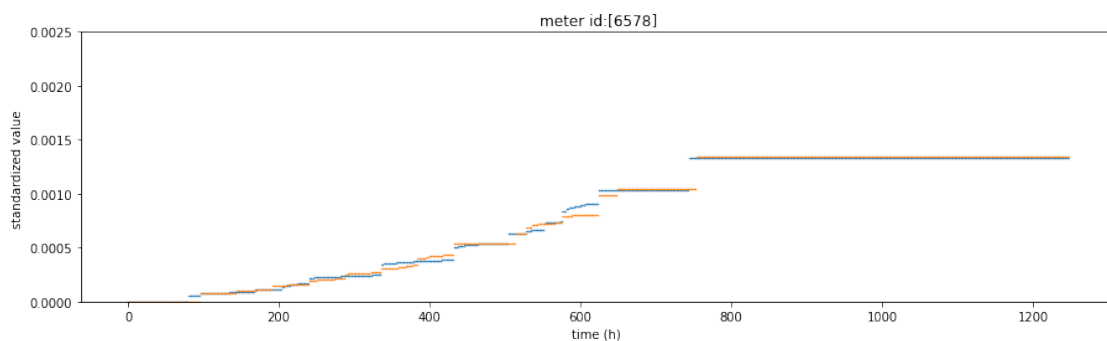
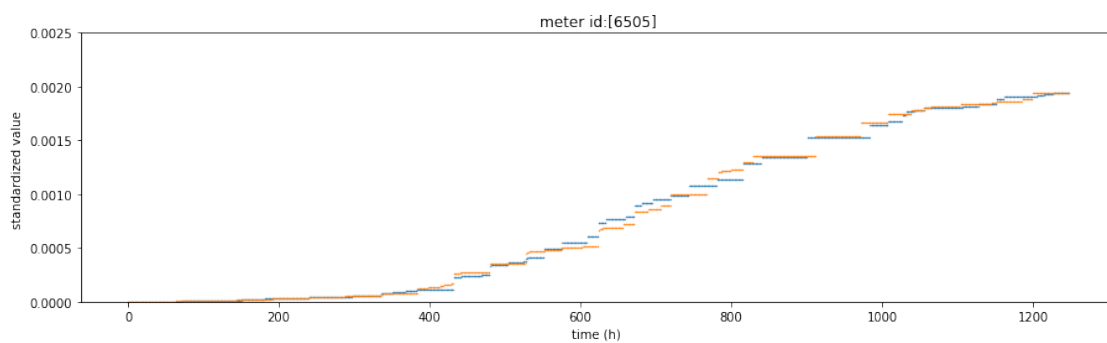
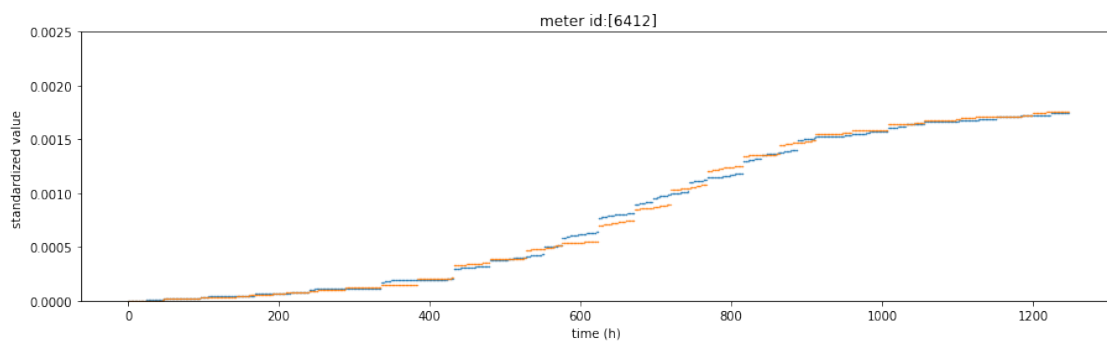
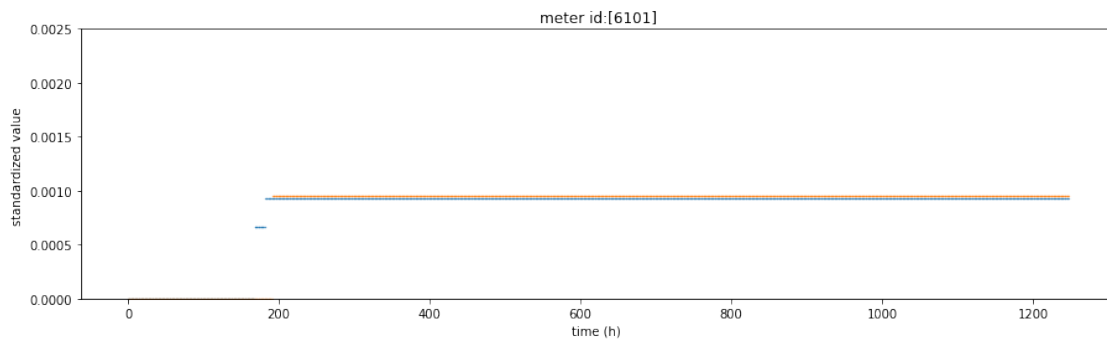


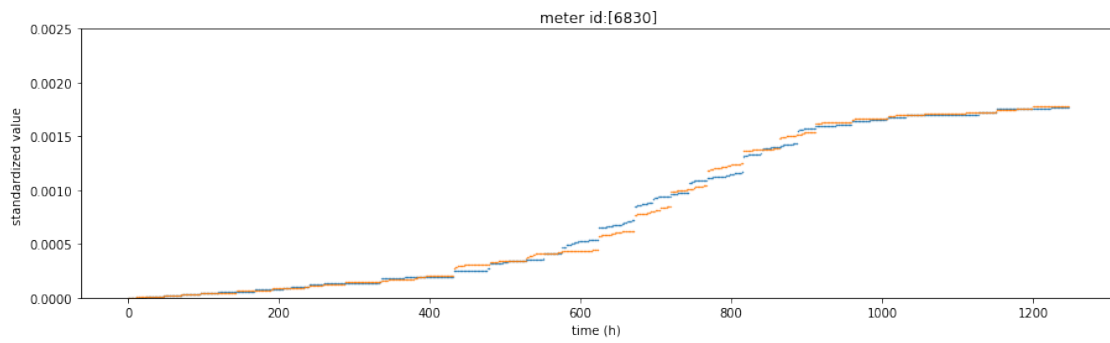
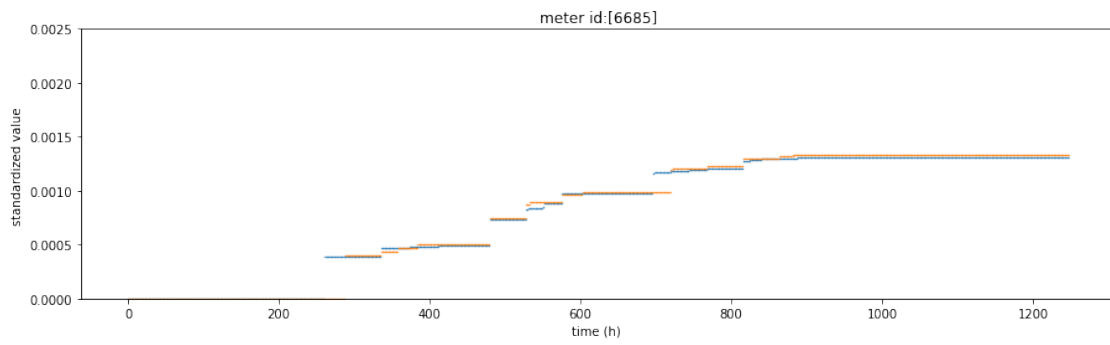
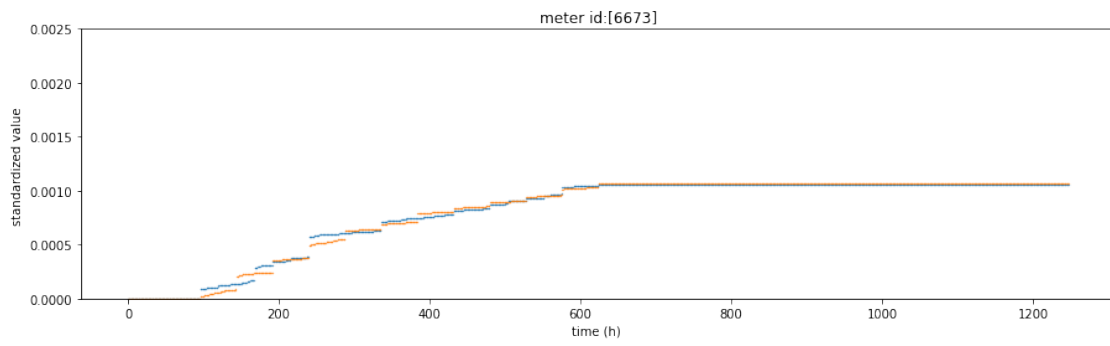


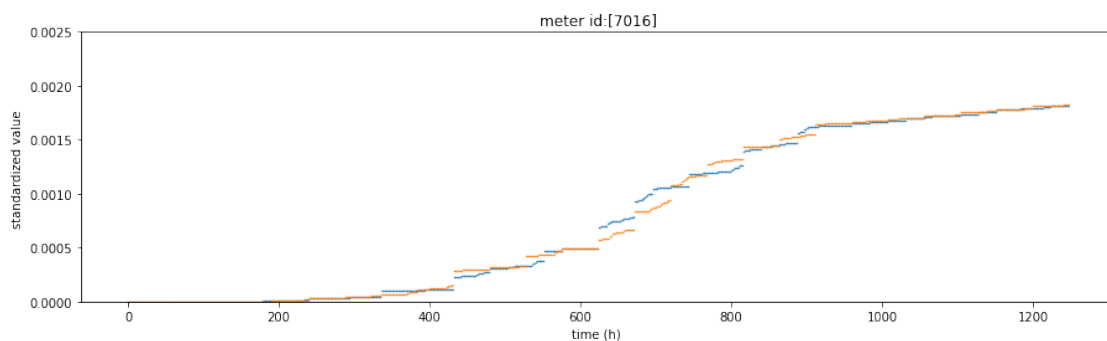
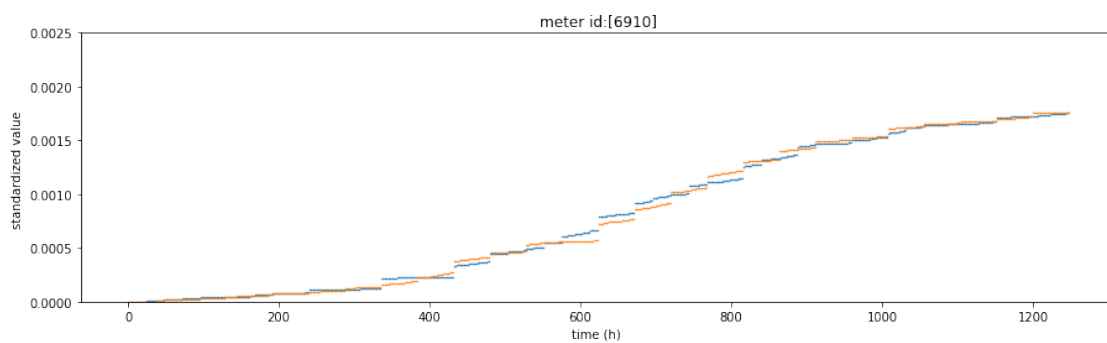
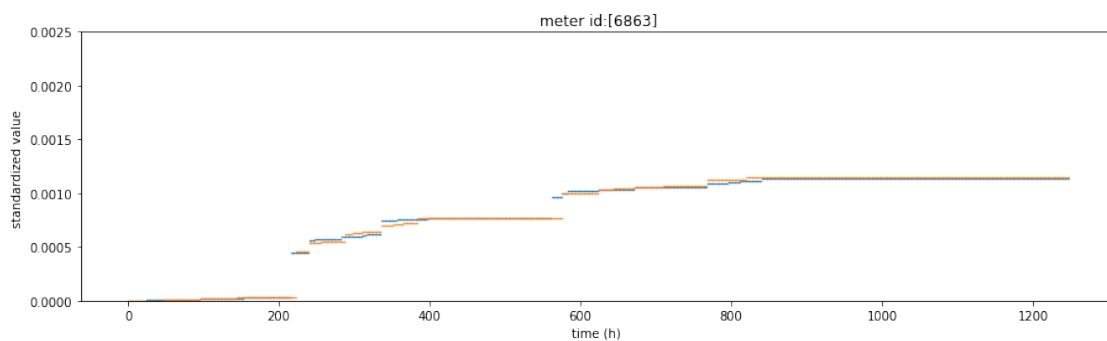
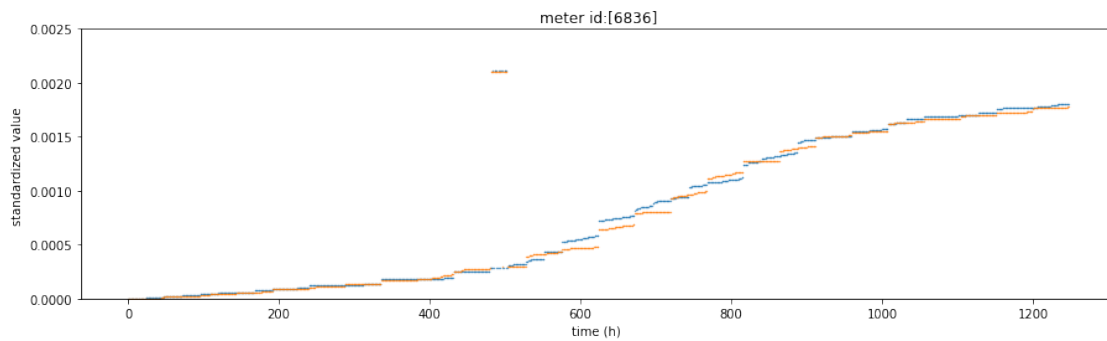


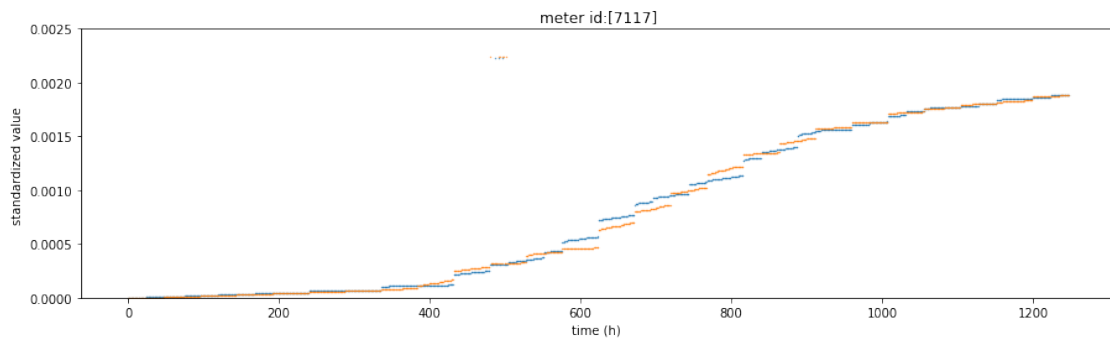
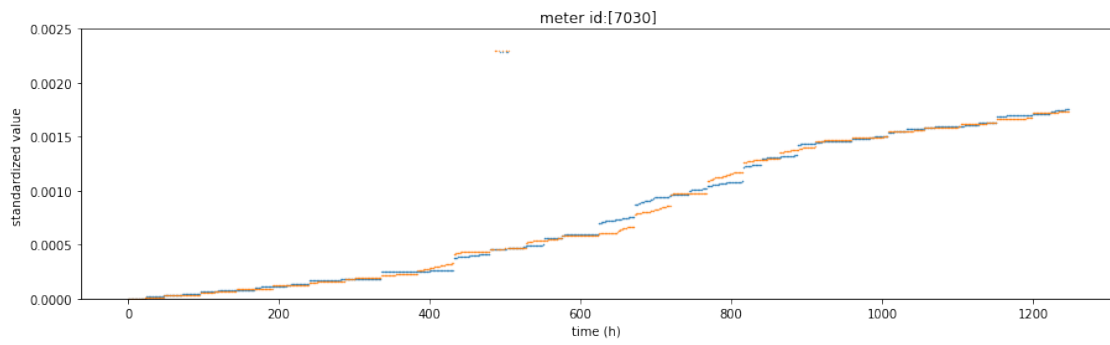
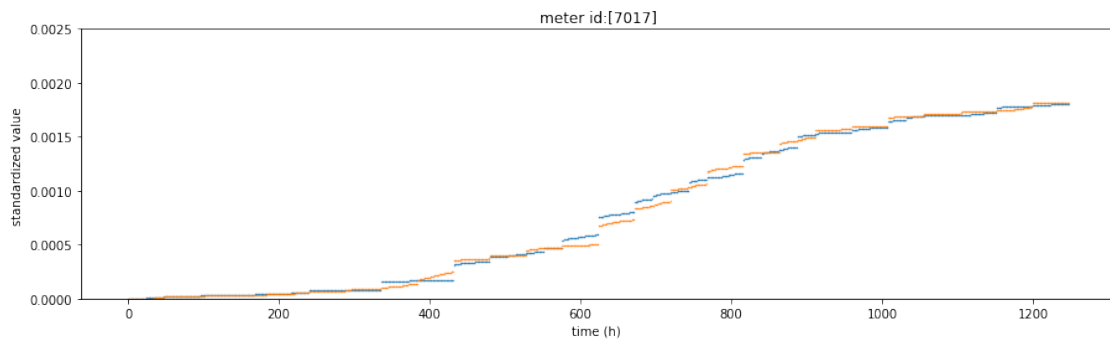


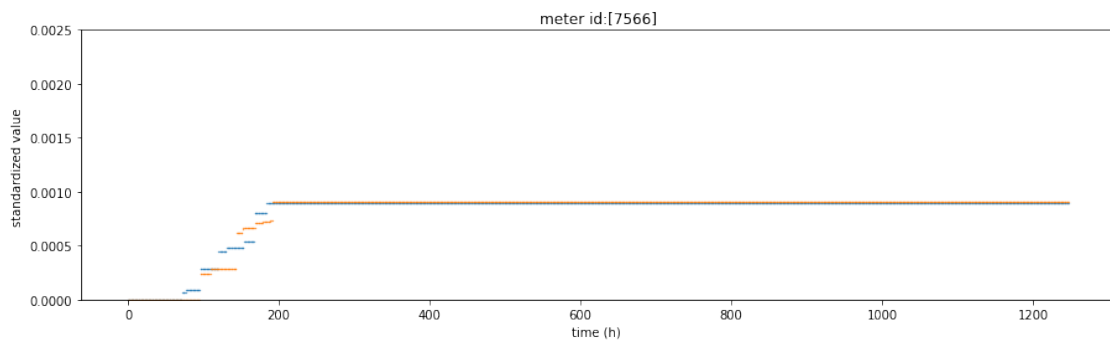
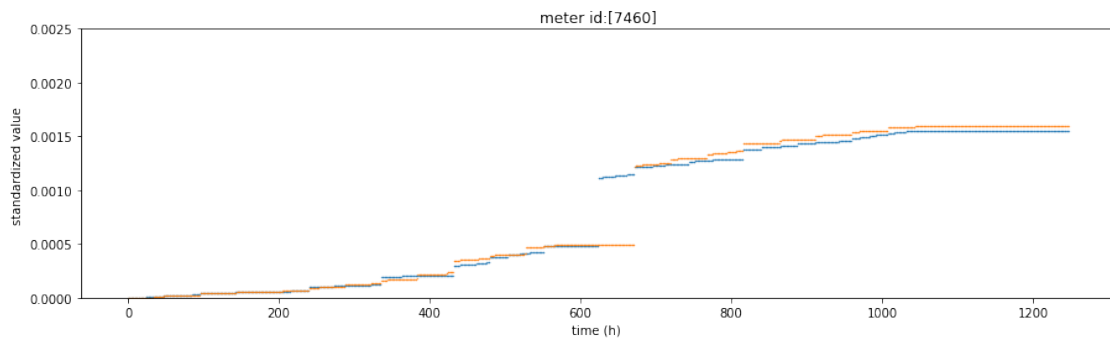
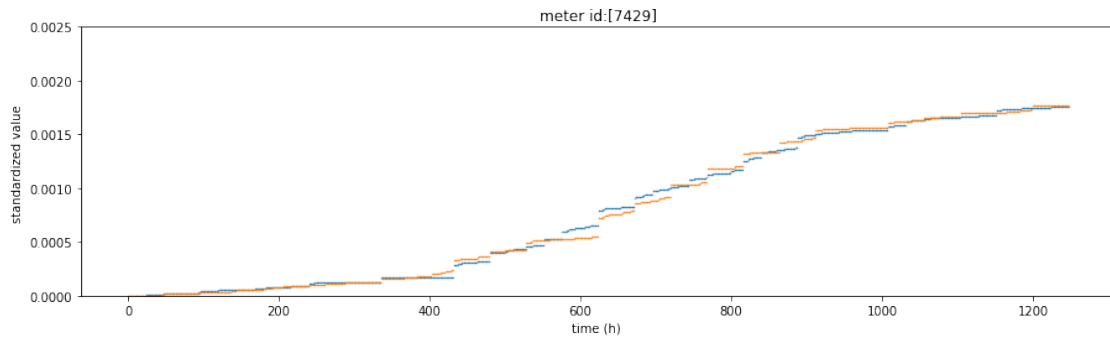
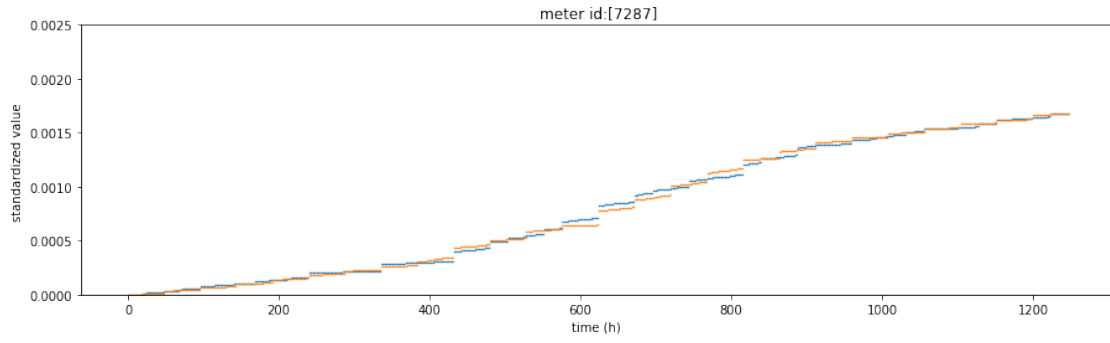


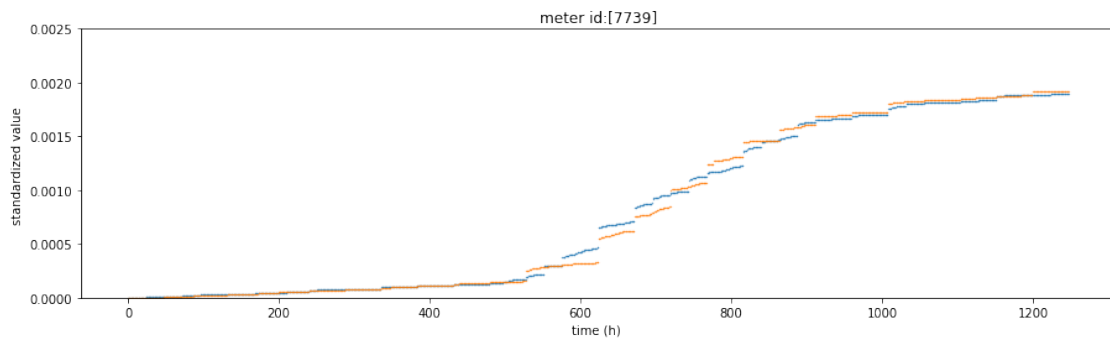
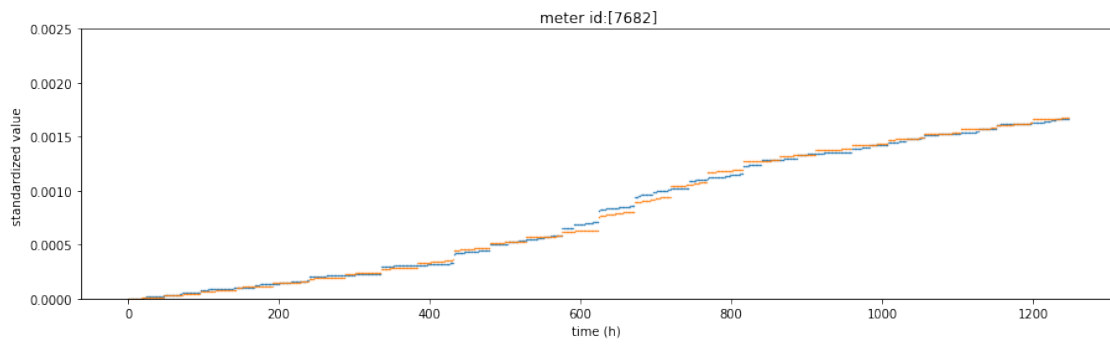
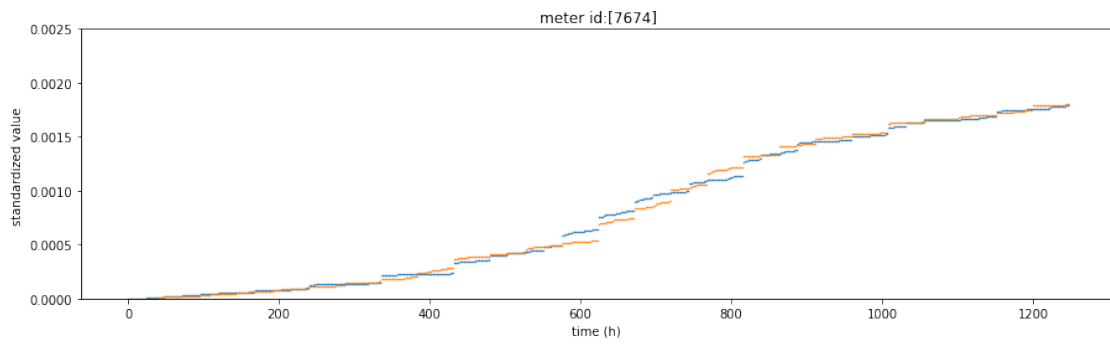


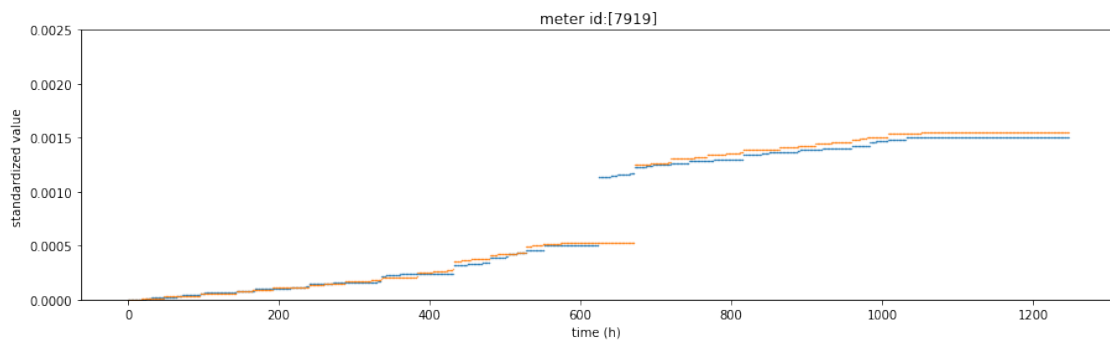
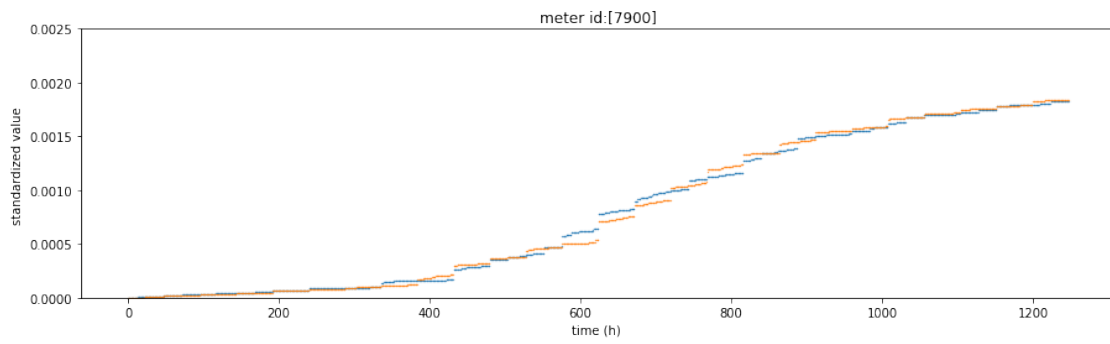
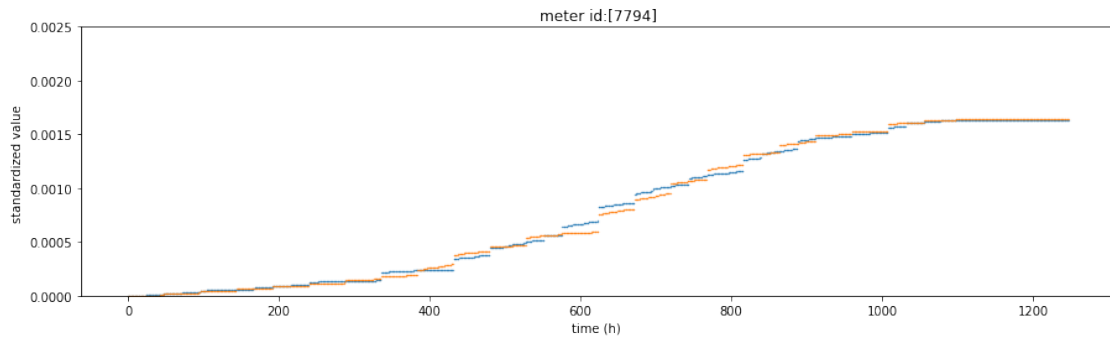
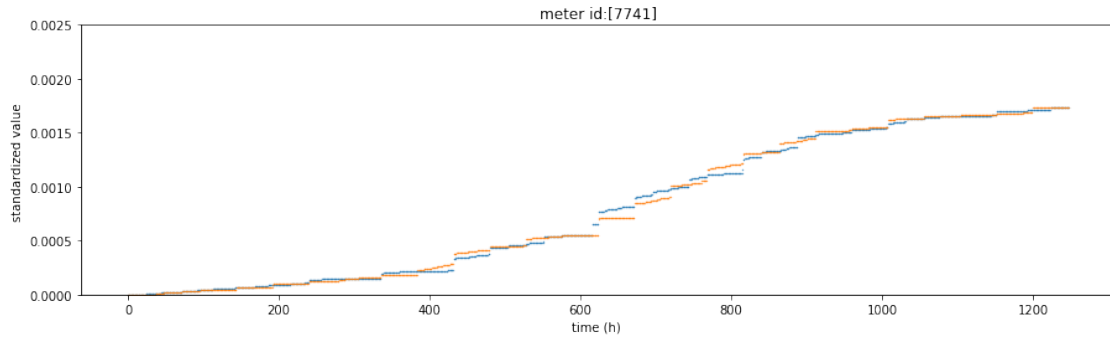


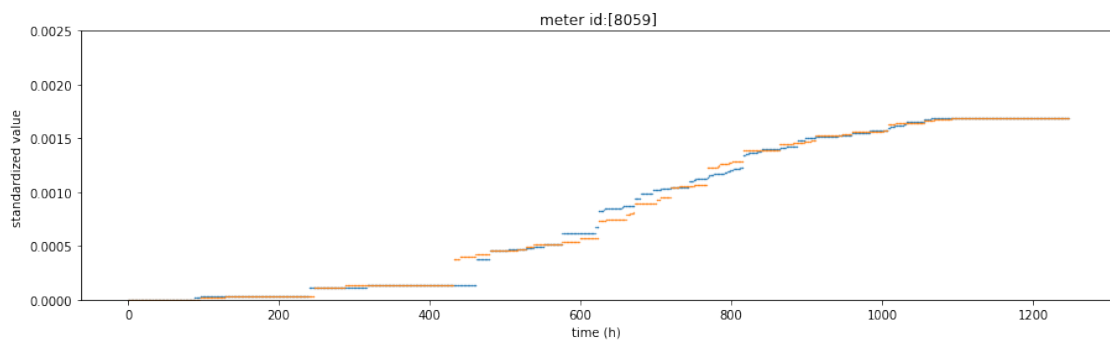
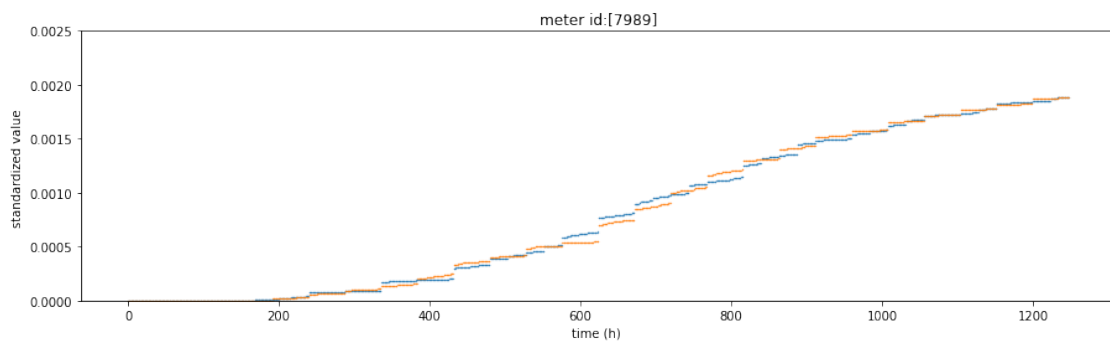
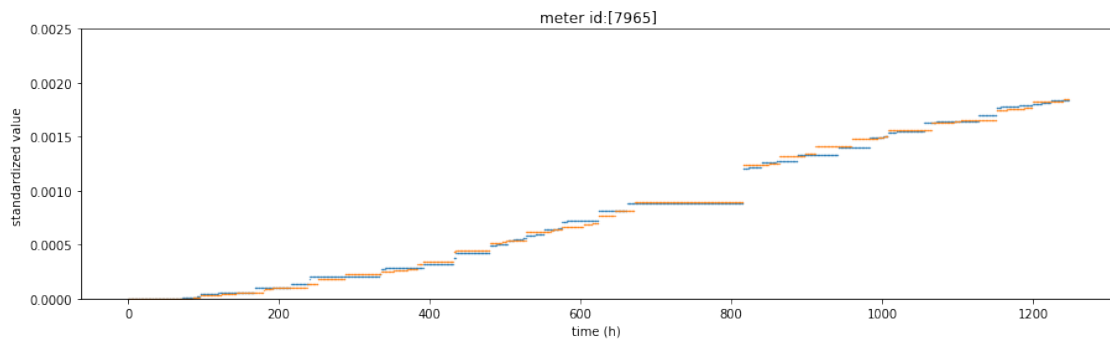


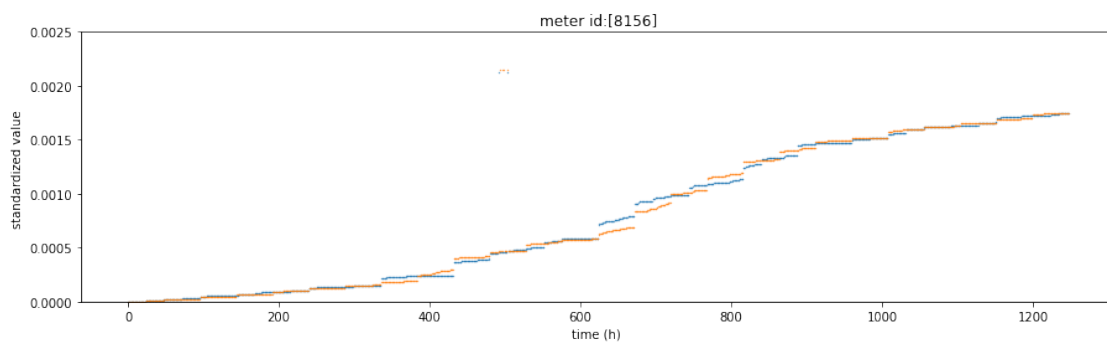
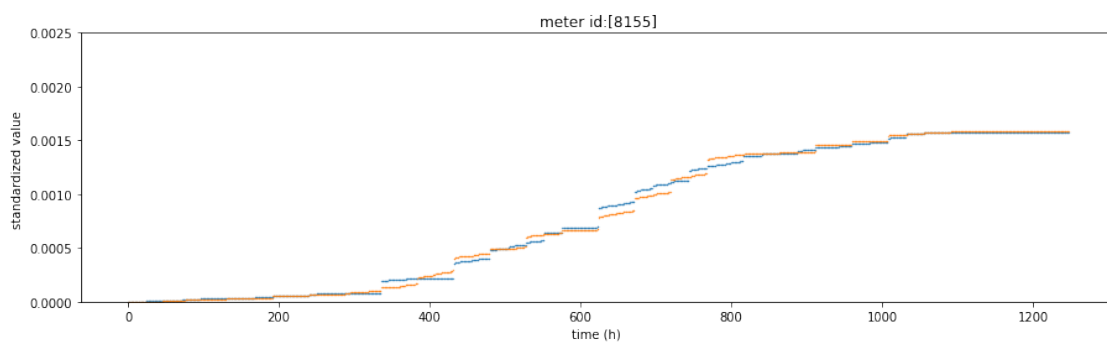
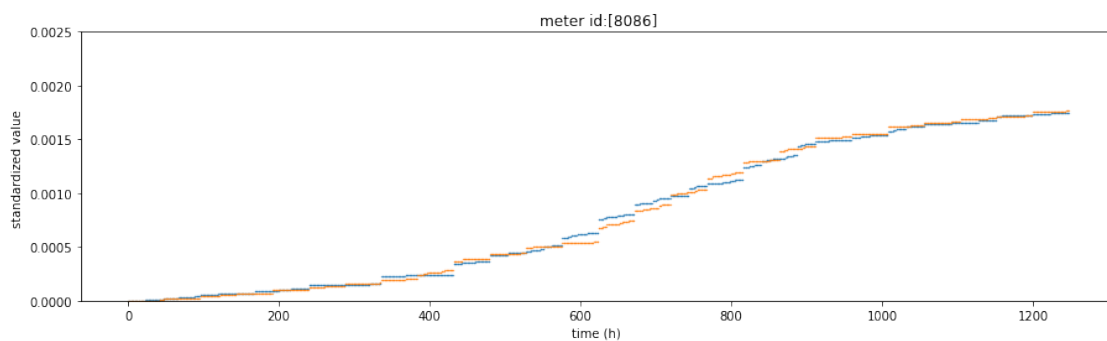
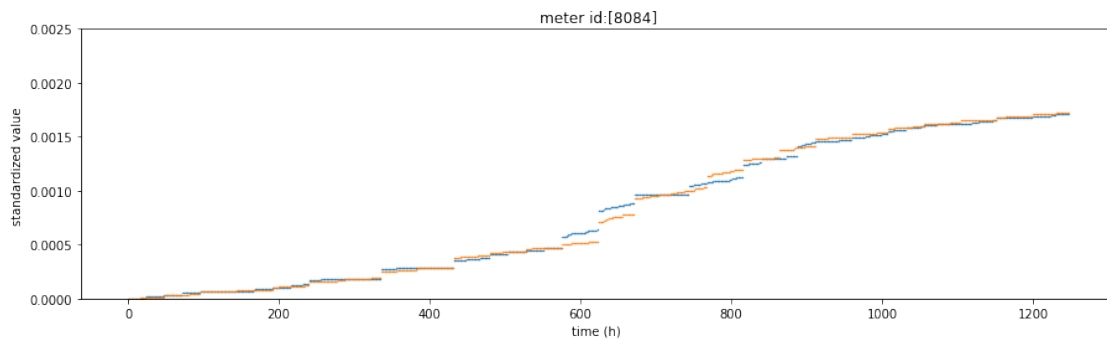


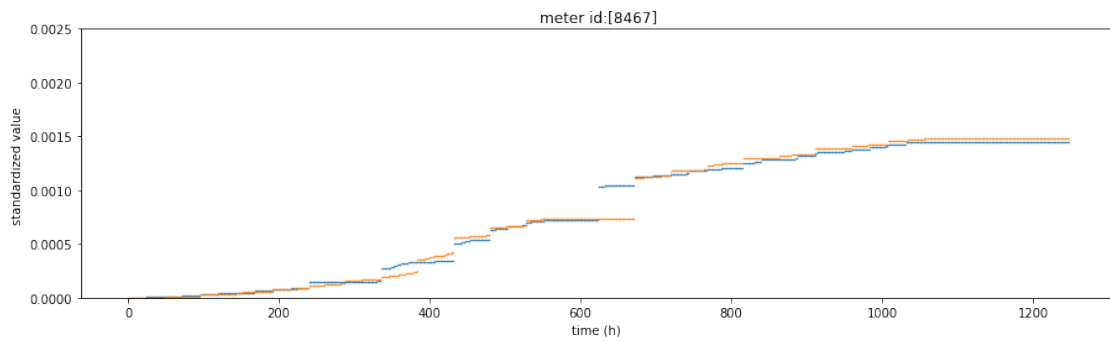
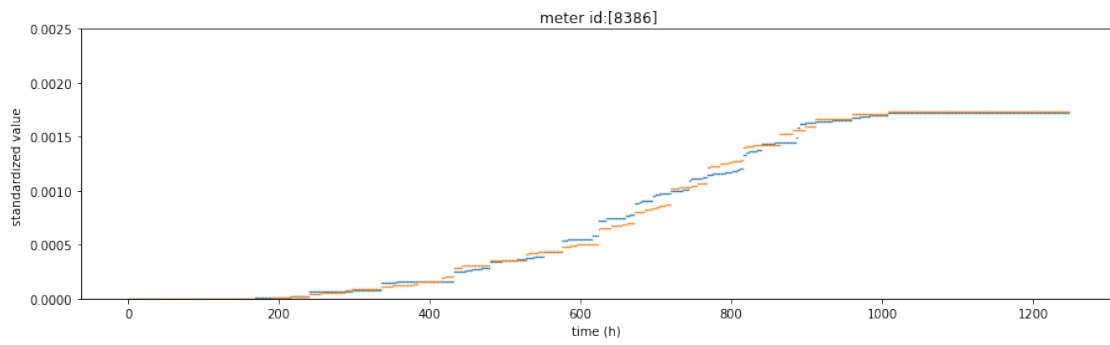
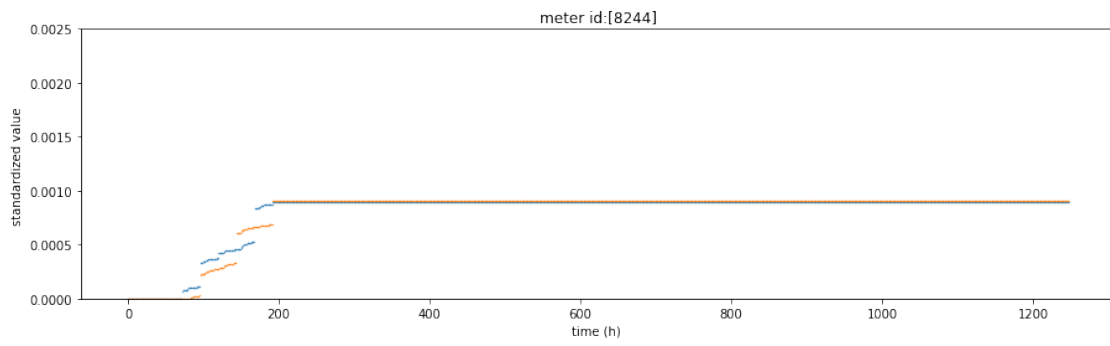


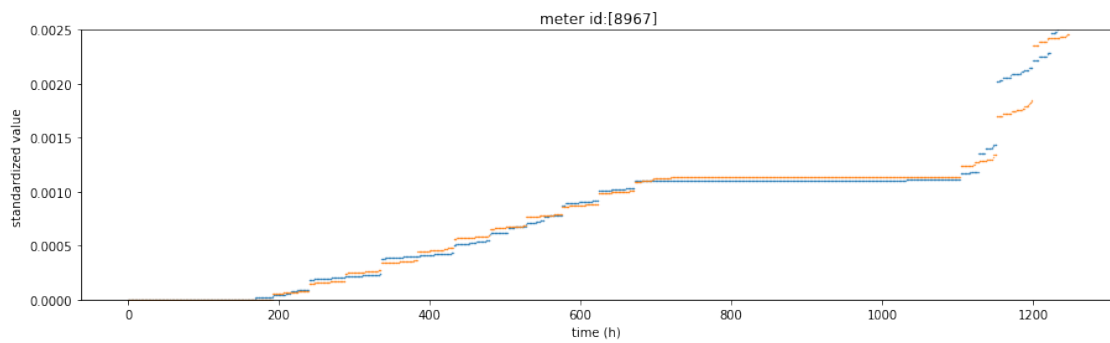
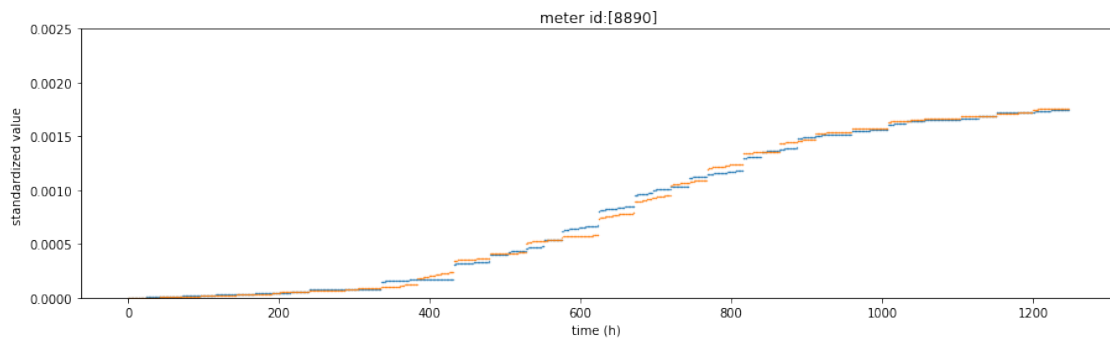
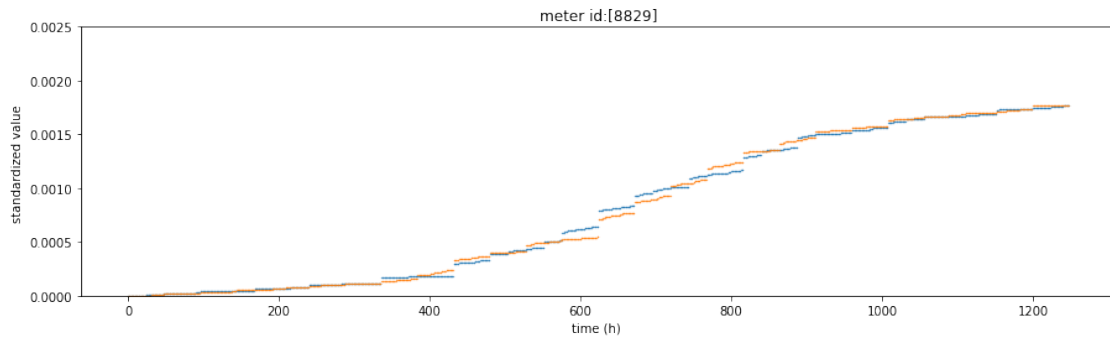
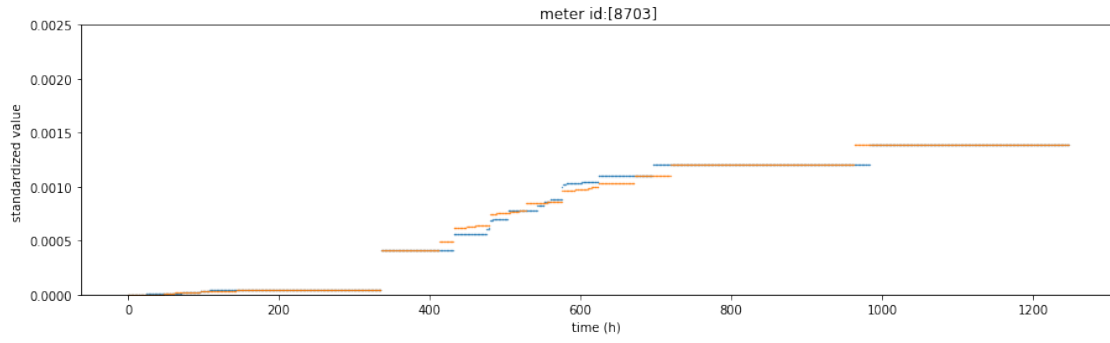


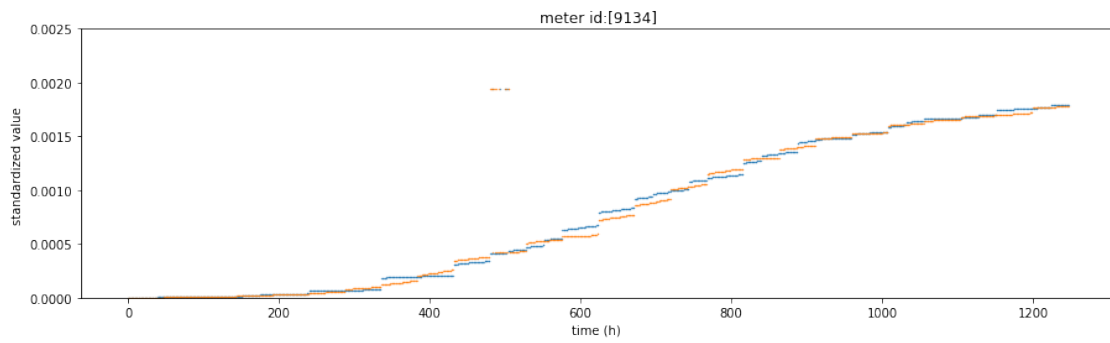
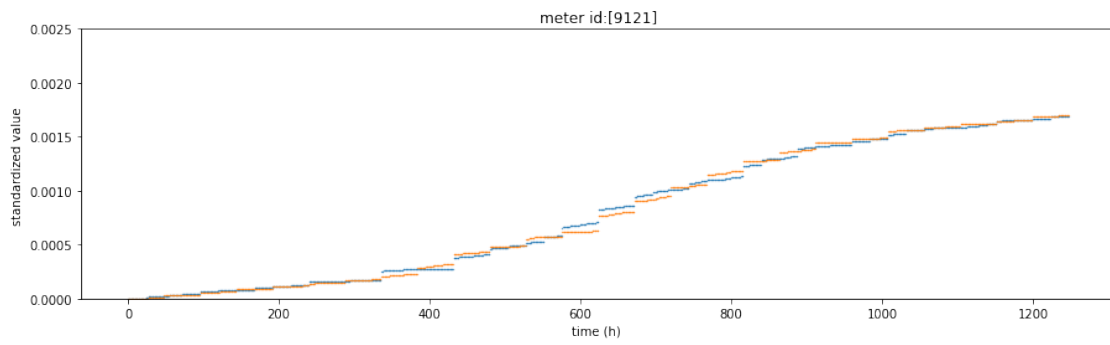
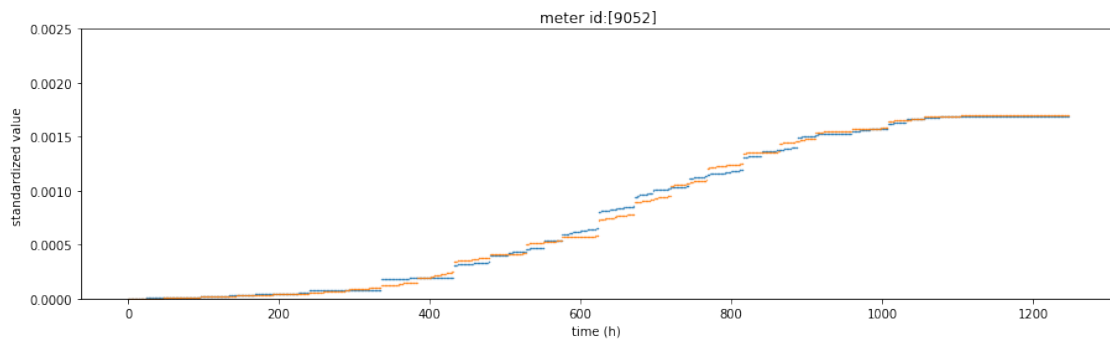


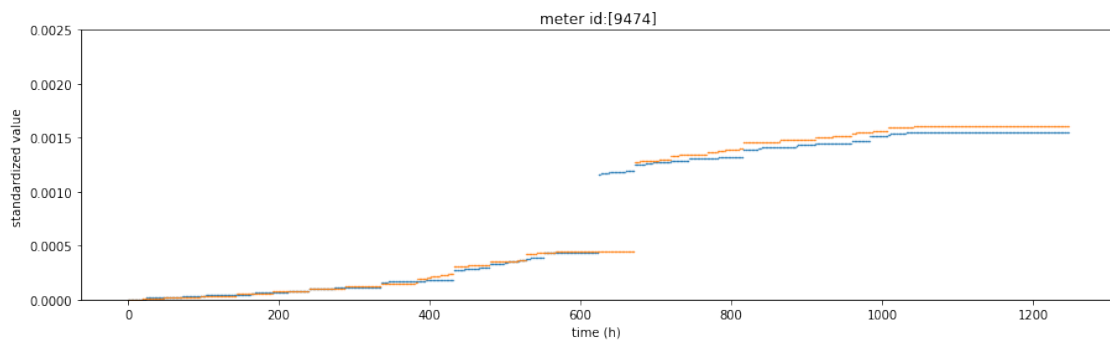
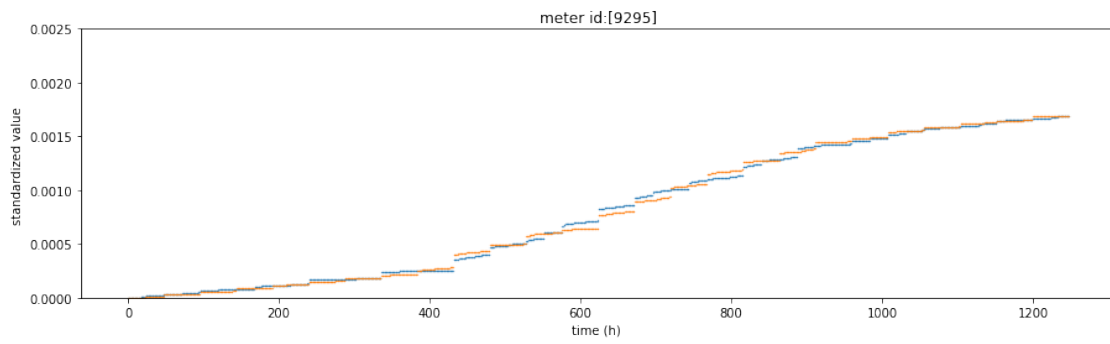
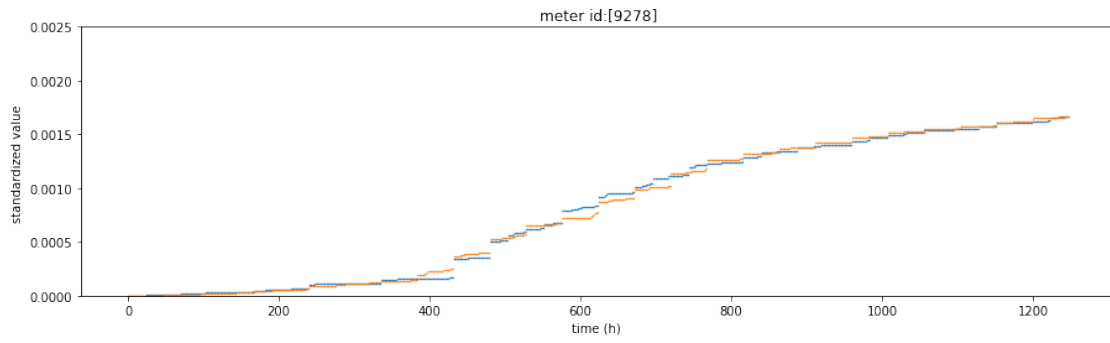
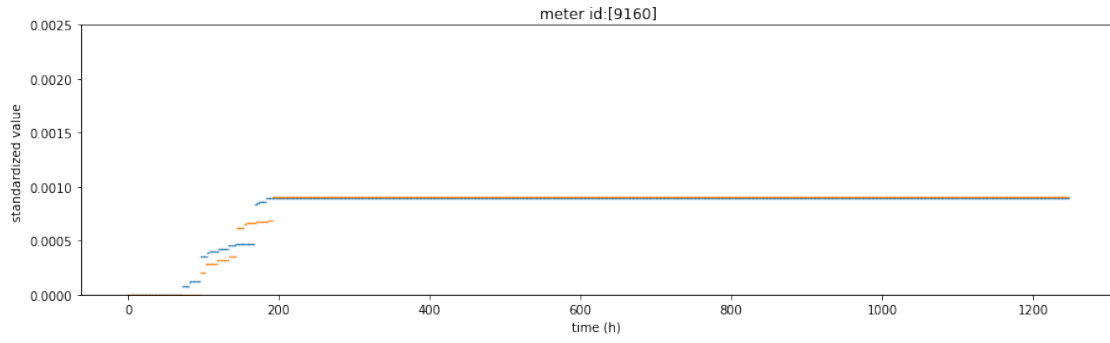


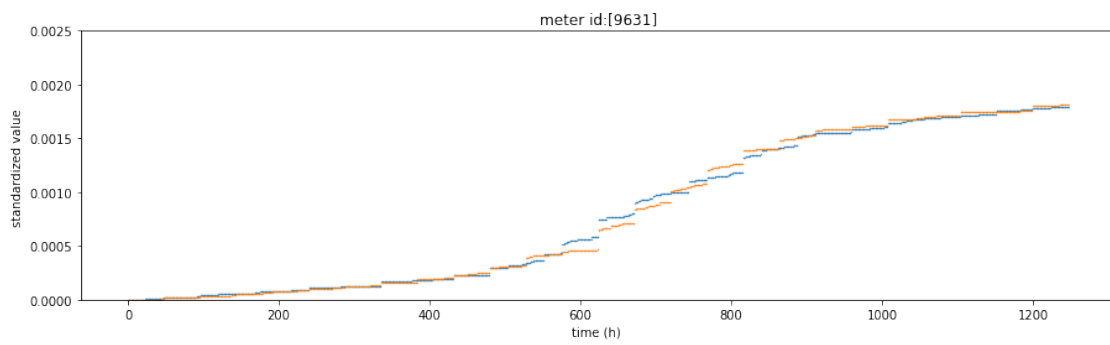
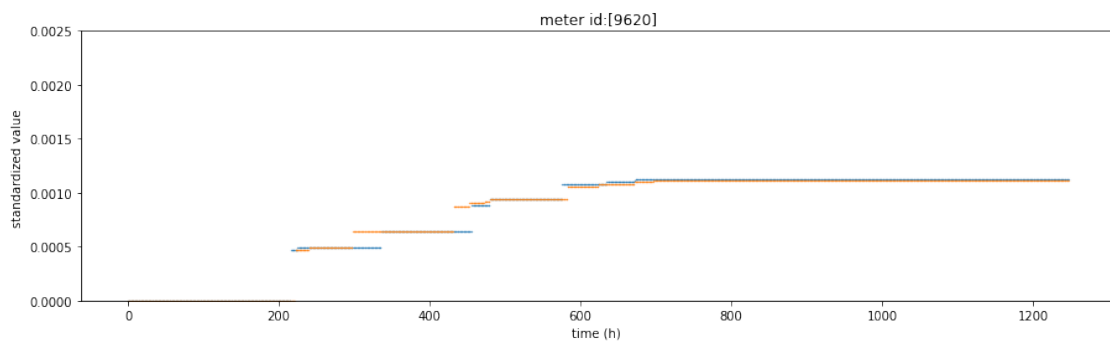
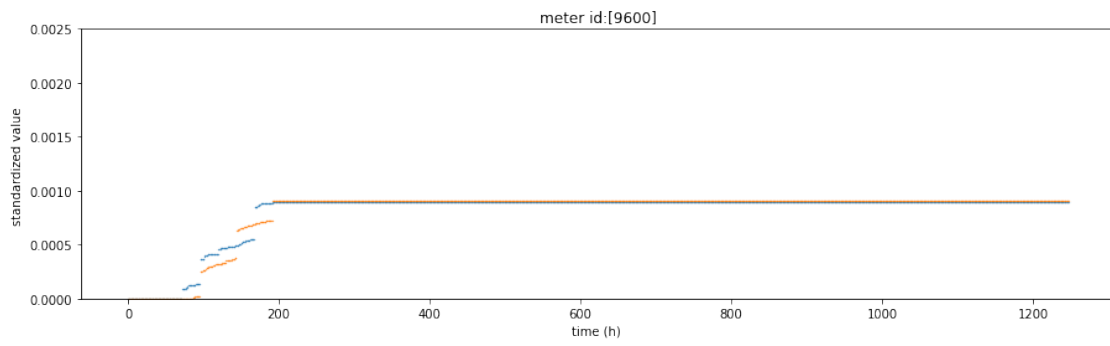


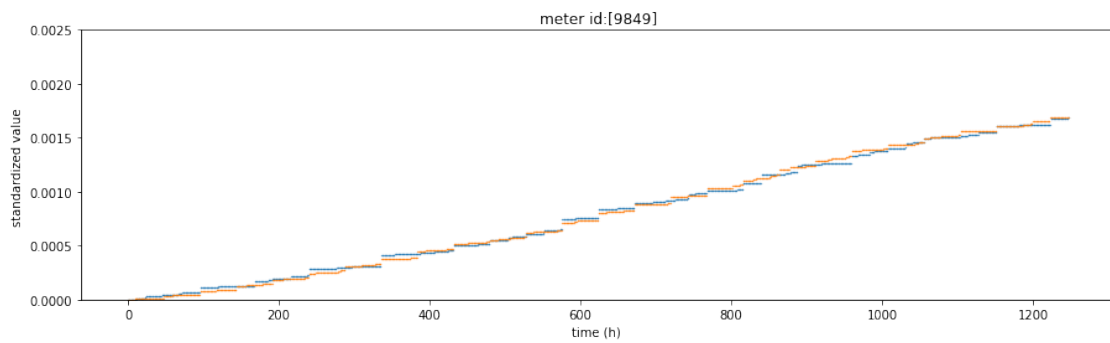
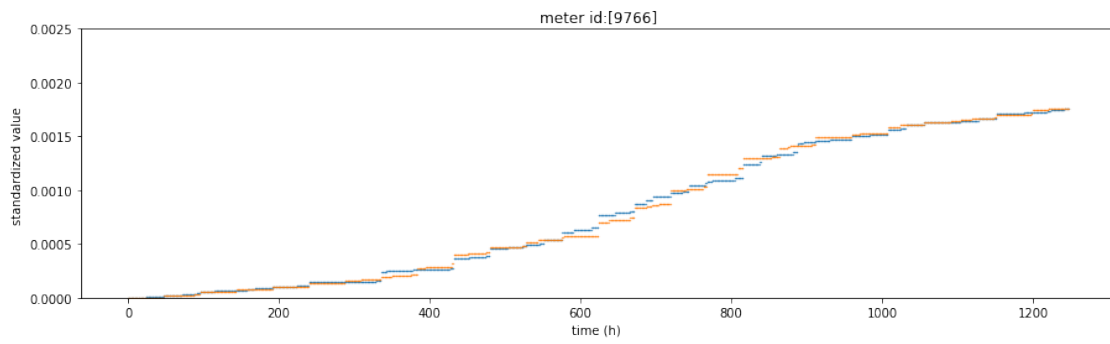
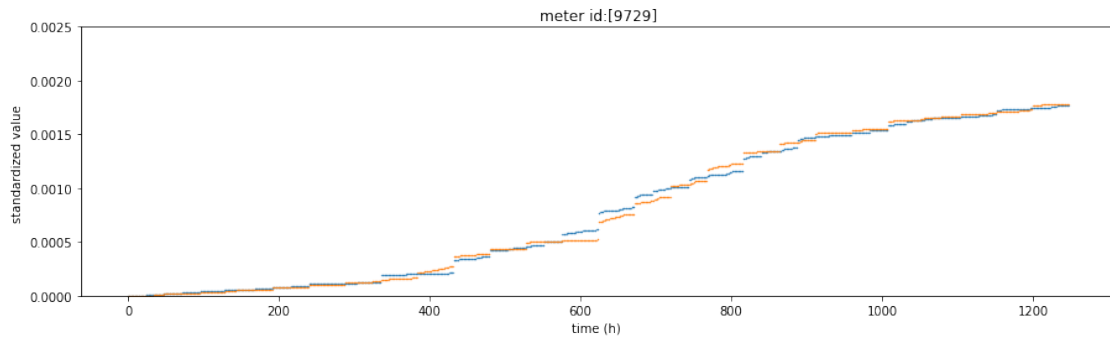
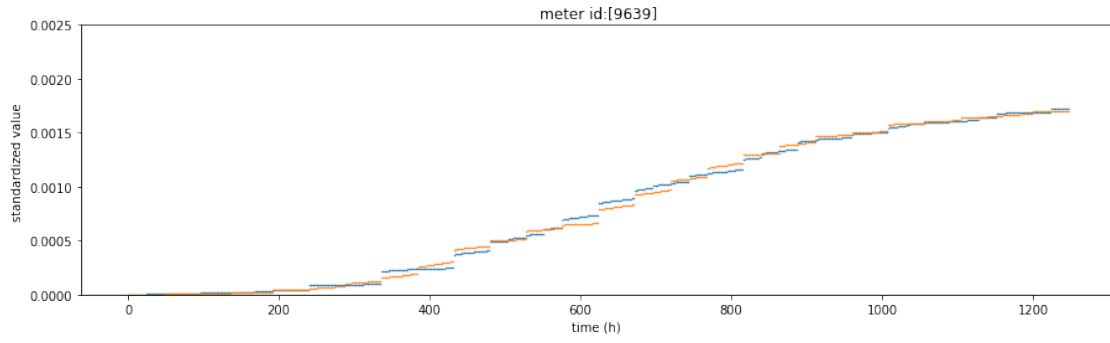


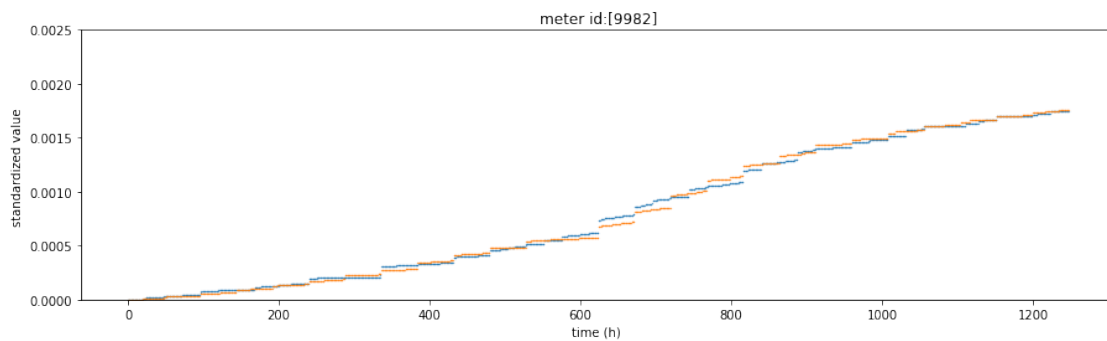
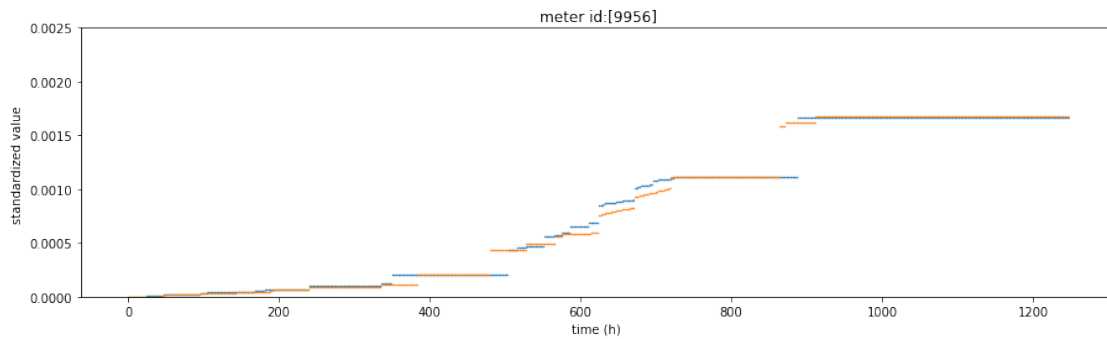












```
In [15]: df_feature['eulidean_dist']= w
df_feature['nor_eulidean_dist']= x
df_feature['js_dist']= z
df_feature.head()
```

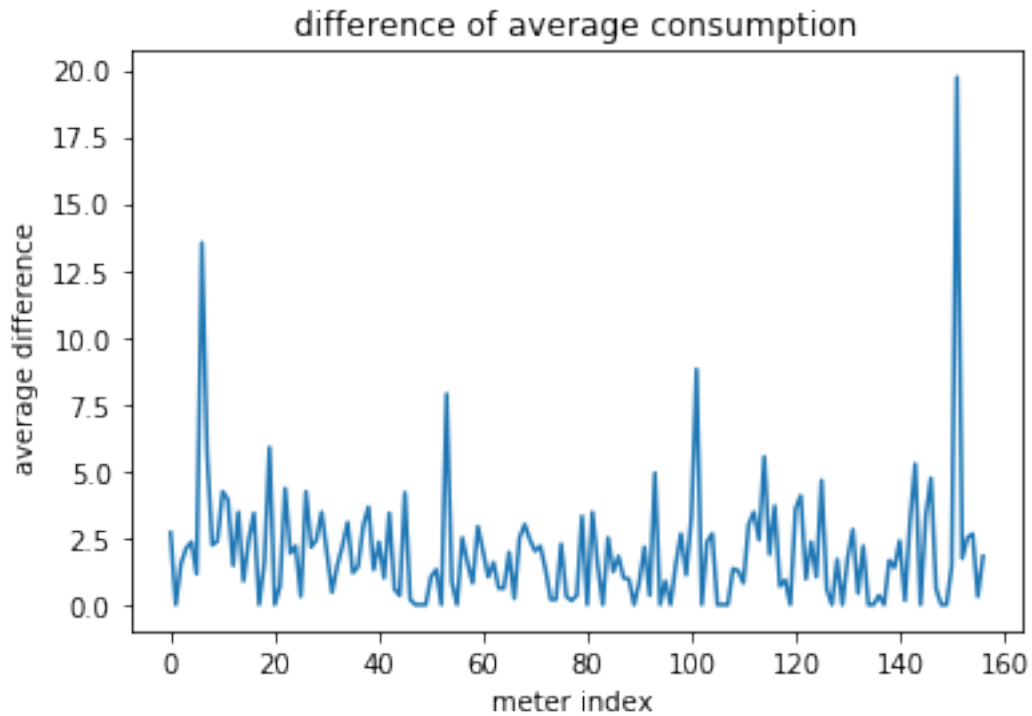
```
Out[15]:
```

	meterid	cost_diff	eulidean_dist	nor_eulidean_dist	js_dist
0	35	2.692308	6640.975531	0.000960	0.000280
1	44	0.000000	6577.397966	0.001146	0.000386
2	77	1.538462	2832.502074	0.000791	0.000249
3	94	2.115385	14553.225897	0.001101	0.000305
4	114	2.346154	11599.042374	0.001161	0.000322

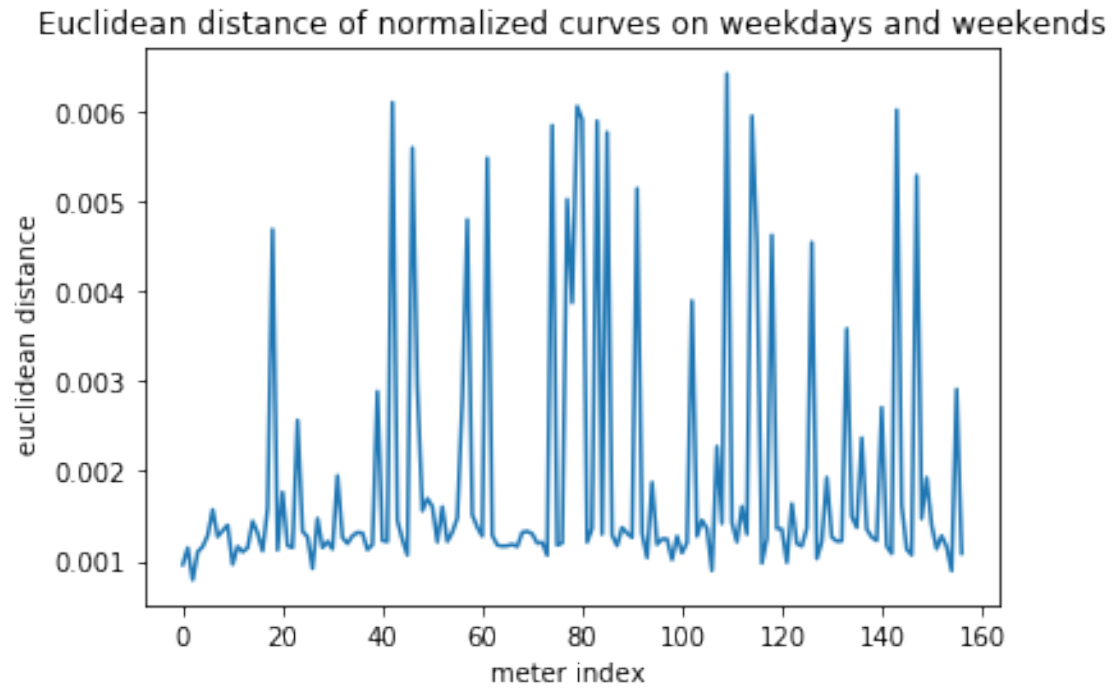
(2) Those three figures below show the distribution of three features separately, Euclidean Distance, Jensen-Shannon Distance and Consumption Difference, in order to make a comparison and guarantee the accuracy of the classification in the following.

```
In [16]: y1 = df_feature['cost_diff']
plt.plot(y1)
plt.xlabel('meter index ')
```

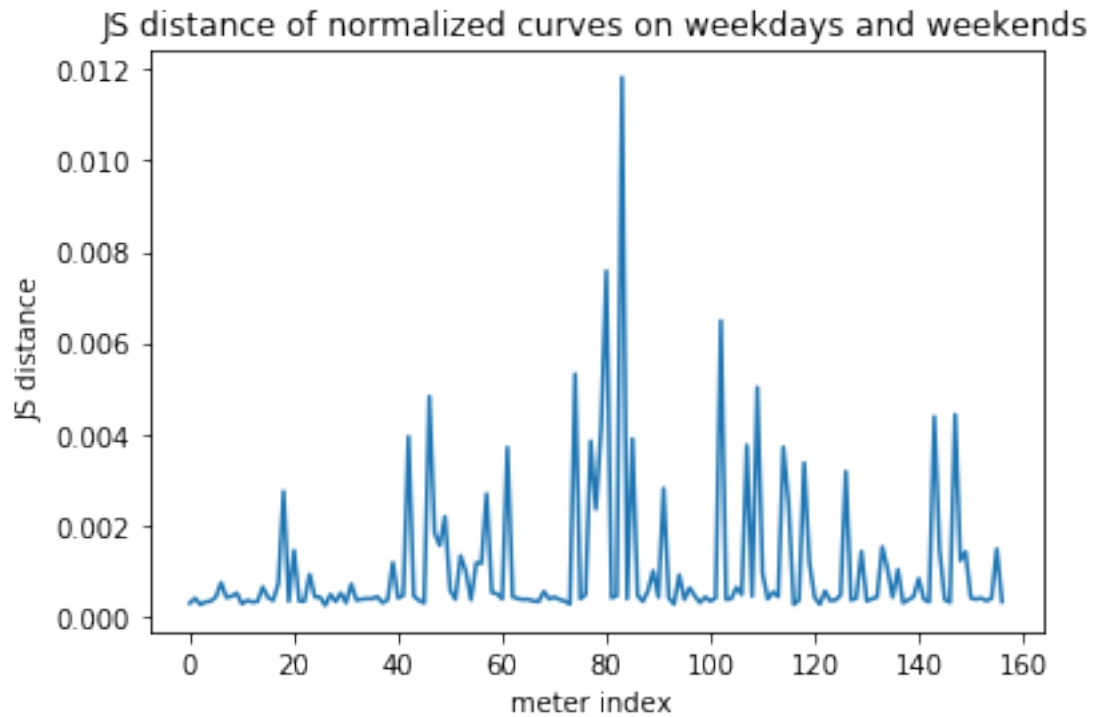
```
plt.ylabel('average difference ')
plt.title('difference of average consumption')
plt.show()
```



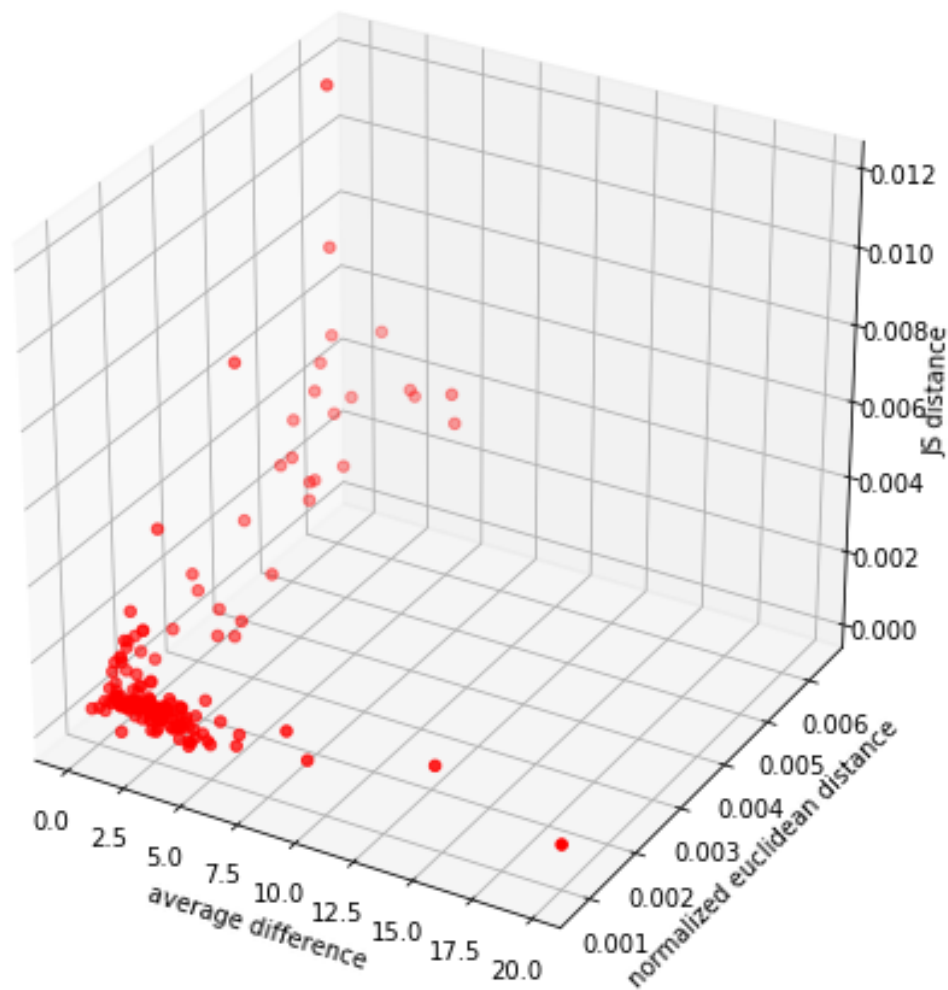
```
In [17]: y2 = df_feature['nor_eulidean_dist']
plt.plot(y2)
plt.xlabel('meter index ')
plt.ylabel('euclidean distance ')
plt.title('Euclidean distance of normalized curves on weekdays and weekends')
plt.show()
```



```
In [18]: y3 = df_feature['js_dist']  
         plt.plot(y3)  
         plt.xlabel('meter index ')  
         plt.ylabel('JS distance ')  
         plt.title('JS distance of normalized curves on weekdays and weekends')  
         plt.show()
```



```
In [19]: ax = plt.figure(figsize=(8,8)).add_subplot(111,projection='3d')
ax.scatter(diff, x, z,c='r',marker='o')
ax.set_zlabel('JS distance')
ax.set_ylabel('normalized euclidean distance')
ax.set_xlabel('average difference')
plt.show()
```

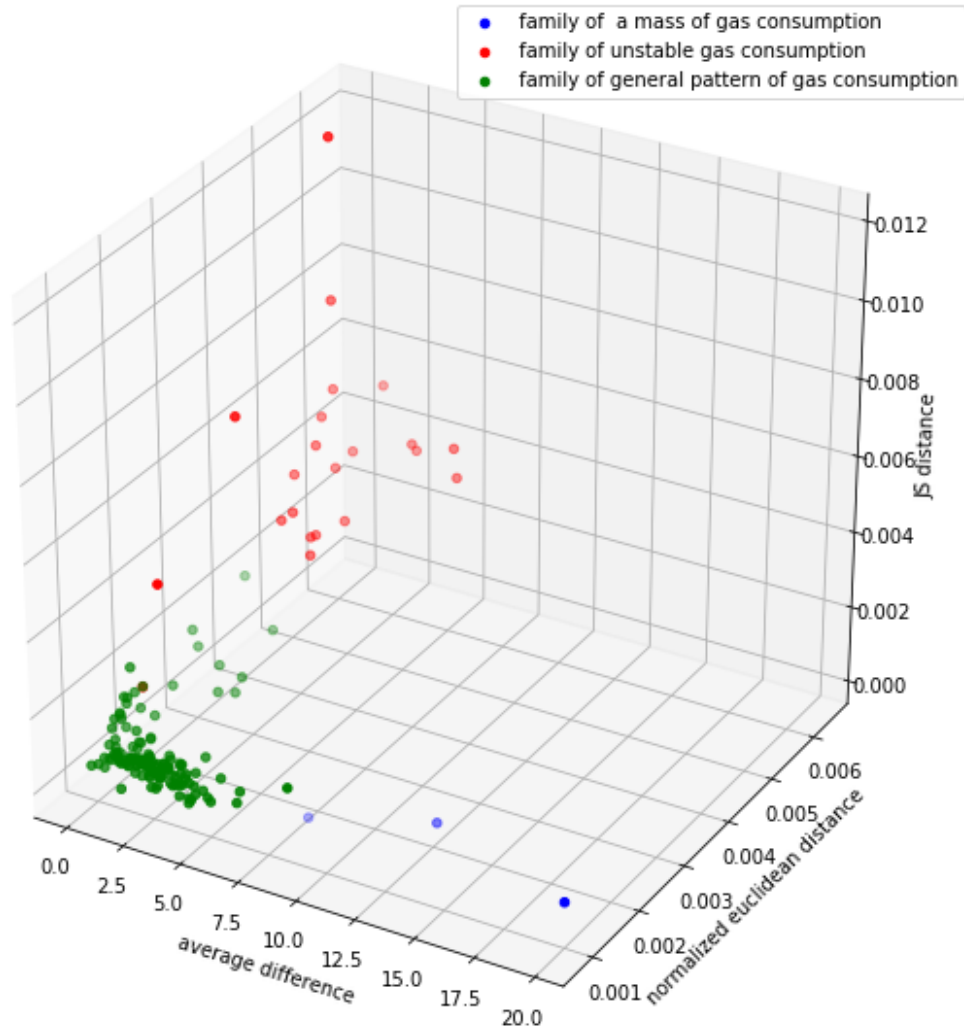



** From the above figure, we can find that the distribution of data has some close relationship with the three axis, which represent the three features. Thus, we decide to separate the non-labeled data into three classes by clusterig method. And the most popular clustering method is K-means.
**

0.0.6 5. Apply K-means algorithm to divide those meters into three groups according to features

We use K-means algorithm to divide those meters into three groups according to three features. Those groups show different types of families, working group, older people and big families.

```
In [20]: from sklearn.cluster import KMeans
          # Normalization
          df_class=df_feature
          df_class['cost_diff']=df_feature['cost_diff']/max(df_feature['cost_diff'])
```

** Conclusion: from above data analysis, we can find that the gas consumption can reflect some human habits and life styles in some degree. In this project, we find the class red represents freelancers who have no fixed job. And the weekday and weekend has no effect on this kind of people. The green ones represent the family with different aging generations. In these families there are working people, children, teenagers, and elder people. Thus the life style are very general, without obvious change on different daytypes. And the blue ones are family with massive gas consumption, which is very special that the consumption difference is big enough but the distributions between weekday and weekend are very similar. **

0.0.7 6. Application scenario

What's more, we would like to propose a novel idea, a system, with the help of GPS. We have got the information of different age groups (different types of families) according to our established model and then find the location of those homes using GPS. Therefore, we can get useful location information which can be used in different areas. For example, the distribution

of different age groups can be used as a basis of the site selection of those medical institutions or different types of restaurant.