In [255…
```
import  pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns
import warnings
warnings.filterwarnings("ignore")
```

In [395…
```
df=pd.read_csv("home.csv")
df
```

Out[395…

| | Unix Timestamp | Transaction_ID | Television | Dryer | Oven | Refrigerator | Microwave | I Volt |
|---|---|---|---|---|---|---|---|---|
| **0** | 1577836800 | 1 | 0 | 0 | 0 | 1 | 0 | |
| **1** | 1577839322 | 2 | 0 | 1 | 0 | 0 | 1 | |
| **2** | 1577841845 | 3 | 0 | 1 | 0 | 0 | 0 | |
| **3** | 1577844368 | 4 | 1 | 0 | 1 | 1 | 0 | |
| **4** | 1577846891 | 5 | 1 | 0 | 0 | 1 | 0 | |
| **...** | ... | ... | ... | ... | ... | ... | ... | ... |
| **48967** | 1701377135 | 48968 | 1 | 0 | 1 | 0 | 0 | |
| **48968** | 1701379658 | 48969 | 0 | 0 | 1 | 0 | 1 | |
| **48969** | 1701382181 | 48970 | 1 | 0 | 0 | 1 | 1 | |
| **48970** | 1701384704 | 48971 | 1 | 1 | 1 | 1 | 1 | |
| **48971** | 1701387227 | 48972 | 0 | 0 | 0 | 0 | 1 | |

48972 rows × 13 columns

# understand the business problem

In [ ]:
```
# how to save the electrictiy
# how to safe the electronics devices
```

# data understanding and exploration

In [9]:
```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 48972 entries, 0 to 48971
Data columns (total 13 columns):
 #   Column                    Non-Null Count  Dtype  
---  ------                    --------------  -----  
 0   Unix Timestamp            48972 non-null  int64  
 1   Transaction_ID            48972 non-null  int64  
 2   Television                48972 non-null  int64  
 3   Dryer                     48972 non-null  int64  
 4   Oven                      48972 non-null  int64  
 5   Refrigerator              48972 non-null  int64  
 6   Microwave                 48972 non-null  int64  
 7   Line Voltage              48972 non-null  int64  
 8   Voltage                   48972 non-null  int64  
 9   Apparent Power            48972 non-null  int64  
 10  Energy Consumption (kWh)  48972 non-null  float64
 11  Offloading Decision       48972 non-null  int64  
 12  Bandwidth                 48972 non-null  int64  
dtypes: float64(1), int64(12)
memory usage: 4.9 MB
```

In [11]:
```
df.dtypes
```

Out[11]:
```
Unix Timestamp              int64
Transaction_ID              int64
Television                  int64
Dryer                       int64
Oven                        int64
Refrigerator                int64
Microwave                   int64
Line Voltage                int64
Voltage                     int64
Apparent Power              int64
Energy Consumption (kWh)    float64
Offloading Decision         int64
Bandwidth                   int64
dtype: object
```

In [13]:
```
df.keys().to_list()
```

Out[13]:
```
['Unix Timestamp',
 'Transaction_ID',
 'Television',
 'Dryer',
 'Oven',
 'Refrigerator',
 'Microwave',
 'Line Voltage',
 'Voltage',
 'Apparent Power',
 'Energy Consumption (kWh)',
 'Offloading Decision',
 'Bandwidth']
```

In [15]:
```
df.shape
```

Out[15]: (48972, 13)

In [17]:
```
df.ndim
```

Out[17]: 2

In [19]:
```
df.isnull().sum()
```

Out[19]:
```
Unix Timestamp              0
Transaction_ID              0
Television                  0
Dryer                       0
Oven                        0
Refrigerator                0
Microwave                   0
Line Voltage                0
Voltage                     0
Apparent Power              0
Energy Consumption (kWh)    0
Offloading Decision         0
Bandwidth                   0
dtype: int64
```

In [21]:
```
df.head(2)
```

Out[21]:

| | Unix Timestamp | Transaction_ID | Television | Dryer | Oven | Refrigerator | Microwave | Line Voltage |
|---|---|---|---|---|---|---|---|---|
| **0** | 1577836800 | 1 | 0 | 0 | 0 | 1 | 0 | 237 |
| **1** | 1577839322 | 2 | 0 | 1 | 0 | 0 | 1 | 232 |

In [23]:
```
df.tail()
```

Out[23]:

| | Unix Timestamp | Transaction_ID | Television | Dryer | Oven | Refrigerator | Microwave | I Volt |
|---|---|---|---|---|---|---|---|---|
| **48967** | 1701377135 | 48968 | 1 | 0 | 1 | 0 | 0 | |
| **48968** | 1701379658 | 48969 | 0 | 0 | 1 | 0 | 1 | |
| **48969** | 1701382181 | 48970 | 1 | 0 | 0 | 1 | 1 | |
| **48970** | 1701384704 | 48971 | 1 | 1 | 1 | 1 | 1 | |
| **48971** | 1701387227 | 48972 | 0 | 0 | 0 | 0 | 1 | |

# column=1 Unix Timestamp

In [25]:
```
# this is the continuous variable and correct data types and there is not any null
# but there is no use of this column in the analysis simply drop this column
df["Unix Timestamp"].dtypes
```

Out[25]:
```
dtype('int64')
```

In [27]:
```
df["Unix Timestamp"].isnull().sum()
```

Out[27]:
```
0
```

In [ ]:
```
#column=2 Transaction_ID
```

In [42]:
```
# this is the continuous variable and correct data types and there is not any null
# but there is no use of this column in the analysis simply drop this column
df["Transaction_ID"].dtypes
```

Out[42]:
```
dtype('int64')
```

In [29]:
```
df["Transaction_ID"].isnull().sum()
```

Out[29]:
```
0
```

# column=3 Television

In [31]:
```
# this is the count variable and correct data types and there is not any null value
df["Television"].dtypes
```

Out[31]:
```
dtype('int64')
```

In [33]:
```
df["Television"].unique()
```

Out[33]:
```
array([0, 1], dtype=int64)
```

In [35]:
```
df["Television"].value_counts()
```

Out[35]:
```
Television
1    24655
0    24317
Name: count, dtype: int64
```

In [37]:
```
df["Television"].isnull().sum()
```

Out[37]:
```
0
```

# column 4 Dryer

In [54]:
```
# this is the count variable and correct data types and there is not any null value
df["Dryer"].dtypes
```

Out[54]:
```
dtype('int64')
```

In [56]:
```
df["Dryer"].unique()
```

Out[56]:
```
array([0, 1], dtype=int64)
```

In [39]:
```
df["Dryer"].value_counts()
```

Out[39]:
```
Dryer
1    24490
0    24482
Name: count, dtype: int64
```

In [60]:
```
df["Dryer"].isnull().sum()
```

Out[60]:
```
0
```

# column=5 Oven

In [41]:
```
# this is the count variable and correct data types and there is not any null value
df["Oven"].dtypes
```

Out[41]:
```
dtype('int64')
```

In [43]:
```
df["Oven"].unique()
```

Out[43]:
```
array([0, 1], dtype=int64)
```

In [45]:
```
df["Oven"].value_counts()
```

Out[45]:
```
Oven
1    24583
0    24389
Name: count, dtype: int64
```

In [68]:
```
df["Oven"].isnull().sum()
```

Out[68]:
```
0
```

# column=7 Refrigerator

In [70]:
```
# this is the count variable and correct data types and there is not any null value
df["Refrigerator"].dtypes
```

Out[70]:
```
dtype('int64')
```

In [47]:
```
df["Refrigerator"].unique()
```

Out[47]:
```
array([1, 0], dtype=int64)
```

In [72]:
```
df["Refrigerator"].value_counts()
```

Out[72]:
```
Refrigerator
1    24601
0    24371
Name: count, dtype: int64
```

In [49]:
```
df["Refrigerator"].isnull().sum()
```

Out[49]:
```
0
```

# column=8 Microwave

In [78]:
```
# this is the count variable and correct data types and there is not any null value
df["Microwave"].dtypes
```

Out[78]:
```
dtype('int64')
```

In [80]:
```
df["Microwave"].unique()
```

Out[80]:
```
array([0, 1], dtype=int64)
```

In [51]:
```
df["Microwave"].value_counts()
```

Out[51]:
```
Microwave
1    24542
0    24430
Name: count, dtype: int64
```

In [84]:
```
df["Microwave"].isnull().sum()
```

Out[84]:
```
0
```

# column=9 Line Voltage

In [53]:
```
# this is the continuous variable and correct data types and there is not any null
df["Line Voltage"].dtypes
```

Out[53]:
```
dtype('int64')
```

In [90]:
```
df["Line Voltage"].isnull().sum()
```

Out[90]:
```
0
```

# column=10 Voltage

In [92]:
```
# this is the continuous variable and correct data types and there is not any null
```

```
df["Voltage"].dtypes
```

Out[92]:
```
dtype('int64')
```

In [96]:
```
df["Voltage"].isnull().sum()
```

Out[96]:
```
0
```

# column=11 Energy Consumption (kWh)

In [98]:
```
# this is the continuous variable and correct data types and there is not any null
df["Energy Consumption (kWh)"].dtypes
```

Out[98]:
```
dtype('float64')
```

In [55]:
```
df["Energy Consumption (kWh)"].isnull().sum()
```

Out[55]:
```
0
```

# column= 12 Apparent Power

In [102…
```
# this is the continuous variable and correct data types and there is not any null
df["Apparent Power"].dtypes
```

Out[102…
```
dtype('int64')
```

In [106…
```
df["Apparent Power"].isnull().sum()
```

Out[106…
```
0
```

# column= 13 Bandwidth

In [108…
```
# this is the continuous variable and correct data types and there is not any null
df["Bandwidth"].dtypes
```

Out[108…
```
dtype('int64')
```

In [110…
```
df["Bandwidth"].isnull().sum()
```

Out[110…
```
0
```

# data preprocessing

In [ ]:
```
# Data cleaning
# demension reduction
```

```
# Data transformation
```

In [250…
```
#df.drop(columns=["Unix Timestamp","Transaction_ID"],inplace=True)
```

In [7]:
```
df
```

Out[7]:

| | Unix Timestamp | Transaction_ID | Television | Dryer | Oven | Refrigerator | Microwave | Volt |
|---|---|---|---|---|---|---|---|---|
| **0** | 1577836800 | 1 | 0 | 0 | 0 | 1 | 0 | |
| **1** | 1577839322 | 2 | 0 | 1 | 0 | 0 | 1 | |
| **2** | 1577841845 | 3 | 0 | 1 | 0 | 0 | 0 | |
| **3** | 1577844368 | 4 | 1 | 0 | 1 | 1 | 0 | |
| **4** | 1577846891 | 5 | 1 | 0 | 0 | 1 | 0 | |
| **…** | … | … | … | … | … | … | … | … |
| **48967** | 1701377135 | 48968 | 1 | 0 | 1 | 0 | 0 | |
| **48968** | 1701379658 | 48969 | 0 | 0 | 1 | 0 | 1 | |
| **48969** | 1701382181 | 48970 | 1 | 0 | 0 | 1 | 1 | |
| **48970** | 1701384704 | 48971 | 1 | 1 | 1 | 1 | 1 | |
| **48971** | 1701387227 | 48972 | 0 | 0 | 0 | 0 | 1 | |

48972 rows × 13 columns

In [ ]:
```

```

In [115…
```
df.duplicated().sum()
```

Out[115…
```
0
```

In [103…
```
df.isnull().sum()
```

Out[103…
```
Television                0
Dryer                     0
Oven                      0
Refrigerator              0
Microwave                 0
Line Voltage              0
Voltage                   0
Apparent Power            0
Energy Consumption (kWh)  0
Offloading Decision       0
Bandwidth                 0
dtype: int64
```

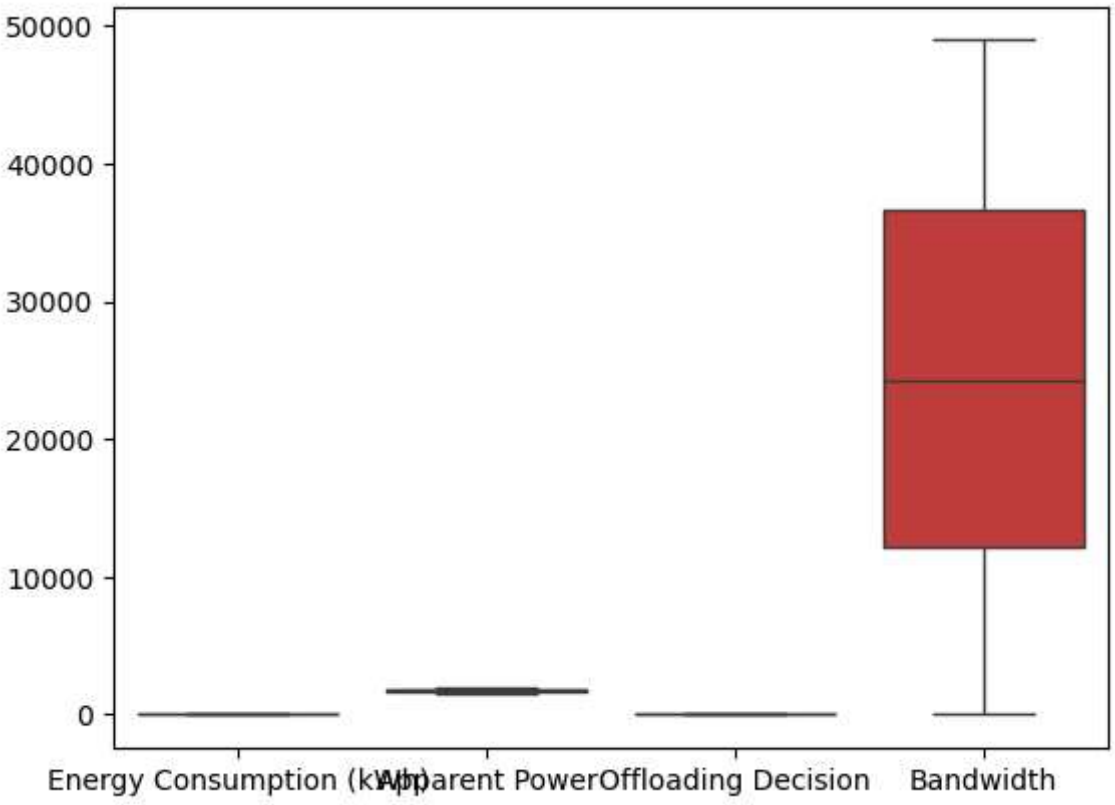
In [235…
```
conti=["Bandwidth","Voltage","Line Voltage","Energy Consumption","Offloading Decisi
      "Apparent Power"]
conti
discrete=["Television","Dryer","Oven","Refrigerator","Microwave"]
discrete
```

Out[235…
```
['Television', 'Dryer', 'Oven', 'Refrigerator', 'Microwave']
```

# treat the outliers

In [11]:
```
sns.boxplot(df[["Energy Consumption (kWh)","Apparent Power","Offloading Decision","
```

Out[11]:
```
<Axes: >
```




# data analysis and visualization

In [13]:
```
df.head(2)
```

Out[13]:

| | Unix Timestamp | Transaction_ID | Television | Dryer | Oven | Refrigerator | Microwave | Line Voltage |
|---|---|---|---|---|---|---|---|---|
| **0** | 1577836800 | 1 | 0 | 0 | 0 | 1 | 0 | 237 |
| **1** | 1577839322 | 2 | 0 | 1 | 0 | 0 | 1 | 232 |

In [15]:
```
df
```

Out[15]:

| | Unix Timestamp | Transaction_ID | Television | Dryer | Oven | Refrigerator | Microwave | I Volt |
|---|---|---|---|---|---|---|---|---|
| **0** | 1577836800 | 1 | 0 | 0 | 0 | 1 | 0 | |
| **1** | 1577839322 | 2 | 0 | 1 | 0 | 0 | 1 | |
| **2** | 1577841845 | 3 | 0 | 1 | 0 | 0 | 0 | |
| **3** | 1577844368 | 4 | 1 | 0 | 1 | 1 | 0 | |
| **4** | 1577846891 | 5 | 1 | 0 | 0 | 1 | 0 | |
| **...** | ... | ... | ... | ... | ... | ... | ... | ... |
| **48967** | 1701377135 | 48968 | 1 | 0 | 1 | 0 | 0 | |
| **48968** | 1701379658 | 48969 | 0 | 0 | 1 | 0 | 1 | |
| **48969** | 1701382181 | 48970 | 1 | 0 | 0 | 1 | 1 | |
| **48970** | 1701384704 | 48971 | 1 | 1 | 1 | 1 | 1 | |
| **48971** | 1701387227 | 48972 | 0 | 0 | 0 | 0 | 1 | |

48972 rows × 13 columns

In [ ]:
```
# q 1 what is the average  energy consumption across all
```

In [242…
```
df["Energy Consumption (kWh)"].mean()
```

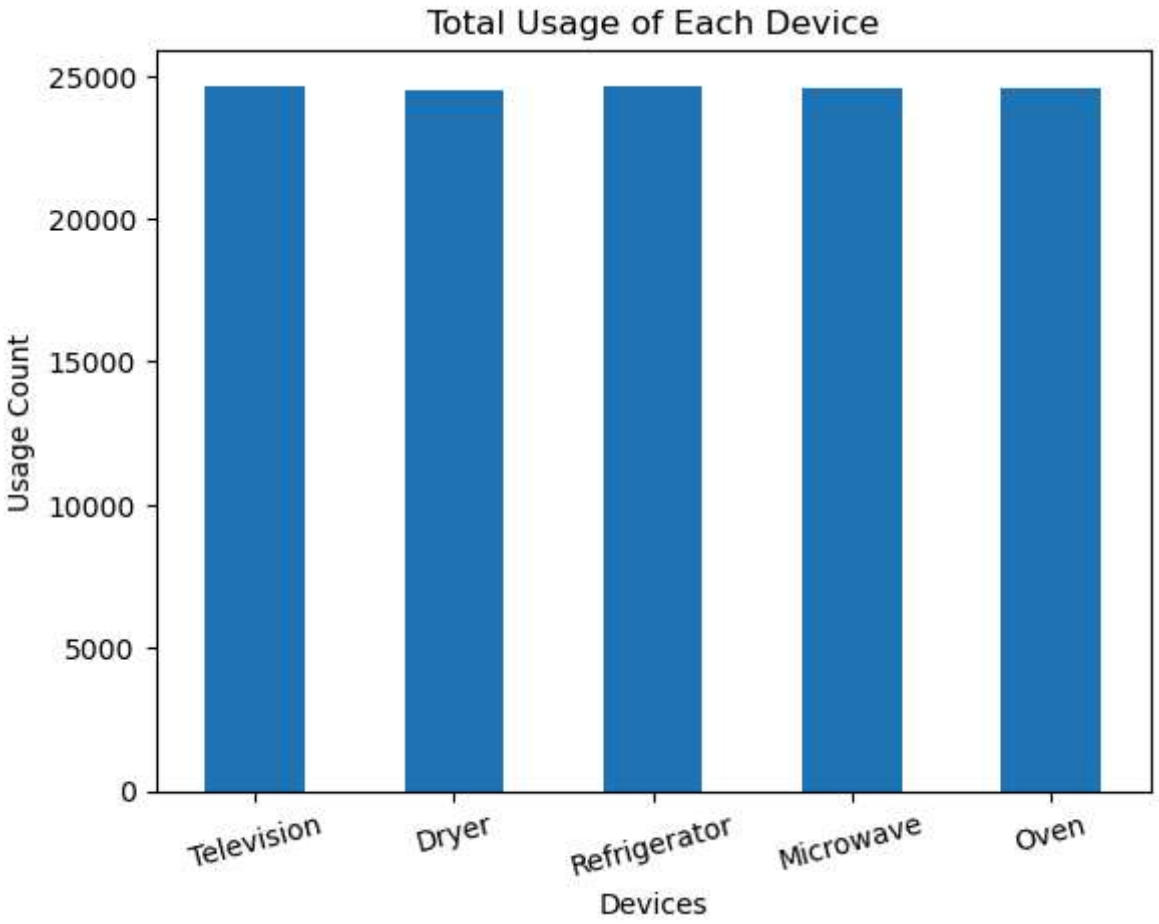
Out[242…
```
55.10126995297966
```

In [ ]:
```
# question 2 which device used most (by frequency)
# ans= television=24655
```

In [277…
```
total=df[["Television","Dryer","Refrigerator","Microwave","Oven"]].sum()
total
```

Out[277…
```
Television      24655
Dryer           24490
Refrigerator    24601
Microwave       24542
Oven            24583
dtype: int64
```

In [279…
```
total.plot(kind='bar')
plt.title('Total Usage of Each Device')
plt.ylabel('Usage Count')
plt.xlabel('Devices')
plt.xticks(rotation=15)
plt.show()
```




In [ ]:
```
# q 3 what is the average  energy consumption each type of devices
```

In [315…
```
avg_energy = {}
for device in device_columns:
    avg = df[df[device] == 1]['Energy Consumption (kWh)'].mean()
    avg_energy[device] = avg
print(avg_energy)
```

```
{'Television': 55.13789495582316, 'Dryer': 55.06501663212863, 'Oven': 55.16255192216
9385, 'Refrigerator': 55.22102349917767, 'Microwave': 55.280956186982316}
```

In [119…
```
df[df['Television'] == 1]['Energy Consumption (kWh)'].mean()
```

Out[119… 55.13789495582316

In [127…
```
df[df["Dryer"]==1]['Energy Consumption (kWh)'].mean()
```

Out[127… 55.06501663212863

In [129…
```
df[df["Oven"]==1]['Energy Consumption (kWh)'].mean()
```

Out[129… 55.162551922169385

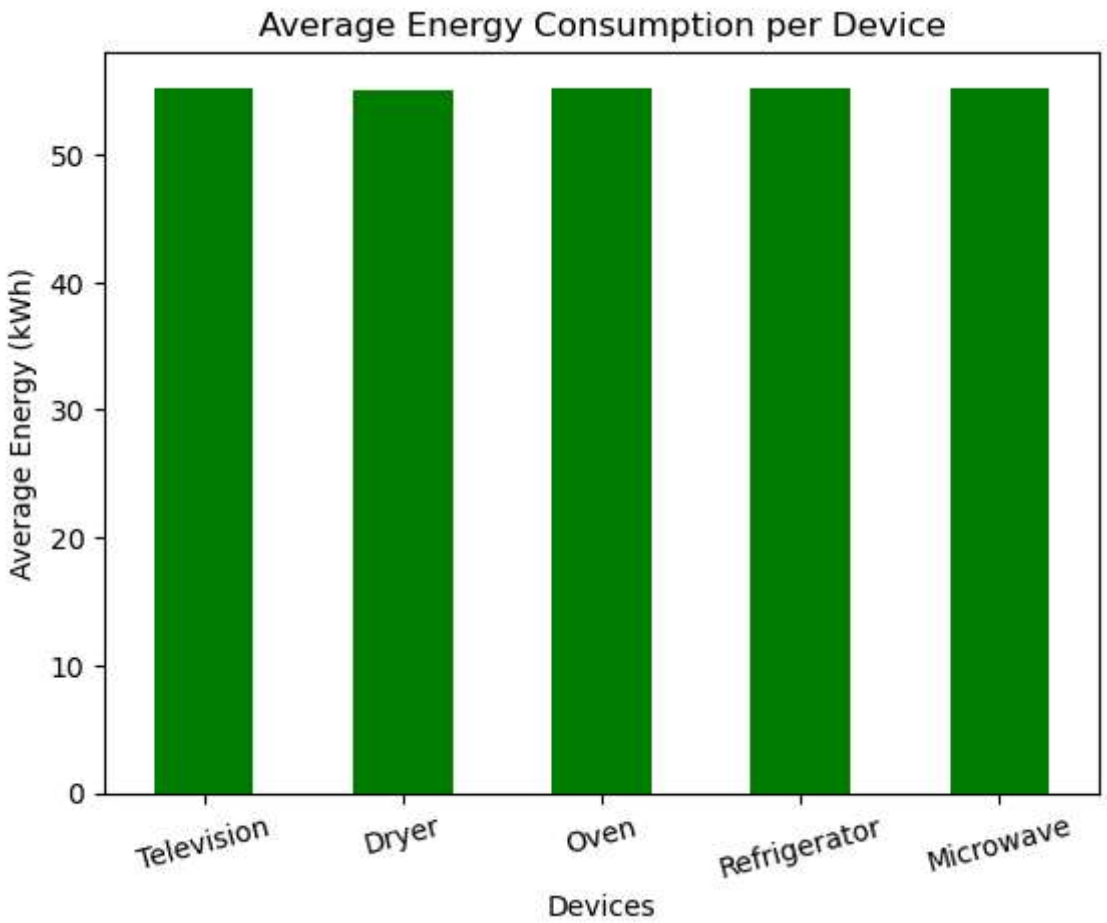
In [131…
```
df[df[""]==1]['Energy Consumption (kWh)'].mean()
```

Out[131… 55.22102349917767

In [133…
```
df[df["Microwave"]==1]['Energy Consumption (kWh)'].mean()
```

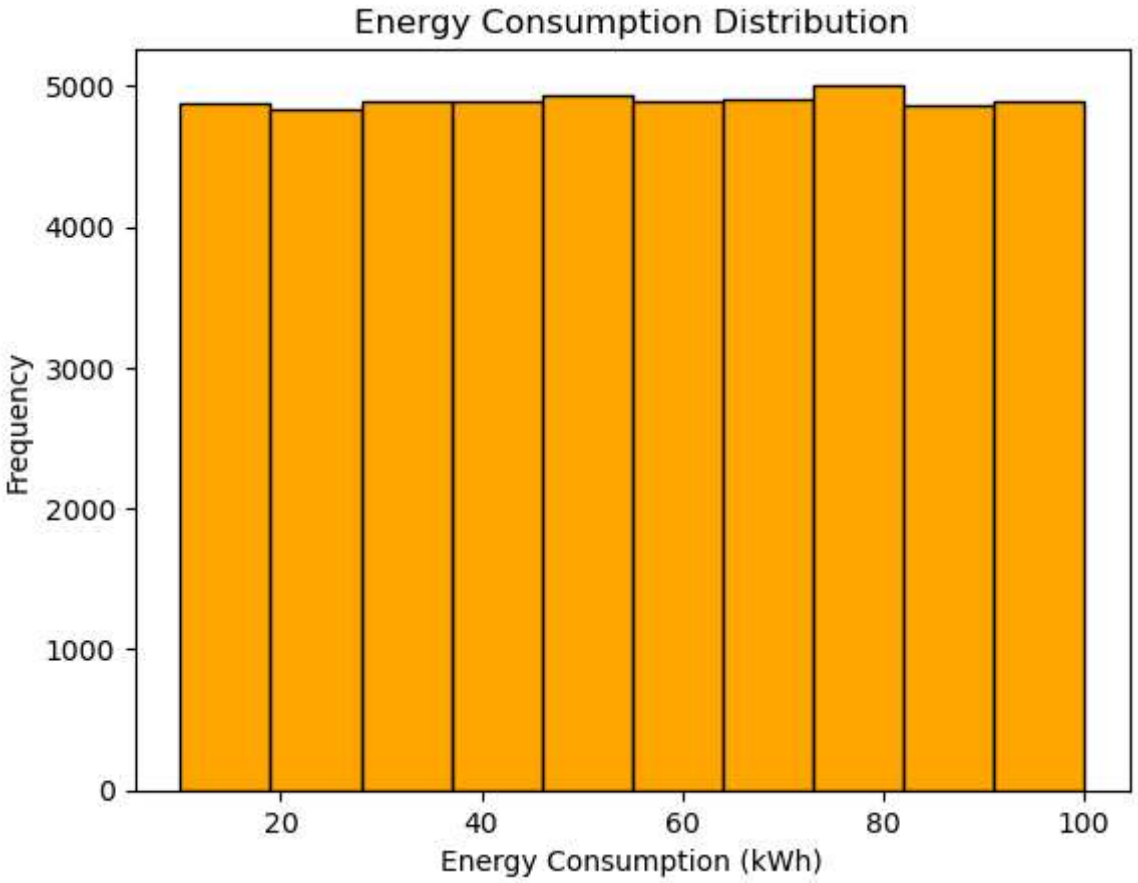
Out[133… 55.280956186982316

In [339…
```
pd.Series(avg_energy).plot(kind='bar', color='green')
plt.title('Average Energy Consumption per Device')
plt.ylabel('Average Energy (kWh)')
plt.xlabel('Devices')
plt.xticks(rotation=15)
plt.show()
```



In [ ]:
```
# question 4 energy consumption distribution
```

In [283…
```
df['Energy Consumption (kWh)'].plot(kind='hist', color='orange', edgecolor='black')
plt.title('Energy Consumption Distribution')
plt.xlabel('Energy Consumption (kWh)')
plt.ylabel('Frequency')
plt.show()
```




In [ ]:
```
# question 5 correlation b/w the devices
```

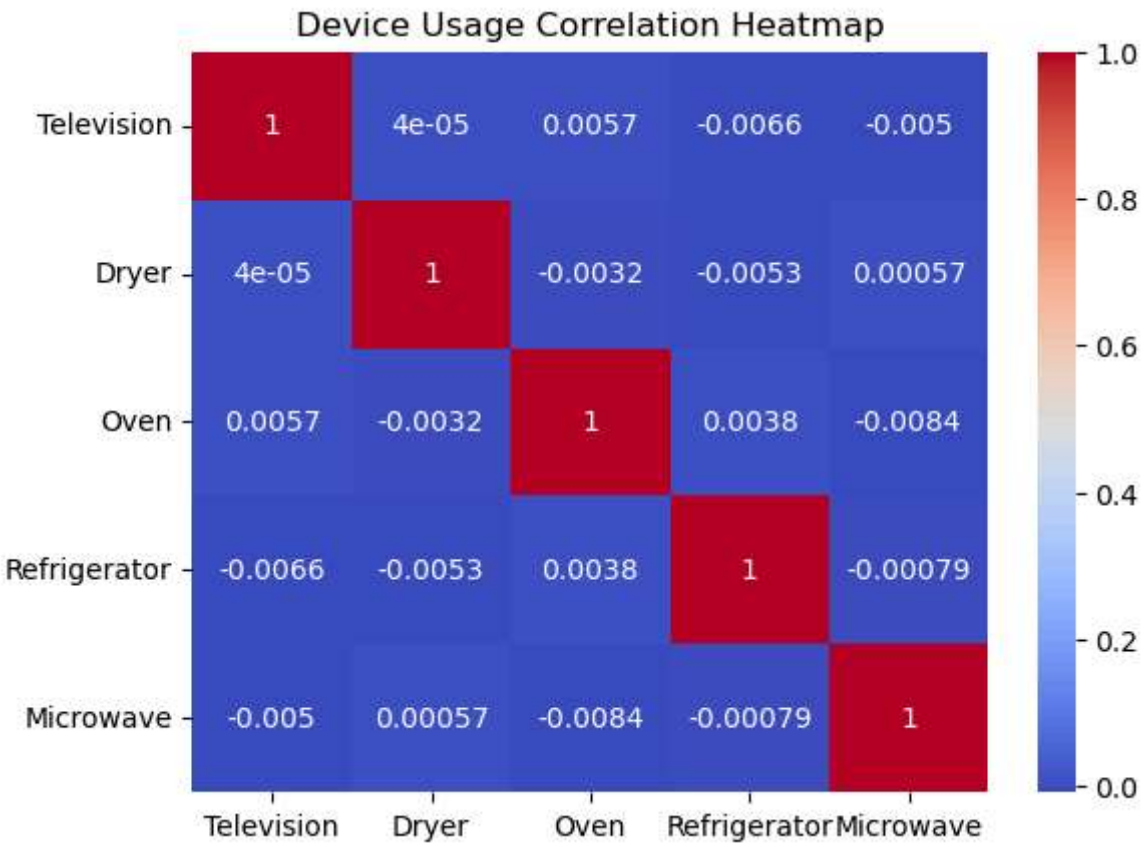
In [327…
```
device_corr = df[['Television', 'Dryer', 'Oven', 'Refrigerator', 'Microwave']].corr
device_corr
```

Out[327…

| | Television | Dryer | Oven | Refrigerator | Microwave |
|---|---|---|---|---|---|
| **Television** | 1.000000 | 0.000040 | 0.005690 | -0.006567 | -0.005039 |
| **Dryer** | 0.000040 | 1.000000 | -0.003227 | -0.005269 | 0.000571 |
| **Oven** | 0.005690 | -0.003227 | 1.000000 | 0.003820 | -0.008381 |
| **Refrigerator** | -0.006567 | -0.005269 | 0.003820 | 1.000000 | -0.000787 |
| **Microwave** | -0.005039 | 0.000571 | -0.008381 | -0.000787 | 1.000000 |

In [329…
```
sns.heatmap(device_corr, annot=True, cmap='coolwarm')
plt.title('Device Usage Correlation Heatmap')
```

```
plt.show()
```

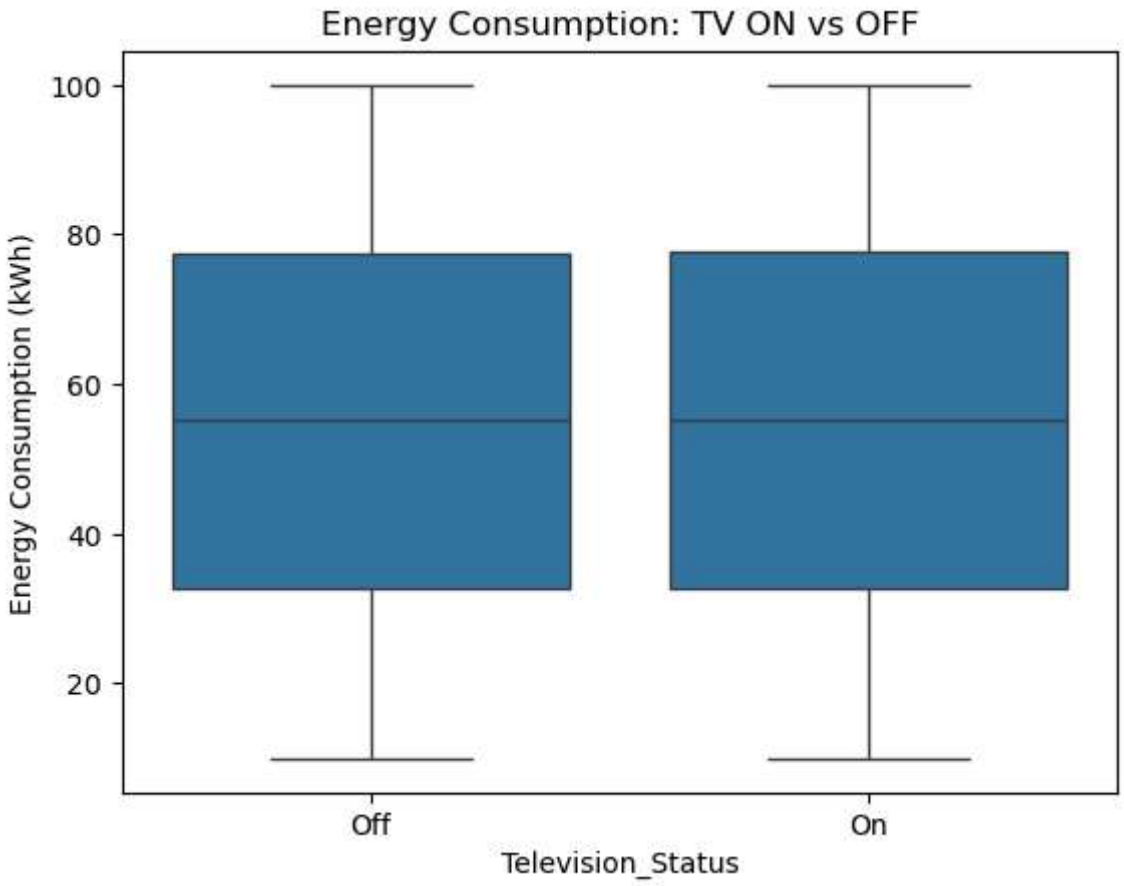



In [ ]:
```
# question 6 Compare average energy consumption when Television is ON vs OFF.
```

In [401…
```
df['Television_Status'] = df['Television'].replace({1: 'On', 0: 'Off'})
df.groupby("Television")["Energy Consumption (kWh)"].mean()
```

Out[401…
```
Television
0    55.064136
1    55.137895
Name: Energy Consumption (kWh), dtype: float64
```

In [403…
```
sns.boxplot(x='Television_Status', y='Energy Consumption (kWh)', data=df)
plt.title('Energy Consumption: TV ON vs OFF')
plt.show()
```




In [349…
```
df[['Television']].value_counts(normalize=True)*100
```

Out[349…
```
Television
1             50.345095
0             49.654905
Name: proportion, dtype: float64
```