step : Imports & Reading Data

In [1]:
```
pip install pandas sqlite3 matplotlib seaborn
```

```
Requirement already satisfied: pandas in c:₩users₩seoin₩anaconda₩lib₩site-packages
(2.2.2)
Note: you may need to restart the kernel to use updated packages.
```

```
ERROR: Could not find a version that satisfies the requirement sqlite3 (from version
s: none)
ERROR: No matching distribution found for sqlite3
```

In [2]:
```
import pandas as pd
import sqlite3
import matplotlib.pyplot as plt
import seaborn as sns
import numpy as np
from scipy import stats
pd.set_option('display.max_columns', None)
```

```
C:₩Users₩seoin₩anaconda₩Lib₩site-packages₩pandas₩core₩arrays₩masked.py:60: UserWarni
ng: Pandas requires version '1.3.6' or newer of 'bottleneck' (version '1.3.5' curren
tly installed).
  from pandas.core import (
```

In [3]:
```
# Connect to SQLite database
conn = sqlite3.connect('cruise_data.db')
cursor = conn.cursor()

# Load CSV data into a DataFrame
df = pd.read_csv('C:/Users/seoin/Desktop/Tui/task_data/data.csv')

# Create a table in the SQLite database
df.to_sql('cruise_data', conn, if_exists='replace', index=False)

# Verify the data is loaded
query = "SELECT * FROM cruise_data"
df_sql = pd.read_sql_query(query, conn)
print(df_sql.head())
```

	Start Time	End Time	Vessel Name	Power Galley 1 (MW)	₩
0	2023-01-01T00:00:00	2023-01-01T00:05:00	Vessel 1	0.0946	
1	2023-01-01T00:05:00	2023-01-01T00:10:00	Vessel 1	0.0540	
2	2023-01-01T00:10:00	2023-01-01T00:15:00	Vessel 1	0.0439	
3	2023-01-01T00:15:00	2023-01-01T00:20:00	Vessel 1	0.0733	
4	2023-01-01T00:20:00	2023-01-01T00:25:00	Vessel 1	0.0780	

	Power Galley 2 (MW)	Power Service (MW)	HVAC Chiller 1 Power (MW)	₩
0	0.1384	5.4654	0.5074	
1	0.1370	5.4387	0.5158	
2	0.1785	5.5265	0.5117	
3	0.1725	5.5257	0.5177	
4	0.1397	5.4634	0.5169	

	HVAC Chiller 2 Power (MW)	HVAC Chiller 3 Power (MW)	Scrubber Power (MW)	₩
0	0.0	0.4979	0.4191	
1	0.0	0.4982	0.4204	
2	0.0	0.5032	0.4199	
3	0.0	0.5103	0.4188	
4	0.0	0.5100	0.4203	

	Sea Temperature (Celsius)	Boiler 1 Fuel Flow Rate (L/h)	₩
0	27.3000	0.0000	
1	27.3000	47.7695	
2	27.3000	77.2034	
3	27.3076	60.6369	
4	27.3518	55.2184	

	Boiler 2 Fuel Flow Rate (L/h)	Incinerator 1 Fuel Flow Rate (L/h)	₩
0	0.0	19.0090	
1	0.0	216.3180	
2	0.0	439.4300	
3	0.0	218.2797	
4	0.0	0.0000	

	Diesel Generator 1 Power (MW)	Diesel Generator 2 Power (MW)	₩
0	0.0	0.0	
1	0.0	0.0	
2	0.0	0.0	
3	0.0	0.0	
4	0.0	0.0	

	Diesel Generator 3 Power (MW)	Diesel Generator 4 Power (MW)	₩
0	0.0	7.3349	
1	0.0	7.3011	
2	0.0	7.3299	
3	0.0	7.3712	
4	0.0	7.3032	

	Latitude (Degrees)	Longitude (Degrees)	Relative Wind Angle (Degrees)	₩
0	17.72523	-65.45738	8.4428	
1	17.73088	-65.44803	41.3100	
2	17.73655	-65.43887	23.9997	
3	17.74202	-65.42980	14.5540	
4	17.74713	-65.42042	14.5632	

	True Wind Angle (Degrees)	Depth (m)	Relative Wind Direction (Degrees)	₩
0	10.9049	NaN	64.3112	
1	78.7817	NaN	62.8161	
2	33.6216	NaN	80.7356	
3	20.0348	NaN	75.9723	
4	20.0328	NaN	74.6509	

	True Wind Direction (Degrees)	Draft (m)	Speed Over Ground (knots)	₩

0	66.7735	7.8721	7.6300
1	64.3452	7.8713	7.5800
2	90.3574	7.8718	7.4379
3	81.4529	7.8710	7.3979
4	80.1204	7.8707	7.4343

	True Wind Speed (knots)	Relative Wind Speed (knots)	₩
0	19.5050	27.0579	
1	19.2968	26.8067	
2	19.4491	25.8380	
3	20.6231	27.6498	
4	20.4554	27.5341	

	Speed Through Water (knots)	Local Time (h)	Trim (m)	₩
0	7.8881	19.67367	-0.1425	
1	7.7438	19.75763	-0.1405	
2	7.6320	19.84158	-0.1450	
3	7.5080	19.92551	-0.1308	
4	7.5521	20.00947	-0.1269	

	Propulsion Power (MW)	Port Side Propulsion Power (MW)	₩
0	1.8691	0.8854	
1	1.8622	0.8737	
2	1.8036	0.8441	
3	1.8457	0.8543	
4	1.8399	0.8467	

	Starboard Side Propulsion Power (MW)	Bow Thruster 1 Power (MW)	₩
0	0.9837	0.0	
1	0.9885	0.0	
2	0.9595	0.0	
3	0.9914	0.0	
4	0.9932	0.0	

	Bow Thruster 2 Power (MW)	Bow Thruster 3 Power (MW)	₩
0	0.0	0.0	
1	0.0	0.0	
2	0.0	0.0	
3	0.0	0.0	
4	0.0	0.0	

	Stern Thruster 1 Power (MW)	Stern Thruster 2 Power (MW)	₩
0	0.0	0.0	
1	0.0	0.0	
2	0.0	0.0	
3	0.0	0.0	
4	0.0	0.0	

	Main Engine 1 Fuel Flow Rate (kg/h)	Main Engine 2 Fuel Flow Rate (kg/h)	₩
0	0.0	0.0	
1	0.0	0.0	
2	0.0	0.0	
3	0.0	0.0	
4	0.0	0.0	

	Main Engine 3 Fuel Flow Rate (kg/h)	Main Engine 4 Fuel Flow Rate (kg/h)
0	0.0	1645.82000
1	0.0	1643.78999
2	0.0	1642.07000
3	0.0	1650.71000
4	0.0	1644.54000

Step : Data Understanding

In [4]:
```
df.shape
```

Out[4]:
```
(210240, 44)
```

In [5]:
```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 210240 entries, 0 to 210239
Data columns (total 44 columns):
 #   Column                                Non-Null Count   Dtype  
---  ------                                --------------   -----  
 0   Start Time                            210240 non-null  object 
 1   End Time                              210240 non-null  object 
 2   Vessel Name                           210240 non-null  object 
 3   Power Galley 1 (MW)                   210224 non-null  float64
 4   Power Galley 2 (MW)                   210224 non-null  float64
 5   Power Service (MW)                    210222 non-null  float64
 6   HVAC Chiller 1 Power (MW)             210033 non-null  float64
 7   HVAC Chiller 2 Power (MW)             210033 non-null  float64
 8   HVAC Chiller 3 Power (MW)             210033 non-null  float64
 9   Scrubber Power (MW)                   210224 non-null  float64
 10  Sea Temperature (Celsius)             210224 non-null  float64
 11  Boiler 1 Fuel Flow Rate (L/h)         210224 non-null  float64
 12  Boiler 2 Fuel Flow Rate (L/h)         210224 non-null  float64
 13  Incinerator 1 Fuel Flow Rate (L/h)    210224 non-null  float64
 14  Diesel Generator 1 Power (MW)         210224 non-null  float64
 15  Diesel Generator 2 Power (MW)         210224 non-null  float64
 16  Diesel Generator 3 Power (MW)         210224 non-null  float64
 17  Diesel Generator 4 Power (MW)         210224 non-null  float64
 18  Latitude (Degrees)                    209900 non-null  float64
 19  Longitude (Degrees)                   209900 non-null  float64
 20  Relative Wind Angle (Degrees)         210226 non-null  float64
 21  True Wind Angle (Degrees)             210166 non-null  float64
 22  Depth (m)                             152746 non-null  float64
 23  Relative Wind Direction (Degrees)     210185 non-null  float64
 24  True Wind Direction (Degrees)         210166 non-null  float64
 25  Draft (m)                             209097 non-null  float64
 26  Speed Over Ground (knots)             209340 non-null  float64
 27  True Wind Speed (knots)               210166 non-null  float64
 28  Relative Wind Speed (knots)           210226 non-null  float64
 29  Speed Through Water (knots)           209299 non-null  float64
 30  Local Time (h)                        209900 non-null  float64
 31  Trim (m)                              209161 non-null  float64
 32  Propulsion Power (MW)                 210224 non-null  float64
 33  Port Side Propulsion Power (MW)       210224 non-null  float64
 34  Starboard Side Propulsion Power (MW)  210224 non-null  float64
 35  Bow Thruster 1 Power (MW)             210224 non-null  float64
 36  Bow Thruster 2 Power (MW)             210224 non-null  float64
 37  Bow Thruster 3 Power (MW)             210224 non-null  float64
 38  Stern Thruster 1 Power (MW)           210224 non-null  float64
 39  Stern Thruster 2 Power (MW)           210224 non-null  float64
 40  Main Engine 1 Fuel Flow Rate (kg/h)   210224 non-null  float64
 41  Main Engine 2 Fuel Flow Rate (kg/h)   210224 non-null  float64
 42  Main Engine 3 Fuel Flow Rate (kg/h)   210224 non-null  float64
 43  Main Engine 4 Fuel Flow Rate (kg/h)   210224 non-null  float64
dtypes: float64(41), object(3)
memory usage: 70.6+ MB
```

In [6]:
```
df.head()
```

Out[6]:

	Start Time	End Time	Vessel Name	Power Galley 1 (MW)	Power Galley 2 (MW)	Power Service (MW)	HVAC Chiller 1 Power (MW)	HVAC Chiller 2 Power (MW)	HVAC Chiller 3 Power (MW)	Scrubber Power (MW)	Tem
0	2023-01-01T00:00:00	2023-01-01T00:05:00	Vessel 1	0.0946	0.1384	5.4654	0.5074	0.0	0.4979	0.4191	
1	2023-01-01T00:05:00	2023-01-01T00:10:00	Vessel 1	0.0540	0.1370	5.4387	0.5158	0.0	0.4982	0.4204	
2	2023-01-01T00:10:00	2023-01-01T00:15:00	Vessel 1	0.0439	0.1785	5.5265	0.5117	0.0	0.5032	0.4199	
3	2023-01-01T00:15:00	2023-01-01T00:20:00	Vessel 1	0.0733	0.1725	5.5257	0.5177	0.0	0.5103	0.4188	
4	2023-01-01T00:20:00	2023-01-01T00:25:00	Vessel 1	0.0780	0.1397	5.4634	0.5169	0.0	0.5100	0.4203	

In [7]:
```
df.columns
```

Out[7]:
```
Index(['Start Time', 'End Time', 'Vessel Name', 'Power Galley 1 (MW)',
       'Power Galley 2 (MW)', 'Power Service (MW)',
       'HVAC Chiller 1 Power (MW)', 'HVAC Chiller 2 Power (MW)',
       'HVAC Chiller 3 Power (MW)', 'Scrubber Power (MW)',
       'Sea Temperature (Celsius)', 'Boiler 1 Fuel Flow Rate (L/h)',
       'Boiler 2 Fuel Flow Rate (L/h)', 'Incinerator 1 Fuel Flow Rate (L/h)',
       'Diesel Generator 1 Power (MW)', 'Diesel Generator 2 Power (MW)',
       'Diesel Generator 3 Power (MW)', 'Diesel Generator 4 Power (MW)',
       'Latitude (Degrees)', 'Longitude (Degrees)',
       'Relative Wind Angle (Degrees)', 'True Wind Angle (Degrees)',
       'Depth (m)', 'Relative Wind Direction (Degrees)',
       'True Wind Direction (Degrees)', 'Draft (m)',
       'Speed Over Ground (knots)', 'True Wind Speed (knots)',
       'Relative Wind Speed (knots)', 'Speed Through Water (knots)',
       'Local Time (h)', 'Trim (m)', 'Propulsion Power (MW)',
       'Port Side Propulsion Power (MW)',
       'Starboard Side Propulsion Power (MW)', 'Bow Thruster 1 Power (MW)',
       'Bow Thruster 2 Power (MW)', 'Bow Thruster 3 Power (MW)',
       'Stern Thruster 1 Power (MW)', 'Stern Thruster 2 Power (MW)',
       'Main Engine 1 Fuel Flow Rate (kg/h)',
       'Main Engine 2 Fuel Flow Rate (kg/h)',
       'Main Engine 3 Fuel Flow Rate (kg/h)',
       'Main Engine 4 Fuel Flow Rate (kg/h)'],
      dtype='object')
```

Step : Data Preperation

In [8]:
```
# Convert time columns to datetime dtype
df['Start Time'] = pd.to_datetime(df['Start Time'])
df['End Time'] = pd.to_datetime(df['End Time'])

# Display info for only 'Start Time' and 'End Time' columns
df[['Start Time', 'End Time']].info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 210240 entries, 0 to 210239
Data columns (total 2 columns):
 #   Column      Non-Null Count   Dtype
---  ------      --------------   -----
 0   Start Time  210240 non-null  datetime64[ns]
 1   End Time    210240 non-null  datetime64[ns]
dtypes: datetime64[ns](2)
memory usage: 3.2 MB
```

Missing value check

In [9]:
```
df.isnull().sum()
```

Out[9]:
```
Start Time                                0
End Time                                  0
Vessel Name                               0
Power Galley 1 (MW)                      16
Power Galley 2 (MW)                      16
Power Service (MW)                       18
HVAC Chiller 1 Power (MW)               207
HVAC Chiller 2 Power (MW)               207
HVAC Chiller 3 Power (MW)               207
Scrubber Power (MW)                      16
Sea Temperature (Celsius)                16
Boiler 1 Fuel Flow Rate (L/h)            16
Boiler 2 Fuel Flow Rate (L/h)            16
Incinerator 1 Fuel Flow Rate (L/h)       16
Diesel Generator 1 Power (MW)            16
Diesel Generator 2 Power (MW)            16
Diesel Generator 3 Power (MW)            16
Diesel Generator 4 Power (MW)            16
Latitude (Degrees)                      340
Longitude (Degrees)                     340
Relative Wind Angle (Degrees)            14
True Wind Angle (Degrees)                74
Depth (m)                             57494
Relative Wind Direction (Degrees)        55
True Wind Direction (Degrees)            74
Draft (m)                              1143
Speed Over Ground (knots)               900
True Wind Speed (knots)                  74
Relative Wind Speed (knots)              14
Speed Through Water (knots)             941
Local Time (h)                          340
Trim (m)                               1079
Propulsion Power (MW)                    16
Port Side Propulsion Power (MW)          16
Starboard Side Propulsion Power (MW)     16
Bow Thruster 1 Power (MW)                16
Bow Thruster 2 Power (MW)                16
Bow Thruster 3 Power (MW)                16
Stern Thruster 1 Power (MW)              16
Stern Thruster 2 Power (MW)              16
Main Engine 1 Fuel Flow Rate (kg/h)      16
Main Engine 2 Fuel Flow Rate (kg/h)      16
Main Engine 3 Fuel Flow Rate (kg/h)      16
Main Engine 4 Fuel Flow Rate (kg/h)      16
dtype: int64
```

In [10]:
```
df.duplicated().sum()
```

Out[10]: 0

In [11]:
```
df[df['Power Galley 1 (MW)'].isna()]
```

Out[11]:

	Start Time	End Time	Vessel Name	Power Galley 1 (MW)	Power Galley 2 (MW)	Power Service (MW)	HVAC Chiller 1 Power (MW)	HVAC Chiller 2 Power (MW)	HVAC Chiller 3 Power (MW)	Scrubber Power (MW)	Temp
88578	2023-11-04 13:30:00	2023-11-04 13:35:00	Vessel 1	NaN	NaN	NaN	NaN	NaN	NaN	NaN	
140167	2023-05-02 16:35:00	2023-05-02 16:40:00	Vessel 2	NaN	NaN	NaN	NaN	NaN	NaN	NaN	
145233	2023-05-20 06:45:00	2023-05-20 06:50:00	Vessel 2	NaN	NaN	NaN	NaN	NaN	NaN	NaN	
161071	2023-07-14 06:35:00	2023-07-14 06:40:00	Vessel 2	NaN	NaN	NaN	NaN	NaN	NaN	NaN	
163498	2023-07-22 16:50:00	2023-07-22 16:55:00	Vessel 2	NaN	NaN	NaN	NaN	NaN	NaN	NaN	
163499	2023-07-22 16:55:00	2023-07-22 17:00:00	Vessel 2	NaN	NaN	NaN	NaN	NaN	NaN	NaN	
163500	2023-07-22 17:00:00	2023-07-22 17:05:00	Vessel 2	NaN	NaN	NaN	NaN	NaN	NaN	NaN	
165191	2023-07-28 13:55:00	2023-07-28 14:00:00	Vessel 2	NaN	NaN	NaN	NaN	NaN	NaN	NaN	
165767	2023-07-30 13:55:00	2023-07-30 14:00:00	Vessel 2	NaN	NaN	NaN	NaN	NaN	NaN	NaN	
165768	2023-07-30 14:00:00	2023-07-30 14:05:00	Vessel 2	NaN	NaN	NaN	NaN	NaN	NaN	NaN	
168077	2023-08-07 14:25:00	2023-08-07 14:30:00	Vessel 2	NaN	NaN	NaN	NaN	NaN	NaN	NaN	
168078	2023-08-07 14:30:00	2023-08-07 14:35:00	Vessel 2	NaN	NaN	NaN	NaN	NaN	NaN	NaN	
179568	2023-09-16 12:00:00	2023-09-16 12:05:00	Vessel 2	NaN	NaN	NaN	NaN	NaN	NaN	NaN	
179569	2023-09-16 12:05:00	2023-09-16 12:10:00	Vessel 2	NaN	NaN	NaN	NaN	NaN	NaN	NaN	
179572	2023-09-16 12:20:00	2023-09-16 12:25:00	Vessel 2	NaN	NaN	NaN	NaN	NaN	NaN	NaN	

	Start Time	End Time	Vessel Name	Power Galley 1 (MW)	Power Galley 2 (MW)	Power Service (MW)	HVAC Chiller 1 Power (MW)	HVAC Chiller 2 Power (MW)	HVAC Chiller 3 Power (MW)	Scrubber Power (MW)	Temp
209699	2023-12-30 02:55:00	2023-12-30 03:00:00	Vessel 2	NaN	NaN	NaN	NaN	NaN	NaN	NaN	

In [12]:
```
# Drop rows where 'Power Galley 1 (MW)' has missing values becasue most of the data
df = df.dropna(subset=['Power Galley 1 (MW)'])
```

In [13]:
```
df[df['HVAC Chiller 1 Power (MW)'].isna()]
```

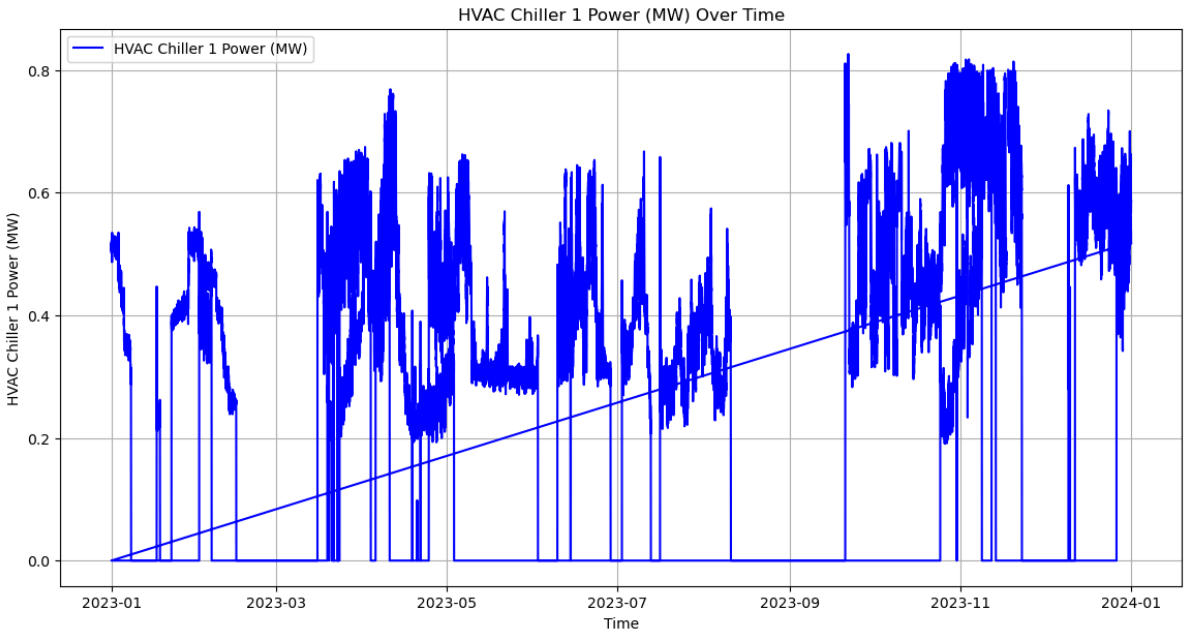
Out[13]:

	Start Time	End Time	Vessel Name	Power Galley 1 (MW)	Power Galley 2 (MW)	Power Service (MW)	HVAC Chiller 1 Power (MW)	HVAC Chiller 2 Power (MW)	HVAC Chiller 3 Power (MW)	Scrubber Power (MW)	Temp
197377	2023-11-17 08:05:00	2023-11-17 08:10:00	Vessel 2	0.0000	0.0918	4.4755	NaN	NaN	NaN	0.1543	
197378	2023-11-17 08:10:00	2023-11-17 08:15:00	Vessel 2	0.0000	0.0716	4.5178	NaN	NaN	NaN	0.1534	
197379	2023-11-17 08:15:00	2023-11-17 08:20:00	Vessel 2	0.0000	0.0638	4.4713	NaN	NaN	NaN	0.1530	
197380	2023-11-17 08:20:00	2023-11-17 08:25:00	Vessel 2	0.0071	0.0620	4.5521	NaN	NaN	NaN	0.1545	
197381	2023-11-17 08:25:00	2023-11-17 08:30:00	Vessel 2	0.0012	0.0420	4.4380	NaN	NaN	NaN	0.1539	
...	...	...	...	...	...	...	...	...	...	...	
197563	2023-11-17 23:35:00	2023-11-17 23:40:00	Vessel 2	0.0218	0.1772	5.5094	NaN	NaN	NaN	0.1577	
197564	2023-11-17 23:40:00	2023-11-17 23:45:00	Vessel 2	0.0487	0.1671	5.5004	NaN	NaN	NaN	0.1569	
197565	2023-11-17 23:45:00	2023-11-17 23:50:00	Vessel 2	0.0308	0.1678	5.5444	NaN	NaN	NaN	0.1581	
197566	2023-11-17 23:50:00	2023-11-17 23:55:00	Vessel 2	0.0497	0.1516	5.5213	NaN	NaN	NaN	0.1584	
197567	2023-11-17 23:55:00	2023-11-18 00:00:00	Vessel 2	0.0697	0.2012	5.6888	NaN	NaN	NaN	0.1585	

191 rows × 44 columns

In [14]:

```
# Ensure 'Start Time' is in datetime format
df['Start Time'] = pd.to_datetime(df['Start Time'])

# Plot the time series for 'HVAC Chiller 1 Power (MW)'
plt.figure(figsize=(14, 7))
plt.plot(df['Start Time'], df['HVAC Chiller 1 Power (MW)'], label='HVAC Chiller 1 Po
plt.xlabel('Time')
plt.ylabel('HVAC Chiller 1 Power (MW)')
plt.title('HVAC Chiller 1 Power (MW) Over Time')
plt.legend()
plt.grid(True)
plt.show()
```



In [15]:
```
# Sort the dataframe by 'Start Time' to ensure proper filling
df = df.sort_values(by='Start Time')

# Set 'Start Time' as the index
df.set_index('Start Time', inplace=True)

# Interpolate to fill missing values for chiller columns
#interpolation is a process of determining the unknown values that lie in between the
df['HVAC Chiller 1 Power (MW)'] = df['HVAC Chiller 1 Power (MW)'].interpolate()
df['HVAC Chiller 2 Power (MW)'] = df['HVAC Chiller 2 Power (MW)'].interpolate()
df['HVAC Chiller 3 Power (MW)'] = df['HVAC Chiller 3 Power (MW)'].interpolate()

# If you need to reset the index back to columns
df.reset_index(inplace=True)
```

In [16]:
```
df[df['Power Service (MW)'].isna()]
```

Out[16]:

	Start Time	End Time	Vessel Name	Power Galley 1 (MW)	Power Galley 2 (MW)	Power Service (MW)	HVAC Chiller 1 Power (MW)	HVAC Chiller 2 Power (MW)	HVAC Chiller 3 Power (MW)	Scrubber Power (MW)	Temp
148890	2023-09-16 12:15:00	2023-09-16 12:20:00	Vessel 2	0.03	0.080	NaN	0.000	0.384	0.0	0.773	
209145	2023-12-30 03:00:00	2023-12-30 03:05:00	Vessel 2	0.03	0.087	NaN	0.508	0.528	0.0	0.346	

In [17]:
```
# First forward fill, then backward fill
# the next available value after the missing data point replaces the missing value be
df['Power Service (MW)'] = df['Power Service (MW)'].ffill().bfill()

print(df[['Start Time', 'Power Service (MW)']].head())
```

```
            Start Time  Power Service (MW)
0 2023-01-01 00:00:00              5.4654
1 2023-01-01 00:00:00              5.3725
2 2023-01-01 00:05:00              5.4387
3 2023-01-01 00:05:00              5.9642
4 2023-01-01 00:10:00              5.5265
```

In [18]:
```
df[df['Speed Over Ground (knots)'].isna()]
```

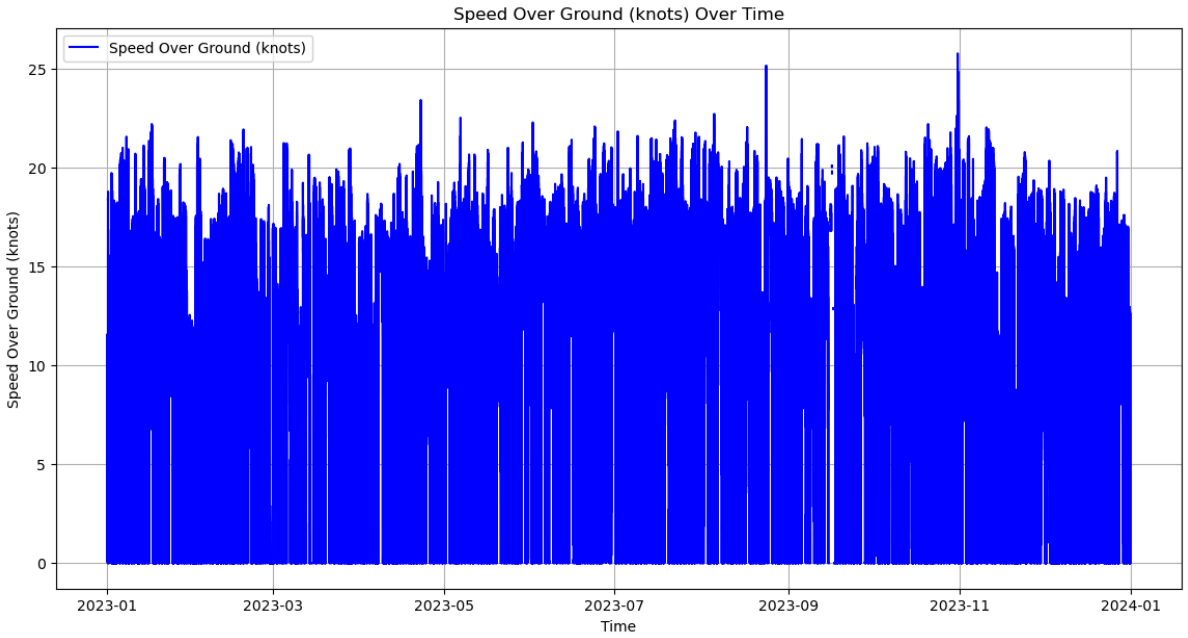
Out[18]:

	Start Time	End Time	Vessel Name	Power Galley 1 (MW)	Power Galley 2 (MW)	Power Service (MW)	HVAC Chiller 1 Power (MW)	HVAC Chiller 2 Power (MW)	HVAC Chiller 3 Power (MW)	Scrubber Power (MW)	Tem
137881	2023-08-28 09:30:00	2023-08-28 09:35:00	Vessel 2	0.1025	0.1235	-0.0400	0.0000	0.0	0.4086	0.0000	
137884	2023-08-28 09:35:00	2023-08-28 09:40:00	Vessel 2	0.1113	0.1194	-0.0400	0.0000	0.0	0.4061	0.0000	
137885	2023-08-28 09:40:00	2023-08-28 09:45:00	Vessel 2	0.0895	0.0986	-0.0400	0.0000	0.0	0.4006	0.0000	
137887	2023-08-28 09:45:00	2023-08-28 09:50:00	Vessel 2	0.1265	0.1295	-0.0400	0.0000	0.0	0.3959	0.0000	
137889	2023-08-28 09:50:00	2023-08-28 09:55:00	Vessel 2	0.1095	0.1345	-0.0400	0.0000	0.0	0.3969	0.0000	
...	...	...	...	...	...	...	...	...	...	...	
153941	2023-09-25 06:45:00	2023-09-25 06:50:00	Vessel 2	0.0281	0.1347	5.8139	0.4105	0.0	0.0000	0.7854	
153943	2023-09-25 06:50:00	2023-09-25 06:55:00	Vessel 2	0.0195	0.1565	5.8844	0.4183	0.0	0.0000	0.7832	
153945	2023-09-25 06:55:00	2023-09-25 07:00:00	Vessel 2	0.0317	0.1817	5.8343	0.4083	0.0	0.0000	0.7865	
153947	2023-09-25 07:00:00	2023-09-25 07:05:00	Vessel 2	0.0166	0.2210	5.9644	0.4213	0.0	0.0000	0.7857	
153949	2023-09-25 07:05:00	2023-09-25 07:10:00	Vessel 2	0.0486	0.2097	5.9657	0.4175	0.0	0.0000	0.7886	

886 rows × 44 columns

In [19]:
```
# Plot the time series for 'Speed Over Ground (knots)'
plt.figure(figsize=(14, 7))
plt.plot(df['Start Time'], df['Speed Over Ground (knots)'], label='Speed Over Ground
plt.xlabel('Time')
plt.ylabel('Speed Over Ground (knots)')
```

```
plt.title('Speed Over Ground (knots) Over Time')
plt.legend()
plt.grid(True)
plt.show()
```



In [20]:
```
# Sort the dataframe by 'Start Time' to ensure proper filling
df = df.sort_values(by='Start Time')

# Set 'Start Time' as the index
df.set_index('Start Time', inplace=True)

# Interpolate to fill missing values
df['Speed Over Ground (knots)'] = df['Speed Over Ground (knots)'].interpolate()

# If you need to reset the index back to columns
df.reset_index(inplace=True)
```

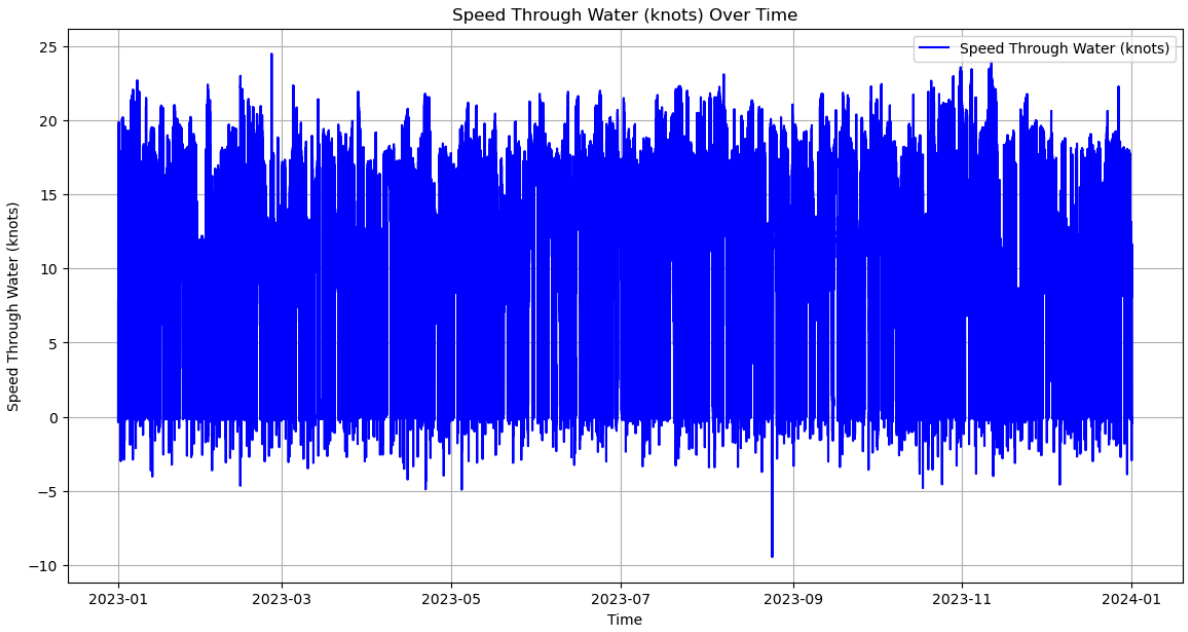
In [21]:
```
# # missing value check
df.isnull().sum()
```

Out[21]:

```
Start Time                                0
End Time                                  0
Vessel Name                               0
Power Galley 1 (MW)                       0
Power Galley 2 (MW)                       0
Power Service (MW)                        0
HVAC Chiller 1 Power (MW)                 0
HVAC Chiller 2 Power (MW)                 0
HVAC Chiller 3 Power (MW)                 0
Scrubber Power (MW)                       0
Sea Temperature (Celsius)                 0
Boiler 1 Fuel Flow Rate (L/h)             0
Boiler 2 Fuel Flow Rate (L/h)             0
Incinerator 1 Fuel Flow Rate (L/h)        0
Diesel Generator 1 Power (MW)             0
Diesel Generator 2 Power (MW)             0
Diesel Generator 3 Power (MW)             0
Diesel Generator 4 Power (MW)             0
Latitude (Degrees)                      326
Longitude (Degrees)                     326
Relative Wind Angle (Degrees)             0
True Wind Angle (Degrees)                60
Depth (m)                             57479
Relative Wind Direction (Degrees)        41
True Wind Direction (Degrees)            60
Draft (m)                              1127
Speed Over Ground (knots)                 0
True Wind Speed (knots)                  60
Relative Wind Speed (knots)               0
Speed Through Water (knots)             927
Local Time (h)                          326
Trim (m)                               1063
Propulsion Power (MW)                     0
Port Side Propulsion Power (MW)           0
Starboard Side Propulsion Power (MW)      0
Bow Thruster 1 Power (MW)                 0
Bow Thruster 2 Power (MW)                 0
Bow Thruster 3 Power (MW)                 0
Stern Thruster 1 Power (MW)               0
Stern Thruster 2 Power (MW)               0
Main Engine 1 Fuel Flow Rate (kg/h)       0
Main Engine 2 Fuel Flow Rate (kg/h)       0
Main Engine 3 Fuel Flow Rate (kg/h)       0
Main Engine 4 Fuel Flow Rate (kg/h)       0
dtype: int64
```

In [22]:

```
# Set 'Start Time' as the index
df.set_index('Start Time', inplace=True)

# Interpolate to fill missing values
df['Speed Through Water (knots)'] = df['Speed Through Water (knots)'].interpolate()

# If you need to reset the index back to columns
df.reset_index(inplace=True)

# Plot the time series for 'Speed Through Water (knots)'
plt.figure(figsize=(14, 7))
plt.plot(df['Start Time'], df['Speed Through Water (knots)'], label='Speed Through W
plt.xlabel('Time')
plt.ylabel('Speed Through Water (knots)')
plt.title('Speed Through Water (knots) Over Time')
plt.legend()
plt.grid(True)
plt.show()
```



In [23]:
```
# Set 'Start Time' as the index
df.set_index('Start Time', inplace=True)

# Interpolate to fill missing values
df['Speed Through Water (knots)'] = df['Speed Through Water (knots)'].interpolate()

# If you need to reset the index back to columns
df.reset_index(inplace=True)

print(df[['Start Time', 'Speed Through Water (knots)']].head())
```

```
           Start Time  Speed Through Water (knots)
0 2023-01-01 00:00:00                       7.8881
1 2023-01-01 00:00:00                      -0.1337
2 2023-01-01 00:05:00                       7.7438
3 2023-01-01 00:05:00                      -0.3794
4 2023-01-01 00:10:00                       7.6320
```

In [24]:
```
df.isnull().sum()
```

Out[24]:
```
Start Time                                0
End Time                                  0
Vessel Name                               0
Power Galley 1 (MW)                       0
Power Galley 2 (MW)                       0
Power Service (MW)                        0
HVAC Chiller 1 Power (MW)                 0
HVAC Chiller 2 Power (MW)                 0
HVAC Chiller 3 Power (MW)                 0
Scrubber Power (MW)                       0
Sea Temperature (Celsius)                 0
Boiler 1 Fuel Flow Rate (L/h)             0
Boiler 2 Fuel Flow Rate (L/h)             0
Incinerator 1 Fuel Flow Rate (L/h)        0
Diesel Generator 1 Power (MW)             0
Diesel Generator 2 Power (MW)             0
Diesel Generator 3 Power (MW)             0
Diesel Generator 4 Power (MW)             0
Latitude (Degrees)                      326
Longitude (Degrees)                     326
Relative Wind Angle (Degrees)             0
True Wind Angle (Degrees)                60
Depth (m)                             57479
Relative Wind Direction (Degrees)        41
True Wind Direction (Degrees)            60
Draft (m)                              1127
Speed Over Ground (knots)                 0
True Wind Speed (knots)                  60
Relative Wind Speed (knots)               0
Speed Through Water (knots)               0
Local Time (h)                          326
Trim (m)                               1063
Propulsion Power (MW)                     0
Port Side Propulsion Power (MW)           0
Starboard Side Propulsion Power (MW)      0
Bow Thruster 1 Power (MW)                 0
Bow Thruster 2 Power (MW)                 0
Bow Thruster 3 Power (MW)                 0
Stern Thruster 1 Power (MW)               0
Stern Thruster 2 Power (MW)               0
Main Engine 1 Fuel Flow Rate (kg/h)       0
Main Engine 2 Fuel Flow Rate (kg/h)       0
Main Engine 3 Fuel Flow Rate (kg/h)       0
Main Engine 4 Fuel Flow Rate (kg/h)       0
dtype: int64
```

Sorting Vessels data to Vessel 1 & Vessel 2

In [25]:
```
# Assuming 'Vessel Name' is the column indicating the vessel
vessel_1_data = df[df['Vessel Name'] == 'Vessel 1']
vessel_2_data = df[df['Vessel Name'] == 'Vessel 2']

# Verify the split
print(vessel_1_data.shape)
print(vessel_2_data.shape)
```

```
(105119, 44)
(105105, 44)
```

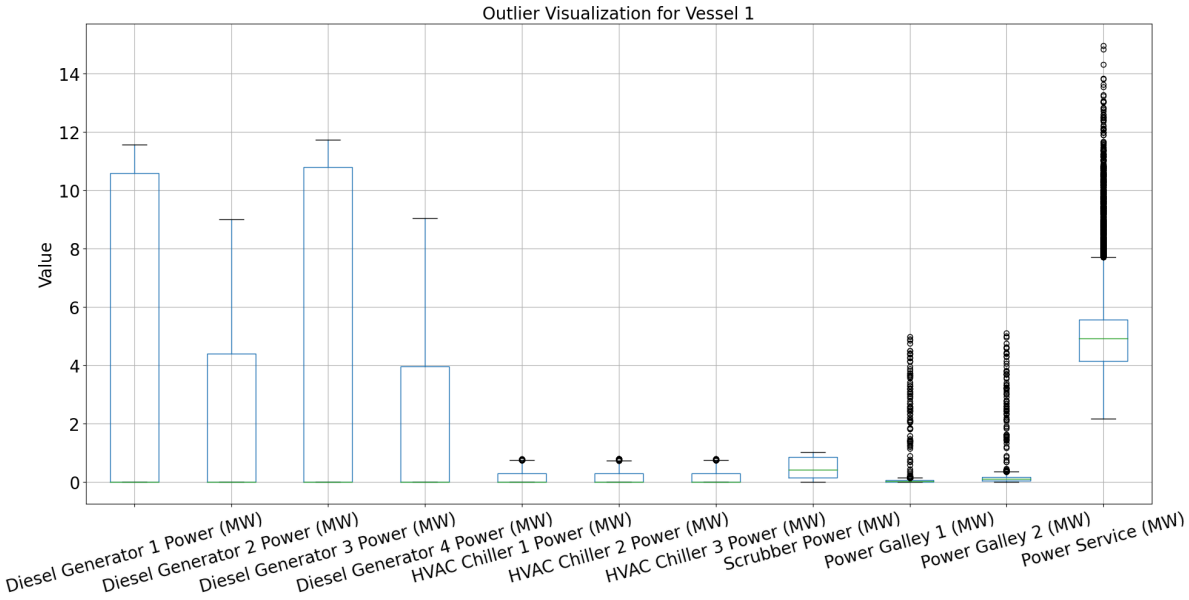
In [26]:
```
df.columns
```

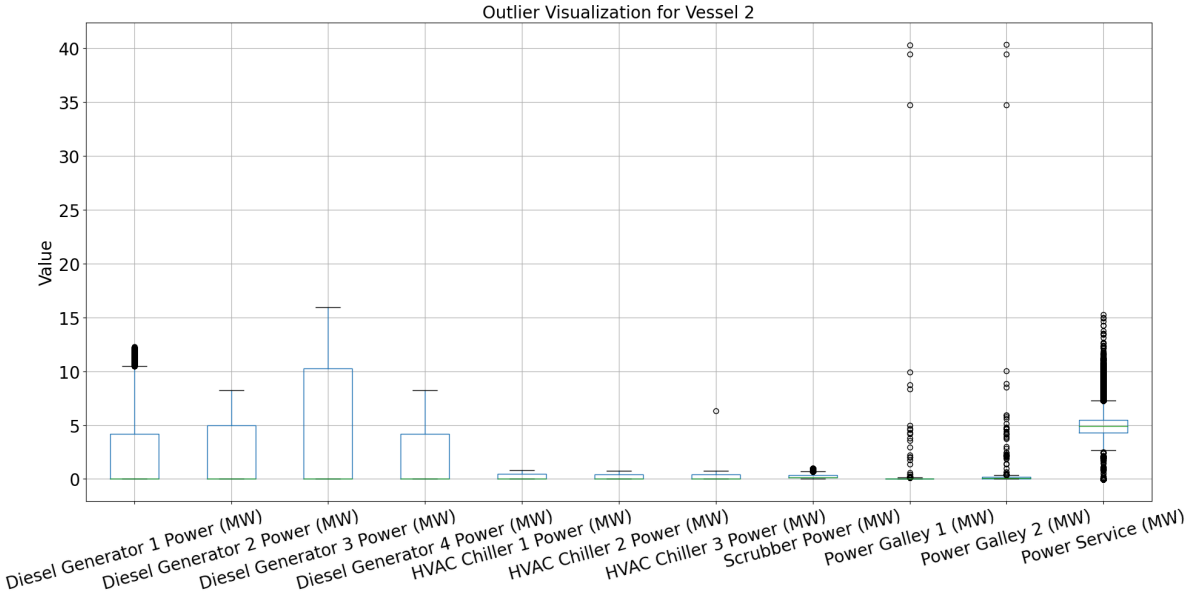
Out[26]:
```
Index(['Start Time', 'End Time', 'Vessel Name', 'Power Galley 1 (MW)',
       'Power Galley 2 (MW)', 'Power Service (MW)',
       'HVAC Chiller 1 Power (MW)', 'HVAC Chiller 2 Power (MW)',
       'HVAC Chiller 3 Power (MW)', 'Scrubber Power (MW)',
       'Sea Temperature (Celsius)', 'Boiler 1 Fuel Flow Rate (L/h)',
       'Boiler 2 Fuel Flow Rate (L/h)', 'Incinerator 1 Fuel Flow Rate (L/h)',
       'Diesel Generator 1 Power (MW)', 'Diesel Generator 2 Power (MW)',
       'Diesel Generator 3 Power (MW)', 'Diesel Generator 4 Power (MW)',
       'Latitude (Degrees)', 'Longitude (Degrees)',
       'Relative Wind Angle (Degrees)', 'True Wind Angle (Degrees)',
       'Depth (m)', 'Relative Wind Direction (Degrees)',
       'True Wind Direction (Degrees)', 'Draft (m)',
       'Speed Over Ground (knots)', 'True Wind Speed (knots)',
       'Relative Wind Speed (knots)', 'Speed Through Water (knots)',
       'Local Time (h)', 'Trim (m)', 'Propulsion Power (MW)',
       'Port Side Propulsion Power (MW)',
       'Starboard Side Propulsion Power (MW)', 'Bow Thruster 1 Power (MW)',
       'Bow Thruster 2 Power (MW)', 'Bow Thruster 3 Power (MW)',
       'Stern Thruster 1 Power (MW)', 'Stern Thruster 2 Power (MW)',
       'Main Engine 1 Fuel Flow Rate (kg/h)',
       'Main Engine 2 Fuel Flow Rate (kg/h)',
       'Main Engine 3 Fuel Flow Rate (kg/h)',
       'Main Engine 4 Fuel Flow Rate (kg/h)'],
      dtype='object')
```

Outlier check of Power Generation

In [27]:
```
power_generation_columns = [
    'Diesel Generator 1 Power (MW)', 'Diesel Generator 2 Power (MW)',
    'Diesel Generator 3 Power (MW)', 'Diesel Generator 4 Power (MW)',
    'HVAC Chiller 1 Power (MW)', 'HVAC Chiller 2 Power (MW)',
    'HVAC Chiller 3 Power (MW)', 'Scrubber Power (MW)',
    'Power Galley 1 (MW)', 'Power Galley 2 (MW)', 'Power Service (MW)'
]

# Assuming 'Vessel Name' is the column indicating the vessel
vessel_1_data = df[df['Vessel Name'] == 'Vessel 1'].copy()
vessel_2_data = df[df['Vessel Name'] == 'Vessel 2'].copy()
```

In [28]:
```
# Function to create box plots for outliers visualization
def plot_outliers(df, columns, vessel_name):
    plt.figure(figsize=(20, 10))
    df[columns].boxplot()
    plt.title(f'Outlier Visualization for {vessel_name}', fontsize=20)
    plt.ylabel('Value', fontsize=20)
    plt.xticks(rotation=15, fontsize=20)  # Change rotation to 0 for horizontal labe
    plt.yticks(fontsize=20)
    plt.grid(True)
    plt.tight_layout()  # Adjust layout to make room for the labels
    plt.show()

# Plot outliers for Vessel 1
plot_outliers(vessel_1_data, power_generation_columns, 'Vessel 1')

# Plot outliers for Vessel 2
plot_outliers(vessel_2_data, power_generation_columns, 'Vessel 2')
```





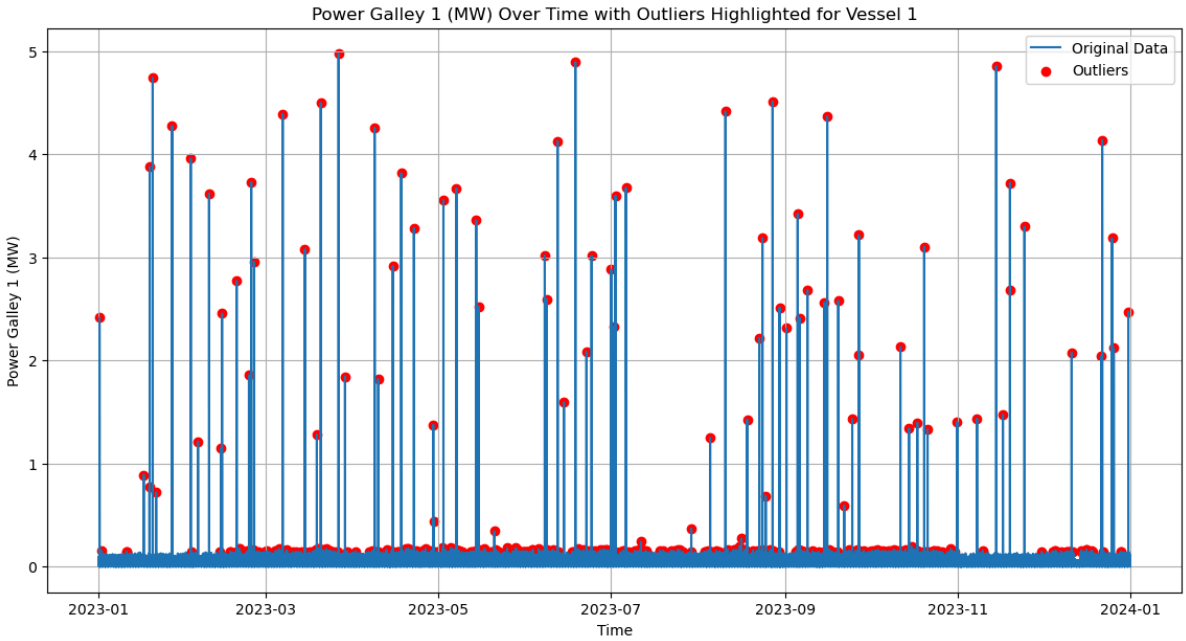
Each outlier check

In [29]:

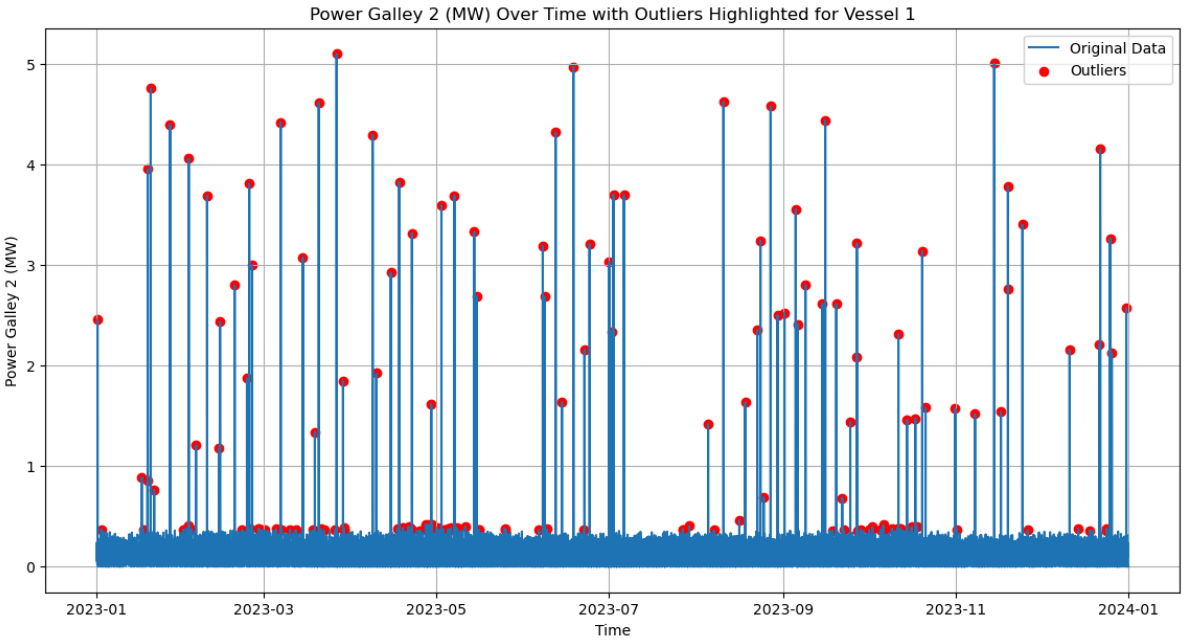
```
# Ensure 'Start Time' is in datetime format and set as index
df['Start Time'] = pd.to_datetime(df['Start Time'])
vessel_1_data.set_index('Start Time', inplace=True)
vessel_2_data.set_index('Start Time', inplace=True)

# Function to detect outliers using IQR method
def detect_outliers(df, column):
    Q1 = df[column].quantile(0.25)
    Q3 = df[column].quantile(0.75)
    IQR = Q3 - Q1
    lower_bound = Q1 - 1.5 * IQR
    upper_bound = Q3 + 1.5 * IQR
    outliers = df[(df[column] < lower_bound) | (df[column] > upper_bound)]
    return outliers

# Function to plot original data with outliers highlighted
def plot_with_outliers(df, column, outliers, vessel_name):
    plt.figure(figsize=(14, 7))
    plt.plot(df.index, df[column], label='Original Data')
    plt.scatter(outliers.index, outliers[column], color='red', label='Outliers')
    plt.xlabel('Time')
    plt.ylabel(column)
    plt.title(f'{column} Over Time with Outliers Highlighted for {vessel_name}')
```

```
    plt.legend()
    plt.grid(True)
    plt.show()

# Function to calculate and print statistical summaries
def print_summaries(df, column, outliers):
    data_without_outliers = df[~df.index.isin(outliers.index)]
    summary_with_outliers = df[column].describe()
    summary_without_outliers = data_without_outliers[column].describe()

    print(f"Summary with Outliers for {column}:₩n", summary_with_outliers)
    print(f"₩nSummary without Outliers for {column}:₩n", summary_without_outliers)

# Columns to check
columns_to_check = ['Power Galley 1 (MW)', 'Power Galley 2 (MW)', 'Power Service (MW

# Vessel 1 Analysis
print("Vessel 1 Analysis:₩n")
for column in columns_to_check:
    outliers_vessel_1 = detect_outliers(vessel_1_data, column)
    plot_with_outliers(vessel_1_data, column, outliers_vessel_1, 'Vessel 1')
    print_summaries(vessel_1_data, column, outliers_vessel_1)

# Vessel 2 Analysis
print("₩nVessel 2 Analysis:₩n")
for column in columns_to_check:
    outliers_vessel_2 = detect_outliers(vessel_2_data, column)
    plot_with_outliers(vessel_2_data, column, outliers_vessel_2, 'Vessel 2')
    print_summaries(vessel_2_data, column, outliers_vessel_2)
```

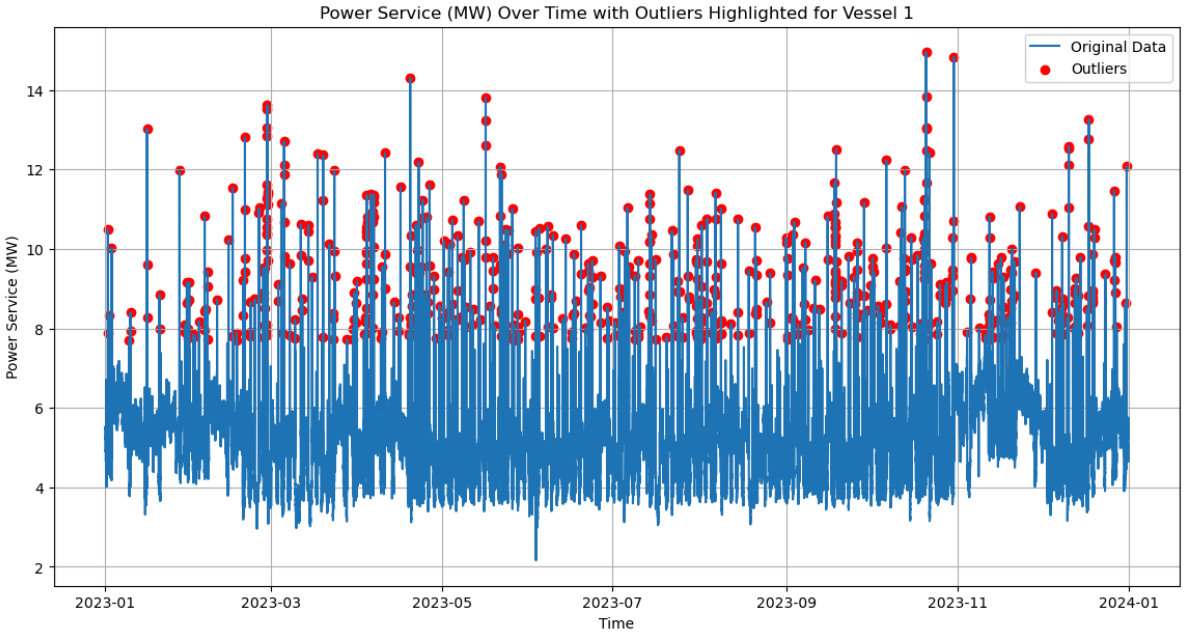
Vessel 1 Analysis:



```
Summary with Outliers for Power Galley 1 (MW):
 count    105119.000000
mean          0.041498
std           0.088231
min           0.000000
25%           0.008800
50%           0.030600
75%           0.061400
max           4.973600
Name: Power Galley 1 (MW), dtype: float64

Summary without Outliers for Power Galley 1 (MW):
 count    104441.000000
mean          0.038812
std           0.035026
min           0.000000
25%           0.008700
50%           0.030300
75%           0.060500
max           0.140300
Name: Power Galley 1 (MW), dtype: float64
```

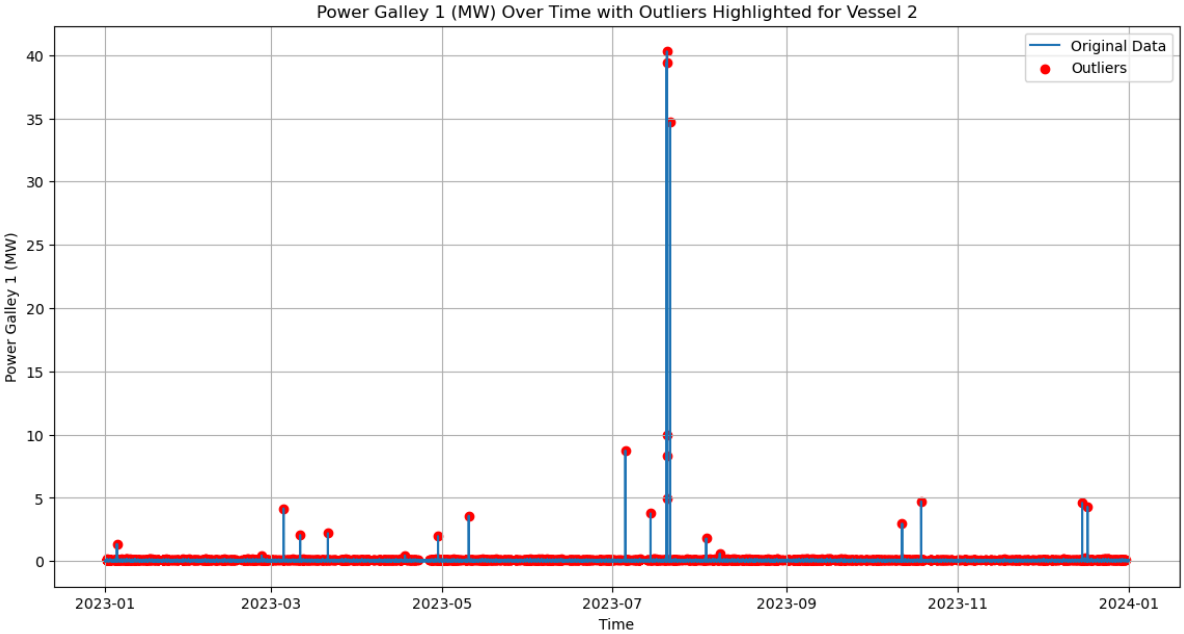



```
Summary with Outliers for Power Galley 2 (MW):
 count    105119.000000
mean          0.119118
std           0.112306
min           0.000000
25%           0.053400
50%           0.106600
75%           0.176000
max           5.097700
Name: Power Galley 2 (MW), dtype: float64

Summary without Outliers for Power Galley 2 (MW):
 count    104942.000000
mean          0.116837
std           0.077931
min           0.000000
25%           0.053300
50%           0.106400
75%           0.175700
max           0.359900
Name: Power Galley 2 (MW), dtype: float64
```

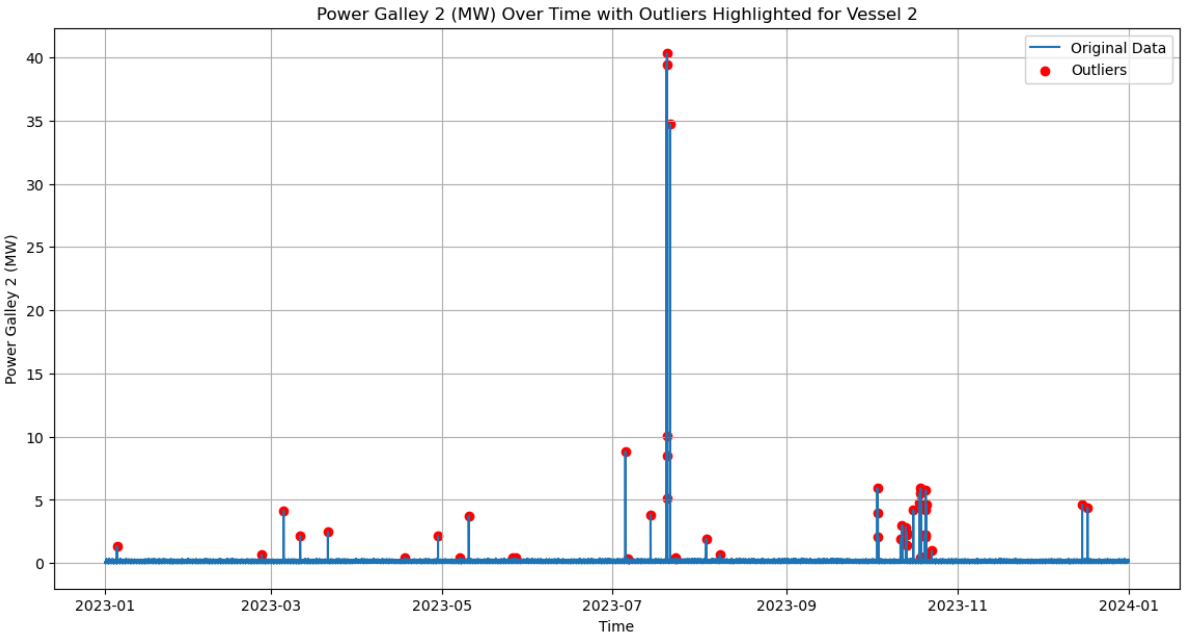



```
Summary with Outliers for Power Service (MW):
 count    105119.000000
mean          4.930506
std           0.924900
min           2.162600
25%           4.141750
50%           4.917700
75%           5.567000
max          14.950500
Name: Power Service (MW), dtype: float64

Summary without Outliers for Power Service (MW):
 count    104478.000000
mean          4.903686
std           0.855240
min           2.162600
25%           4.137200
50%           4.910300
75%           5.553100
max           7.700200
Name: Power Service (MW), dtype: float64
```

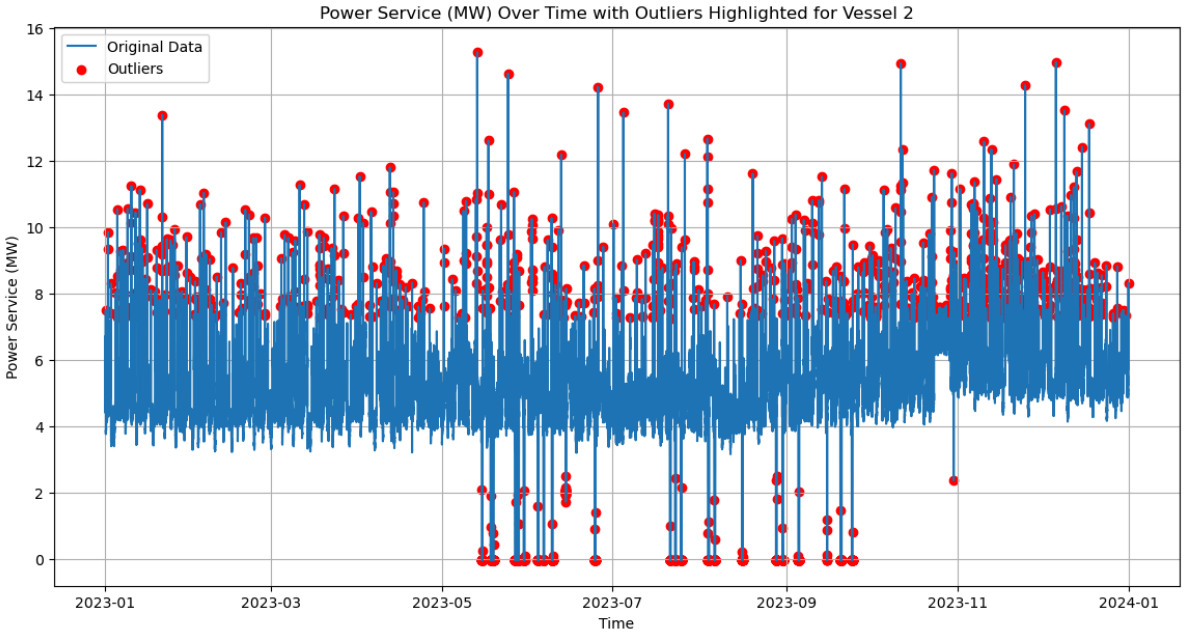
Vessel 2 Analysis:



```
Summary with Outliers for Power Galley 1 (MW):
 count    105105.000000
mean          0.034159
std           0.215483
min           0.000000
25%           0.006400
50%           0.021300
75%           0.048600
max          40.285400
Name: Power Galley 1 (MW), dtype: float64

Summary without Outliers for Power Galley 1 (MW):
 count    103065.000000
mean          0.030652
std           0.030372
min           0.000000
25%           0.006200
50%           0.020700
75%           0.046000
max           0.111900
Name: Power Galley 1 (MW), dtype: float64
```




```
Summary with Outliers for Power Galley 2 (MW):
 count    105105.000000
mean          0.118563
std           0.232160
min           0.000000
25%           0.050000
50%           0.101600
75%           0.181300
max          40.305400
Name: Power Galley 2 (MW), dtype: float64

Summary without Outliers for Power Galley 2 (MW):
 count    105055.000000
mean          0.116177
std           0.078353
min           0.000000
25%           0.050000
50%           0.101500
75%           0.181200
max           0.371700
Name: Power Galley 2 (MW), dtype: float64
```



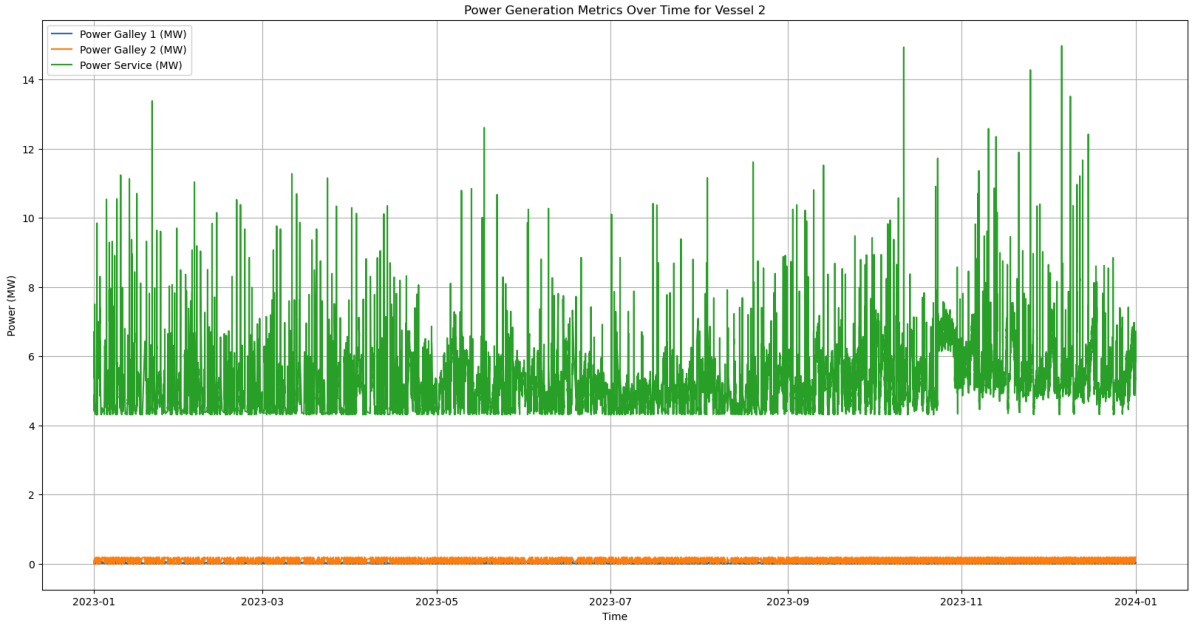

```
Summary with Outliers for Power Service (MW):
 count    105105.000000
mean          4.916077
std           1.097217
min          -0.040000
25%           4.307700
50%           4.915700
75%           5.486500
max          15.264000
Name: Power Service (MW), dtype: float64

Summary without Outliers for Power Service (MW):
 count    101910.000000
mean          4.968452
std           0.788179
min           2.644600
25%           4.328000
50%           4.925250
75%           5.475600
max           7.254300
Name: Power Service (MW), dtype: float64
```

Outliers Delete or keep it depends on the status

In [30]:

```
# Ensure 'Start Time' is in datetime format and set as index
df['Start Time'] = pd.to_datetime(df['Start Time'])
vessel_2_data = df[df['Vessel Name'] == 'Vessel 2'].copy()
vessel_2_data.set_index('Start Time', inplace=True)

# Function to calculate Q1 and Q3
def calculate_q1_q3(df, column):
    Q1 = df[column].quantile(0.25)
    Q3 = df[column].quantile(0.75)
    return Q1, Q3

# Calculate Q1 and Q3 for the relevant columns
q1_pg1, q3_pg1 = calculate_q1_q3(vessel_2_data, 'Power Galley 1 (MW)')
q1_pg2, q3_pg2 = calculate_q1_q3(vessel_2_data, 'Power Galley 2 (MW)')
q1_ps, q3_ps = calculate_q1_q3(vessel_2_data, 'Power Service (MW)')

# Remove outliers
vessel_2_data_cleaned = vessel_2_data[
    (vessel_2_data['Power Galley 1 (MW)'] <= q3_pg1) &
```

```
    (vessel_2_data['Power Galley 2 (MW)'] <= q3_pg2) &
    (vessel_2_data['Power Service (MW)'] >= q1_ps)
]


# Plotting function to visualize the cleaned data (Optional)
def plot_cleaned_data(df, columns, vessel_name):
    plt.figure(figsize=(20, 10))
    for column in columns:
        plt.plot(df.index, df[column], label=column)
    plt.xlabel('Time')
    plt.ylabel('Power (MW)')
    plt.title(f'Power Generation Metrics Over Time for {vessel_name}')
    plt.legend()
    plt.grid(True)
    plt.show()

# Plot the cleaned data for the relevant columns
plot_cleaned_data(vessel_2_data_cleaned, ['Power Galley 1 (MW)', 'Power Galley 2 (MW
```

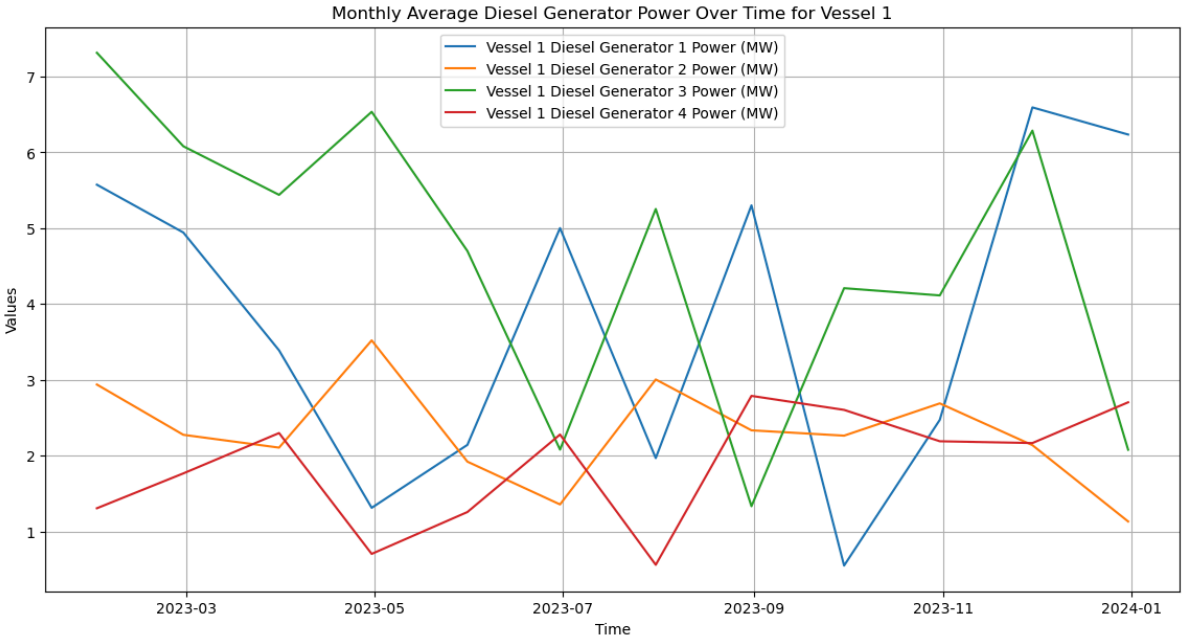


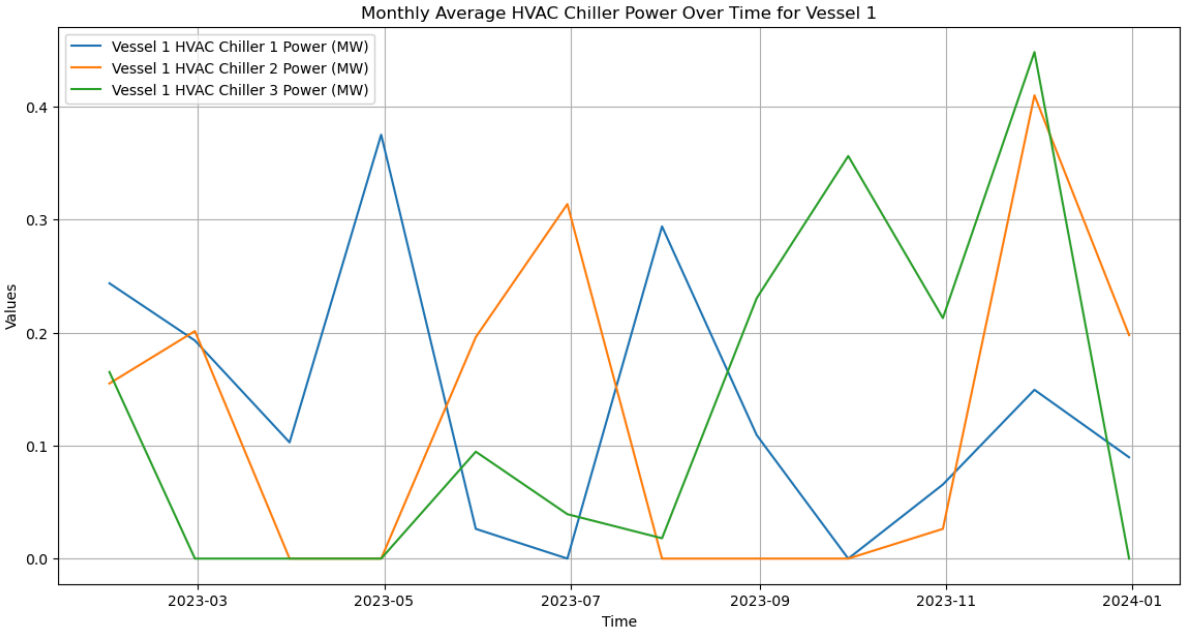
Data Analysis

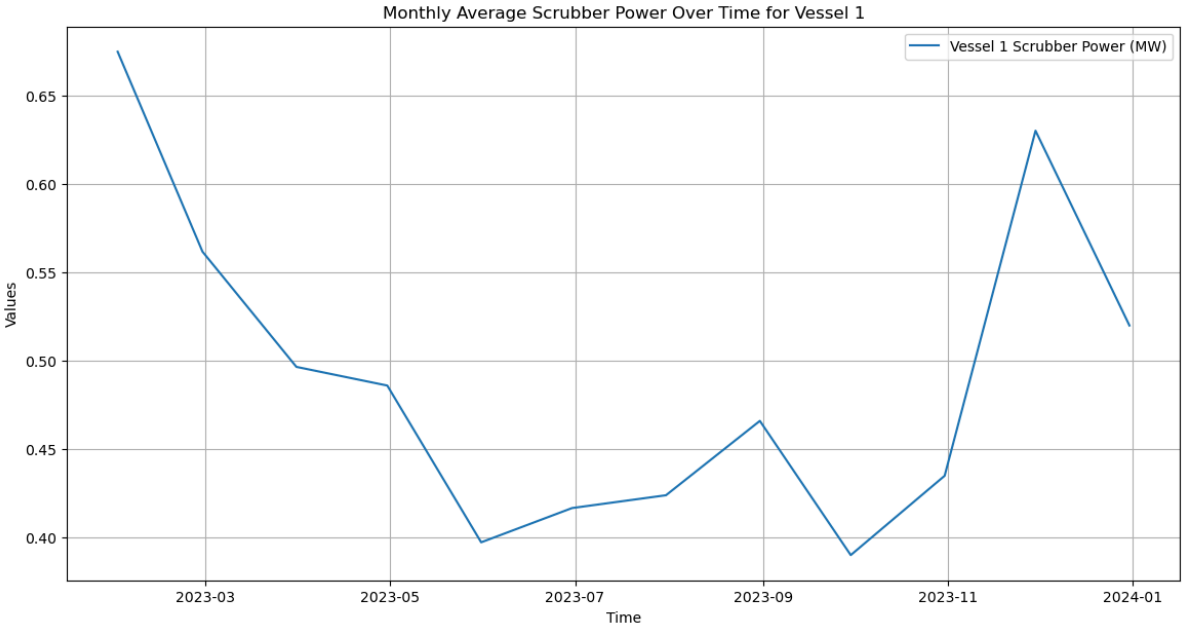
In [31]:
```
# Define categories for Power Generation Analysis
diesel_generators = ['Diesel Generator 1 Power (MW)', 'Diesel Generator 2 Power (MW)
                     'Diesel Generator 3 Power (MW)', 'Diesel Generator 4 Power (MW)
hvac_chillers = ['HVAC Chiller 1 Power (MW)', 'HVAC Chiller 2 Power (MW)', 'HVAC Chi
scrubber_power = ['Scrubber Power (MW)']
power_galley = ['Power Galley 1 (MW)', 'Power Galley 2 (MW)']
power_service = ['Power Service (MW)']

# Combine all columns into a single list
power_columns = diesel_generators + hvac_chillers + scrubber_power + power_galley +

# Ensure all columns are numeric
df[power_columns] = df[power_columns].apply(pd.to_numeric, errors='coerce')

# Assuming 'Vessel Name' is the column indicating the vessel
vessel_1_data = df[df['Vessel Name'] == 'Vessel 1'].copy()
vessel_2_data = df[df['Vessel Name'] == 'Vessel 2'].copy()

# Calculate monthly averages for Vessel 1
```

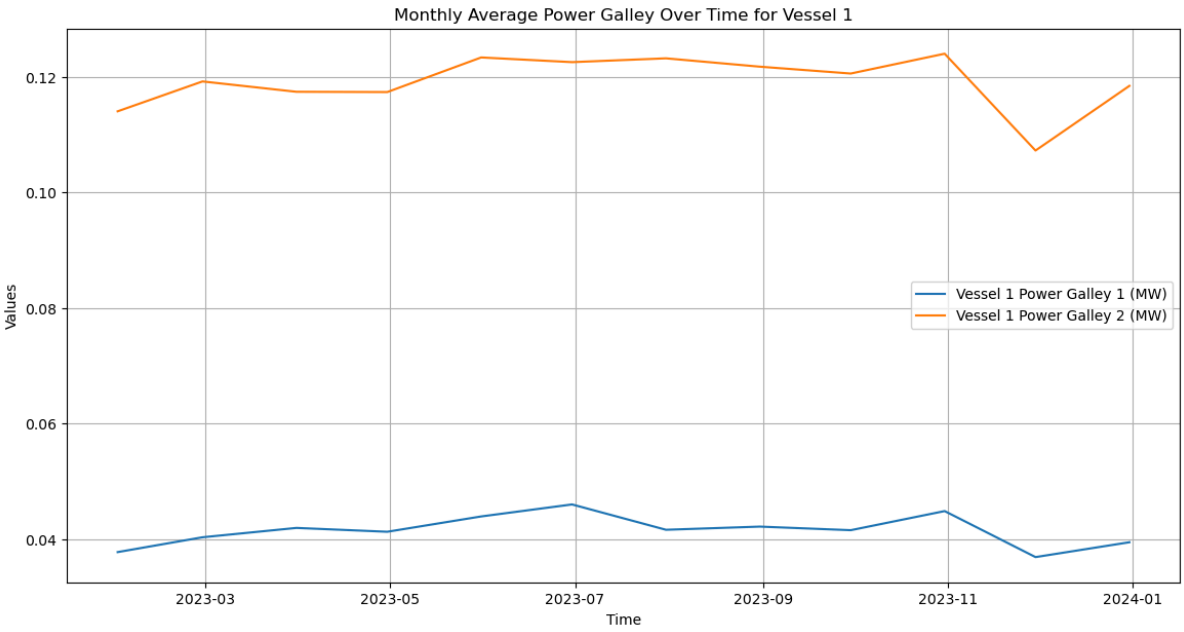
```
vessel_1_data.set_index('Start Time', inplace=True)
vessel_1_monthly_avg = vessel_1_data[power_columns].resample('M').mean()

# Calculate monthly averages for Vessel 2
vessel_2_data.set_index('Start Time', inplace=True)
vessel_2_monthly_avg = vessel_2_data[power_columns].resample('M').mean()

# Function to plot monthly averages for Vessel 1
def plot_monthly_averages_vessel_1(columns, title):
    plt.figure(figsize=(14, 7))
    for column in columns:
        plt.plot(vessel_1_monthly_avg.index, vessel_1_monthly_avg[column], label=f'V
    plt.xlabel('Time')
    plt.ylabel('Values')
    plt.title(f'Monthly Average {title} Over Time for Vessel 1')
    plt.legend()
    plt.grid(True)
    plt.show()

# Function to plot monthly averages for Vessel 2
def plot_monthly_averages_vessel_2(columns, title):
    plt.figure(figsize=(14, 7))
    for column in columns:
        plt.plot(vessel_2_monthly_avg.index, vessel_2_monthly_avg[column], label=f'V
    plt.xlabel('Time')
    plt.ylabel('Values')
    plt.title(f'Monthly Average {title} Over Time for Vessel 2')
    plt.legend()
    plt.grid(True)
    plt.show()

# Plotting for each category for Vessel 1
plot_monthly_averages_vessel_1(diesel_generators, 'Diesel Generator Power')
plot_monthly_averages_vessel_1(hvac_chillers, 'HVAC Chiller Power')
plot_monthly_averages_vessel_1(scrubber_power, 'Scrubber Power')
plot_monthly_averages_vessel_1(power_galley, 'Power Galley')
plot_monthly_averages_vessel_1(power_service, 'Power Service')

# Plotting for each category for Vessel 2
plot_monthly_averages_vessel_2(diesel_generators, 'Diesel Generator Power')
plot_monthly_averages_vessel_2(hvac_chillers, 'HVAC Chiller Power')
plot_monthly_averages_vessel_2(scrubber_power, 'Scrubber Power')
plot_monthly_averages_vessel_2(power_galley, 'Power Galley')
plot_monthly_averages_vessel_2(power_service, 'Power Service')
```

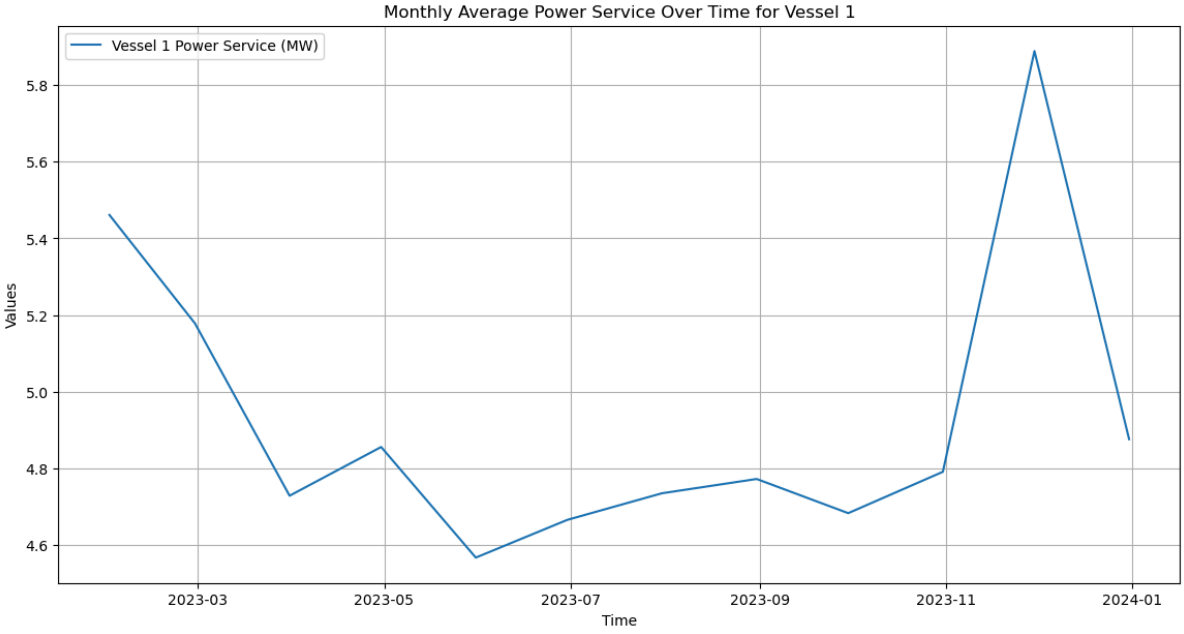
```
C:₩Users₩seoin₩AppData₩Local₩Temp₩ipykernel_2904₩3416136731.py:21: FutureWarning:
'M' is deprecated and will be removed in a future version, please use 'ME' instead.
  vessel_1_monthly_avg = vessel_1_data[power_columns].resample('M').mean()
C:₩Users₩seoin₩AppData₩Local₩Temp₩ipykernel_2904₩3416136731.py:25: FutureWarning:
'M' is deprecated and will be removed in a future version, please use 'ME' instead.
  vessel_2_monthly_avg = vessel_2_data[power_columns].resample('M').mean()
```

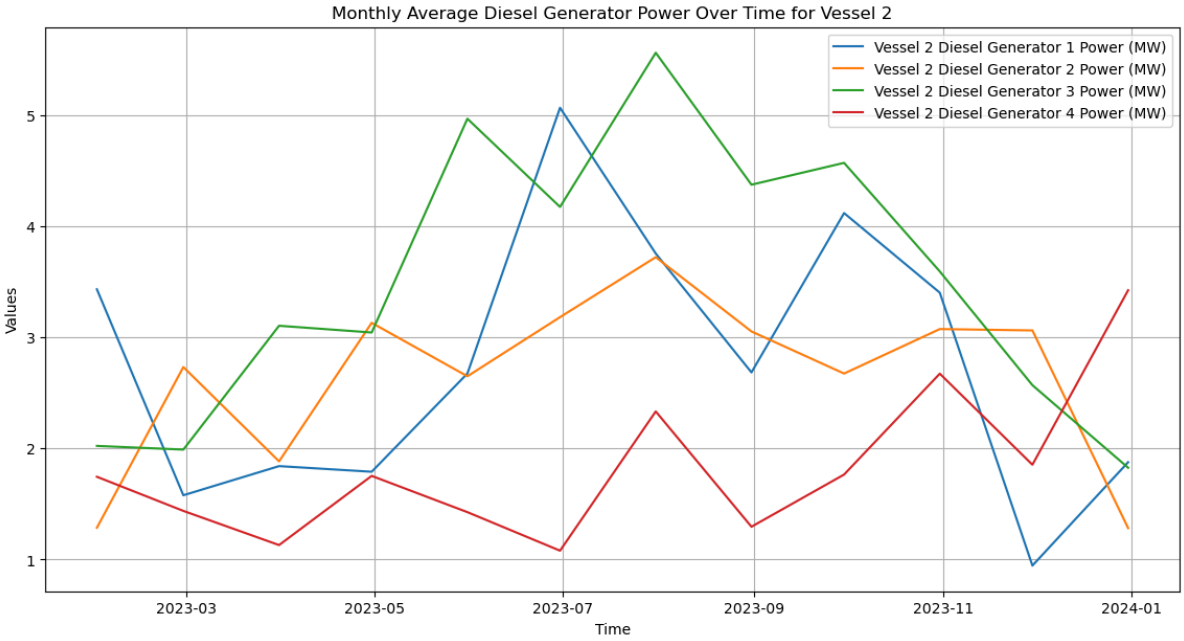

Monthly Average Diesel Generator Power Over Time for Vessel 1
Vessel 1 Diesel Generator 1 Power (MW)
Vessel 1 Diesel Generator 2 Power (MW)
Vessel 1 Diesel Generator 3 Power (MW)
Vessel 1 Diesel Generator 4 Power (MW)
Values
Time
2023-03
2023-05
2023-07
2023-09
2023-11
2024-01

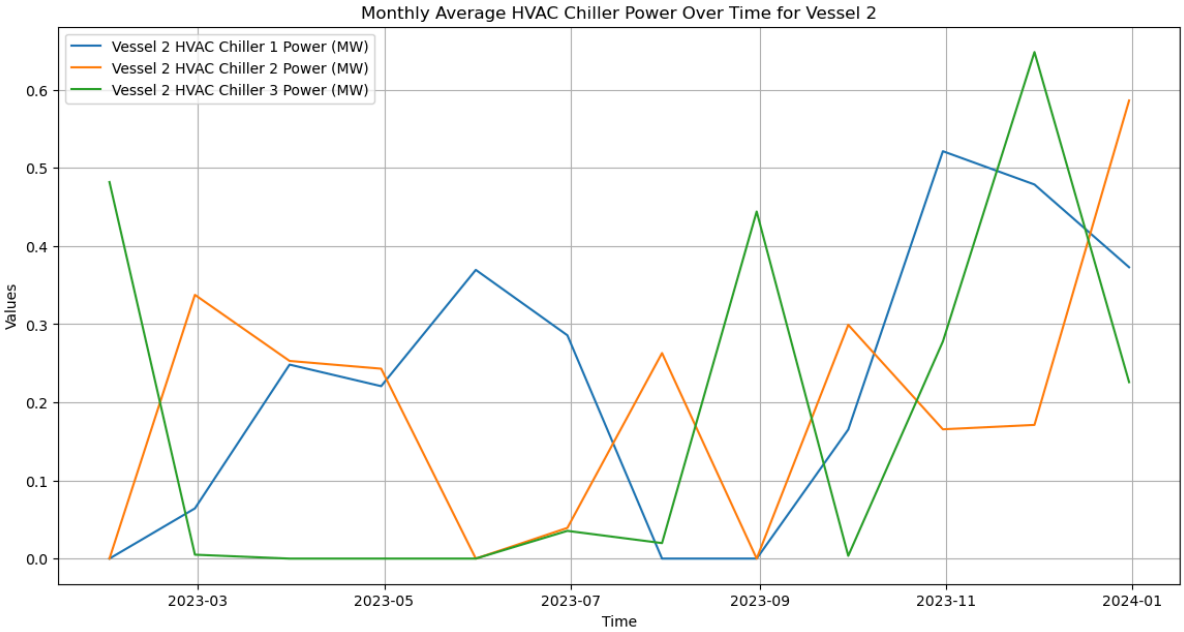

Monthly Average HVAC Chiller Power Over Time for Vessel 1
Vessel 1 HVAC Chiller 1 Power (MW)
Vessel 1 HVAC Chiller 2 Power (MW)
Vessel 1 HVAC Chiller 3 Power (MW)
Values
Time
2023-03
2023-05
2023-07
2023-09
2023-11
2024-01

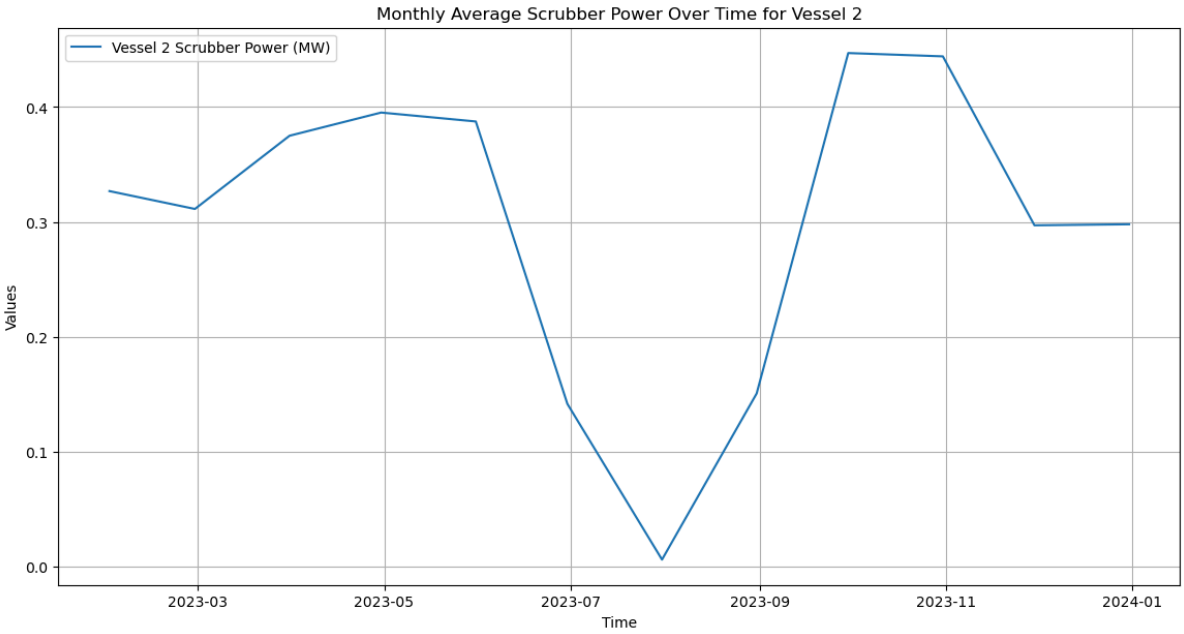

Monthly Average Scrubber Power Over Time for Vessel 1
Vessel 1 Scrubber Power (MW)
Values
Time
2023-03
2023-05
2023-07
2023-09
2023-11
2024-01

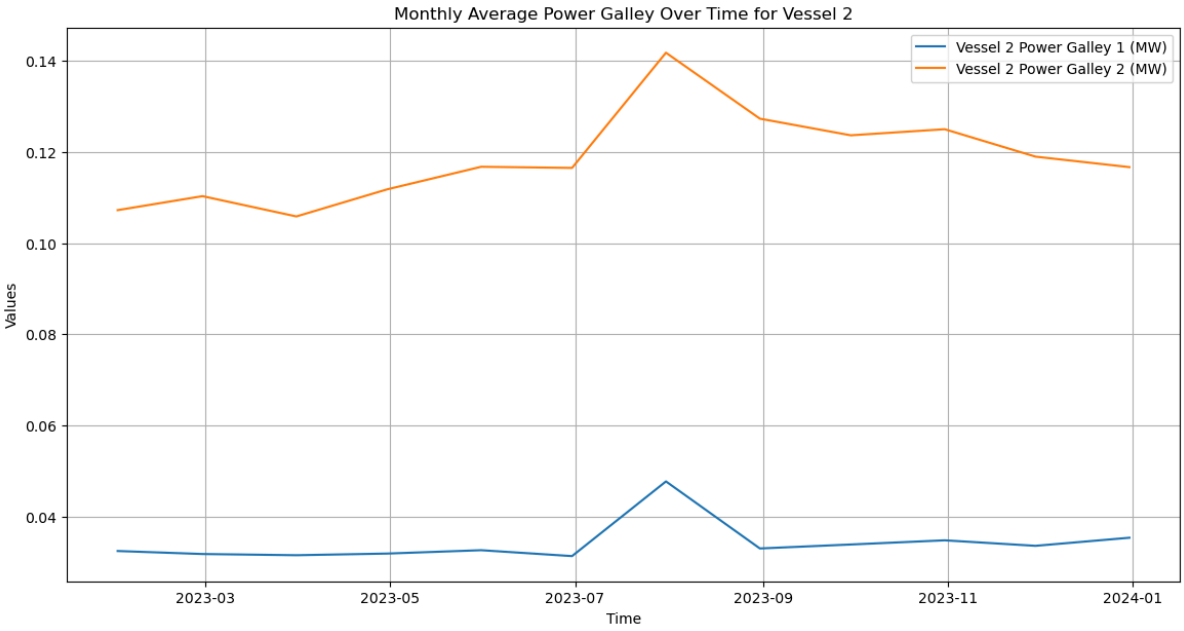

Monthly Average Power Galley Over Time for Vessel 1
Vessel 1 Power Galley 1 (MW)
Vessel 1 Power Galley 2 (MW)
Values
Time
0.12
0.10
0.08
0.06
0.04
2023-03
2023-05
2023-07
2023-09
2023-11
2024-01

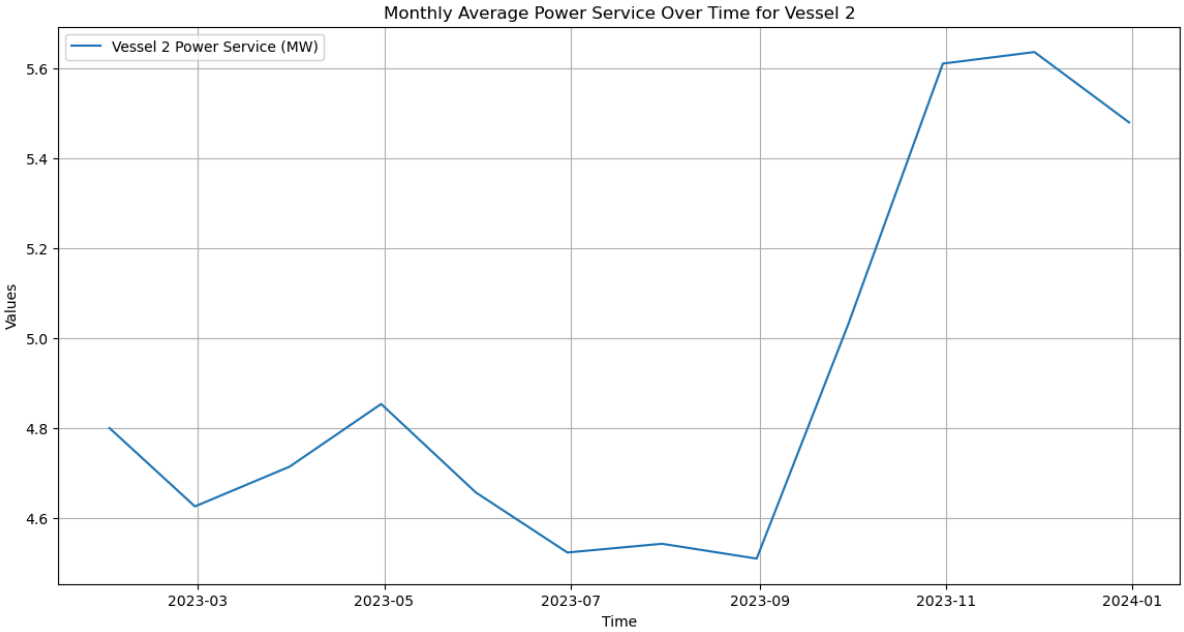

Monthly Average Power Service Over Time for Vessel 1
Vessel 1 Power Service (MW)
Values
Time
5.8
5.6
5.4
5.2
5.0
4.8
4.6
2023-03
2023-05
2023-07
2023-09
2023-11
2024-01


Monthly Average Diesel Generator Power Over Time for Vessel 2
Vessel 2 Diesel Generator 1 Power (MW)
Vessel 2 Diesel Generator 2 Power (MW)
Vessel 2 Diesel Generator 3 Power (MW)
Vessel 2 Diesel Generator 4 Power (MW)
Values
Time
5
4
3
2
1
2023-03
2023-05
2023-07
2023-09
2023-11
2024-01


Monthly Average HVAC Chiller Power Over Time for Vessel 2
Vessel 2 HVAC Chiller 1 Power (MW)
Vessel 2 HVAC Chiller 2 Power (MW)
Vessel 2 HVAC Chiller 3 Power (MW)
Values
Time
0.0
0.1
0.2
0.3
0.4
0.5
0.6
2023-03
2023-05
2023-07
2023-09
2023-11
2024-01


Monthly Average Scrubber Power Over Time for Vessel 2
Vessel 2 Scrubber Power (MW)
Values
Time
0.0
0.1
0.2
0.3
0.4
2023-03
2023-05
2023-07
2023-09
2023-11
2024-01


Monthly Average Power Galley Over Time for Vessel 2
Vessel 2 Power Galley 1 (MW)
Vessel 2 Power Galley 2 (MW)
Values
Time
0.04
0.06
0.08
0.10
0.12
0.14
2023-03
2023-05
2023-07
2023-09
2023-11
2024-01



In [32]:
```
# Combine all columns into a single list
power_columns = diesel_generators + hvac_chillers + scrubber_power + power_galley +

# Ensure all columns are numeric
df[power_columns] = df[power_columns].apply(pd.to_numeric, errors='coerce')

# Ensure 'Start Time' is in datetime format and set as index
df['Start Time'] = pd.to_datetime(df['Start Time'])
vessel_1_data = df[df['Vessel Name'] == 'Vessel 1'].copy()
vessel_2_data = df[df['Vessel Name'] == 'Vessel 2'].copy()
vessel_1_data.set_index('Start Time', inplace=True)
vessel_2_data.set_index('Start Time', inplace=True)

# Calculate monthly averages for Vessel 1
vessel_1_monthly_avg = vessel_1_data[power_columns].resample('M').mean()

# Calculate monthly averages for Vessel 2
vessel_2_monthly_avg = vessel_2_data[power_columns].resample('M').mean()

# Prepare DataFrames for SQL storage
power_vessel_1 = vessel_1_monthly_avg.copy()
power_vessel_1['Vessel'] = 'Vessel 1'

power_vessel_2 = vessel_2_monthly_avg.copy()
power_vessel_2['Vessel'] = 'Vessel 2'

# Combine all results
combined_power_results = pd.concat([power_vessel_1, power_vessel_2])

# Store combined results into SQLite database
combined_power_results.to_sql('power_generation_analysis', conn, if_exists='replace'

# Verify data is stored correctly
query = "SELECT * FROM power_generation_analysis"
df_sql = pd.read_sql_query(query, conn)
print(df_sql.head())

# Close the connection
conn.close()
```

```
            Start Time  Diesel Generator 1 Power (MW)  ₩
0  2023-01-31 00:00:00                       5.573617
1  2023-02-28 00:00:00                       4.943044
2  2023-03-31 00:00:00                       3.389795
3  2023-04-30 00:00:00                       1.313696
4  2023-05-31 00:00:00                       2.143690

   Diesel Generator 2 Power (MW)  Diesel Generator 3 Power (MW)  ₩
0                       2.939083                       7.313376
1                       2.276261                       6.080360
2                       2.107315                       5.439922
3                       3.521354                       6.534617
4                       1.922345                       4.699523

   Diesel Generator 4 Power (MW)  HVAC Chiller 1 Power (MW)  ₩
0                       1.307893                    0.243542
1                       1.767643                    0.192895
2                       2.299480                    0.102834
3                       0.706250                    0.375020
4                       1.258140                    0.026296

   HVAC Chiller 2 Power (MW)  HVAC Chiller 3 Power (MW)  Scrubber Power (MW)  ₩
0                   0.154953                   0.165033             0.675067
1                   0.201288                   0.000000             0.561772
2                   0.000000                   0.000000             0.496456
3                   0.000000                   0.000000             0.485872
4                   0.195975                   0.094598             0.397032

   Power Galley 1 (MW)  Power Galley 2 (MW)  Power Service (MW)    Vessel
0             0.037764             0.114036            5.460985  Vessel 1
1             0.040328             0.119204            5.178252  Vessel 1
2             0.041948             0.117415            4.728527  Vessel 1
3             0.041283             0.117366            4.855669  Vessel 1
4             0.043934             0.123354            4.567114  Vessel 1
C:₩Users₩seoin₩AppData₩Local₩Temp₩ipykernel_2904₩510739112.py:15: FutureWarning: 'M'
is deprecated and will be removed in a future version, please use 'ME' instead.
  vessel_1_monthly_avg = vessel_1_data[power_columns].resample('M').mean()
C:₩Users₩seoin₩AppData₩Local₩Temp₩ipykernel_2904₩510739112.py:18: FutureWarning: 'M'
is deprecated and will be removed in a future version, please use 'ME' instead.
  vessel_2_monthly_avg = vessel_2_data[power_columns].resample('M').mean()
```

Power Generation Performance Trend Analysis Report

Introduction

The power generation performance of vessels is critical to ensure operational efficiency and compliance with environmental standards. This report analyzes the trends in power generation for two vessels over a year. The analysis covers various components such as diesel generators, HVAC chillers, scrubbers, galley power, and power service.

- Diesel Generators Power Analysis

Vessel 1:

The monthly average power generated by Diesel Generators 1-4 shows significant fluctuations throughout the year. Diesel Generator 1 saw a gradual decrease until mid-year and then an increase towards the end of the year. Diesel Generator 2 had relatively stable

power generation with minor fluctuations. Diesel Generator 3 showed high variability with peaks during mid-year and at the end. Diesel Generator 4 had lower but more consistent power generation.

Vessel 2:

Diesel Generators on Vessel 2 also exhibited variability, with Diesel Generator 3 showing the highest fluctuations. Diesel Generator 2 displayed a gradual increase over the year. Diesel Generators 1 and 4 showed relatively stable trends with minor fluctuations.

- HVAC Chillers Power Analysis

Vessel 1:

The HVAC Chiller power consumption showed notable variability. HVAC Chiller 1 had a few peaks during the mid-year but generally maintained lower power consumption. HVAC Chiller 2 and 3 had irregular peaks throughout the year, indicating sporadic high usage periods.

Vessel 2:

HVAC Chiller 1 showed significant fluctuations, particularly towards the end of the year. HVAC Chiller 2 and 3 had erratic usage patterns with notable peaks at various times.

- Scrubber Power Analysis

Vessel 1:

The scrubber power consumption trend decreased during the first half of the year but increased significantly towards the year-end, indicating more extensive use possibly due to stricter emission control periods.

Vessel 2:

Scrubber power usage was relatively low but spiked dramatically in the mid and later parts of the year, suggesting intermittent but intense usage periods.

- Power Galley Analysis

Vessel 1:

Power Galley 1 maintained low and stable power consumption. Power Galley 2 had higher but consistent power consumption throughout the year.

Vessel 2:

Power Galley 1 also showed stable and low power consumption. Power Galley 2 experienced higher power usage, with a peak towards the end of the year.

- Power Service Analysis

Vessel 1:

Power service consumption decreased during the first half but increased towards the end of the year, suggesting variations in operational demand or seasonal changes.

Vessel 2:

Power service consumption had a steady trend with a significant increase at the end of the year.

Conclusion

The power generation trends for both vessels indicate variability across different components. Diesel generators, HVAC chillers, and scrubbers show significant fluctuations, likely due to operational demands and environmental compliance requirements. Stable components like power galley indicate consistent energy usage patterns. Monitoring these trends helps in optimizing power management strategies and ensuring efficient vessel operations.

In [ ]: