Vessel Performance: KPI Analysis and Recommendations

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1. Task Description

This task involved analyzing vessel operational data, focusing on key performance indicators (KPIs), and proposing improvements.

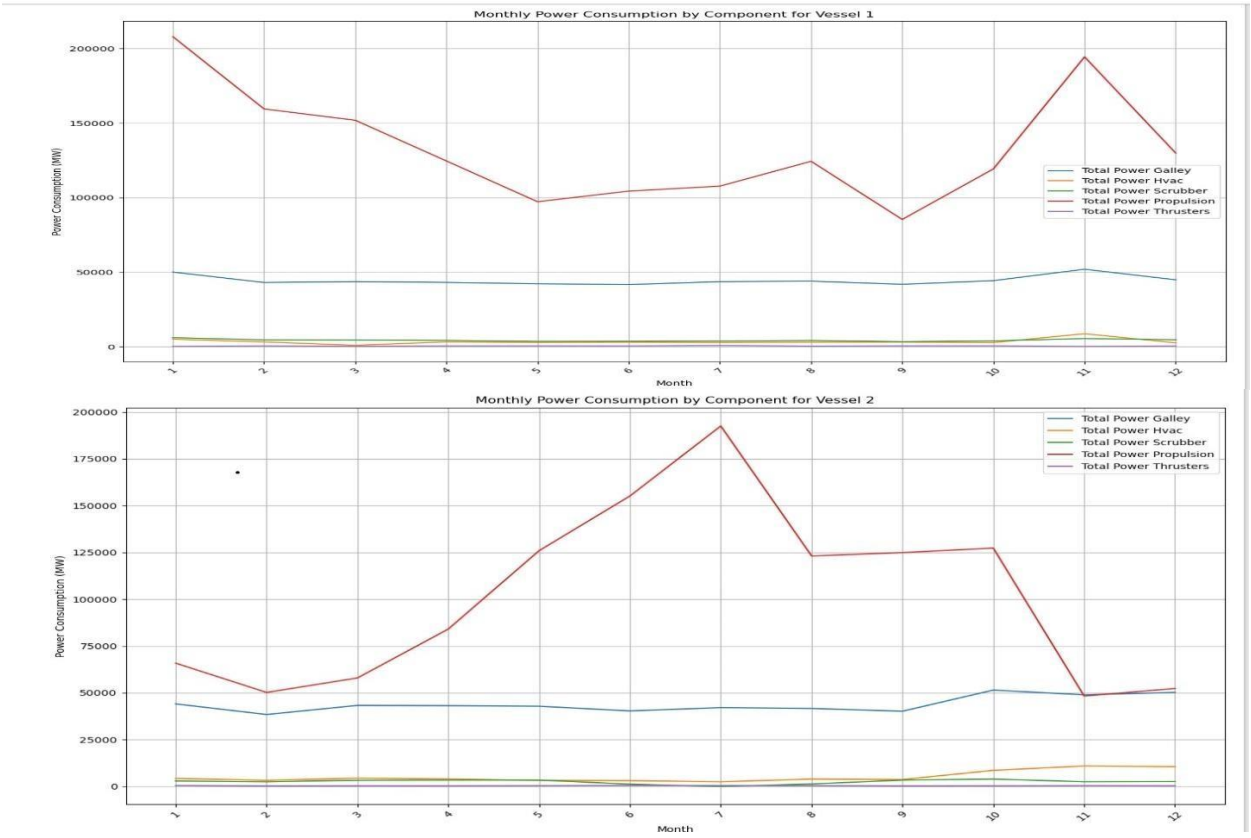
2. Overview

I performed descriptive analysis, exploratory data analysis (EDA), and feature engineering to get an overview of the provided data. I handled missing values and created new features such as distance traveled. The analysis examined various KPIs related to power consumption, power generation, and fuel consumption efficiencies to analyze the overall performance of vessels.

3. KPI Analysis and Recommendations

3.1. Category: Power Consumption

3.1.1 KPI: Analysis of Power Consumption of different components of both cruises.



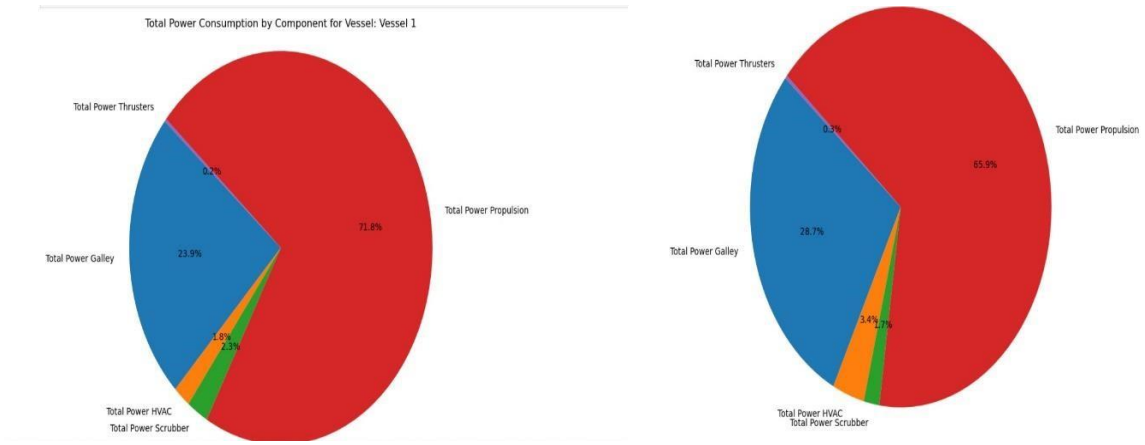


Figure 1: Power Consumption for different systems of Vessels

- **Analysis:** The most power is being consumed for propulsion in the cruise.
- **Improvements:** When modifications are implemented, it is essential for technicians to focus on reducing power consumption for propulsion.

3.1.2 KPI: Analysis of Power Consumption Relative to Sea Temperature.

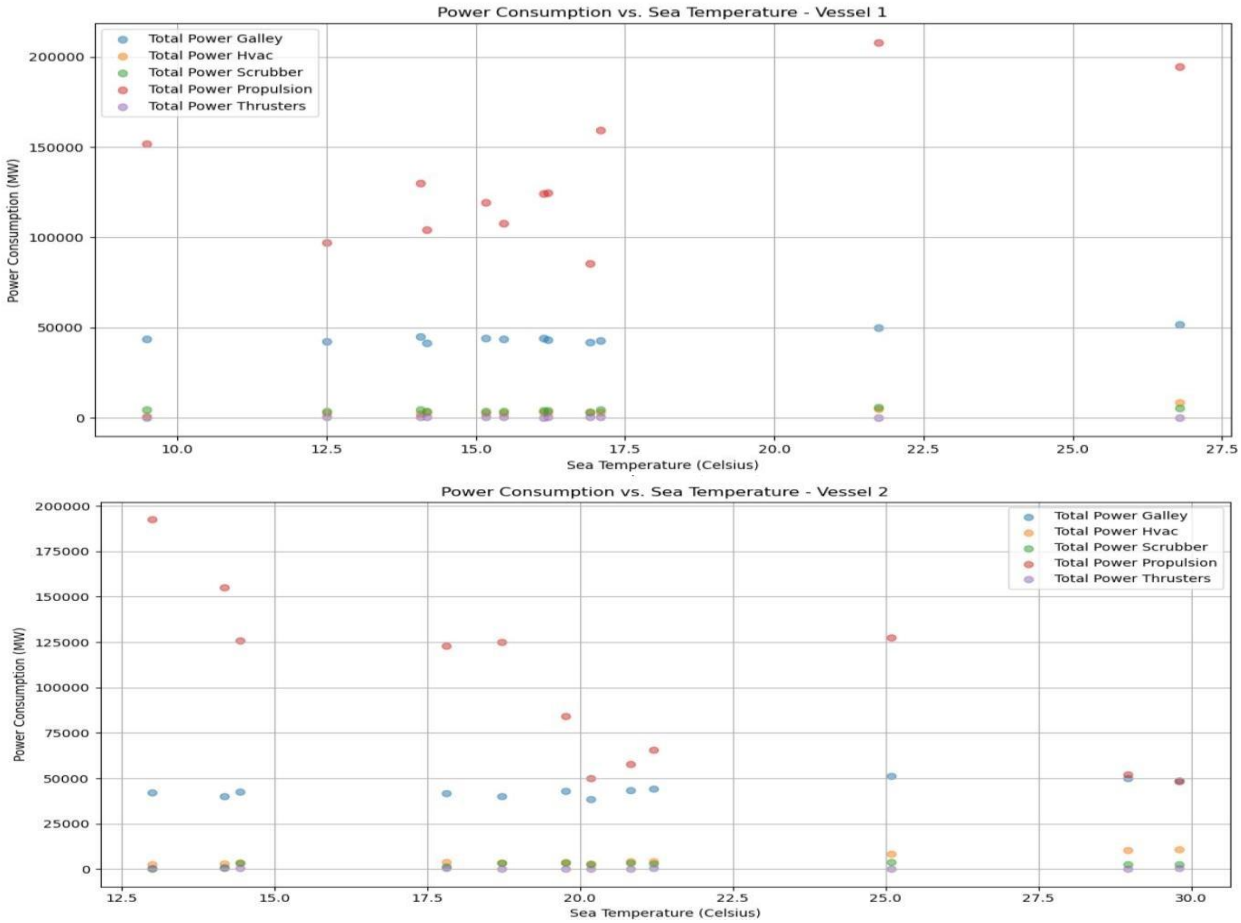


Figure 2: Power Consumption over Sea Temperature for both Vessels

- **Analysis:** As sea temperature increases, power consumption also rises, particularly for propulsion, galley, and HVAC systems.
- **Improvements:** To mitigate this, the vessel should use energy-efficient systems, improve insulation, and train the crew to minimize power use when sea temperatures rise.

3.2 Category: Power Generation

3.2.1 KPI: Analysis of Power Generation by Diesel Generators of Cruises.

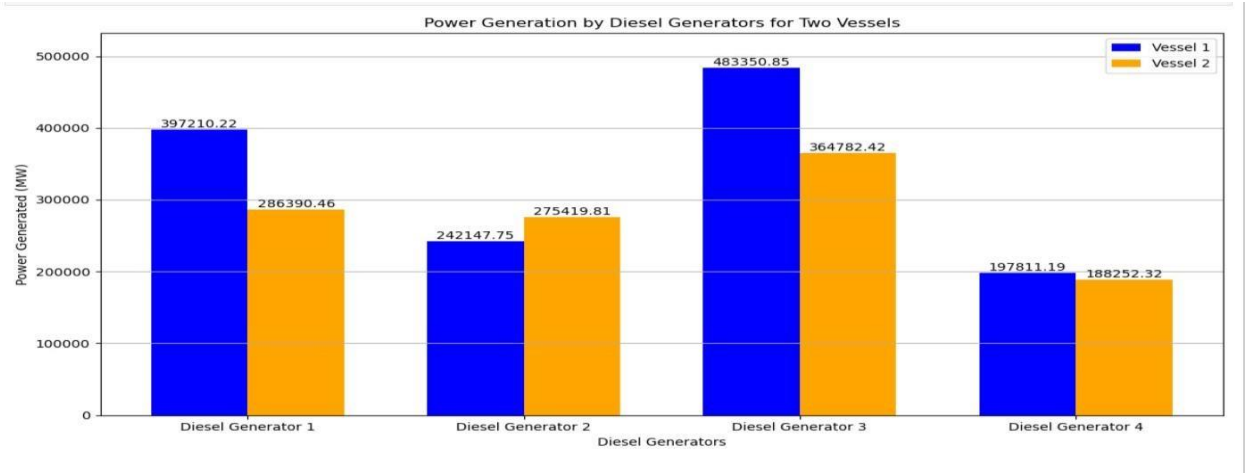


Figure 3: Power Generation by the generators of both Vessels

- **Analysis:** The most power is generated by Generator 3 for both vessels, and the least power is generated by Generator 4.
- **Improvements:** Enhance the efficiency of Generator 3 and explore improvements to boost the performance of Generator 4.

3.2.2 KPI: Power Generation Efficiency relative to Total Propulsion Power (inclusive of Starboard Side, Port Side, etc.).

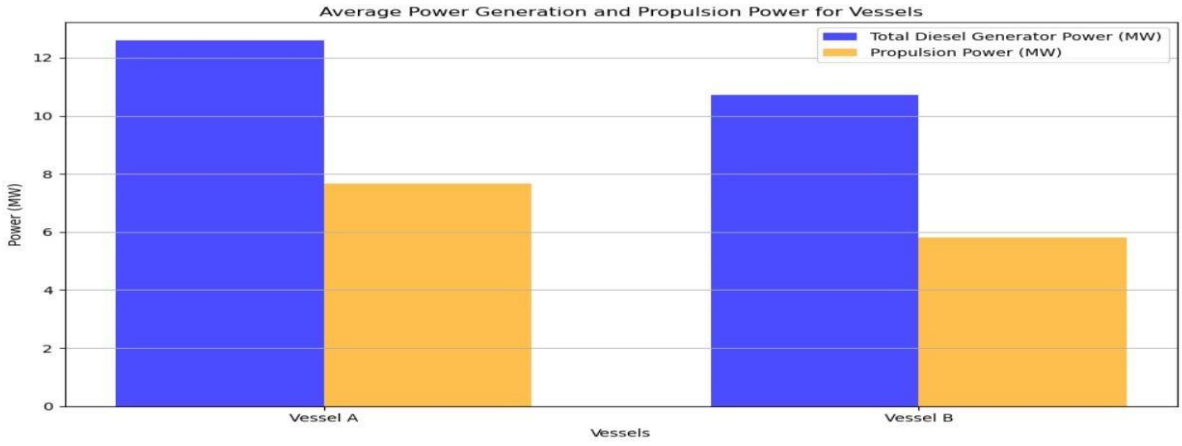


Figure 4: Power Generation Efficiency relative to Propulsion Power for both Vessels

- **Analysis:** The power generation efficiency is lower when compared to the total propulsion power required or consumed by both vessels.
- **Improvements:** Upgrade generators, optimize fuel use, and maintain equipment regularly to improve power generation efficiency.

3.2.3 KPI: Power Generation Efficiency relative to Propulsion Power (exclusive of Starboard Side, Port Side, etc.).

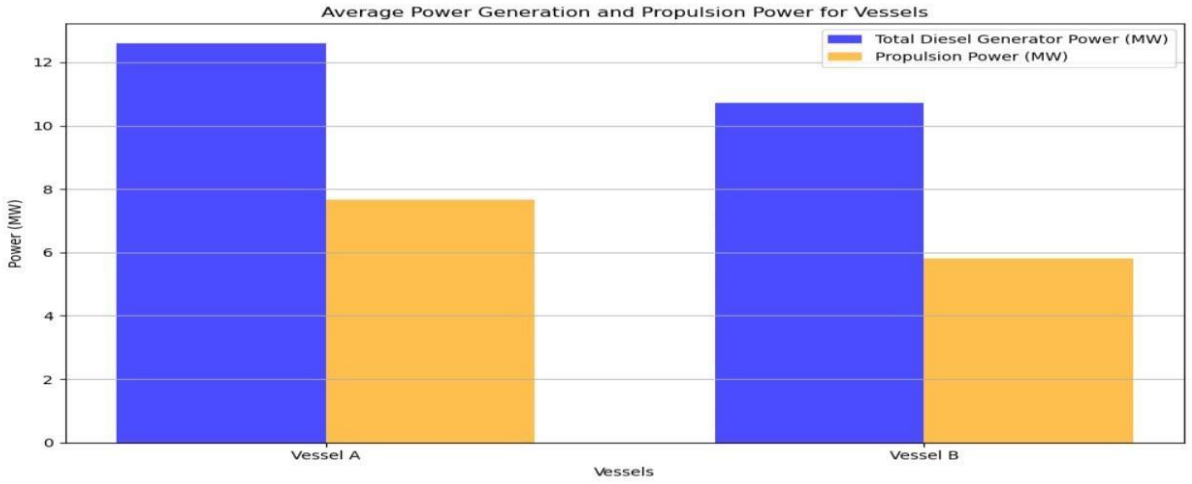
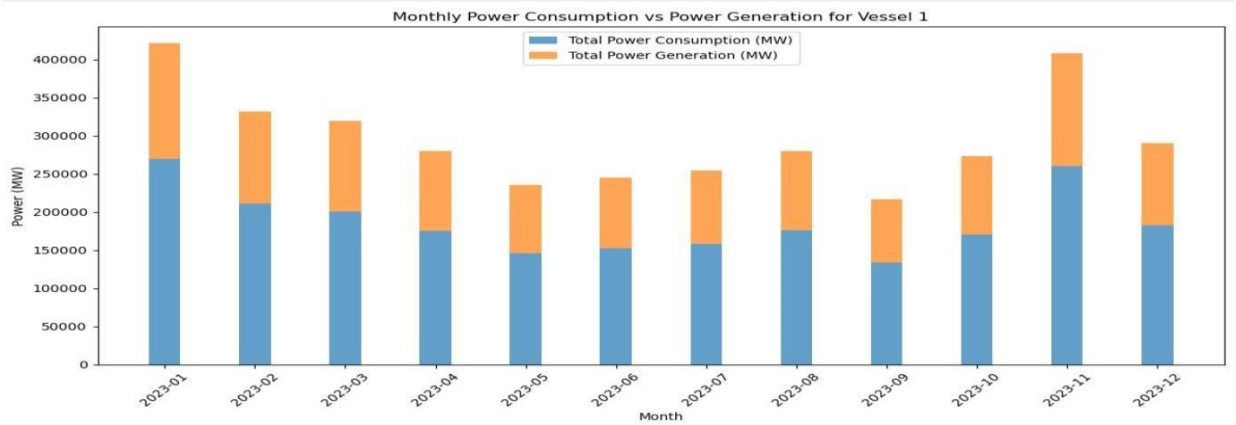


Figure 5: Power Generation Efficiency relative to Propulsion Power for both Vessels

- **Analysis:** The power generation efficiency relative to general propulsion power is better but not with the total propulsion power.
- **Improvements:** Upgrade generators, manage loads better, keep equipment well-maintained, and use energy recovery systems to improve power generation efficiency.

3.3 Category: Overall Vessels Performance

3.3.1 KPI: Monthly Power Generation relative to Monthly Power Consumption.



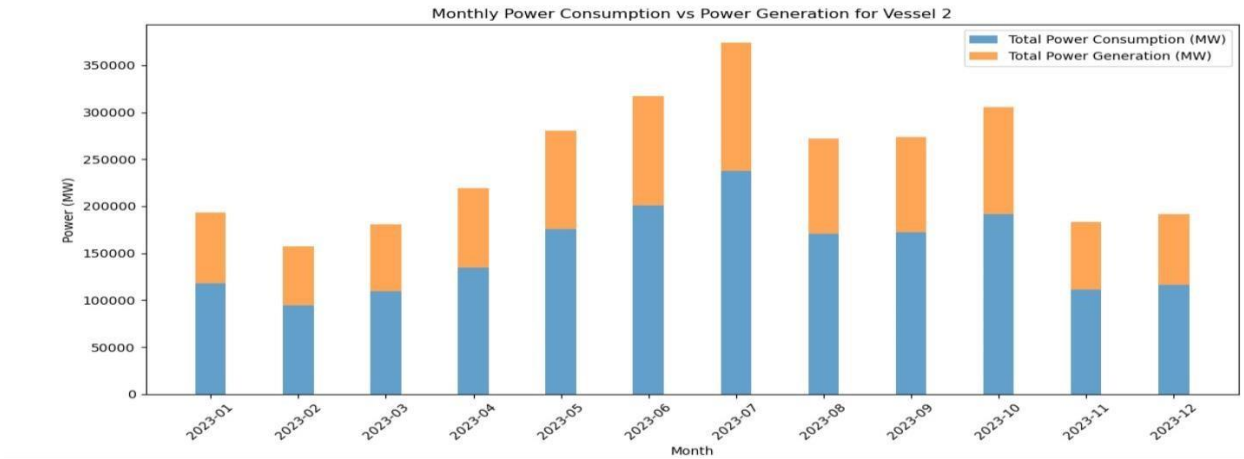


Figure 6: Power Generation Vs Consumption

- **Analysis:** It shows that the overall performance of both vessels in terms of Energy Efficiency is good. It generates sufficient amount of power which is required.
- **Improvements:** By adopting the latest technologies, utilizing renewable energy sources, and optimizing systems, we can significantly enhance energy efficiency and performance.

3.3.2 KPI: Power Efficiency Ratio (Power Generation vs Power Consumption)

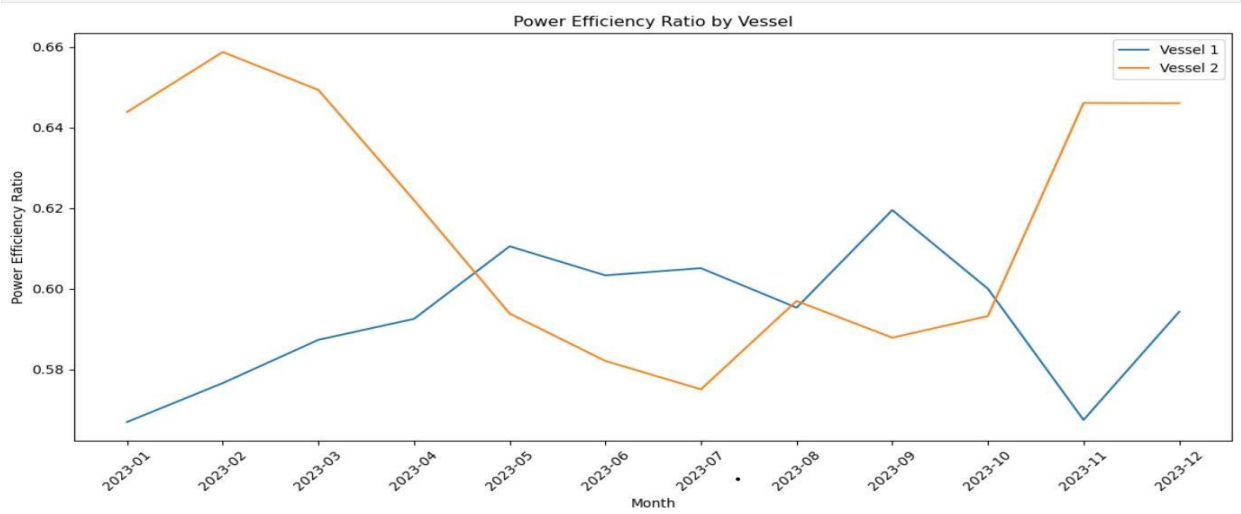


Figure 7: Power Efficiency Ratio

- **Analysis:** Vessel 1 (blue line) steadily improved, reaching its highest point in the middle of the year. Vessel 2 (orange line) had more ups and downs, dropping in the middle of the year but improving a lot towards the end. Vessel 1 was more stable, while Vessel 2's efficiency changed more often.
- **Improvements:** Vessel 2 needs to focus on maintaining consistent power efficiency throughout the year.

3.3.3 KPI: Energy Efficiency Ratio (MWh/kg/h) by Vessel

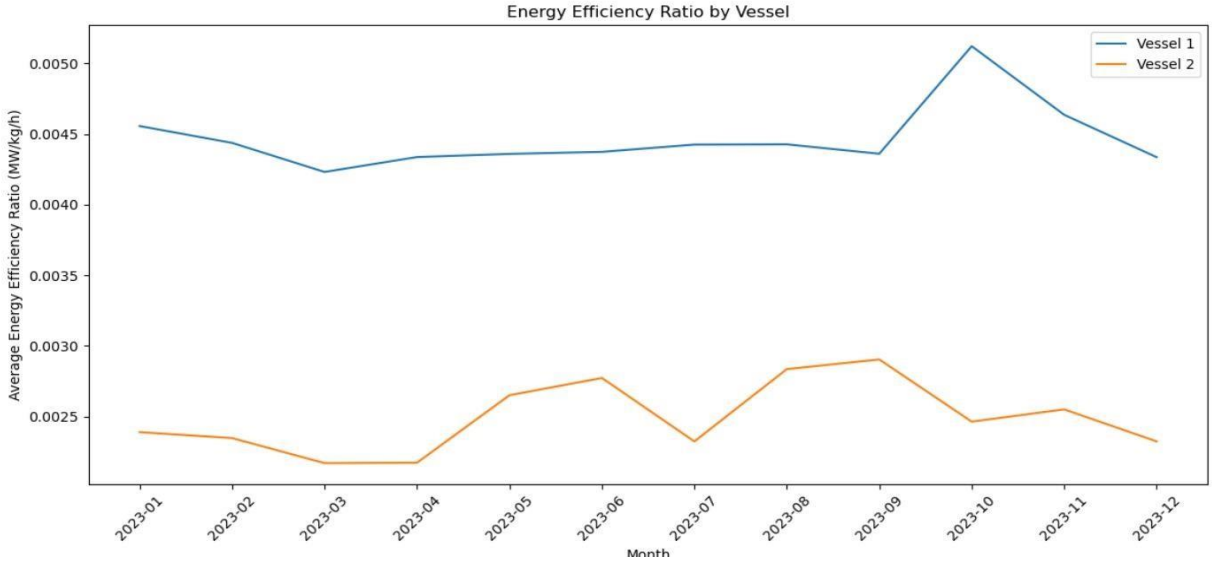


Figure 8: Energy Efficiency

- **Analysis:** Vessel 1 maintains a higher and relatively stable energy efficiency throughout 2023, while Vessel 2 remains lower and fluctuates, peaking mid-year but dropping towards the end.
- **Improvements:** Vessel 2 should focus on improving and stabilizing its energy efficiency to match Vessel 1's consistent performance.

3.3.4 KPI: Specific Power Consumption Efficiency Relative to Speed (MWh/knot)

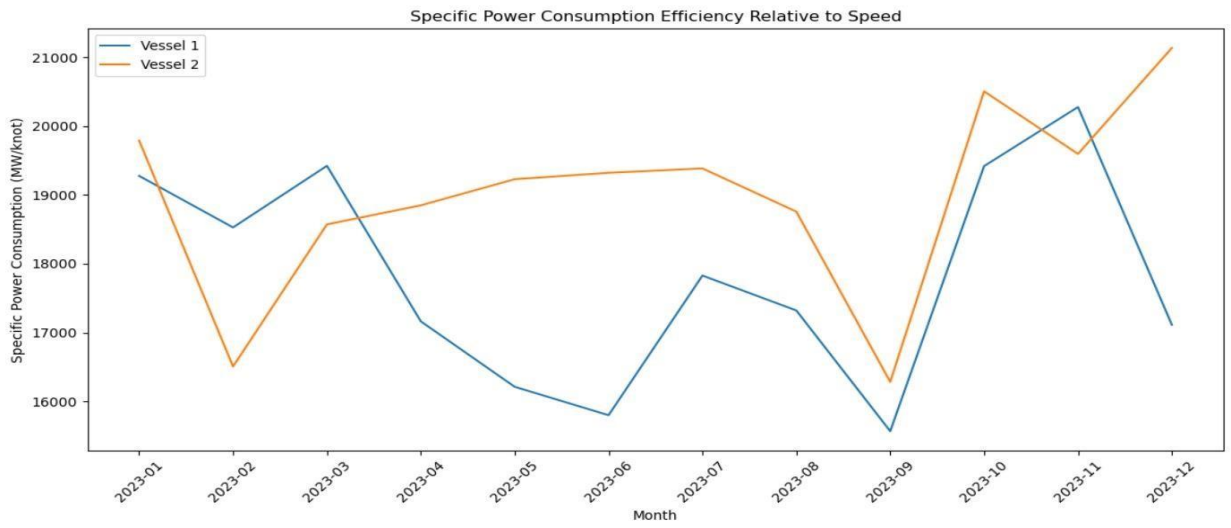


Figure 9: Specific Power Consumption Efficiency

- **Analysis:** This plot analyzes how the vessels efficiently use the power when the speed of the vessels increases. Vessel 1 fluctuates throughout the year, peaking in November before dropping sharply in December. Vessel 2 performs more consistently, peaking in December with a steady rise towards the end. Overall, Vessel 2 shows more stability, while Vessel 1 is more volatile.

- **Improvements:** Vessel 1 should work on being more consistent and keeping its efficiency higher, especially in the second half of the year, to match Vessel 2's steadier performance at the end of the year.

3.3.5 KPI: Fuel Efficiency Ratio by Vessel (nm/kg)

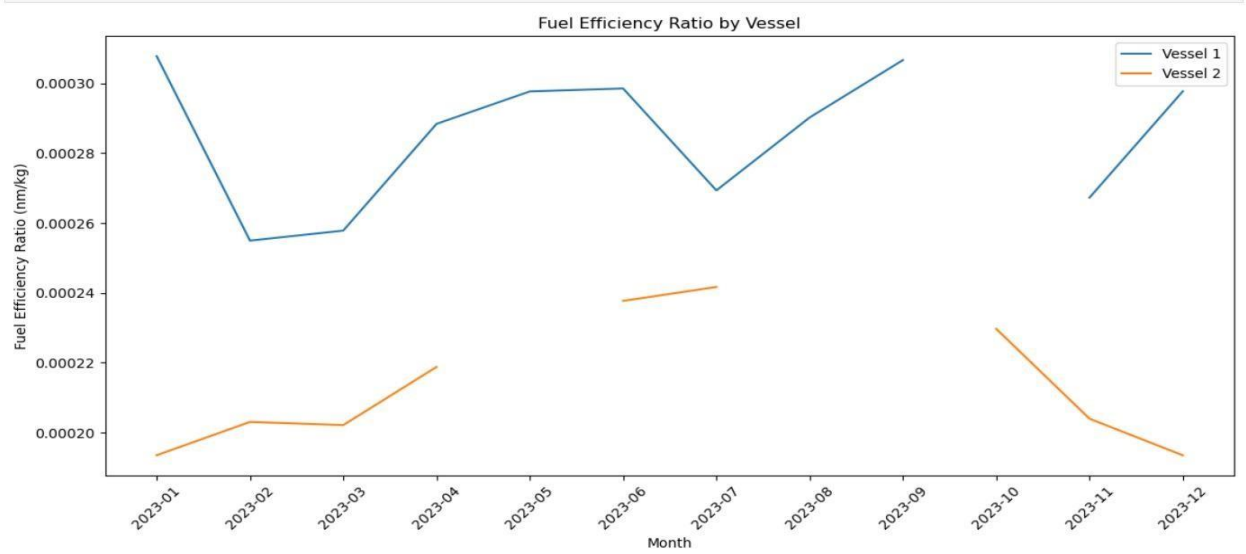


Figure 10: Fuel Efficiency Ratio

- **Analysis:** This plot shows how efficiently the vessels use fuel based on distance traveled, with gaps showing periods when they didn't move. Vessel 1 performs better, with higher fuel efficiency and peaks in January, mid-year, and December. Vessel 2 has lower efficiency and a decline towards the end of the year.

- **Improvements:** Vessel 2 should focus on improving fuel efficiency, especially towards the end of the year, and aim for more consistent performance like Vessel 1.

Note:

Another way to load the data for this analysis would be to write a Python script to import the CSV data into a database and then connect to that database from the notebook. But here, I am using a CSV file because it's simpler and easier to work with. It doesn't need any setup like a database, and the file can be easily shared and used directly.