Performance Trends of Two Vessels Based on KPIs

# 1. Fuel Efficiency (kg/MW) Over Time

What it shows: This graph plots the fuel efficiency of the two vessels over time. Fuel efficiency is calculated as the total fuel consumed (in kg) per megawatt (MW) of propulsion power generated.  
  
Trends:  
- Fluctuations in fuel efficiency are visible for both vessels. These fluctuations could be due to varying operational conditions (e.g., weather, load conditions, speed).  
- If the trend shows rising values, it indicates less efficient fuel usage, meaning more fuel is being consumed per unit of power. Conversely, declining values represent better fuel efficiency.  
- Vessel 2 appears to show more consistent fuel efficiency, while Vessel 1 may experience more variance, potentially indicating changing operational conditions.

# 2. HVAC Power Consumption (%) Over Time

What it shows: This graph represents the percentage of total service power consumed by the HVAC (Heating, Ventilation, and Air Conditioning) system over time.  
  
Trends:  
- The HVAC power consumption seems relatively stable for both vessels, with some minor fluctuations.  
- Vessel 2 appears to have slightly higher HVAC power consumption than Vessel 1. This may suggest that Vessel 2 requires more energy for temperature regulation, possibly due to different environmental conditions or vessel design.  
- Steady HVAC consumption is expected, as this system typically runs consistently during voyages to ensure proper temperature regulation for passengers and cargo.

# 3. Scrubber Power Consumption (%) Over Time

What it shows: The scrubber system is responsible for cleaning exhaust gases to comply with environmental regulations, such as reducing sulfur emissions. The graph shows scrubber power consumption as a percentage of total power.  
  
Trends:  
- Vessel 1 and Vessel 2 both show consistent scrubber power consumption over time, with minor variations.  
- Vessel 2 shows slightly higher scrubber power usage, indicating that it may have stricter emissions control needs or be operating under more stringent environmental conditions.  
- If a vessel shows increasing scrubber power consumption, it may reflect higher operational loads or changing emissions control requirements.

# 4. EEOI (Energy Efficiency Operational Indicator) Over Time

What it shows: The EEOI is a measure of how efficiently the vessel operates, calculated as the fuel consumed per nautical mile. It is a critical performance indicator for emissions and energy efficiency.  
  
Trends:  
- Both vessels show a fluctuating EEOI, with Vessel 1 displaying slightly higher EEOI values on average. Higher values suggest less efficient operation, where more fuel is consumed for each nautical mile traveled.  
- Vessel 2 appears more energy-efficient overall, maintaining lower EEOI values.  
- Operational factors like weather conditions, load, and routing affect the EEOI trends. Spikes in the EEOI may indicate suboptimal operational conditions like rough seas or increased fuel consumption.

# 5. SFOC (Specific Fuel Oil Consumption) Over Time

What it shows: The SFOC measures how efficiently fuel is used to produce propulsion power. It is calculated as the fuel consumed per megawatt (MW) of power generated.  
  
Trends:  
- Both vessels show some fluctuations in SFOC over time, but Vessel 1 exhibits slightly higher SFOC values, suggesting that it may be consuming more fuel relative to the power generated.  
- Vessel 2 maintains lower SFOC values, indicating that it is more fuel-efficient in converting fuel to propulsion power.  
- Monitoring SFOC is essential for reducing operational costs and emissions, with lower values indicating more efficient fuel use.

# 6. Engine Load Factor (%) Over Time

What it shows: The engine load factor shows how close the engines are operating to their maximum rated power. A load factor near 100% indicates that the engine is running at its design capacity.  
  
Trends:  
- Both vessels show relatively stable engine load factors, with no significant spikes. This suggests that the engines are being operated within their designed limits, which reduces wear and ensures reliability.  
- However, occasional dips in the load factor could indicate periods of reduced engine usage, possibly during slower sailing or idling conditions.

# 7. Bow and Stern Thruster Utilization (%) Over Time

What it shows: The thruster utilization graphs show how much energy is consumed by the bow and stern thrusters as a percentage of the total propulsion power. Thrusters are typically used for maneuvering, particularly during docking or tight navigation.  
  
Trends:  
- Thruster utilization shows occasional spikes, likely corresponding to docking maneuvers or complex navigation through narrow passages.  
- Vessel 2 seems to use thrusters more often or more intensively than Vessel 1, which may indicate different operational needs or environments.  
- Regular monitoring of thruster usage is important to ensure efficient energy use during maneuvers.

# Overall Insights

- Fuel Efficiency: Vessel 2 tends to be more fuel-efficient than Vessel 1, with a more stable fuel efficiency profile.  
- HVAC and Scrubber Systems: Vessel 2 appears to consume slightly more energy for HVAC and scrubber systems, possibly due to environmental conditions or stricter emissions control needs.  
- EEOI: Vessel 2 has a better operational efficiency (lower EEOI) than Vessel 1, suggesting that it consumes less fuel relative to distance traveled.  
- Engine Load Factor: Both vessels seem to be operating within their design limits, as indicated by stable load factors.  
- Thruster Utilization: Vessel 2 shows higher thruster utilization, which could be due to more frequent maneuvering needs.

Key Performance Indicators (KPIs) for Vessel Performance Evaluation

# 1. Fuel Efficiency (kg/MW)

Definition: Measures how much fuel is consumed per unit of propulsion power generated (in MW).  
Formula: Fuel Efficiency = (Fuel Flow (kg/h)) / (Total Propulsion Power (MW))  
Purpose: Helps assess how efficiently the vessel is using fuel to generate propulsion power.

# 2. HVAC Power Consumption (%)

Definition: The percentage of total service power that is consumed by the HVAC (Heating, Ventilation, and Air Conditioning) system.  
Formula: HVAC Power Consumption = (HVAC Power (MW)) / (Total Service Power (MW)) × 100  
Purpose: Monitors how much energy is dedicated to temperature regulation, which is crucial for passenger comfort and cargo preservation.

# 3. Scrubber Power Consumption (%)

Definition: The percentage of total service power consumed by the scrubber system, which cleans exhaust gases to meet environmental regulations.  
Formula: Scrubber Power Consumption = (Scrubber Power (MW)) / (Total Service Power (MW)) × 100  
Purpose: Evaluates the energy consumption of the scrubber system, which is important for ensuring emissions compliance.

# 4. Energy Efficiency Operational Indicator (EEOI)

Definition: A measure of how efficiently the vessel operates, expressed as the amount of fuel consumed per nautical mile.  
Formula: EEOI = (Fuel Consumed (kg)) / (Distance Traveled (nautical miles))  
Purpose: Evaluates the operational efficiency of the vessel in real-world conditions, particularly in terms of emissions and fuel use per unit of distance.

# 5. Specific Fuel Oil Consumption (SFOC)

Definition: Measures the amount of fuel consumed to produce a unit of power (MW). It is a key KPI for engine efficiency.  
Formula: SFOC = (Fuel Flow (kg/h)) / (Total Propulsion Power (MW))  
Purpose: Tracks engine fuel efficiency, with lower values indicating better fuel-to-power conversion.

# 6. Engine Load Factor (%)

Definition: The percentage of the engine’s actual load compared to its maximum rated load.  
Formula: Engine Load Factor = (Total Propulsion Power (MW)) / (Max Rated Power (MW)) × 100  
Purpose: Monitors how close the engine is operating to its design limits, ensuring the engines are used within safe and efficient operating ranges.

# 7. Bow and Stern Thruster Utilization (%)

Definition: Measures how much of the total propulsion power is consumed by the bow and stern thrusters, which are used during docking and maneuvering.  
Formula:  
- Bow Thruster Utilization = (Bow Thruster Power (MW)) / (Total Propulsion Power (MW)) × 100  
- Stern Thruster Utilization = (Stern Thruster Power (MW)) / (Total Propulsion Power (MW)) × 100  
Purpose: Tracks how often and how intensively the thrusters are used, particularly during complex navigation or docking operations.

# 8. Speed and Fuel Consumption Correlation

Definition: Measures the correlation between the vessel's speed through the water and its fuel consumption.  
Purpose: Helps identify the relationship between the vessel's speed and fuel efficiency, which is useful for optimizing voyage speeds to reduce fuel consumption.