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Energy efficiency Proxy. What does offshore have to do with it?

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Abstract

With the aim of reducing GHG emissions, much has been said about the Energy Efficiency Proxies EEXI and IIC that are related to the amendments to Circular 4350 defined in MEPC 75, which will enter into force in January 2023 for existing vessels (definition given by Marpol Annex 6 for ships built before 2017). [4]

Although these requirements do not include *offshore vessels, since* 2020 IMO has been studying a way to include these vessels in the short-term measures established by MEPC Res.304. Among the measures suggested is the IMCA proposal that, through the document MEPC 74/6, proposes two specific proxy possibilities for offshore vessels, namely: Proxy A and Proxy B. The two proxies have an annual analysis with different approaches, the proxy A on the gross power generated by the vessel and the second on the operating time.

This work will present a comparative analysis between proxies, applied in 10 offshore vessels of type PSV with dynamic positioning class 2 operating in Brazilian jurisdictional waters.

Keywords: Energy Efficiency, IMO, Dynamic Positioning, Fuel, Proxy, Offshore.

Abbreviation

IMO - International Maritime Organization
EEXI - Energy Efficiency Existing Ship Index
EEDI - Energy Efficiency Design Index
DP - Dinamic Positioning
PSV - Supply Vessel Platform
ABEAM - Brazilian Association of Maritime Support
ME - Main Engine
AE - Auxiliary Engine

Introduction

The IMO is committed to reduce GHG emissions from maritime transport, as a matter of urgency, aimed at eliminating them as soon as possible later this century. That's why long-term targets have been set to reduce greenhouse gas emissions by 50% by 2050, and all of these targets have a direct impact on the vessel. [3]

Based on various long-term economic and energy scenarios (without considering the long-term effects of the COVID-19 Pandemic), and without any additional measures, imo in the 4th Study describes that transport emissions are projected to increase emissions by about 90% to 130% by 2050. [6]

Bibliographic Research

IMCA has been working on development proxies specifically for offshore vessels since 2017. In 2019, IMCA, through document MEPC 74/6, proposed two specific indicators for offshore vessels called Proxy A and Proxy B. In the proposed indicators for offshore vessels included, according to MEPC74/INF15. [1.2]

The proposal of indicators for offshore vessels is part of the strategies described in MEPC 304, categorized as short-term measures by IMO, i.e., measures with priority of support. The proposal developed by IMCA and Russia is in line with the measures foreseen in the IMO strategies. [3]

The main difficulty of IMO is the definition of what is energy efficiency for non-conventional propulsion vessels, which according to Marpol Annex 6, are included ships that have diesel-electric propulsion, just the main and most common means of propulsion among dynamic positioning vessels. [4]

In a conventional vessel, energy efficiency is the relationship between fuel consumption and speed combined with load capacity. That is, energy efficiency is the quantitative result of the ratio between CO2 emissions (which is directly proportional to fuel consumption) and the contribution that this vessel makes to society through the displacement of cargo.

Analyzing the significance of the contribution to the traditional concept of energy efficiency by IMO, it is possible to see that the parameter is linked in displacement and load capacity, an analysis parameter that does not apply to the contribution analysis curve of an offshore vessel, which most often, its main contribution happens just when the ship is under DP.

Brazil Scenario

Currently, there are 7555 offshore vessels worldwide. Among these, according to a beam's June inventory, 411 are operating in Brazilian jurisdictional waters, of which 367 are brazilian flag. [5]

Brazilian offshore vessels account for just over 5% of the total offshore vessels in the world. [5,6].

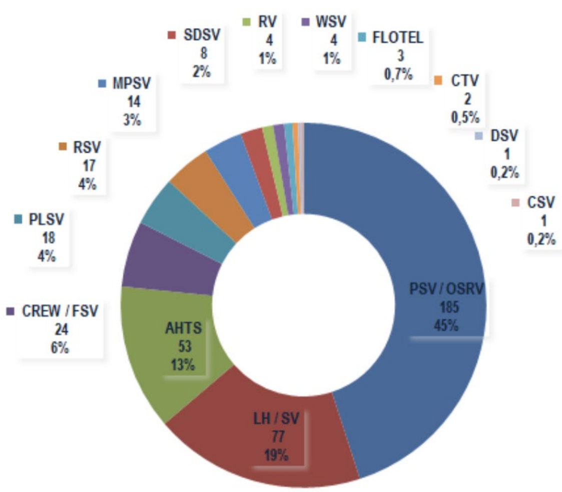


Figure 1 - Distribution of vessels working in Brazilian waters by type
Source: ABEAM

As can be seen in Figure 1 the offshore vessels with the highest quantity in Brazilian waters are the PSV vessels, which in June 2022 totaled 185 vessels.

Objective

The objective of this work is to analyze the behavior and the impacts of the adoption of each Proxies (A and B) indicated by the IMCA in the Brazilian offshore industry, using as a case study 10 PSV's vessels with dynamic positioning class 2 of the Brazilian flag.

Methodology

The data used in this work were voluntarily sent by the companies through ABEAM and are related to the particularities of the boats and consumption during the years 2018, 2019 and 2020 in order to discover the Brazil curve of each proxy.

Among the data sent, 10 vessels DP class 2 were selected with characteristics of the general average of the Brazilian PSV vessels that coadulate with the international averages exposed in the 4th imo study. [6]

Ship type	Offshore
Number of vessels (un) Avg.	7.555
DWT (tonnes) Avg.	4.765
design speed (kn) Avg.	13,98

Table 1 - Averages of the general characteristics of offshore vessels in the world
Source: 4th IMO Study

In June 2022, ABEAM counted 411 offshore vessels operating in AJB, among these 116 were PSVs and Brazilian flag. Among the PSV boats, with a dynamic positioning system predominantly class 2, we obtained a gross tom between the average of 3476. [5]

The behavior of the Brazilian fleet in 2018, 2019 and 2020 was analyzed, but fuel consumption data only continue until 2020, as they were the last data sent in 2021.

The data is always counted related to the previous year. This year (2022) will be considered the data of 2021 that are still in validation by the Brazilian flag and GISIS.

The following data were collected:

Type of vessel	Psv
DP class	2
Dwt	(mton)
Speed (average 3 years)	(Kn)
Maximum Continuous Rating	(kw)
Hours in operation in DP	(h)
Hours in navigation	(h)

Hours in port	(h)
Hours in repair	(h)
Main Engines quantities	(un)
Power - Man Engine	(kw)
Specific Fuel Oil Consumption – Main engine	(g/kw h)
Amount of Auxiliary Engine	(un)
Power - Auxiliary Engine	(kw)
Fuel Type	MDO
Specific Fuel Oil Consumption - Auxiliary Engine	(g/kw h)

Table 2 - Data collected

The proposed indicators have two different approaches, the first on the annual energy consumption of the vessel, and the second on the annual and effective operating time of use of the vessel. [1]

PROXY A - Approach to annual energy consumption.

The proposed formula is:

$$R=\frac{E}{Pg}=\frac{\text{Total kg } CO_2 \text{ emitted / year}}{\text{Total gross power output generated/year}} = \mathbf{kg\ CO_2 / Gross\ kWh}$$

(i.e.$\sum$ installed rated power per engine x yearly running hours per engine)

where:

A: The average energy ratio based on a measure of E and Pg.
E: Total kg CO_2 emitted/year, i.e. the total amount of CO_2 calculated on the basis of the fuel consumed per year, taking into account the applicable conversion factors for a particular type of fuel.
Pg: Total calculated gross kWh generated/year, i.e. the sum of the installed rated power per engine multiplied by the yearly running hours per engine.

PROXY B - Effective (operational) approach to vessel use.

As an alternative approach, it was proposed to use the formula:

$$R=\frac{E}{U}=\frac{\text{Total kg } CO_2 \text{ emitted / year}}{\text{Total hours under way / year}} = \mathbf{kg\ CO_2 / operational\ utilization\ hour}$$

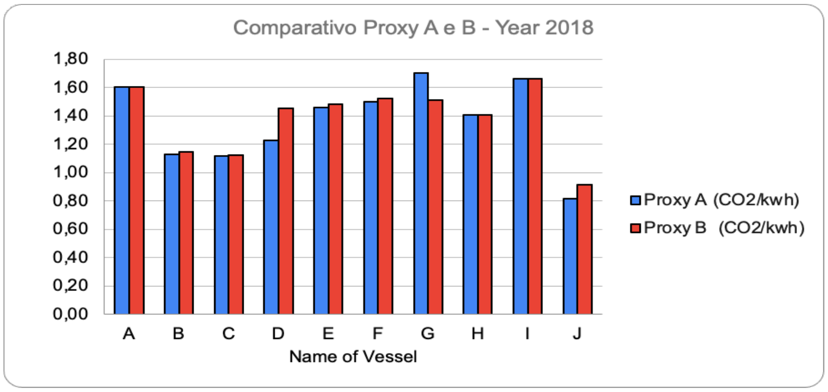
Where:

A: The average energy ratio based on a measure E and U.
E: Total Kg CO_2 emitted/year, i.e. the total amount of CO_2 calculated on the basis on the basis of the fuel consumed per year, taking into account the applicable conversion factors for a particular type of fuel.
U: Total hours under way. Time spent undergoing repairs or mobilizing in port should not be included in the calculation.

Conclusion

It was analyzed and compared the performance of 10 boats with characteristics common to Brazilian vessels during the period 2018 to 2020.

In 2018, Graph 1 shows that the 10 Brazilian vessels analyzed had a low variation in the behavior of Proxy A and B throughout 2018.



Graph 1 - Proxy Comparison A and B - Year 2018

In 2019, the graph 2 shows a considerable increase in the variation between proxies A and B. In this period, the data show studied that the annual powers average of the vessels was less than the number of hours of operation of the vessels.

The low power generated directly implies the low power consumed, on the other hand, the proxy B curve shows that there was an increase in the amounts of hours in operation of the engines.

Analyzing Table 3, observe that the average specific consumption of vessels during the year 2018 to 2020 detects an increase of 10% in 2019, based on 2018.

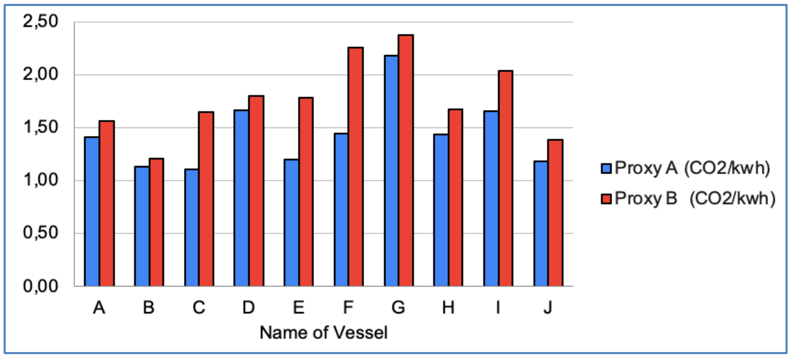
Analyzing the behavior of the vessels studied in 2019, an increase in the energy reserve is detected, through the low power generated and the increase in engine operating hours, indicating the underutilization of the engines considering the potential load that can be generated with the actual generated.

Main Features Proxy A and B	2018	2019	2020
Specific average fuel consumption (g/kWh)	2736,963	2932,582	2704,4293
Average amount of operation (h)	*This data started to be monitored only from 2019 onwards	2.495,56	2.200,01

Table 3 - Main Features Proxy A and B

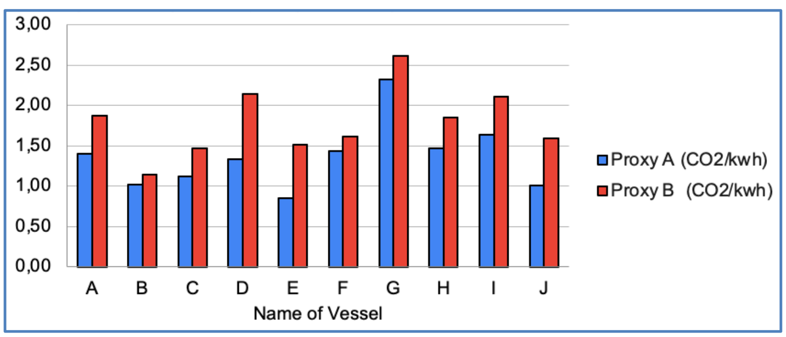
The decrease in the power consumed combined with an increase in specific fuel consumption is a clear indication of an increase in energy reserve.

The energy reserve is shown that engines are not being used at regular power and that although power consumption decreases as well as CO2 generation that directly tracks fuel consumption, it does not mean that the engine is working efficiently. On the contrary, it indicates the possibility of engines subject to low loads directly implying the reliability of the equipment response in view of the possibility of carbonization of combustion chambers, in addition to the higher generation CO2, due to the greater imbalance of the stochimetric ratio of fuel burning.



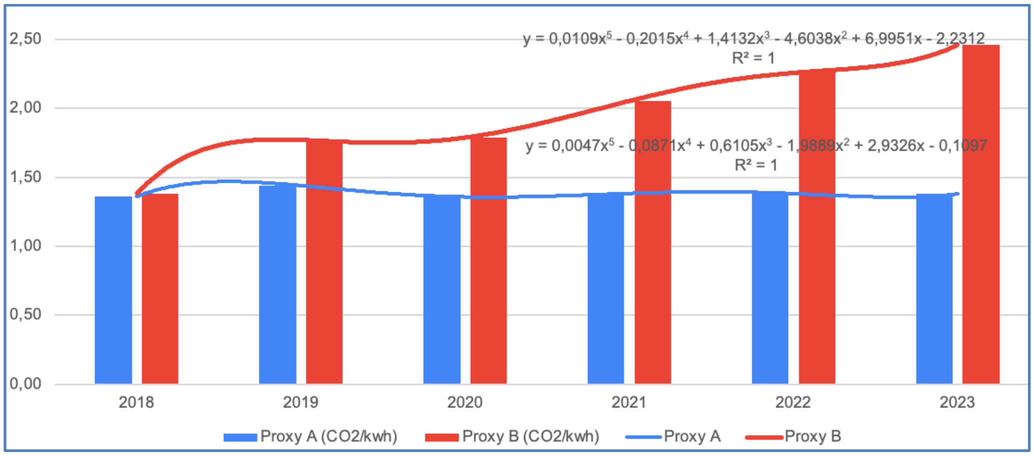
Graph 2 - Proxy Comparison A and B - Year 2019

The year 2020 was an atypical year due to COVID and the compulsory adoption of low-sulfur fuel. In graph 3, a fall is used in Proxy A and B. Which are justified by the decrease in specific fuel consumption below the estimated level in 2018 and a decrease in operating hours in PD considering the year 2019.



Graph 3 - Proxy Comparison A and B - Year 2020

Graph 4, considering the behavior of the vessel from 2018 to 2020, shows the trend curve to predict the behavior of the vessel for the years 2021 to 2023.



Graph 4 - Curve to predict the behavior of the vessel for the years 2021 to 2023.

Conclusion

Proxy A has an approach by the annual energy consumption and proxy B in the operational time of use of the vessel.

Proxy A has an approach based on annual energy consumption, while proxy B uses the vessel's operating time. The results show that depending on the chosen proxy, one may be more strategic than the other.

Comparing proxies, A and B, the variability of proxy A over the years is smaller than that of proxy B and that the tendency is for these variations to increase mainly at Proxy B where the curve has an exponential behavior while A has a more linear.

The results showed that proxy A has a more conservative strategy, which the trend curve has a trajectory with very few variations at the 5-year logo of different analysis than Proxy B, which presents larger variations and has temporally propagative characteristics, as observed in Graph 4.

Future Work and Solutions

After surveying the behavior of vessels that suggests the Brazilian standard, the next step is to identify patterns in energy balances and exercise of offshore vessels in the use of energy (1st law of thermodynamics) and exergistic (second law of thermodynamics) for analysis of the quality of consumption.

The objective is to identify the main inefficiencies and evaluate the potential for residual heat recovery and improvement of engine efficiency, represented in the Grassman Diagram. [12] The implementation of these system modifications allows the ship to reduce specific energy consumption and consequently contributes to reducing emissions.

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