RESIZING STUDY OF MAIN AND AUXILIARY ENGINES OF THE TANKER VESSELS AND THEIR CONTRIBUTION TO THE REDUCTION OF FUEL CONSUMPTION AND GHG.

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Abstract
The maritime industry has great potential for improving energy efficiency in both new builds and existing ships. It is, therefore, necessary to identify the areas where improvements can be made to reduce fuel consumption, and influence to the shipowners, shipyards and designers of ships on the need to implement these improvements in energetic efficiency and to achieve a reduction of between 25% and 75% of CO2 emissions as IMO report 2009 provides, making ships even more environmentally friendly.

The study was conducted focusing on one type of ship such as tanker vessels, compiling a database of these ships built from 2000 to 2014. The ships comprising the study were taken from the database of Lloyd´s Register of Shipping. With all the technical data on each of the ships, we proceeded to relate the main and auxiliary power, with the operating speed of the vessel, its displacement and GT, by size, age and generation ships.

All the above comparisons were made according to ship sizes, graphically and analytically in which interesting conclusions could be drawn in the relevant dimensioning of the main and auxiliary engines, as well as the operation of the ship. Because of the current crisis some owners have already begun to change their size criteria of propulsion and auxiliary engines of these vessels, their management and operation as well as their speed.

Another significant finding was the identification of some shipyards that build their ships with an oversize and exaggerated power of the main and auxiliary engines, regardless of the effect on increasing fuel consumption and impact on the environment.

Finally, we have performed a comparative study of EEOI of these vessels by size and age to determine the environmental signature and their evolution.

All this leads us to determine a set of measures to be applied, for example, power reduction or derating, etc. on existing ships and applied to new designs , thus reducing the propulsion and auxiliary power of these ships and collaborating to reduce greenhouse gases .

Keywords

Energy efficiency; Energy management; Energy policy; Shipping economic.

1. INTRODUCTION

As explained in the abstract, the objective of this paper is going deeper in the measures that can be implemented in tankers during the design ant building and during the operating life.

In order to minimize the fuel consumption and the emission of greenhouse gases, there is the possibility to use waste heat recovery plants to produce all electric and thermal energy of the ship and this should be extended to the greatest number of ships. Then it is necessary to find relationships between dead weight, displacement, main engine power and electric generators power.

First, a data base of all tankers existing in the world has been used, and then ships have been classified following size and age, from year 2000 to 2014.

It has been used the FARPLAY database associated with Lloyd's Register of Shipping that is the most reliable in the shipping world. Total of tankers is 3788 and of all of them are taken IMO identification number, dimensions, displacement, Gross Tonnage, speed, main engine power and auxiliary power.

Ships are classified by size as: Handy tanker (10000-50000 t), Panamax (50000-80000 t), Aframax (80000-120000 t), Suezmax (120000-200000 t), VLCC (200000-320000 t) and ULCC (+320000 t).

Once the data base has been made it has been searched, for each ship size, the relationship between main and auxiliary power; main power with auxiliary power and speed; main and auxiliary power with displacement; main and auxiliary power with GT; main power and displacement with speed; main power with speed and GT.

HANDY TANKER

In figure .1, propulsive power is related to auxiliary power and displacement of these ships. Main power goes from 6078 to 11200 kW and auxiliary power from 1980 to 5220 kW. Most ships have between 7150 and 8580 kW and auxiliary power from a 23% to a 64% of main power, these last values too high explained by the use of electrical driven cargo pumps and other equipment and for the fulfilment of the SOLAS rule to double electric power of auxiliary engines for safety.

In the same figure are related propulsive power with displacement and can be seen that there is one series of ships with the same displacement and propulsive power, other with higher displacement have a slightly higher main power and other that have higher displacement that the first and higher main power but not exponentially as would be expected showing that in some ships, main engine is oversized. It is also observed that there is a series of ships with the same dimensions in displacement and main power and probably have not the main engine optimized for the displacement.

In figure .2, propulsive power is related with displacement and speed. It can be seen three groups: In the first there is a large number of ships with the same main power, displacement and speed like if these had been designed and built by the same technical office and yard. There is a second group with the same speed of the first group but with a 9000 t higher displacement and a 23% higher main power, about twice that it would be. The third group has a higher speed, one or two knots and their power is exponentially higher.
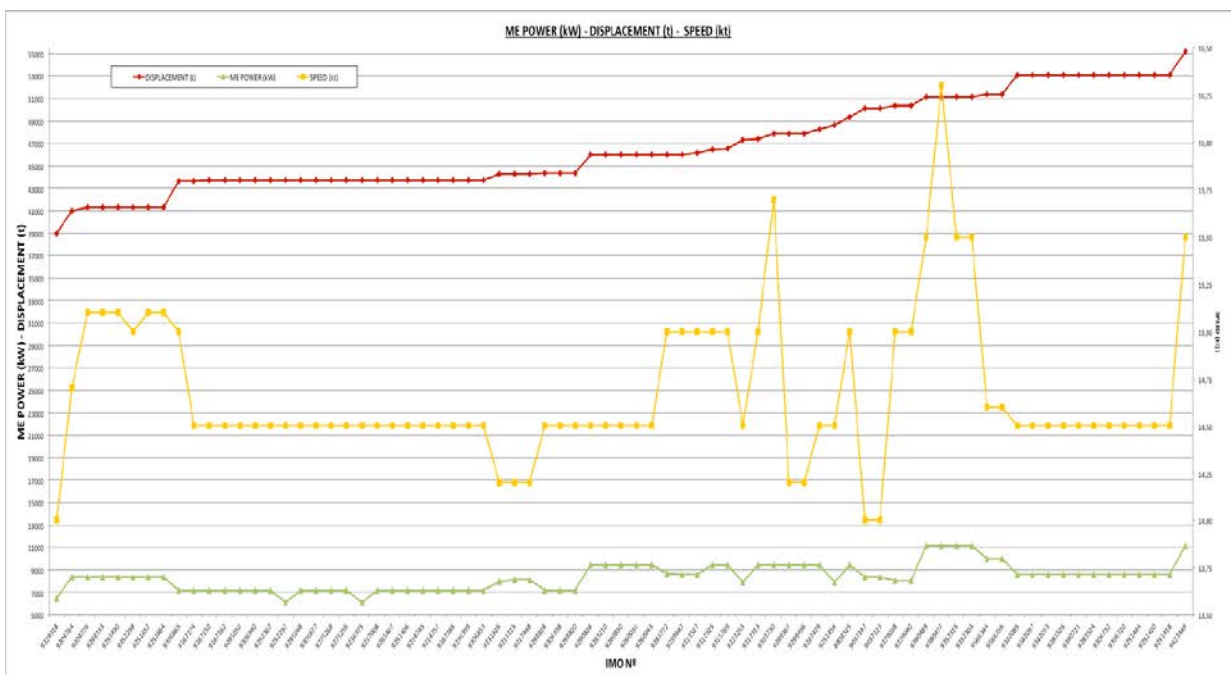
Figure 1
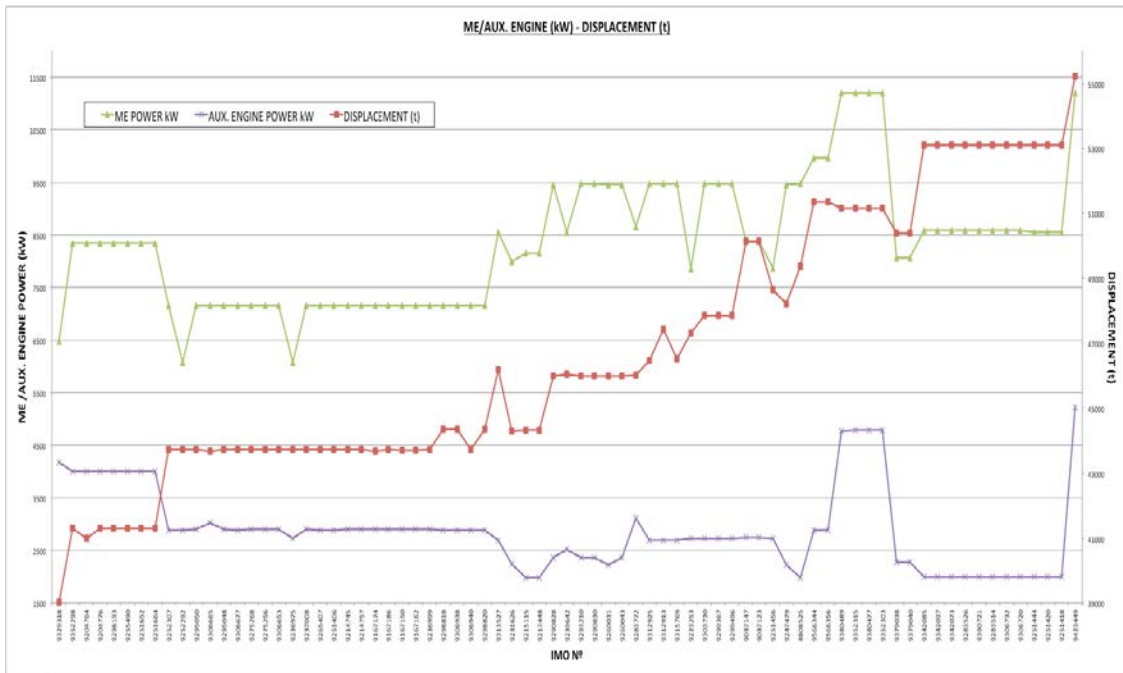
Figure 2

AFRAMAX

In Aframax ships it has been related main and auxiliary power with displacement.

In figure 3 main power goes from 11000 kW to 16000 kW and auxiliary power from 1200 to 4200 kW that is the auxiliary power is from 23% to 27,5 % of main power.

Displacement goes from 121000 t to 123000 t. For the lower limit there is a large number of ships with main power in their lower value, a more reduced number of ships have a displacement 2000 t higher with the main power also in their lower value and a third group that with the same increase of displacement have a power from 1000 to 2000 kW higher.

In figure 3 main power, displacement and speed are related. It can be seen that speed goes from 14 to 15,4 knots and neither the slight increase of power nor that of the displacement make a increase of the propulsive power that in some instances increases slighty and in others decreases.
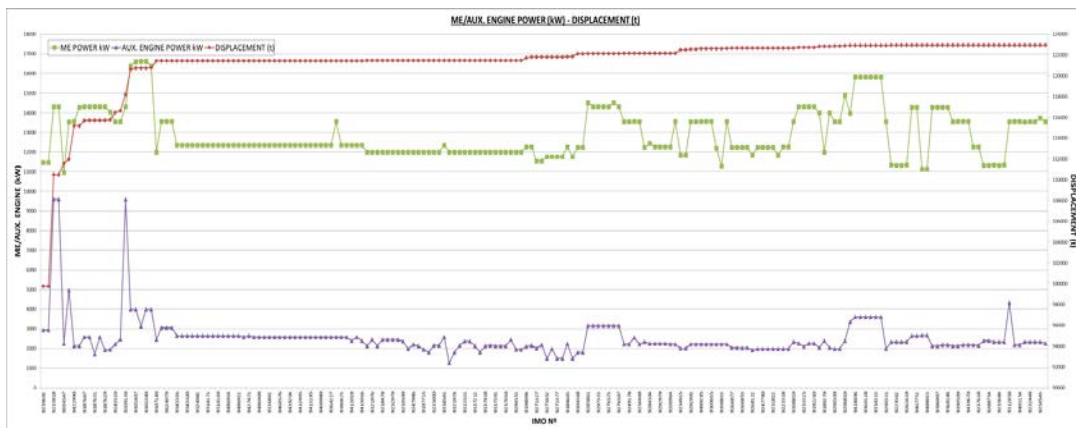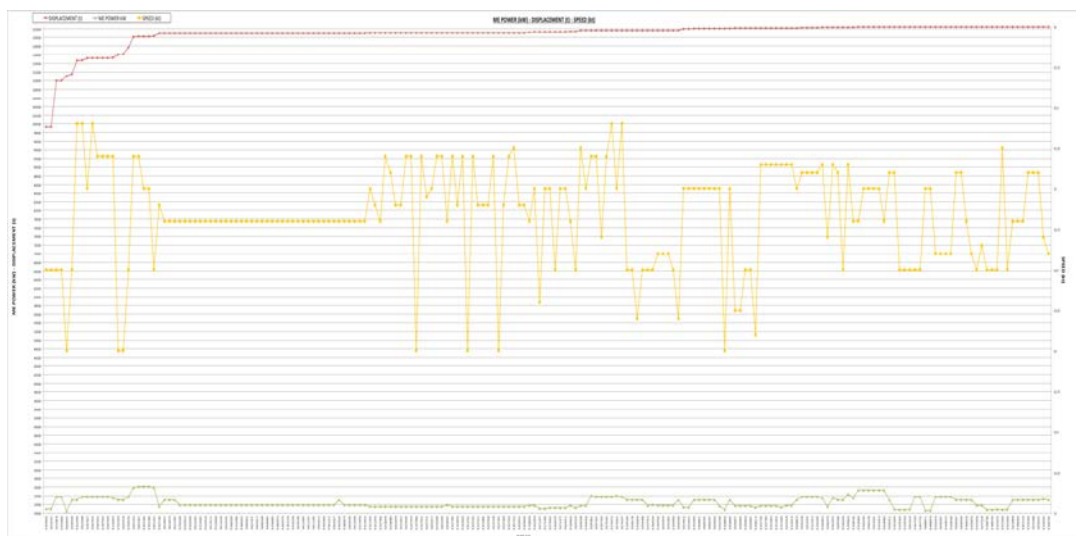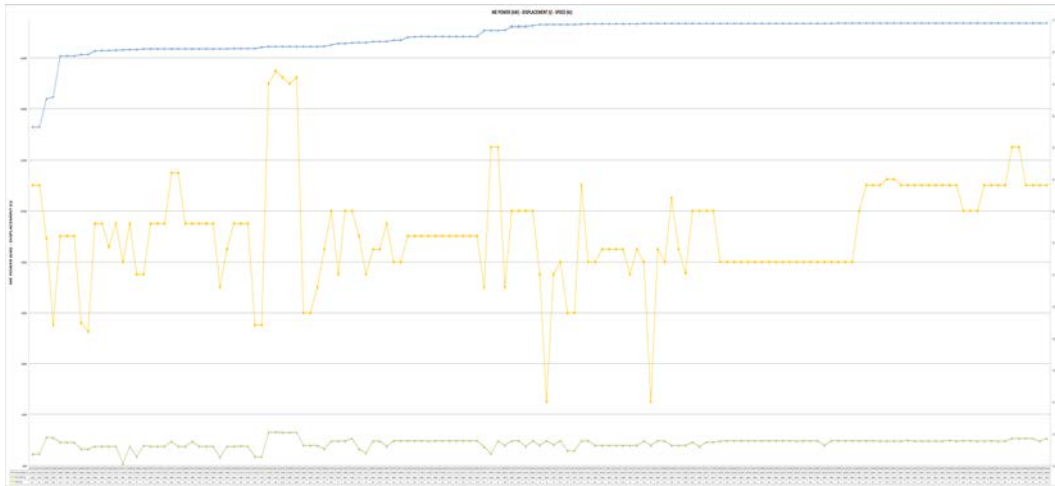
Figure 3

Figure 4

SUEZMAX

In Suezmax tankers, propulsive power have a broad range from 9500 kW to 22000 kW. Auxiliary power goes from 1800 kW to 4000 kW, that is from a 15 % to a 21% of main power. There are some ships with an auxiliary power of 18000 kW, that is a 81,8 % of main power. This high auxiliary power is probably due to special purpose ships.

In figure 5 it can be seen a first group from 16500 to 17000 kW for a displacement of 172000 t, that can be defined as standard. Also a second group with a higher displacement, 183000 t and a main power of 18500 kW. There is a third group with a displacement of 173000 t have the higher main and auxiliary power in these ships.

Relating to the speed of these ships with displacement and main power, figure 6, it can be seen that it goes from 14 to 16,5 knots, being the most usual 15,5 knots. There is a large number of sips with the same speed, displacement and main power and other group with higher speed and same displacement that have the same propulsive power, showing an oversizing of main engine with the consequences for operation and environment.

Figure 5

Figure 6

VLCC

Figures 7 and 8 belong to VLCC showing the relationship between power and displacement. Main power goes from 22700 kW to 31900 k and there are five groups of ships: first, for a displacement from 319000 to 345000 t, main power is 22700 kW; second, for a displacement of 339000 t and main power of 25000 kW; third, a displacement of 350000 t and main power of 25700 kW; fourth, for a displacement of between 342000 and 348000 t and main power of 27000 kW and fifth, for a displacement of 355000 t and main power of 29700 kW.

In the same FIGURE 7 it can be seen that auxiliary power goes from 1700 kW to 3700 kW and some special ships with auxiliary power from 7700 kW to 9700 kW, that is from a 33,9% to a 42,7% of propulsive power instead of the usual in these ships that is a 10 or 12%.

In figure 8 it can be seen that speed is between 14 and 16,5 knots with some exception of 17,5 knots.

It can be seen that there is good parallelism between displacement, speed and propulsive power, there are ships that with the same displacement and speed that the other ships, have a higher propulsive power, that supports our thesis that, depending in which yard or technical office where the ship is designed and built, there are differences in the optimisation and efficiency of main and auxiliary engines.
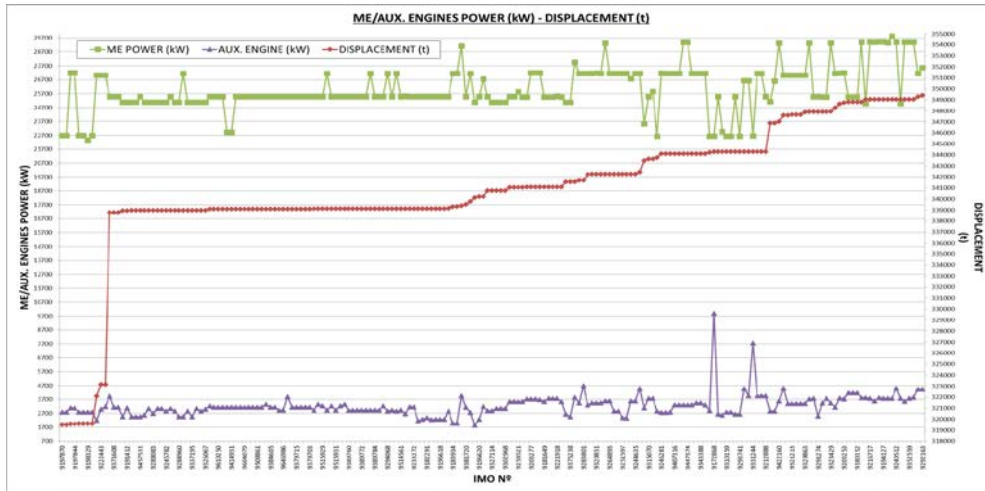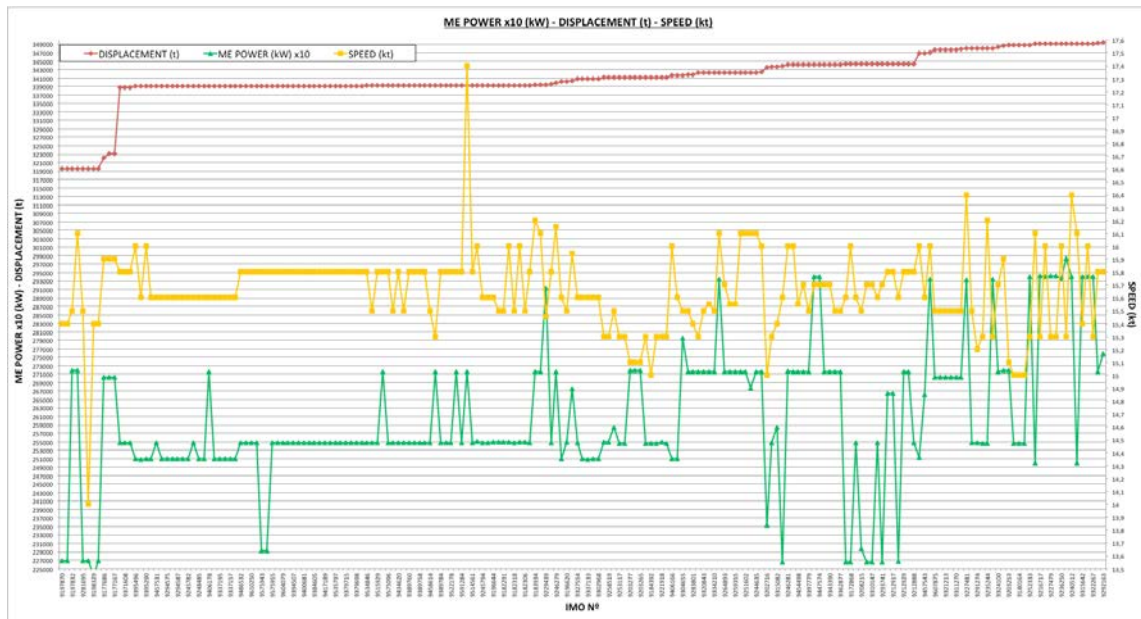
Figure 7

Figure 8

ULCC

ULCC tankers, the biggest in the world, are built by very few yards that are able to cope with their huge dimensions and all are very similar in design and building.

In figure 9 we find that main power goes from 27000 kW to 32000 kW for the biggest units with a displacement higher than 500000 t. There are two groups: first, with 365000 t of displacement and 27000 kW of main power; second, for the same displacement, with 29000 kW.

Auxiliary power goes from 2000 kW to 6000 kW, between a 6,9 and 13,8% of main power.

Speed can be seen in figure 10 and is between 15,3 and 16,3 knots.

Finally we can say that there is a high parallelism between main and auxiliary power and displacement. There are some cases with main and auxiliary powers oversized.
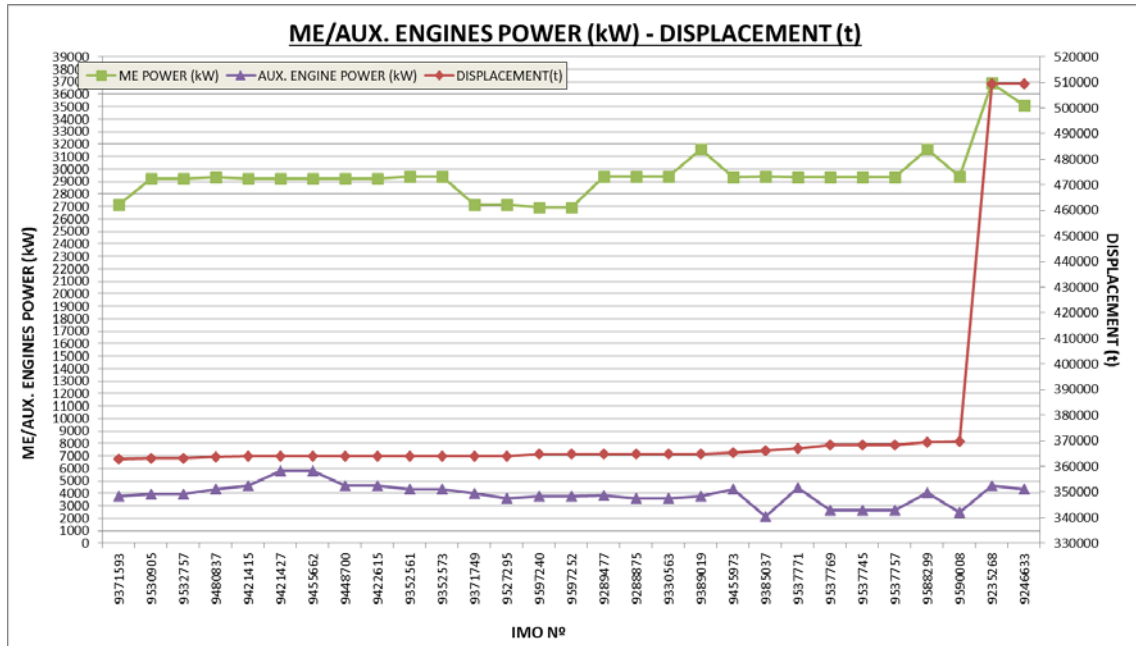
Figure 9

Figure 10

2. CONCLUSIONS

Powers and speeds show, generally speaking, good correspondence between them. There are isolated cases that show big variations with very high main and auxiliary power that can be due to severe operation conditions.

In many instances, main and auxiliary powers are oversized and this can be explained for different reasons like a lack of detailed study for each ship and submission to the conditions of the yard or the engine builder. There are yards that generally install oversized powers.

The relationship between main power and electric power varies of the following way:

	HANDY	AFRAMAX	SUEZMAX	VLCC	ULCC
MAIN ENGINE (kW)	6.078-11.200	11.000-16.000	9.500-22.000	22.700-31.900	27.000-37.000
AUX. ENGINE (kW)	1.980-5.220	1.200-4.200	1.800-4.000	1.700-3700	2.000-6.000

It is the possibility to adjust main and auxiliary powers to a minimum values in order to have a substantial fuel saving and, thus, of greenhouse gases.

BIBLIOFIGUREY

-N.Wijnolst; T. Wergeland. *Shipping Innovation*. IOS Press, January 2009, The Netherlands.

-M. Sopford. *Maritime Economic*. E. Routledge, New York 2008.

-K. Van Dokkom. *Ship Knowledge*. Dokmar, The Netherlands 2003

-Sea-web database of ships.