Estimated Index Values of New Ships

Analysis of EIVs of Ships That Have Entered The Fleet Since 2009

Rapport
Delft, March 2015

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Publication Data

Bibliographical data:
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Ships / Energy efficiency / Innovation / Regulation / Standards
FT: Design

Publication code: 15.7E50.14

CE publications are available fromwww.cedelft.eu

Commissioned by: Seas At Risk and Transport & Environment.
Further information on this study can be obtained from the contact person, Jasper Faber.

Preface

This study has been commissioned by Transport & Environment and Seas at Risk. We have presented preliminary findings to a number of people from shipping industries in May 2013 and later at the 67th session of the Marine Environment Protection Committee (MEPC) of the International Maritime Organisation (IMO) in October 2014. We thank the participants at those meetings for comments received. If, despite their valuable comments, errors remain, they can only be attributed to us.

The authors

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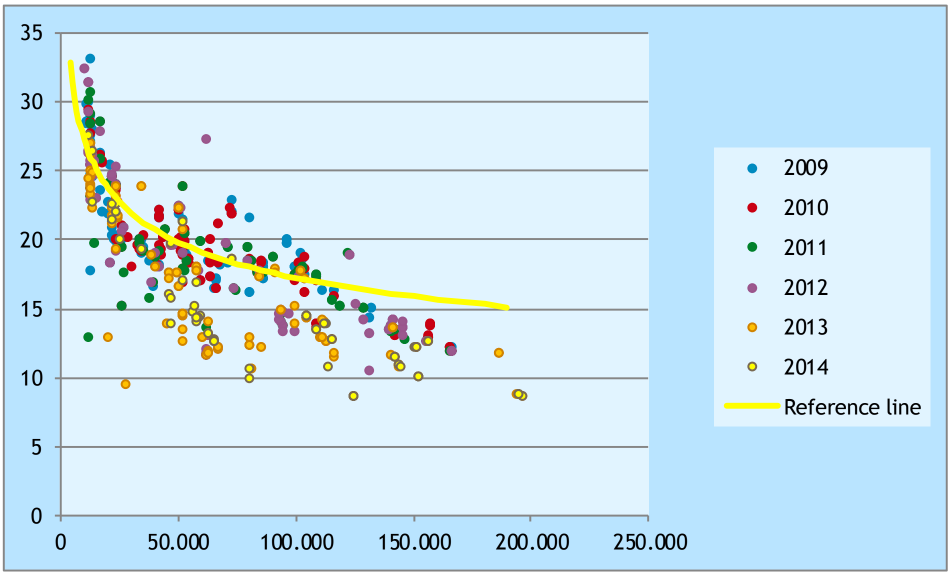
Summary

As of January 1st 2013, all new ships have to meet a minimum value for their Energy Efficiency Design Index (EEDI). The EEDI value ships have to meet is a function of ship type and size of the ship. It is based on an empirical regression line of the efficiency of ships built between 1999 and 2009 which is called the reference line. The reference lines were calculated using publicly available data to construct a simplified version of the EEDI called the Estimated Index Value (EIV).

There is little publicly available information on how the design efficiency of ships that have entered the fleet since 2009 has developed. The IMO has published the EEDI of a limited number of ships launched since 2012, but the sample of ships is small and the time period limited. The published data show clearly, however, that EIVs and EEDIs of ships are well correlated.

This report analyses the EIV of over 9,000 new ships that have entered the fleet between January 2009 and July 2014. By way of an example, Figure 1 shows the analysis for container ships. Their design efficiency has improved considerably between 2009 and 2014. In 2013 and 2014, approximately 90% of new container ships had EIVs below the reference line.

Figure 1 EIVs of Containerships built in 2009-2014



The detailed analysis of ship types shows many ships have an EIV 10% or more below the reference line. This is the case for about a fifth of tankers, gas carriers and combination carriers, over a quarter of bulk carriers, and over three quarters of container ships and general cargo ships that have entered the fleet since 2013. Taking into account that the EIV is an overestimation of the EEDI, this result suggests many ships already exceed the EEDI required from 2015.

The EIV improvements have, for a number of ship categories, coincided with increases in average design speed and decreases in main engine power.
This suggests that hull or propulsion efficiency has been improved.
These findings also suggest that, if design speeds were kept constant, even larger improvements in design efficiency would have been possible.

1 Introduction

1.1 Policy context

As of January 1st 2013, all new ships have to meet a minimum value for their Energy Efficiency Design Index (EEDI). The EEDI is a measure of a ship's efficiency under standardized conditions, expressed by the amount of CO_2 emissions per tonne-mile.

The EEDI value ships have to meet is a function of ship type and size of the ship. It is based on an empirical regression line of the efficiency of ships built between 1999 and 2009 which is called the reference line. The reference lines were calculated by the IMO using publicly available data to construct a simplified version of the EEDI called the Estimated Index Value (EIV).

For 2013 and 2014, the EEDI of new ships cannot exceed the reference line; between 2015 and 2019, ships need to have an EEDI that is at least 10% better than the reference line and this improvement is set to increase over time up to 30% after 2025. Small ships are either exempted or have a relaxed stringency requirement.

MEPC 67 decided to conduct a 2015 review of the status of technological developments relevant to implementing phase 2 of the EEDI regulation as required under regulation 21.6 of MARPOL Annex VI.

In the past, there have been large changes in the efficiency of ships. However, they have not been well documented in terms relevant to the EEDI, except for one qualitative graph in the 2nd IMO GHG Study 2009 (Buhaug, et al., 2009). Economic logic would suggest that fuel prices have been a major driver of efficiency changes.

As fuel prices increased over the last decade and were projected to increase even further, there has presumably been an incentive to improve the energy efficiency of both new and existing ships. Discussions within the IMO regulatory framework on the curbing of GHG emissions of international maritime transport and the current economic crisis may have given added impetus to economize on fuel use.

1.2 Objective of the study

The aim of this study is to analyse how the design efficiency of ships has changed over time. More specifically, this report answers the following questions:
1. What is the relationship between the EEDI and the EIV?
2. How has the EIV of ships that have entered the fleet since 2009 changed and how have changes in the EIV been achieved?

1.3 Methodology of the study

We calculate Estimated Index Values in conformity with resolution MEPC.215(63) (MEPC, 2012) EIVs should not be mistaken for EEDI scores. The EIV is more a measure of the design efficiency than of fuel efficiency of ships as there are a number of simplifying assumptions used in the calculation.

In line with resolution MEPC.215(63) (MEPC, 2012), the following assumptions have been made in calculating the EIV:

1. The carbon emission factor is constant for all engines, i.e. CF,ME = CF,AE = CF = 3.1144 g CO_2/g fuel.
2. The specific fuel consumption for all ship types is constant for all main engines, i.e. SFC_{ME} = 190 g/kWh.
3. $P_{ME(i)}$ is main engines power and is 75% of the total installed main power (MCRME(i)).
4. The specific fuel consumption for all ship types is constant for all auxiliary engines, i.e. SFC_{AE} = 215 g/kWh.
5. P_{AE} is the auxiliary power and is calculated according to paragraphs 2.5.6.1 and 2.5.6.2 of the annex to MEPC.212(63).
6. No correction factors on ice class, voluntary structural enhancement, etc. are used.
7. Innovative mechanical energy efficiency technology, shaft motors and other innovative energy efficient technologies are all excluded from the calculation, i.e. P_{AEeff} = 0, P_{PTI} = 0, P_{eff} = 0.

This results in the following formula:

$$Estimated\ Index\ Value = 3.1144 \cdot \frac{190 \cdot \sum_{i=1}^{NME} P_{MEi} + 215 \cdot P_{AE}}{Capacity \cdot V_{ref}}$$

Capacity is defined as 70% of dead weight tonnage (dwt) for containerships and 100% of dwt for other ship types. V_{ref} refers to design speed. In conformity with the reference line calculations (MEPC.215(63) (MEPC, 2012), only ships of 400 GT or above are included.

Reference line values have been calculated according to the guidelines set out in MEPC.203(62) Annex 19 (MEPC, 2011). Each ship type has a different reference line that is an exponential function of dwt. These functions are shown in Table 1 and in the graphs in the second chapter.

Table 1 Reference line value for different ship types

Ship type	Reference line value
Bulker	$961.79*(dwt)^{-0.477}$
Gas carrier	$1120*(dwt)^{-0.456}$
Tanker	$1218.8*(dwt)^{-0.488}$
Container ship	$174.22*(dwt)^{-0.201}$
General Cargo ship	$107.48*(dwt)-^{-0.216}$
Combination carrier	$1219*(dwt)^{-0.488}$

The calculations are presented in a graphical and tabular manner. The EIVs of ships are compared with the reference line value in a graph for each ship type. We expect most EIVs to lie below the reference line as ships built since 2009 should be more fuel efficient than ships built between 1999 and 2009.

We also calculated the mean and median deviation of the EIV from the reference line value for each ship type and its standard deviation. The median deviation is more useful as a central measure when observations are not spread evenly around the mean or when there are many outliers in the data. The standard deviation is a measure of the variation in the EIV.

We expect the mean and median deviation to be positive as this indicates that the fuel efficiency performance of ships built since 2009 is on average better than that of ships of the same capacity built in the years 1999-2009.
We further expect that the mean and median deviation have increased in the years 2009-2014 as ships built in 2011 and 2012 may have been ordered when fuel prices were relatively high and freight rates relatively low. We also present the number and percentage of ships whose EIVs exceed their reference line values in the years 2009-2014 to double check the assumptions.

1.4 Scope of the study

All ship types for which an EEDI reference line has been published have been included in the study (see Table 1). This excludes specific ship types such as Lakers, landing craft, passenger ships or Ro-Ro vessels. Furthermore, results for reefers are not presented as only ten such ships have entered the fleet since 2009 (and eight of them have EIVs in excess of their reference line value).

Shipping data has been obtained from Clarksons World Fleet Register. In order to weed out improbable results, the data have been processed in four ways:
1. Ships with exceptionally high or low engine power, capacity or design speed have been identified. The data (ship type, main engine power, capacity and speed) on these ships has been cross checked with other sources and the ships have been excluded from the analysis if the data did not match. The reference values calculated for these ships have been compared with values of similar ships.
2. The calculated EIVs have been compared with the published graphs and statistics on reference lines. When values were significantly above or below the range of published values, they have been analysed in more detail.
3. Outliers have been analysed in more detail and omitted if data was corrupted or when values seemed improbable.
4. Small ships that do not have to comply with the EEDI have been excluded from the analysis.

1.5 Outline

Chapter 2 establishes that the EIV is strongly correlated with the EEDI and can therefore be considered a good indicator of the design efficiency of ships.
The analysis of the EIV of recent ships is presented in Chapter 3.
Chapter 4 concludes.

2 The relation between EEDI and EIV

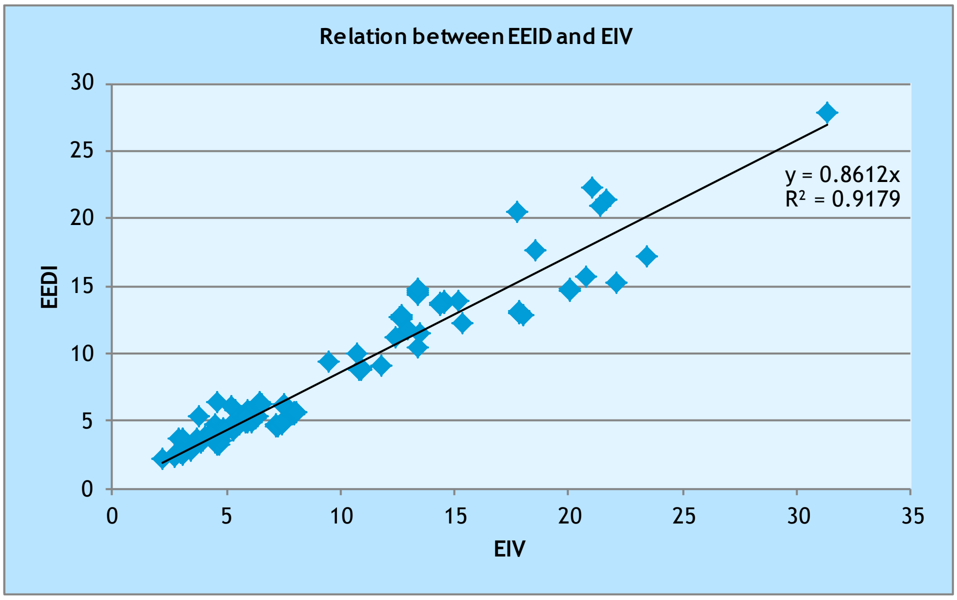
2.1 Matching ships from Clarksons Register and IMO EEDI database

Clarksons World Fleet Register comprises all ships in the world fleet and contains information that allows the calculation of the EIV of most of them. MEPC 67/INF.4 (IMO, 2014) provides the EEDI (Energy Efficiency Design Index) for 158 ships, together with their year of build and deadweight tonnage.
In some cases, the combination of deadweight tonnage and year of build is unique and allows for linking both datasets. In other cases a direct match was not possible because the datasets disagreed on date or size of the ship, but an internet search allows to match the ships anyway. In total, we have found 154 matches.

2.2 Correlation between EEDI and EIV

After linking the ships in Clarksons Register to the IMO database, the relationship between the EEDI and EIV is studied. Figure 2 shows the relationship between these parameters and a clear linear trend is shown with a coefficient of determination (R^2) of 0.92. On average, the EEDI value is smaller than the EIV or, in other words, the EIV is an overestimation of the EEDI.

Figure 2 Relationship between EEDI and EIV for all types of ships



A closer look per ship type reveals that there is a good correlation for all ship types, but the strength of the correlation is smaller for bulkers than for example. container ships and tankers.

Table 2 Coefficient of determination per ship type

Shiptype	Number of ships	R^2
Bulk carrier	75	0.66
Combination carrier	17	0.73
Containership	35	0.73
Gas carrier	7	0.91
Tanker	20	0.88
All shiptypes	154	0.92

3 Design efficiency of ships 2009-2014

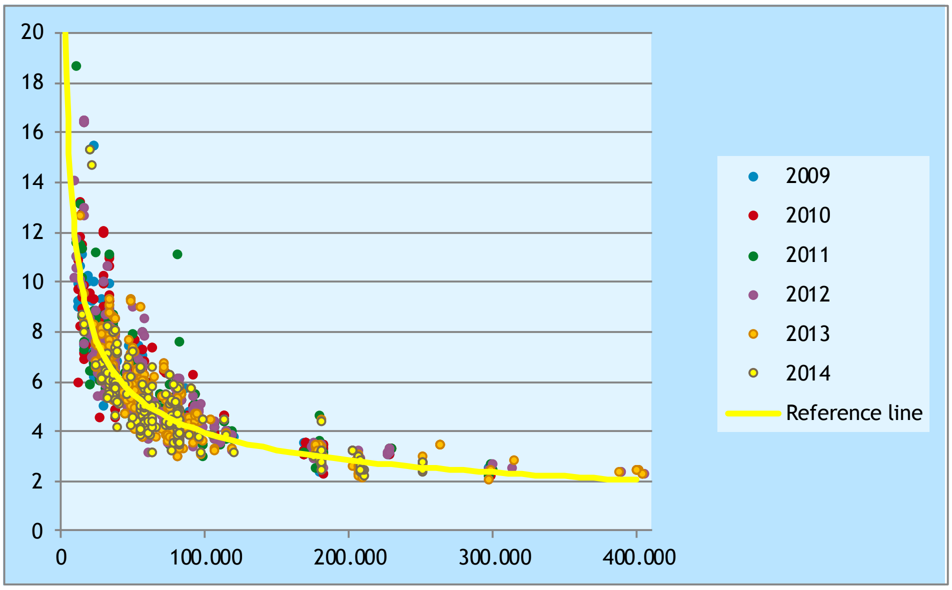
This chapter analyses how the EIV of ships that have entered the fleet since 2009 has changed and how these changes have been achieved. Various ship types show different patterns, which are discussed separately in Sections 3.1 through 3.6. Section 3.7 analyses the impact of the specific fuel consumption on the EIV and on the results of the analysis.

3.1 Bulkers

The Estimated Index Values and reference line values of 4,326 bulk carriers built in the years 2009-2014 have been calculated. Figure 3 illustrates the outcome for each bulker. Deadweight tonnage is on the horizontal axis. Observations below the continuous yellow curve refer to bulkers whose EIV is better than the reference line; observations above the same curve imply that the design efficiency of these bulkers is worse than the reference line.

An improvement in fuel efficiency performance between 1999-2009 and 2009-2014 should become visible through a majority of observations being below the yellow curve and an improvement between 2009 to 2014 would be evidenced by fewer EIVs in excess of the reference line value for later launch years. However, such developments are not immediately apparent from the figure.

Figure 3 EIVs of Bulkers built in 2009-2014



Further details on the EIVs of bulk carriers are presented in Table 3. The mean and median deviation are given in terms of the EIV minus the reference line value. The standard deviation is a measure for the variation in the EIV.

We calculated the share of ships with an EIV below the reference line value and the share of ships for which the EIV is below the objectives for 2015-2025. Based on the stated assumptions, we expect efficiency improvements in the period under study resulting in lower EIVs. The analysis however shows that this is not the case for the years 2009 through 2012, but that the EIVs of bulkers improved considerably in 2013 and during the first half of 2014. Table 3 shows that in 2013 and 2014, over half of the ships had EIVs below the reference line and over a quarter had EIVs more than 10% below the reference line.

Table 3 Analytics for bulkers 2009-2014

		2009-2014	2009	2010	2011	2012	2013	2014
EIV	Mean	5.4	5.6	5.4	5.4	5.4	5.1	4.9
%deviation from reference line	Mean	5%	5%	6%	7%	6%	2%	-3%
	Median	5%	5%	6%	6%	5%	-1%	-6%
	Standard deviation	15%	14%	14%	14%	17%	16%	20%
Number of ships	Total number	4,482	545	960	1,105	1,023	614	235
	With EIVs under reference line (in %)	34%	30%	29%	23%	35%	53%	68%
	With EIVs 10% under reference line (in %)	13%	9%	8%	8%	11%	25%	36%
	With EIVs 20% under reference line (in %)	2%	1%	1%	1%	2%	3%	8%
	With EIVs 30% under reference line (in %)	0%	0%	0%	0%	0%	0%	1%

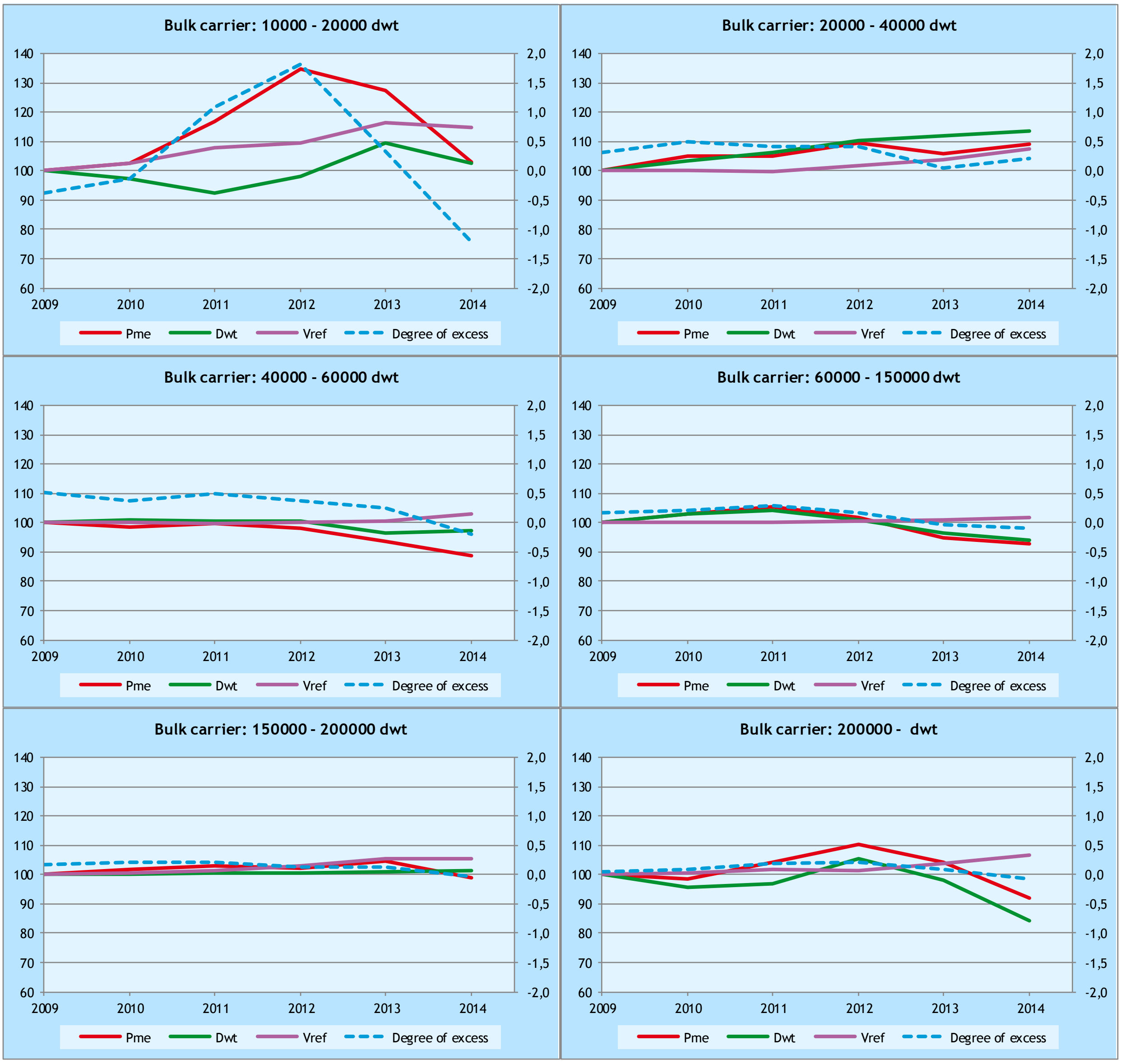
Bulkers have improved their EIV despite increasing design speed as becomes clear when we analyse the development of the different factors of the EIV and disaggregate the bunkers into size brackets.

New bulkers between 40,000 and 60,000 dwt are a prime example. They had on average a higher speed in 2014 than in 2012, but lower engine power (see Table 4 and Figure 4). On average, they were slightly smaller. This seems to suggest that the design of the ships has improved: their hull form, propulsion system, and other design elements, allowed them to sail at a higher speed with less engine power than previously. A similar pattern, though somewhat less pronounced, can be seen for larger bulk carriers up to 200,000 dwt, while the largest size category shows a very pronounced pattern.

Table 4 Development of speed, engine power, size and EIV of bulkers

Size (dwt)	EIV relative to reference line	Main engine power	Size	Speed	Remarks
10,000-20,000	+-	+-	-+	+	Only 5 and 3 ships in 2013-2014
20,000-40,000	0-	+	+	+	
40,000-60,000	-	-	0	0+	
60,000-150,000	-	-	-	0	
150,000-200,000	-	0	0	+	
> 200,000	0	+-	-	+	

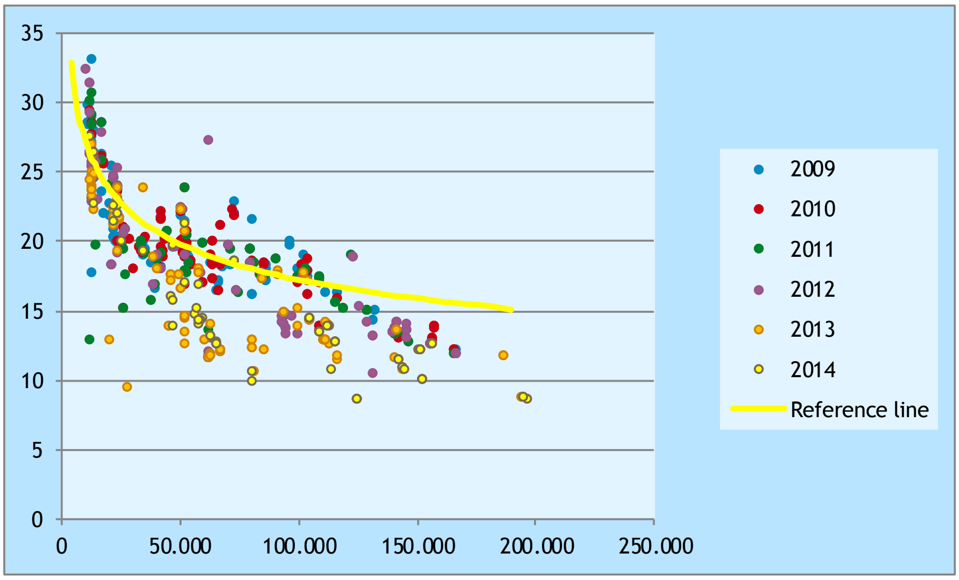
Figure 4 Development of speed, engine power, size and EIV of bulkers



3.2 Containerships

The EIVs and reference line values for 1,162 containerships built in the years 2009-2014 are presented in Figure 5. It is apparent from this chart that all large container ships have EIVs well below their reference line values (i.e. considerably better design efficiency than ships built in the decade beginning in 1999). It is clear that a reference line calculated on the basis of ships that entered the fleet in the period 2009–2014 would have quite different parameters than the reference line based on ships entering the fleet between 1999 and 2009 that was used to determine EEDI requirements. One possible explanation is that energy efficiency improvements since 2009 have concentrated more on large container ships, leading to a reduction in their EIVs but not in the EIVs of small and medium-sized ships.

Figure 5 **EIVs of Containerships built in 2009-2014**



Further analysis in Table 5 reveals that between 60 and 70% (depending on their launch year) of new container ships built in the years up until 2012 have EIVs that are below their reference line values. This share increases to 87-95% for 2013-2014.

Table 5 Analytics for Containerships 2009-2014

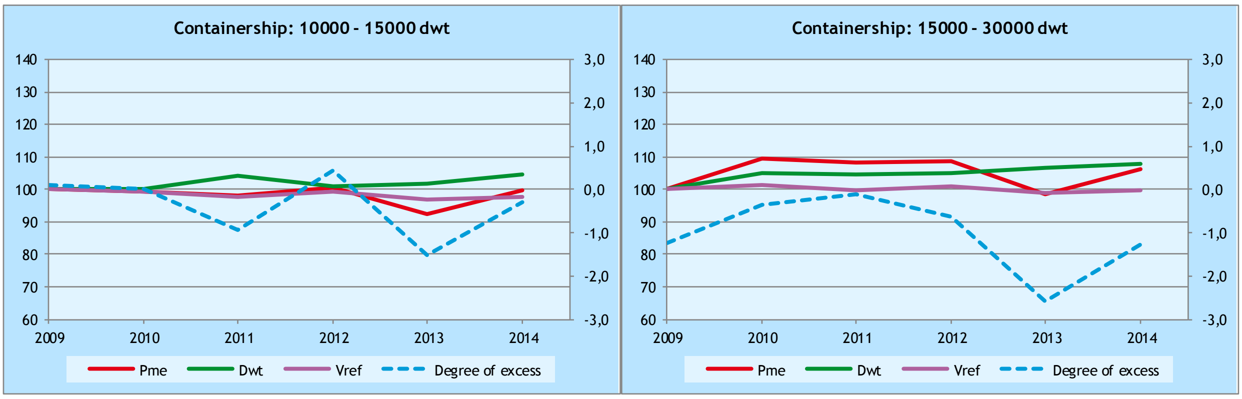
		2009-2014	2009	2010	2011	2012	2013	2014
EIV	Mean	18.2	20.3	19.3	17.8	18.2	15.6	14.2
%deviation from reference line	Mean	-8%	-2%	-2%	-8%	-9%	-21%	-29%
	Median	-8%	-2%	-1%	-8%	-10%	-24%	-29%
	Standard deviation	15%	10%	10%	14%	15%	17%	16%
Number of ships	Total number	1,162	259	255	181	195	192	80
	With EIVs under reference line (in %)	70%	64%	57%	63%	73%	87%	95%
	With EIVs 10% under reference line (in %)	41%	16%	21%	43%	52%	72%	84%
	With EIVs 20% under reference line (in %)	20%	5%	5%	14%	20%	51%	61%
	With EIVs 30% under reference line (in %)	10%	2%	1%	6%	9%	26%	34%

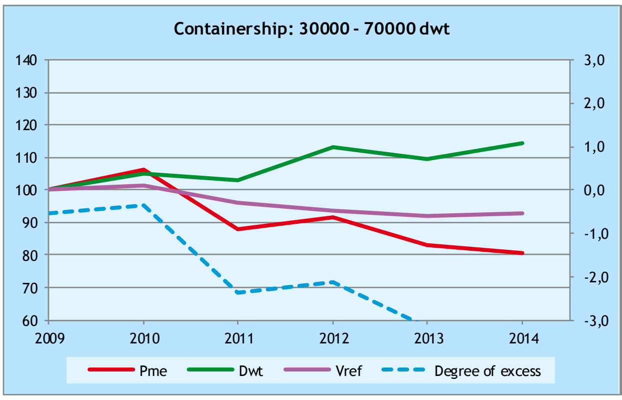
In contrast to bulkers, containerships have generally reduced their design speed and engine power to a larger extent, while slightly increasing their size. This has resulted in an improvement of the EIV, as is apparent from Table 6 and Figure 6.

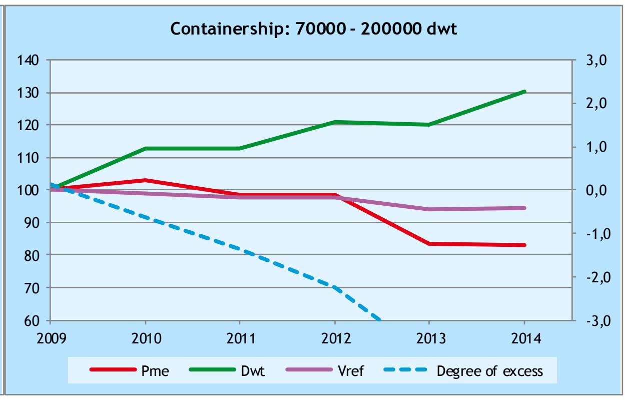
Table 6 Development of speed, engine power, size and EIV of container ships

Size (dwt)	EIV relative to reference line	Main engine power	Size	Speed	Remarks
10,000-15,000	~	0	0	0	Only 3 (2014)
15,000-30,000	+-	+	+	0	Only 6 (2014)
30,000-70,000	-	-	+	-	
70,000-200,000	-	-	+	-	

Figure 6 Development of speed, engine power, size and EIV of container ships



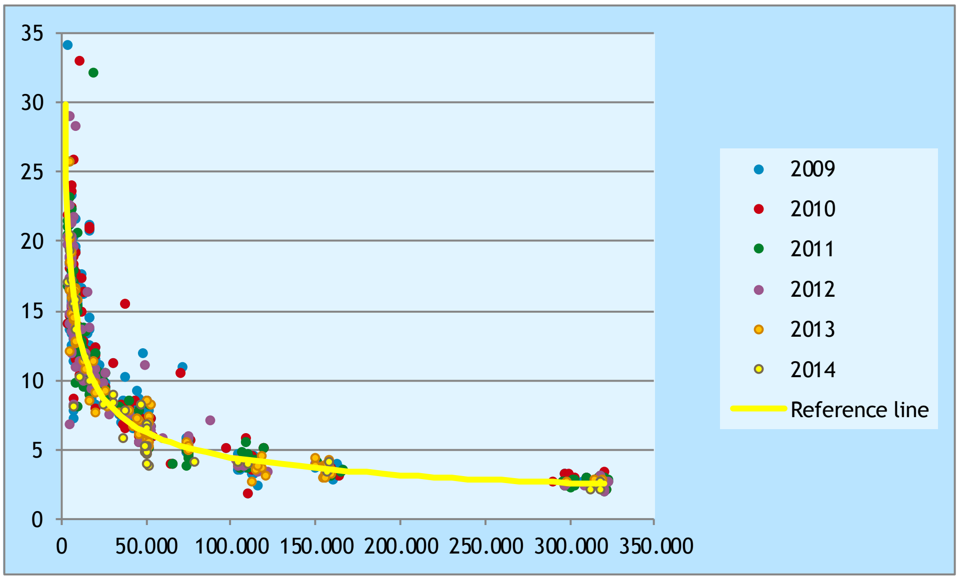




3.3 Tankers

The EIVs and reference line values of 1,983 tankers built between 2009 and 2014 are presented in Figure 7. On the whole, most results are clustered neatly around the reference line curve with few significantly above the reference line. This indicates that little has changed in the energy efficiency performance of tankers in the period between between 1999-2009 and 2009-2013 all other factors (e.g. the efficiency of main engines) being equal.

Figure 7 EIVs of Tankers built in 2009-2014



The analytics in Table 7 confirm the impression from the graph: the deviation from the reference line is small. Just under half the tankers built in 2009-2014 have EIVs below their reference line value. There is an improvement in fuel efficiency performance visible in the years 2011 and 2012: the mean and median deviation is higher and the number of ships that are above their reference line value has also fallen. 2014 is the exception: although the number of new tankers in the first half of the year was not large, an increasing number of them have EIVs below the reference line, and almost half have EIVs that are more than 10% below the line.

Table 7 Analytics for Tankers 2009-2014

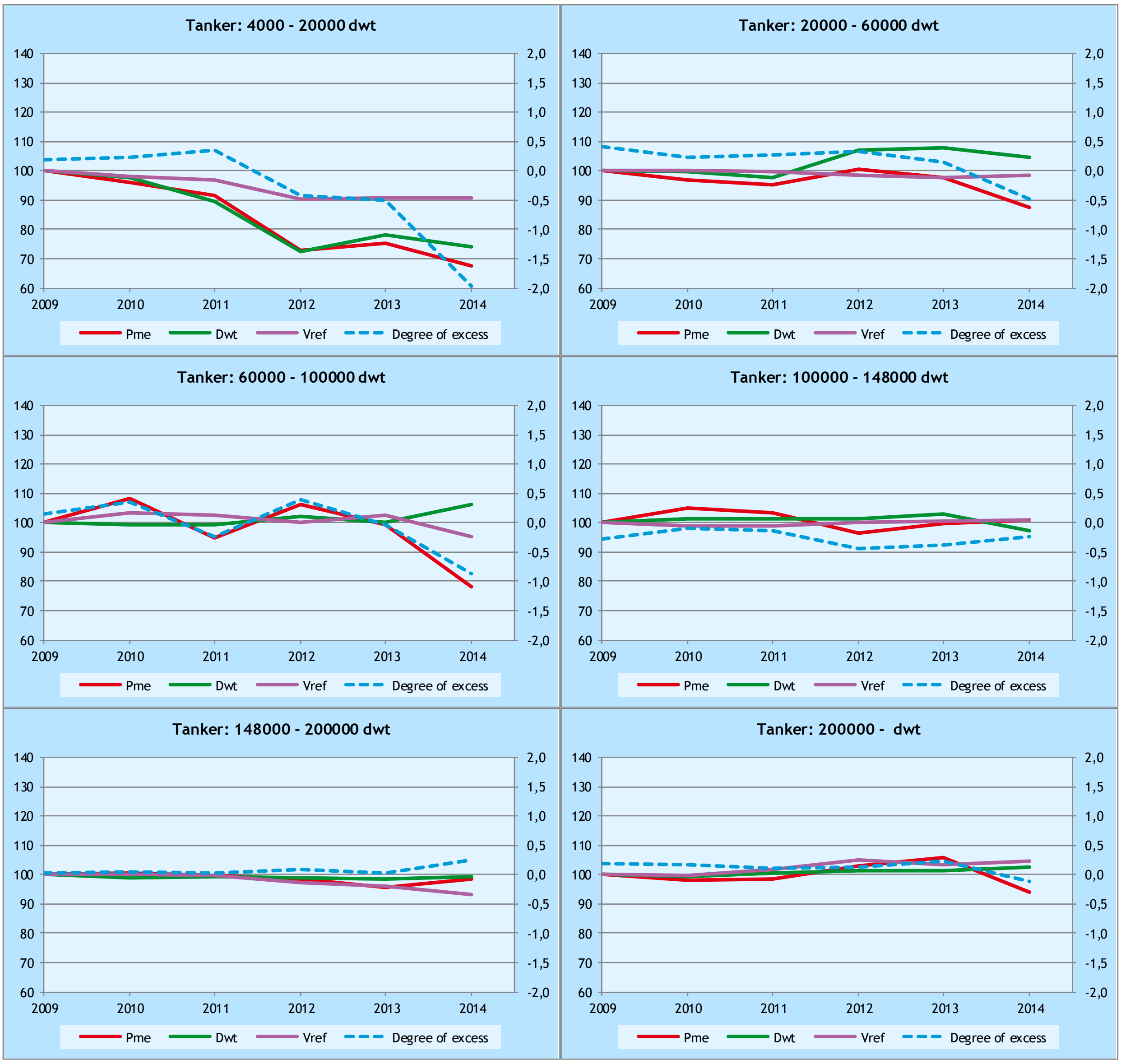
		2009-2014	2009	2010	2011	2012	2013	2014
EIV	Mean	8.9	9.0	8.9	8.7	10.3	8.0	7.4
%deviation from reference line	Mean	1%	2%	2%	2%	-1%	-1%	-10%
	Median	1%	2%	0%	0%	0%	0%	-6%
	Standard deviation	21%	20%	21%	20%	22%	15%	25%
Number of ships	Total number	1,983	696	513	345	224	151	54
	With EIVs under reference line (in %)	46%	43%	47%	45%	49%	48%	63%
	With EIVs 10% under reference line (in %)	16%	14%	15%	15%	18%	16%	46%
	With EIVs 20% under reference line (in %)	4%	3%	2%	2%	6%	5%	26%
	With EIVs 30% under reference line (in %)	1%	1%	1%	1%	2%	1%	11%

For tankers, different trends are visible for different size categories.
The smallest tankers are getting smaller, have less engine power and sail at a slower speed. Tankers in the weight class 20,000–60,000 dwt have become larger and have reduced their engine power while keeping their design speed constant. Large tankers have remained pretty constant in their size, engine power and speed, and therefore in their EIV.

Table 8 Development of speed, engine power, size and EIV of tankers

Size (dwt)	EIV relative to reference line	Main engine power	Size	Speed	Remarks
4,000-20,000	-	-	-	-	
20,000-60,000	-	-	+	0	
60,000-100,000					Unclear results, only 1 ship 2014
100,000-150,000	0	0	0	0	Only 2 ships 2014
150,000-200,000	0	0	0	0-	Only 2 ships 2014
> 200,000	0	0	0	0	Only a few ships (2013-2014)

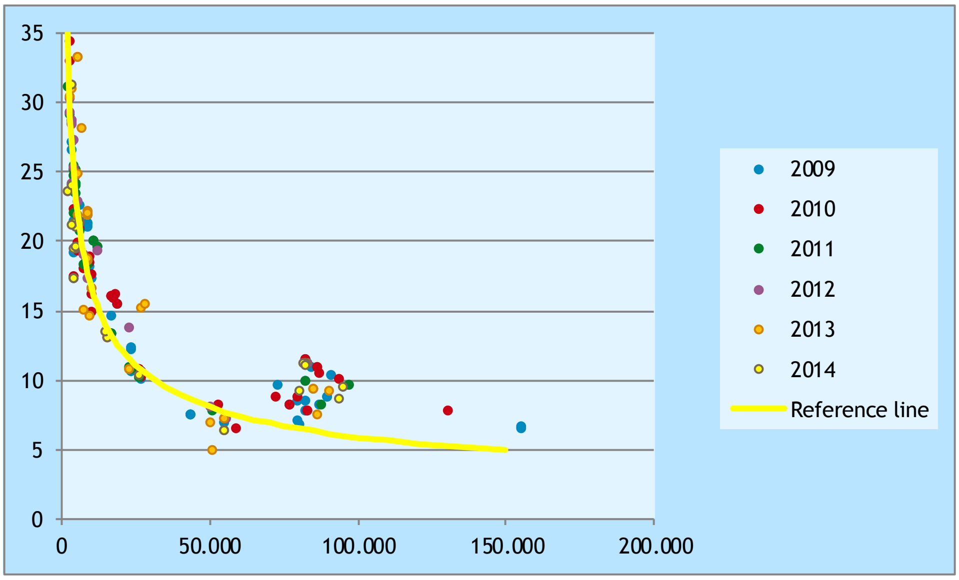
Figure 8 Development of speed, engine power, size and EIV of tankers



3.4 Gas Carriers

The EIVs and reference line values of 259 gas carriers built in 2009-2014 are presented in Figure 9. It seems as if the fuel efficiency performance of newly built gas carriers has deteriorated over time. This trend seems primarily due to carriers with a capacity of about 80,000 to 100,000 dwt as these ships have EIVs that are consistently above their reference line values.

Figure 9 EIVs of Gas carriers built in 2009-2014



The assumption is confirmed in the analysis in Table 9. Depending on the launch year, between 60 and 70% of gas carriers built in 2009-2013 have EIVs above the reference line. Only in 2014, do more gas carriers have EIVs below the reference line than above. To some extent this is due to the relatively small number of large ships built in that year.

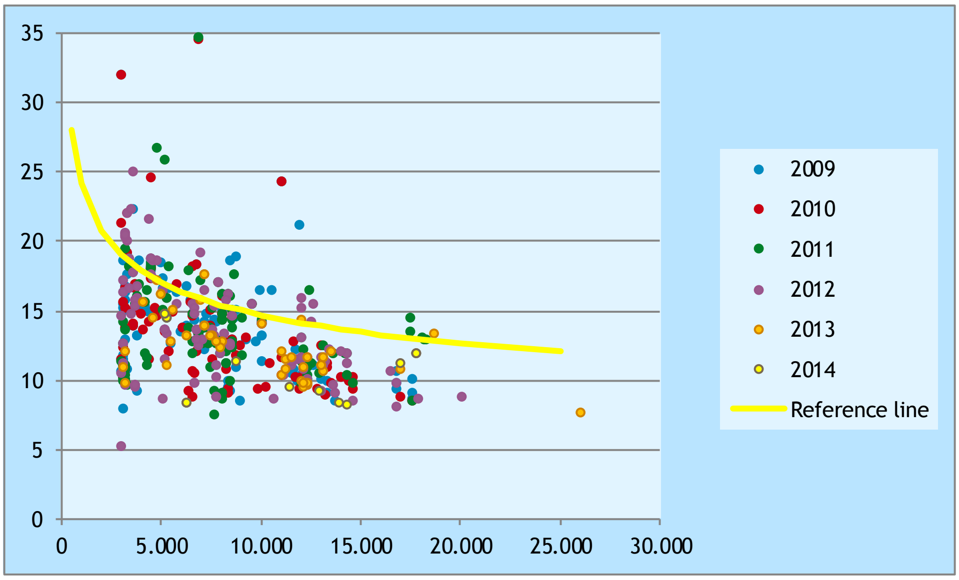
Table 9 Analytics for Gas carriers 2009-2014

		2009-2014	2009	2010	2011	2012	2013	2014
EIV	Mean	16.5	13.5	15.9	18.6	21.5	15.9	16.4
%deviation from reference line	Mean	5%	6%	6%	5%	4%	10%	-5%
	Median	4%	5%	8%	3%	1%	6%	-3%
	Standard deviation	19%	17%	18%	14%	13%	24%	26%
Number of ships	Total number	259	59	55	42	32	48	23
	With EIVs under reference line (in %)	42%	44%	38%	33%	41%	42%	61%
	With EIVs 10% under reference line (in %)	14%	12%	13%	5%	3%	17%	43%
	With EIVs 20% under reference line (in %)	4%	2%	4%	2%	0%	6%	13%
	With EIVs 30% under reference line (in %)	3%	0%	4%	2%	0%	4%	9%

3.5 General Cargo Carriers

The EIVs and reference line values of 618 general cargo carriers built in 2009-2014 are presented in Figure 10. The spread in EIVs is large, reflecting the heterogeneous nature of this particular ship type. The figure further suggests that the fuel efficiency of general cargo carriers improved relative to the 1999-2009 period as most observations are below the curve.

Figure 10 EIVs of General cargo carriers built in 2009-2014



The analysis for general cargo carriers built in 2009-2014 is shown in Table 10. The vast majority of new carriers have EIVs below their reference line values. However, the mean and median deviation from the reference line value decreased in the years 2009-2014 while the number of general cargo carriers whose EIV exceeds their reference line value rose from about 10 to 20% between 2009 and 2012. In 2013 and 2014 these percentages fell to around 10% and almost 0%.

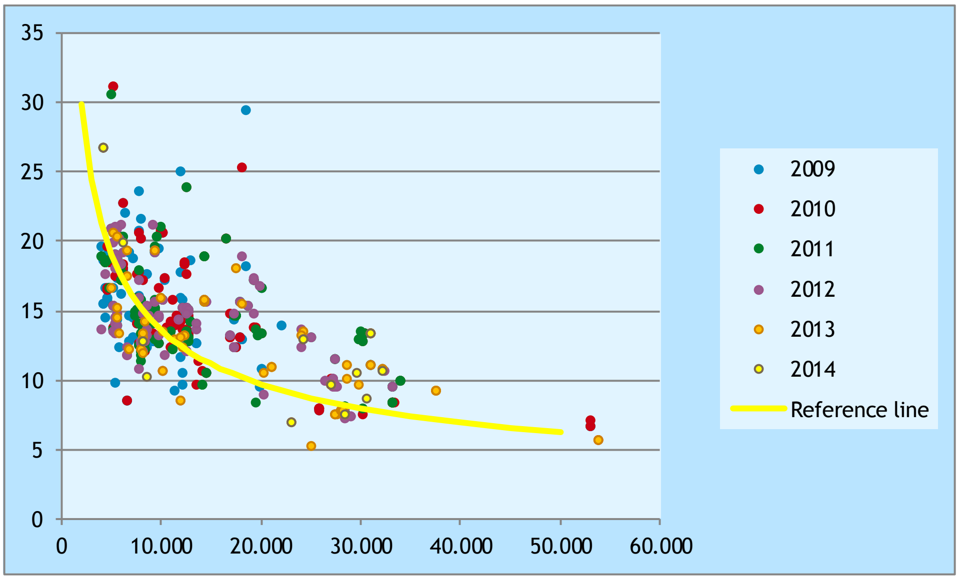
Table 10 Analytics for General cargo carriers 2009-2014

		2009-2014	2009	2010	2011	2012	2013	2014
EIV	Mean	13.6	13.3	14.2	13.9	13.7	12.5	11.0
%deviation from reference line	Mean	-19%	-27%	-15%	-15%	-17%	-22%	-34%
	Median	-19%	-25%	-18%	-17%	-17%	-20%	-28%
	Standard deviation	29%	28%	33%	31%	23%	17%	21%
Number of ships	Total number	618	141	147	137	121	58	14
	With EIVs under reference line (in %)	83%	89%	82%	78%	78%	91%	100%
	With EIVs 10% under reference line (in %)	67%	74%	62%	62%	63%	81%	79%
	With EIVs 15% under reference line (in %)	57%	65%	59%	52%	49%	66%	50%
	With EIVs 30% under reference line (in %)	24%	33%	22%	20%	22%	22%	43%

3.6 Combination Carriers

The EIVs and reference line values of 674 combination carriers built in 2009-2014 are presented in Figure 11. Like general cargo carriers, combination carriers are clearly a heterogeneous ship type. The chart suggests that the fuel efficiency of combination carriers has not improved appreciably over time.

Figure 11 EIVs of Combination carriers built in 2009-2014



The analytics for combination carriers built in 2009-2014 in Table 11 confirm this. About 60% of combination carriers built since 2009 have EIVs above their reference line values. It would also seem that ships built in 2009 have a better fuel efficiency performance than ships built after that year. A sizable fraction of combination carriers have EIVs that deviate far from the reference line, both above and below the line.

Table 11 Analytics for combination carriers 2009-2014

		2009-2014	2009	2010	2011	2012	2013	2014
EIV	Mean	14,3	15,0	14,4	14,7	13,7	12,8	14,4
%deviation from reference line	Mean	8%	5%	11%	9%	6%	11%	17%
	Median	8%	4%	7%	7%	9%	11%	19%
	Standard deviation	24%	25%	25%	21%	22%	29%	22%
Number of ships	Total number	674	142	140	168	134	74	16
	With EIVs under reference line (in %)	37%	39%	35%	35%	38%	39%	25%
	With EIVs 10% under reference line (in %)	18%	20%	11%	18%	23%	20%	19%
	With EIVs 20% under reference line (in %)	8%	10%	4%	5%	10%	11%	13%
	With EIVs 30% under reference line (in %)	2%	4%	1%	0%	4%	3%	0%

3.7 Adjustment of the results for specific fuel consumption

Clarksons' database further contains the specific fuel consumption of the main engine for 7,992 vessels (87% of the 9,179 ships built between 2009 and 2014 that were analysed in this Chapter). The average specific fuel consumption for these ships is close to 175 g/kWh, which is much lower than the constant value of 190 g/kWh set by MEPC.215(63) (MEPC, 2012) for calculating the EIV. In the preceding sections, we have consistently used the 190 g/kWh in order to establish a trend.

In order to assess which share of ships is likely to meet the EEDI, it is relevant to use the actual value of the SFOC. Using this average fuel consumption value, 67% of vessels are able to meet the reference line value once actual fuel consumption is used in the calculation, whereas only 42% met this requirement with the value set at 190 g/kWh. This result indicates that the EEDI of ships is likely to be significantly better than the EIV.

Figure 12 % of ships with EIVs above and below reference line value SFCME=190 g/kWh

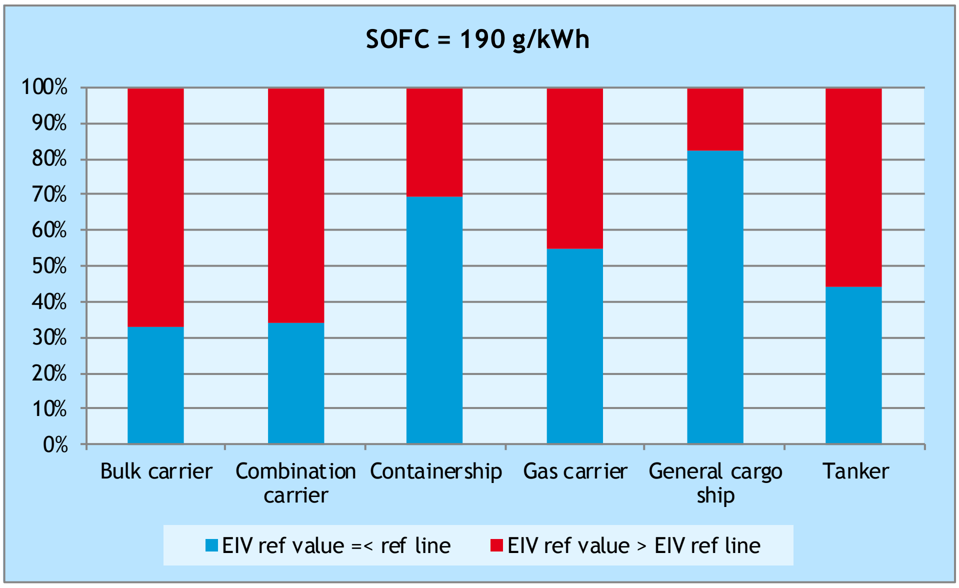
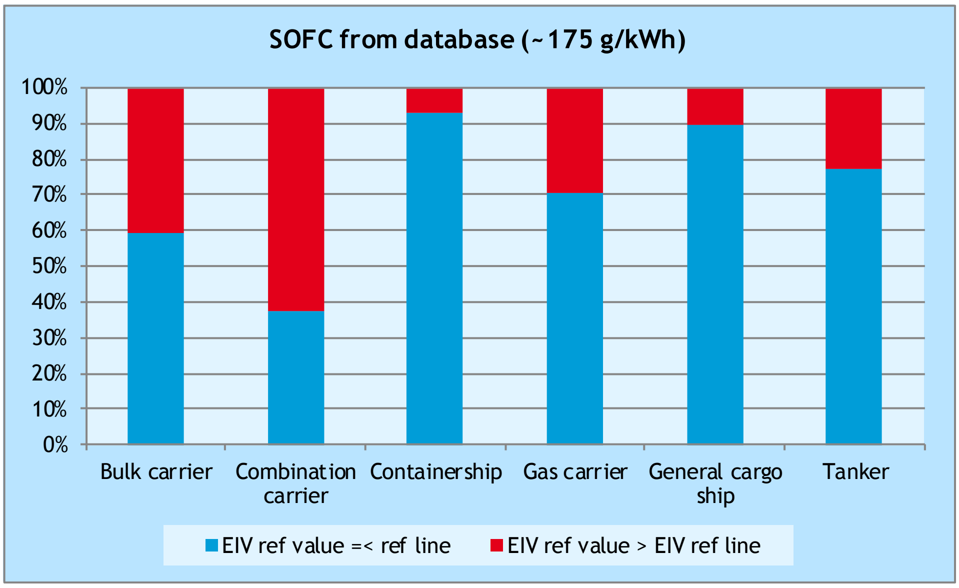


Figure 13 % of ships with EIVs above and below reference line value SFCME≈175 g/kWh



4 Conclusions

This study has analysed how the design efficiency of new ships has changed between 2009 – the first year that ship values were not included in the calculation of the EEDI reference line – and mid 2014 – the last year of data used for this study.

The analysis shows that container ships have improved their design efficiency since 2009, bulkers since 2013, and tankers possibly in 2014, although the sample of ships in that year was quite small. For all ship types, the majority of ships have an EIV below the reference line. Additionally, 25% of all new tankers and 61% of all new container ships have EIVs of at least 20% below the reference line. If one would take the actual specific fuel consumption of new engines into account, rather than the value prescribed in the EIV formula, the share of ships below the reference lines would be larger.

The EIV improvements have, for a number of size categories, coincided with increases in average design speed and decreases in main engine power. This suggests that hull or propulsion efficiency have been improved. These findings also suggest that, if design speeds were kept constant, even larger improvements in design efficiency would have been possible.

Our analysis indicates that the current and future EEDI limit values are achievable for all major ship types, as many ships in all size categories already meet and exceed them.

5 Bibliography

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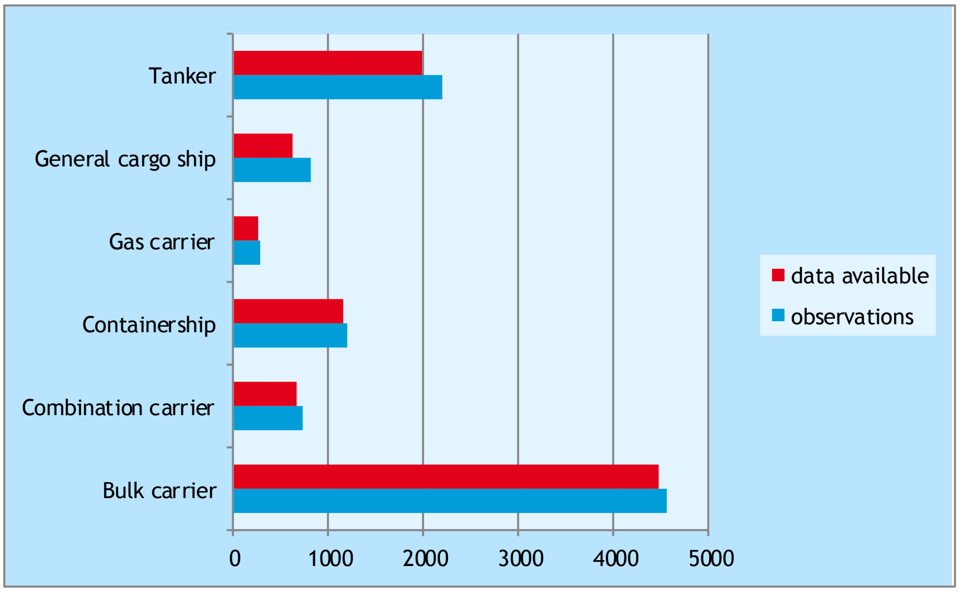
Annex A Data

Data on ship type, design speed, capacity, launch year, ice-class and propulsion power has been gathered from Clarkson Research World Fleet Register. In conformity with reference line calculations (MEPC.215(63) (MEPC, 2012), only ships of 400 GT or above are included in the dataset. Ships with zero or missing data on power, reference speed and/or capacity have been deleted. Speed was adjusted for one ship, dead weight tonnage for seven ships on the basis of other sources. Two ships with very low engine power were omitted. Thirteen outliers turned out to be ship types not included in the reference line calculations. These were omitted as well.

The number of vessels of the six IHSF ship types included in the calculation of reference lines built in the period 2009-2014is 9,786 of which 9,179 are included in the dataset. Of these, 1,842 (20%) were built in 2009, 2,070 (23%) in 2010, 1,978 (22%) in 2011, 1,729 (19%) in 2012, 1,137 (12%) in 2013 and 423 (5%) in 2014. Bulk carriers account for 4,483 (45%), gas carriers for 259 (2%), tankers for 1.983 (24%), containerships for 1,162 (13%), combination carriers for 674 (8%) and general cargo ships for 618 (8%) of observations in the dataset.

Figure 14 Clarkson Research shipping data 2009-2014



Annex B Analytics for bulkers, tankers, containerships based on SOFC

Table 12 Analytics for Bulkers 2009-2014

		2009-2014	2009	2010	2011	2012	2013	2014
EIV	Mean	5.0	5.1	5.0	5.0	5.0	4.7	4.5
%deviation from reference line	Mean	6%	7%	7%	8%	7%	1%	-2%
	Median	5%	6%	6%	7%	5%	-1%	-6%
	Standard deviation	16%	14%	14%	15%	18%	17%	22%
Number of ships	Total number	4,326	522	939	1,077	993	590	205
	With EIVs under reference line (in %)	59%	56%	60%	54%	57%	70%	79%
	With EIVs 10% under reference line (in %)	23%	19%	14%	14%	24%	47%	58%
	With EIVs 20% under reference line (in %)	7%	3%	2%	4%	7%	18%	25%
	With EIVs 30% under reference line (in %)	1%	0%	0%	0%	1%	2%	3%

Table 13 Analytics for Tankers 2009-2014

		2009-2014	2009	2010	2011	2012	2013	2014
EIV	Mean	7.5	7.5	7.5	7.3	8.2	7.6	6.5
%deviation from reference line	Mean	2%	5%	2%	3%	0%	-2%	-14%
	Median	1%	2%	1%	1%	1%	0%	-13%
	Standard deviation	20%	21%	17%	23%	17%	12%	30%
Number of ships	Total number	1,632	572	439	297	167	119	38
	With EIVs under reference line (in %)	77%	74%	76%	74%	87%	89%	89%
	With EIVs 10% under reference line (in %)	33%	33%	34%	32%	28%	35%	68%
	With EIVs 20% under reference line (in %)	7%	5%	5%	5%	7%	10%	53%
	With EIVs 30% under reference line (in %)	2%	0%	1%	1%	1%	3%	26%

Table 14 Analytics for Containerships 2009-2014

		2009-2014	2009	2010	2011	2012	2013	2014
EIV	Mean	16.4	18.7	17.8	16.1	16.1	13.8	122
%deviation from reference line	Mean	-9%	-2%	-2%	-9%	-12%	-25%	-36%
	Median	-9%	-1%	-1%	-10%	-15%	-25%	-37%
	Standard deviation	16%	11%	11%	15%	17%	18%	17%
Number of ships	Total number	1,048	228	242	170	170	165	73
	With EIVs under reference line (in %)	93%	87%	92%	96%	93%	98%	99%
	With EIVs 10% under reference line (in %)	62%	46%	42%	62%	71%	87%	95%
	With EIVs 20% under reference line (in %)	38%	10%	15%	41%	51%	69%	88%
	With EIVs 30% under reference line (in %)	16%	2%	1%	7%	15%	49%	62%