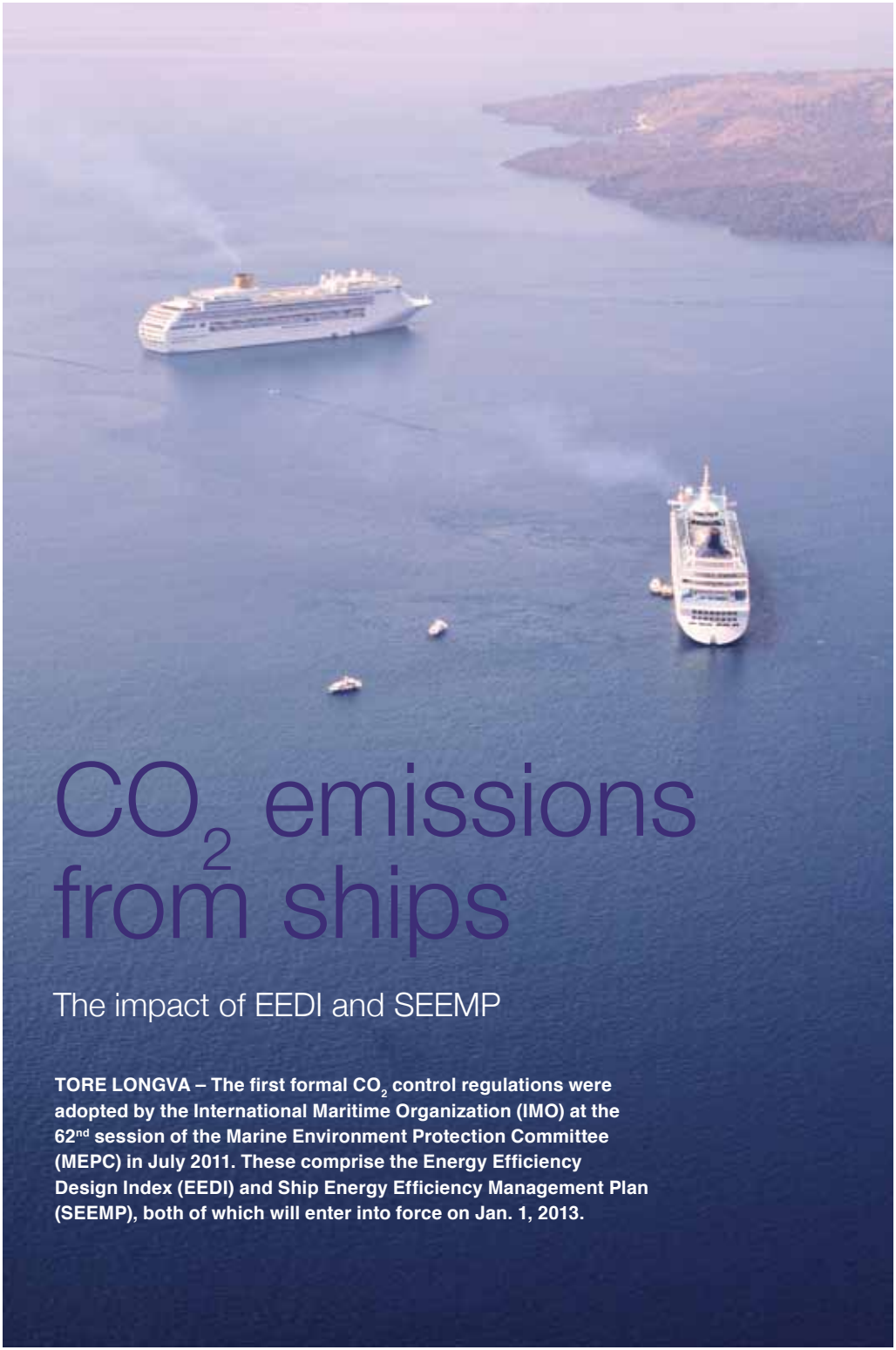


CO_2 emissions from ships

The impact of EEDI and SEEMP

TORE LONGVA – The first formal CO_2 control regulations were adopted by the International Maritime Organization (IMO) at the 62nd session of the Marine Environment Protection Committee (MEPC) in July 2011. These comprise the Energy Efficiency Design Index (EEDI) and Ship Energy Efficiency Management Plan (SEEMP), both of which will enter into force on Jan. 1, 2013.

A new International Energy Efficiency Certificate (IEEC) will be introduced for all vessels. This includes a supplement recording particulars related to the ship's energy efficiency, such as the propulsion system, the attained EEDI for newbuildings and the presence of a SEEMP.

Energy Efficiency Design Index

The EEDI requirements will apply to new ships above 400 gross metric tons only, where "new ship" means a ship:

- for which the building contract is placed on or after Jan. 1, 2013 or
- in the absence of a building contract, the keel of which is laid or which is at a similar stage of construction on or after Jan. 1, 2013 or
- the delivery of which is on or after Jan. 1, 2015

The EEDI is measured in the mass of CO_2 emitted per unit of transport work (gCO_2/ton-nm). The yard, designer or a consultant will have to develop an EEDI technical file containing the necessary documentation and calculations. Verification will be done in two stages, a preliminary verification at the design stage based on tank tests, manufacturers' data and design particulars and final verification at the sea trial. During the sea trial the speed will be measured and the technical file will be updated together with engine certificates and other necessary documentation. The EEDI technical file will then be verified by a flag administration or a recognized organization, and the IEEC will be issued.

The regulation differentiates between ship types which are required to calculate an attained EEDI and those that must have an attained EEDI below a certain required EEDI. Ship types needing to comply with a specific required EEDI level to obtain the IEEC are defined in the table below, which also indicates the timeline for the tightening of the requirement levels.

The reference line value of a ship is calculated based on the following formula: a · capacity-c, where the *a* and *c* parameters are given in the following table:

Ship type	Capacity	a	c
Bulk carrier	DWT	961.79	0.477
Gas tanker	DWT	1120.00	0.456
Tanker	DWT	1218.80	0.488
Container	70% · DWT	174.22	0.201
General cargo	DWT	107.48	0.216
Reefer	DWT	227.01	0.244
Combination	DWT	1218.80	0.488

The reference lines are shown in Figure 2. The lines stop at the lower cut-off lines for the ship types, below which the required EEDI does not apply.

In order to address concerns raised by developing countries, the regulations include a clause allowing any administration to waive the EEDI requirements for ships flying its flag for a period of up to four years (linked to the contract date), or six years and six months (linked to the delivery date) after Jan. 1, 2013. However, the preliminary indications are that the major flag states will be reluctant to invoke the waiver clause.

1 Reduction factors (in percentage) for the EEDI relative to the reference line for each ship type

	Size	Phase 0 Jan. 1, 2013 – Dec. 31, 2014	Phase 1 Jan. 1, 2011 – Dec. 31, 2019	Phase 2 Jan. 1, 2020 – Dec. 31, 2024	Phase 3 Jan. 1, 2025 onwards
Bulk Carriers	>20,000 DWT 10-20,000 DWT	0% n/a	10% 0-10%*	20% 0-20%*	30% 0-30%*
Gas tankers	>10,000 DWT 2-10,000 DWT	0% n/a	10% 0-10%*	20% 0-20%*	30% 0-30%*
Tanker and combination carriers	>20,000 DWT 4-20,000 DWT	0% n/a	10% 0-10%*	20% 0-20%*	30% 0-30%*
Container ships	>15,000 DWT 10-15,000 DWT	0% n/a	10% 0-10%*	20% 0-20%*	30% 0-30%*
General cargo ships	>15,000 DWT 3-15,000 DWT	0% n/a	10% 0-10%*	20% 0-20%*	30% 0-30%*
Refrigerated cargo tankers	>5,000 DWT 3-5,000 DWT	0% n/a	10% 0-10%*	20% 0-20%*	30% 0-30%*

* The reduction factor is to be linearly interpolated between the two values depending on the vessel size. The lower value of the reduction factor is to be applied to the smaller ship size.

The EEDI will, as new ships are built, gradually reduce the emissions from the world fleet with 3 percent in 2020, 13 percent in 2030, and 30 percent in 2050.

Complying to the requirements in Phases 0 and 1 is expected to come at a low cost. There is no commercial reason to order a ship without a calculated EEDI as the second-hand value may be lower and the ability to get a charter may be reduced as charterers will prefer ships with low (and thus calculated) EEDI.

Ship Energy Efficiency Management Plan

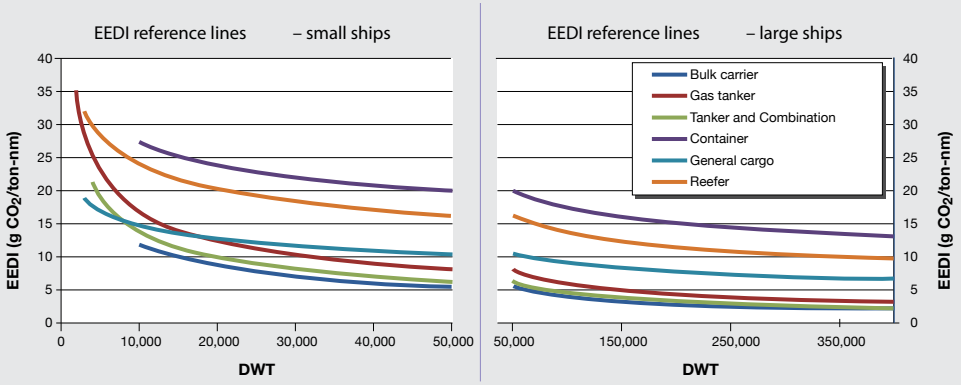
No changes were made to the SEEMP at MEPC 62, but the inclusion of SEEMP in the Annex VI amendments makes it mandatory for all ships – both new and existing – after it enters into force. The presence of a SEEMP will be checked during the first intermediate or renewal survey for the IAPP certificate, at which point the IEEC will be issued. The EEDI will not be calculated for existing vessels and thus not included in the IEEC.

Future CO_2 regulations

The adoption of the amendments is a significant step towards the regulation of greenhouse gas emissions by the IMO. Nevertheless, the EU is likely to consider it insufficient in light of its own ambitions. The EU process for establishing a regional CO_2 emission reduction mechanism for shipping is therefore expected to continue. Other parts of the international community also consider these regulations insufficient.

There is therefore a strong political drive to regulate shipping further, eg, through regional or international Market Based Measures (MBMs). Proposals under review range from a contribution or levy on CO_2 emissions from shipping via emission trading systems to schemes based on ship efficiency. If agreed, MBMs may appear towards the end of this decade.

2 The reference lines of a ship

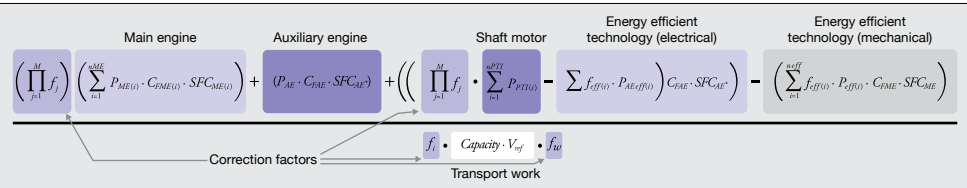


Commercial energy efficiency requirements are becoming increasingly important. The creation of various voluntary schemes for rating environmental performance, including CO_2 performance, provides tools that allow charterers and cargo owners to use only ships that satisfy their environmental requirements. These rating schemes must be based on robust methods and verifiable data in order to create a level playing field for the shipowner.

Reducing the EEDI

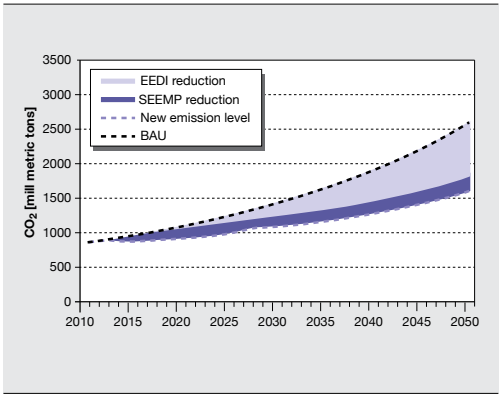
Any measure considered for reducing the EEDI must affect one or more of the parameters in the EEDI equation.

3 The EEDI equation

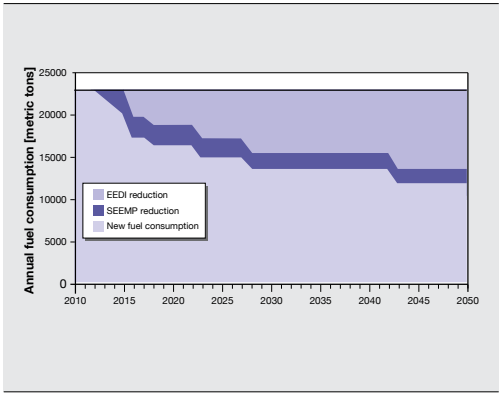


Method	Measures	Parameter affected
Reduce the main engine installed power	Improved hull and propeller efficiency Speed reduction or de-rate engine	P_{ME}
Lower the specific fuel consumption	Switch to a more efficient engine Engine control tuning	SFC_{ME}, SFC_{AE}
Increase the speed (without increasing the installed power)	Improved hull and propeller efficiency (ie, Mewis duct, propeller boss cap fin or other flow devices)	V_{ref}
Use fuel/energy source with a lower carbon content	Ie, LNG, biofuel (no guideline yet)	C_{FME}, C_{FAE}
Innovative mechanical energy-efficient technology	Ie, kites (no guideline yet)	P_{eff}
Innovative electrical energy-efficient technology	Ie, waste heat recovery	P_{AEeff}
Increase the capacity	Larger ships	Capacity

4 World fleet - average scenario: A1B-4 and B2-1



5 Ship type: very large crude carrier (VLCC) - scenario: A1B-4
Fuel: high, SEEMP uptake: high, no waiver



The sulfur regulation coming into force in 2020 will significantly increase the fuel prices, but the increase energy efficiency will reduce the expected cost from 50 million to 30 million dollars per year.

In addition, there will be compensation when using shaft generators (PPTO) and applying ice strengthening (fj). Other correction factors, for example for voluntary structural enhancement, are under development.

Some proposed measures, such as kites or solar panels, cannot provide power all the time and will not enable the main engine power and thus the EEDI to be reduced. At the moment, there are no guidelines for how such measures can be applied to reduce the EEDI, but these are expected to be developed at a later stage, most likely through the Peff parameter. Propulsion efficiency devices, such as Mewis ducts or propeller boss cap fins, can either reduce the main engine power (Pme) or enable the ship to obtain a higher speed (Vref).

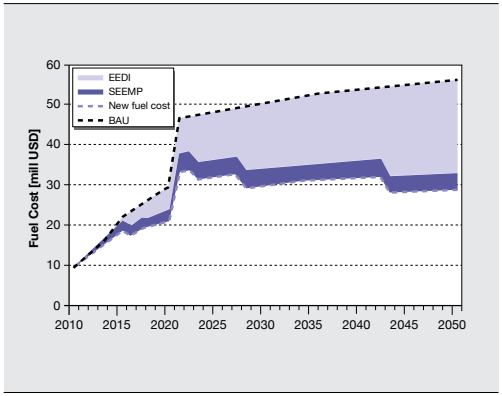
Further, the use of biofuels is not covered by the current framework as the carbon content cannot easily be determined. There are no indications regarding if and when this will be developed.

Further regulatory work

A number of guidelines will be developed during the next few years, with the most important being issued before entry into force in 2013:

- February 2012 – MEPC 63: guidelines for minimum propulsion power
- October 2012 – MEPC 64: guidelines on voluntary structural enhancement
- July 2013 – MEPC 65: guidelines for CO_2 abatement technologies
- March 2014 – MEPC 66: guidelines for calculation of EEDI for RoRo, passenger, diesel-electric and hybrid propulsion ships

6 **Annual fuel cost for newbuild VLCC - scenario: A1B-4 Fuel: high, SEEMP uptake: high, no waiver**



The requirements and dates are subject to two reviews. The first is on the requirements for small ships and large bulkers and tankers and is due in July 2013. The second review allows for a discussion of both the requirements and the timeline for when Phases 2 and 3 are to enter into force, and is due in January 2015.

Impact of EEDI and SEEMP

The IMO commissioned a study by Lloyd's Register and Det Norske Veritas to estimate the impact of the new requirements. The results from the study show that the EEDI will, as new ships are built, gradually reduce the emissions from the world fleet with 3 percent in 2020, 13 percent in 2030, and 30 percent in 2050. The SEEMP will not directly mandate an emission reduction, but by increased awareness of costs and reduction potentials, the study estimated the reduction to between 5-10 percent from 2015 onwards.

Effect of SEEMP

The EEDI will mandate improvements in hull design and machinery, while the SEEMP will require ship-owners to develop a plan for their ships. There are significant potentials for reduction by operational measure, and with the current fuel prices, most are also cost-effective. However, there appears to be a limited uptake of these measures caused by non-financial barriers, such as lack of capital, lack of competence, lack of cooperation between actor and split incentives. Higher fuel prices will lead only to a limited extra implementation of measures, but over time will drive technology development and innovation. Other incentives will have to be in place to implement the existing set of measures. The SEEMP will initiate monitoring and target setting and look at concrete measure to be implemented for each vessel. Awareness of the potential savings is expected to increase the uptake of measures.

Very large crude carrier (VLCC) case

The effect of the new regulations was applied on a VLCC to see how the fuel consumption and cost would develop. The baseline case was a tanker using 23,000 metric tons of fuel per year, which at current fuel prices would cost around $10 million. The first figure shows how a newbuild vessel would perform year by year towards 2050.

A ship built according to the requirements in 2030 would use about 14,000 metric tons per year in 2030. The fuel cost calculations in the second chart are based on a scenario where the sulfur regulation coming into force in 2020 will significantly increase the fuel prices, but the increase energy efficiency will reduce the expected cost from $50 million to $30 million per year.

Tore Longva
Det Norske Veritas