e-ISSN: 2829-6192, p-ISSN: 2829-6184
DOI: https://doi.org/10.38035/ijam.v2i2
Received: 13 July 2023, Revised: 26 July 2023, Publish: 27 July 2023

GREENATION GLOBAL RESEARCH NATIONAL
IJAM
INTERNATIONAL JOURNAL OF ADVANCED MULTIDISCIPLINARY
E-ISSN: XXXX-XXXX, P-ISSN: XXXX-XXXX
https://greenpub.org/index.php/IJAM
editor@greenpub.org
0811 7401 455

Carbon Reduction Program Implementation Strategy on Product Tanker Fleet Against the Carbon Intensity Indicator (CII) Decreasing Target

Dwi Wahju Prasetyo[1], Susi Herawati[2], Tri Hananto[3]
[1] High School of Shipping Science (STIP), Jakarta, Indonesia, dwi.prasetyo@pertamina.com
[2] High School of Shipping Science (STIP), Jakarta, Indonesia, christ.heraw@gmail.com
[3] High School of Shipping Science (STIP), Jakarta, Indonesia, thanantocaaip43@gmail.com

Corresponding Author: dwi.prasetyo@pertamina.com

Abstract: Emissions of gases released into the atmosphere by various human activities on earth cause a greenhouse effect in the atmosphere. Greenhouse gases include carbon dioxide (CO2), sulfur dioxide (SO2), nitrogen monoxide (NO), nitrogen dioxide (NO2), methane (CH4) and chlorofluorocarbons (CFCs). One activity that increases greenhouse gases is shipping. Shipping is a cost-effective and energy-efficient form of bulk transportation, but currently international shipping operations account for approximately 2.5% of man-made greenhouse gas emissions globally [1]. Therefore, in 2018, IMO's initial strategy was adopted to reduce greenhouse gas emissions from ships by reducing carbon dioxide emissions by at least 40% by 2030 and targeting a reduction of carbon dioxide emissions by 70% by 2050. And reduce annual greenhouse gas emissions from ships by at least 50 percent by 2050 compared to 2008 [2]. To reduce the impact of these activities, IMO issued regulation 28 MARPOL Annex VI if ships with a capacity of 400 Gross Tonnage (GT) or more receive a D rating for three consecutive years or an E rating, corrective action is required to achieve an annual operational CII. er to achieve the desired rating in 2025.

Keywords: Shipping Gas Emissions, Carbon Intensity Indicator (CII), Carbon Reduction.

INTRODUCTION

Greenhouse gas emissions from ships can come from various sources such as ship engines, cooling systems, and combustion systems. The most common greenhouse gas emissions are carbon dioxide (CO2), methane (CH4), and nitrogen oxides (N2O). Management of greenhouse gas emissions in international shipping is important to reduce the negative impact on the environment. The carbon intensity indicator (CII) is the annual reduction factor required to ensure a continuous increase in the operational carbon intensity of ships within a given rating level. On 1 November 2022, Amendments to the International Convention for the Prevention of Pollution from Ships (MARPOL) Annex VI enter into force. Developed within the framework of the Initial IMO Strategy on Reducing Greenhouse Gas Emissions from Ships agreed in 2018, these technical and operational amendments require ships to improve their energy efficiency in the short term and thereby reduce their greenhouse gas emissions. Starting January 1, 2023, CII requirements will apply to all cargo, RoPax and cruise ships over 5,000 GT and operating internationally.

METHODS

CII

CII measures how efficiently a ship carries goods or passengers and is given in grams of CO2 emitted per cargo carrying capacity and nautical miles. Ships are then assigned an annual rating from A to E, at which point the rating thresholds will become increasingly stringent towards 2030.

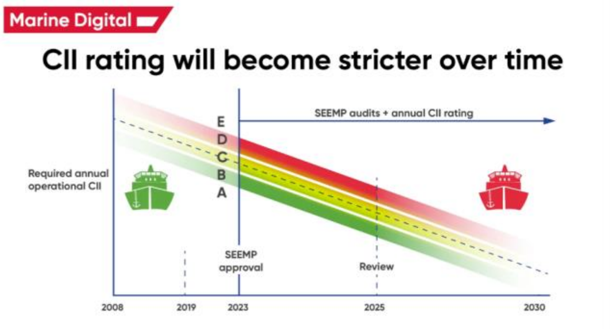

Figure 1. Decreasing CII Annually to 2030

As a stimulus to reduce the carbon intensity of all vessels by 40% by 2030 compared to a 2008 baseline, vessels will be required to calculate two ratings: their Achieved Ship Energy Efficiency Index (EEXI) to determine their energy efficiency, and an annual Operational Carbon Intensity Indicator (CII) and associated CII rating. The following are the requirements of the Carbon Intensity Indicator:

1. Ships over 5,000 GT are IMO DCS (Data Collection System) compliant with any type of propulsion.
2. Exclusion and Correction Factors (ice class, etc.) MEPC 77/78.
3. Required Annual Operational Carbon Intensity Indicator (CII).
4. Annual Operational Achieved Carbon Intensity Indicator (CII).
5. CII SEEMP Implementation Plan (currently).
6. Ratings: A, B, C, D, E.
7. Compliance and Rating Statements are issued within five (5) months of each calendar year.
8. CII SEEMP Improvement Action Plan (in the future).

DWT is used as the capacity when calculating Cll (AER) as the denominator. The data needed to calculate the achieved CLL is as follows

1. Monitoring fuel oil consumption for each type of fuel throughout the year
2. The ship's cargo carrying capacity (DWT) as stated in this manual, and
3. Distance traveled

The CII calculation is as follows:

<u>ATTAINED CII</u>

$$CII = \frac{C0_2\ Emissions}{Transport\ Work} = \frac{Fuel\ Consumption\ \times cf}{DWT * Distance} \dots\dots\dots (1)$$

<u>CII REFERENCE LINE</u>

$$CII_{ref} = a * Capacity^{C} \dots (2)$$

REQUIRED CII

$$CII_{req,year} = CII_{ref}\left(1 * \frac{z}{100}\right) \dots\dots\dots (3)$$

CII RATING

$$CII\ rating\ value = \frac{Attained\ CII}{CII_{req\ year}} \dots\dots\dots (4)$$

1. Attained CII

   Is the current/achieved CII value, cf is the emission conversion factor based on the type of fuel used.CO_2

2. CII Reference

   The CII reference line is the CII value for a particular ship type in 2019, then in calculations the values a and c are the parameters estimated for each type of ship by IMO DCS in 2019, and serve as the base line in the rating determination diagram.

Table 1. CII Reference Line & Required CII

No.	Ship Type		capacity	a	c
1	Bulk Carriers	279,000 DWT and above	279,000	4,977	0.626
		Less than 279,000 DWT	DWT	4,977	0.626
2	tankers		DWT	5,118	0.607
3	Combination Carriers		DWT	151,991	0.930
4	Carrier Gases	65,000 DWT and above	DWT	2.384 x 107	1,910
		Less than 65,000 DWT	DWT	8,032	0.608
5	LNG carriers	100,000 DWT and above	DWT	9,860	0
		65,000 DWT and above but less than 100,000 DWT	DWT	1.966 x 1010	2,498
		Less than 65,000 DWT	65,000	1.966 x 1010	2,498
6	Containership		DWT	1,963	0.487
7	General Cargo Ship	20,000 DWT and above	DWT	61,293	0.854
		Less than 20,000 DWT	DWT	361	0.336
8	Refrigerated Cargo Carrier		DWT	6,736	0.599
9	Ro-ro Cargo Ship - Vehicle Carrier		GT	5,831	0.633
10	Ro-ro Cargo Ship - No Vehicle Carrier		DWT	15,958	0.677
11	Ro-ro Passenger Ship		GT	7,691	0.586
12	Cruise Passenger Ship		GT	904	0.380

3. Required CII

   Is the reduction factor every year to achieve the desired CII target. With z is the addition of a deduction factor of 2% after 2023, with an initial deduction factor of 5% in 2023.

Table 2. CII Reduction Factor

year	Z year	Phases
2020	1%	
2021	2%	1
2022	3%	
2023	5%	
2024	7%	2
2025	9%	
2026	11%	
2027	-	
2028	-	3
2029	-	
2030	-	

4. CII rating

Is a rating of ships that can be awarded from 2023 to 2030, the rating is based on the five limits assigned by IMO. The rating can be assigned by comparing the ship's annual operational CII achieved with the cutoff value.

Table 3. The Four Limits CII

No.	Ship Type		d1	d2	d3	d4
1	Bulk Carriers	279,000 DWT and above	0.86	0.94	1.06	1.18
2	tankers		0.82	0.93	1.80	1.27
3	Combination Carriers		0.88	0.95	1.06	1.26
4	Carrier Gases	65,000 DWT and above	0.79	0.89	1.12	1.38
		Less than 65,000 DWT	0.85	0.95	1.06	1.25
5	LNG carriers	100,000 DWT and above	0.91	0.98	1.05	1.11
		Less than 65,000 DWT	0.77	0.91	1.12	1.37
6	Containership		0.83	0.94	1.07	1.19
7	General Cargo Ship	20,000 DWT and above	0.84	0.95	1.07	1.19
8	Refrigerated Cargo Carrier		0.77	0.90	1.07	1.21
9	Ro-ro Cargo Ship - Vehicle Carrier		0.86	0.94	1.06	1.16
10	Ro-ro Cargo Ship - No Vehicle Carrier		0.67	0.90	1.09	1.37
11	Ro-ro Passenger Ship		0.73	0.87	1.10	1.37
12	Cruise Passenger Ship		0.85	0.94	1.04	1.15

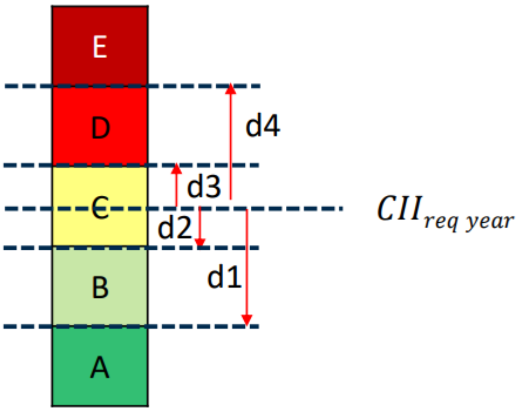

Figure 2. Five CII Ratings

Reference for determining the rating of each type of ship based on ABS data. Ratings A, B, C, D, E indicate the level of performance: major superior, minor superior, moderate, minor inferior, or inferior.

Ship Energy Efficiency Management Plan (SEEMP)

Ship Energy Efficiency Management Plan (SEEMP) is a ship-specific plan to improve ship energy efficiency. All ships of 400 gross tonnage (GT) and above engaged in international voyages must develop and keep a SEEMP on board, in accordance with the guidelines adopted by IMO [3].

SEEMP is divided into 3 sections, namely:

1. The first part of the SEEMP is to monitor and improve the ship's energy efficiency. This should include an estimate of the current energy consumption of the ship and identify actions to improve ship efficiency,
2. The second part of the SEEMP only applies to ships of 5,000 GT and above and engaged in international shipping. This part of the SEEMP should include a description of how

annual fuel oil consumption data for ships will be collected and reported to the ship's flag state.

3. The third part of the SEEMP starting January 1, 2023, new requirements will be applied to vessels that are required to deposit the second part of the SEEMP. As of this date, the SEEMP should outline how the operational carbon intensity of ships will be calculated and scaled up in new short-term MARPOL actions to reduce greenhouse gas emissions from international ships, including:
   a. The method used to calculate the annual operational Carbon Intensity Indicator (CII) achieved by the ship and the process for reporting CII to the ship's flag state.
   b. CII for ships over the next three years, with a plan outlining how this will be achieved.
   c. Process for self-assessment and improvement.
   d. Corrective action plan, if needed.

Product Carrier Ship

A ship is a floating object on the surface of the water, capable of accommodating goods/load, and has the ability to propel itself by means of mechanical power, wind power, and tug. Reporting from IMO resolution MSC.267(85), International Code on Intact Stability, 2008 (2008 IS Code) Product Tankers are tankers with a relatively smaller size than crude oil tankers/chemical tankers, generally used to transport products with a high level (grade) such as diesel oil, heating oil, etc. from factory to port.

Figure 3. Product Carriers

RESULT AND DISCUSSION

Results

Method Flow

Table 4. Method Flow

No.	Channel	Description
1	Study of literature	SEEMP Part III Carbon Intensity Indicator (CII)
2	Data collection	Ship data Vessel Gas Emission Data per Year
3	CII calculation	
4	Results Analysis	Conclusions and recommendations

Study of literature

Literature study was conducted to find out how efficient the actions taken to reduce CO2 gas emissions on product tankers managed by PT. Pertamina International Shipping

The following are 22 steps that can be taken to reduce CO_2 emissions along with references and estimates of the quantitative potential for reducing CO_2 emissions:

Table 5. CO2 Reduction Optimization List

Action aspect	Main action	Short description	CO2 reduction potential	Reference
Hull design	vessel size	economy of scale, improved capacity utilization [4]	4–83 %	Lindstad (2013)
	Hull shape	Dimensions & form optimization [5]	2–30%	Lindstad et al. (2015a, 2013a, 2014)
	Lightweight materials	High strength steel, composite [6]	0.1–22%	Buhaug et al. (2009)
	Lubricating water	Hull air cavity Lubrication [7]	1–15%	Faber et al. (2009,2011),
	Resistance reduction devices	Other devices/retrofitting to reduce resistance [8]	2–15%	EMEC (2010)
	Ballast water reduction	Change in design to reduce ballast size [9]	0–10%	Lindstad et al. (2015a)
	Hull coating	Distinct types of Coatings [10]	1–10%	Lin (2012)
Power & propulsion system	Hybrid power/ propulsion	Hybrid electric auxiliary power and propulsion [11]	2–45%	EA Sciberras, et al.
	power system/machinery	(Incl. eg variable speed electric power generation) [12]	1–35%	Tilig et al. (2015)
	Propulsion efficiency devices	Other devices to increase prop. Efficiency [13]	1–25%	Wang et al. (2010)
	Waste heat recovery	recovers heat from hot streams/gasses which would go unused [14]	1-20%	Psychological (2016)
	On board power demand	On board or auxiliary power demands (eg, lighting) [15]	0.1–3%	Maddox Consulting (2012)
Alternative energy sources	Windpower	Kite, sails/wings [16]	1–50%	Wärtsila (2009)
	Fuel cells	electrochemical cell that converts the chemical energy of a fuel and an oxidizing agent into electricity [17]	2–20%	Gilbert et al. (2014)
	Cold ironing	Electricity from shore, shore-to-ship power (SSP) [18]	3–10%	Miola et al. (2011)
	Solar power	Solar panels on deck [19]	0.2–12%	Sjöbom and Magnus (2014)
Operation	Speed optimization	operational speed, reduced speed [20]	1–60%	Corbett et al. (2009)
	capacity utilization	At vessel and fleet level (fleet management) [21]	5–50%	Gucwa and Schäfer (2013)
	Voyage optimization	Advanced weather routes, routes planning and voyage execution [22]	0.1–48%	Johnson and Styhre (2015)

Other operational measures	Trims/drafts Optimization Energy management, Optimized maintenance [23]	1–10%	Poulsen and Sornn-Friese (2015)

Some of the emission reduction measures listed above are not directly additive due to the interdependence of these steps. However, there are still combinations of actions that are practical and economically feasible. One of these combinations is: Ship size; hull shape; Ballast water reduction; hull coating; Hybrid power/propulsion; Optimization of weather speed and Route. Assuming a large relative independence between individual reduction measures.

Reporting from the journal by Elizabeth Lindstad et al. (2017) published by Elsevier, CII optimization methods can be grouped into four main categories, namely:

1. **Ship hull design**, these actions focus on exploiting the economic side and reducing bottlenecks during operations. The research results show that optimized ship hull design can greatly contribute to reducing CO2 emissions. Increasing ship size reducing emissions per unit haul and optimizing hull shape to reduce drag can significantly reduce power consumption as well as emissions. Other measures, such as lightweighting, hull coating and lubrication can contribute to improving hull performance.
2. **Engine system and propulsion system**, including the design of power systems and machinery, hybrid power solutions, higher propulsion efficiency, waste heat recovery, and reduced power requirements on board with energy efficient devices such as parachutes and sails. Hybrid power systems allow efficient utilization of multiple energy sources, such as combining a battery with an internal combustion engine to maximize the utilization of each technology, i.e. the battery can be used as a buffer to cover peak power requirements and to avoid operating the combustion engine at low power.
3. **Alternative fuel**, covers all aspects related to the replacement or supplementation of main fuels such as Heavy Fuel Oil -Marine Gas Oil with alternative energy. CO2 emissions can be reduced by switching to fuels with lower total emissions, both directly and indirectly throughout the fuel life cycle including production, refining and distribution. Examples are LNG and biofuels.
4. **Operation**, including the regulation of the speed of the ship, the ship is often designed to operate at its hydrodynamic limit that is the speed at which the drag curve on the hull begins to rise as speed increases. With the power requirement proportional to the product of speed and drag, this implies that when the ship decelerates, fuel consumption decreases and the greatest fuel reduction is achieved when the ship decelerates in the limit area. Determination of shipping routes, including finding optimal sailing routes, taking into account current, wave and weather conditions, and shipping according to contractual agreements or published schedules, to minimize bottlenecks and fuel consumption.

Data collection

1. Fleet Data of Product Tanker Ships that meet CII requirements

Table 6. Fleet Data (Ship)

Ship name	Gross Tonnage	Deadweight	Ship Age
Product Tankers 1	22,481	30,770	19
Product Tankers 2	24,167	29,755	13
Product Tankers 3	24,167	29,754	13
Product Tankers 4	24,167	29,755	13
Product Tankers 5	24,167	29,756	10

2. Vessel Emission Data per Year

Based on formula (1) to obtain CO2 emissions per year, it is necessary to multiply the fuel consumption data by the conversion factor (depending on the type of fuel), then the total CO2 emissions will be obtained, with the following data:

Table 7. Fleet (Ship) CO2 Emission Calculation

Boat	Distance Traveled(nm)	HFO(tons)	MGO(tonnes)	LSMGO(tonnes)	HFO(MT CO2)	MDO(MT CO2)	LSMGO(MT CO2)	CO2 Emissions(Total)
Ship 1	5417,900	363,120	250,568	0.000	1130901	803321	0.000	1934.222
Ship 2	30560,000	3361704	174,728	0.000	10469691	560,178	0.000	11029.869
Ship 3	32089850	3141676	312,926	0.000	9784436	1003.241	0.000	10787676
Ship 4	17707000	1957.142	191,990	0.000	6095323	615,520	0.000	6710843
Ship 5	22536000	2284,470	304,237	0.000	7114.753	975,384	0.000	8090137

CII calculation

To find the CII Calculation, you can use the following formula:

$$CII = \frac{CO_2\ Emissions}{DWT * Distance}$$

Then you can determine the CII Reference Line with the following formula:

$$CIIref = a * Capacity^{-c}$$

Furthermore, CIIref is used to find the CII req year with the following formula:

$$CIIreq\ year = CIIref * (1 - Z\ year)$$

And the CII rating value is obtained:

$$CII\ rating\ value = \frac{CII\ Calculation}{CII\ req\ year}$$

From the CII rating value, the CII rating of the fleet (ships) is obtained.

Table 8. CII Fleet Ratings

Boat	CO2 Emissions(Total)	CII Calc	CIIref	CII_req. year	CII_Rating Value	CII_Rating
Ship 1	1934.222	11,602	9,597	9,309	1,246	D
Ship 2	11029.869	12.130	9,796	9,502	1,277	E
Ship 3	10787676	11,298	9,796	9,502	1,189	D
Ship 4	6710843	12,737	9,796	9,502	1,340	E
Ship 5	8090137	12064	9,796	9,502	1270	D

Discussion

From the results of the CII calculation above, it can be seen that there are 5 CII Ratings belonging to the Product carrier fleet in 2022 which are below the annual minimum operating rating, where the annual minimum operating rating is at rating C. Therefore, in 2025 this ship is planned to be at rating C, so corrective steps are needed to optimize the CII such as, Optimized Utilization, Weather Routing, Hull Cleaning, Propeller Polishing, Optimum Trim, Just in Time, Energy Management, Optimized Cargo Heating and In sulation on the Product Tanker Ship fleet in order to achieve the desired rating in 2025.

Table 9. Minimum CII in 2025

Ship name	Min Req C in 2025	Min Req C in 2025 (%)
Product Tankers 1	9,432	23.01%
Product Tankers 2	9,627	26.00%

Product Tankers 3	9,627	17.36%
Product Tankers 4	9,627	32.30%
Product Tankers 5	9,627	29.94%

From the table it can be seen that the Product Tanker Fleet of PT. Pertamina International Shipping has a CII distance that is far enough to meet the minimum CII in 2025 so that in order to meet the minimum CII value in 2025, corrective actions are taken as follows:

Table 10. Corrective Action To Meet CII Minimum By 2025

Ship name	Total	Optimized Utilization	Weather Routing (~ 4%)	Hull Cleaning(~5 %)	Propeller Polishing (~ 2%)	Optimum Trim(~ 3%)	Just in Time(~ 4%)	Energy management(~ 2%)	Optimized Cargo Heating and Insulation (~ 1%)
Product Carrier 1	24 %	6.00%	2%	2%	2%	3%	3%	2%	1%
Product Carrier 2	16 %	1.00%	2%	2%	2%	3%	3%	2%	1%
Product Carrier 3	15 %	0.00%	2%	2%	2%	3%	3%	2%	1%
Product Carrier 4	23 %	8.00%	2%	2%	2%	3%	3%	2%	1%
Product Carrier 5	15 %	0.00%	2%	2%	2%	3%	3%	2%	1%

Corrective steps are determined on the As Low As Reasonably Practicable (ALARP) principle, the principle of which is that residual risk must be reduced as far as possible so that it does not affect the ship's operations too much. From the table it can be seen that the total reduction that must be owned by Product Carrier ships to meet the minimum CII in 2025, it can be seen that there is Optimised Utilization in the form of Voyage Optimization, weather routing in the form of optimizing shipping routes, Just in Time is the timeliness of ships arriving at the port not too fast or too long, and other optimizations which when combined can meet the minimum CII in 20 25.

CONCLUSION

In this section, the author expresses his greatest appreciation to the Fleet III Function - PT Pertamina International Shipping where this research forms the basis for decision making in following up on the latest regulations so that they can comply with international and national regulations..

BIBLIOGRAPHY

Ministry of Environment and Forestry, Measuring and Reducing Greenhouse Gases, Indonesia: Secretariat General of the Data and Information Center for Information Management, 2018.

Ministry of Transportation of the Republic of Indonesia, Minister of Transportation Encourages Maritime Industry Actors to Play an Active Role in Addressing Climate Change: Directorate General of Sea Transportation, 2022.

IMO. RESOLUTION MEPC.346(78) 2022 GUIDELINES FOR THE DEVELOPMENT OF A SHIP ENERGY EFFICIENCY MANAGEMENT PLAN (SEEMP). 2022

H. Lindstad, “Strategies and measures for reducing maritime CO2 emissions,” Energy Policy, 2013.

Lindstad et al, “Reductions in cost and greenhouse gas emissions with new bulk ship designs enabled by the Panama Canal expansion,” Energy Policy, 59, pp. 341-349, 2013.

Buhaug, et al. “Second IMO GHG Study 2009,” International Maritime Organization, 2019.

Faber, et al. “Technical Support for European Action to Reducing Greenhouse Gas Emissions from International Maritime Transport,” CE Delft: NY, 2009.

EMEC, “Green Ship Technology Book,” Brussels: European Marine Equipment Council, 2010.

Lindstad, H., et al, “GHG Emission Reduction Potential of EU-Related Maritime Transport and on its Impacts,” Ocean Engineering, 2015

Lin, S. “Greenhouse gas mitigation strategies: a ship operator's perspective in the container shipping industry,” OAPS (CEE): Nanyang Technological University. Singapore. 2012.

EA Sciberras, et al. "Electric auxiliary propulsion for improved fuel efficiency and reduced emissions," Proc. Inst. Mech. Eng. Part M: J.Eng. Maritime Environ., 229 (1), pp. 36-44. 2015.

Tilig et al, "Systems Modeling for Energy-Efficient Shipping," Chalmers University of Technology, 2015.

Wang, H., Lutsey, N., “Long-term potential for increased shipping efficiency through the adoption of industry-leading practices. In: International Council on Clean Transportation,” international council on clean transportation, 2013.

H. Psaraftis, “Green Transportation Logistics,” Springer International Publishing: Switzerland, pp. 267-297, 2016.

Maddox Consulting, “Analysis of Market Barriers to Cost Effective GHG Emission Reductions in the Maritime Transport Sector,” CLIMA.B.3/SER/2011/0014: London, 2012.

Wärtsila, “Boosting energy efficiency: energy efficiency catalogue. In: Energy Efficiency Catalog/Ship Power R&D,” Wärtsila, 2019.

P. Gilbert, et al., “Technologies for the high seas: meeting the climate challenge,” Carbon Manage., 5 (4) (2014), pp. 447-461, 2014.

Miola et al., “Designing a climate change policy for the international maritime transport sector: market-based measures and technological options for global and regional policy actions,” Energy Policy, 39 (9) (2011), pp. 5490-5498, 2011.

Sjöbom and Magnus, “Energieffektivisering ombord M/S Sydfart: Med hjälp av solceller,” Faculty of Engineering: Sjöingenjörsprogrammet, Uppsala, Sweden, 2014

Corbett et al., “The effectiveness and costs of speed reductions on emissions from international shipping,” Transport. Res. Part D: Transport Environ., 14 (8), pp. 593-598, 2009.

Gucwa and Schäfer, “The impact of scale on energy intensity in freight transportation,” Transport. Res. Part D: Transport Environ., 23, pp. 41-49, 2019.

Johnson and Styhre, “Increased energy efficiency in short sea shipping through decreased time in port,” Transport. Res. Part A: Policy Practice, 71, pp. 167-178, 2015.

Poulsen and Sornn-Friese, “Achieving energy efficient ship operations under third party management: how do ship management models influence energy efficiency?” Res. Transport. buses. Manage., 17, pp. 41-52, 2015.