



WP3 - Young Researcher Competition 2020 on Innovative Transport Concepts for

Road - Rail - Waterborne - Airborne - Cross-modality

IDEA N. C2020 - 58



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Monitoring, Reporting, and Verification of CO₂ Emissions in Shipping: Identification and comparison of available methods

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Key Specifications:

Shipping

Dry bulk carriers

Energy efficiency

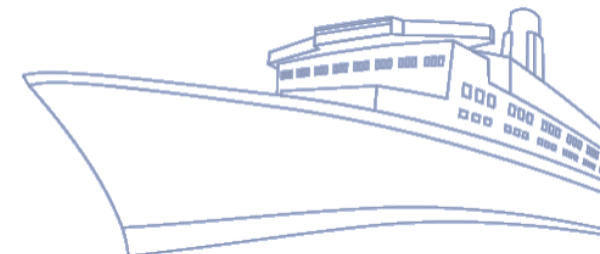
Carbon emissions

Monitoring emissions

Indicators

MRV Regulation

EU policy



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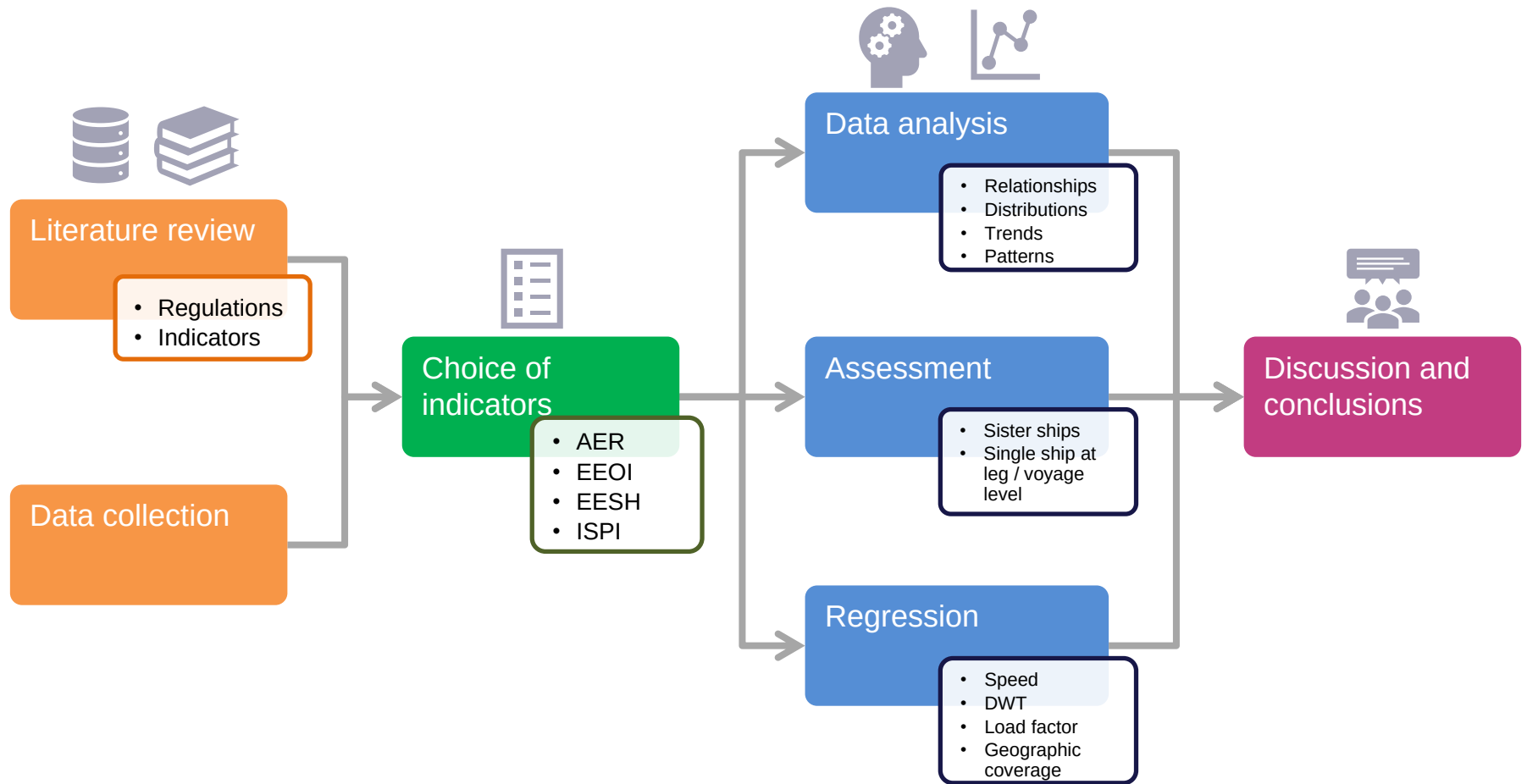


The MASSHIP project

- **Aims to support the policy debate on greening international shipping**
- **Analyses of available data on fuel consumption and CO₂ emissions to:**
 - **assess the effectiveness of the proposed performance indicators in serving the corresponding policy objectives;**
 - **compare the merits and pitfalls of the approaches that the EU and IMO use in enhancing the sustainability of shipping.**
- **EU approach targets the lack of market information on ship efficiency, while at the global level, the IMO follows an approach based on data collection and analysis**
- **Data provided by leading Danish companies that support the project**
- **The project enjoys the support of an Advisory Board of knowledgeable individuals from the authorities, the industry and academia**



Methodology



Indicators for monitoring efficiency

Energy Efficiency Operational Indicator (EEOI)

Proposed as a monitoring tool in the SEEMP [1]

Mandatory in the EU MRV Regulation [2]

$$EEOI = \frac{\sum_j FC_j \cdot C_{Fj}}{m_{\text{cargo}} \cdot D}$$

Annual Efficiency Ratio (AER)

Proposed by Japan in 2014 [3]

Used by the IMO DCS scheme [4]

$$AER = \frac{\sum_j FC_j \cdot C_{Fj}}{DWT \cdot D}$$

Individual Ship Performance Indicator (ISPI)

Proposed by Germany and Japan in 2013 [5]

Mandatory in the EU MRV Regulation (short form) [2]

$$ISPI = \frac{\sum_j FC_j \cdot C_{Fj}}{D}$$

Energy Efficiency per Service Hour (EESH)

The final form was proposed by USA in 2013 [6]

$$EESH = \frac{\sum_j FC_j \cdot C_{Fj}}{\text{hours of service}}$$

[6] MEPC 65/4/19 Proposal of the United States to enhance energy efficiency in international shipping

[5] MEPC 66/4/6 Further details of possible metric options to develop further technical and operational measures for enhancing the energy efficiency of international shipping

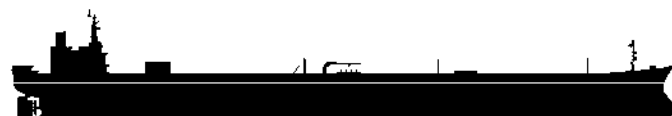
[4] MEPC.278(70) Amendments to MARPOL Annex VI (Data collection system for fuel oil consumption of ships)

[3] MEPC 67/5/4 Further consideration on the development of a data collection system to enhance energy efficiency of international shipping

[2] Regulation (EU) 2015/757 of the European Parliament on the monitoring, reporting and verification of CO2 emissions from maritime transport

[1] MEPC.203(62) Inclusion of regulations on energy efficiency for ships in MARPOL Annex VI

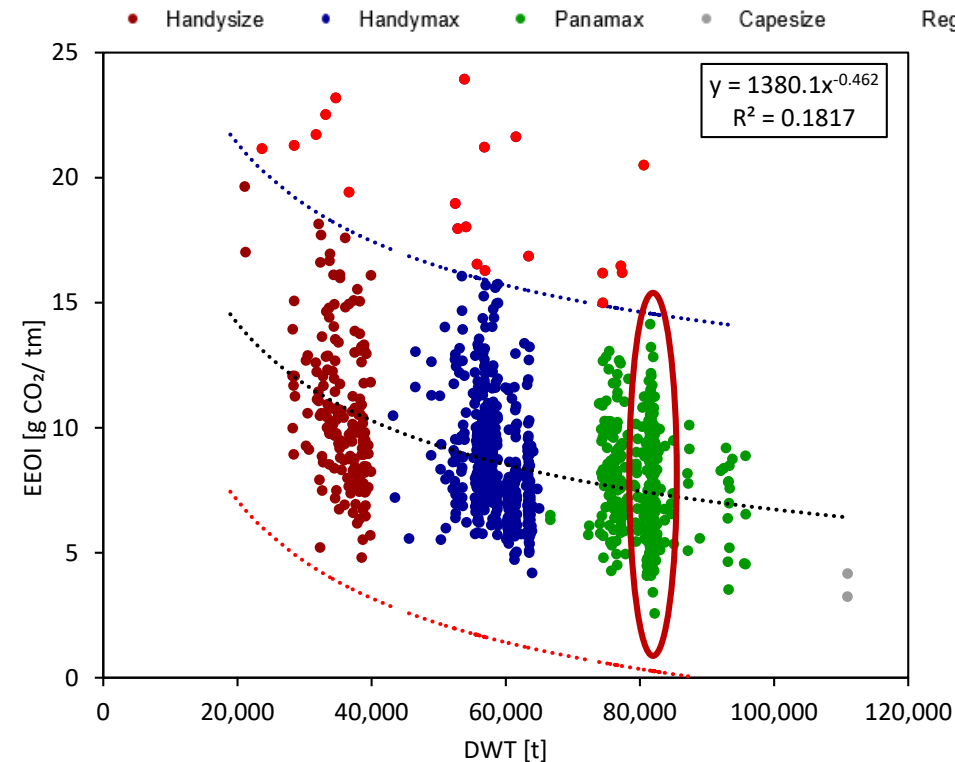
The project fleet



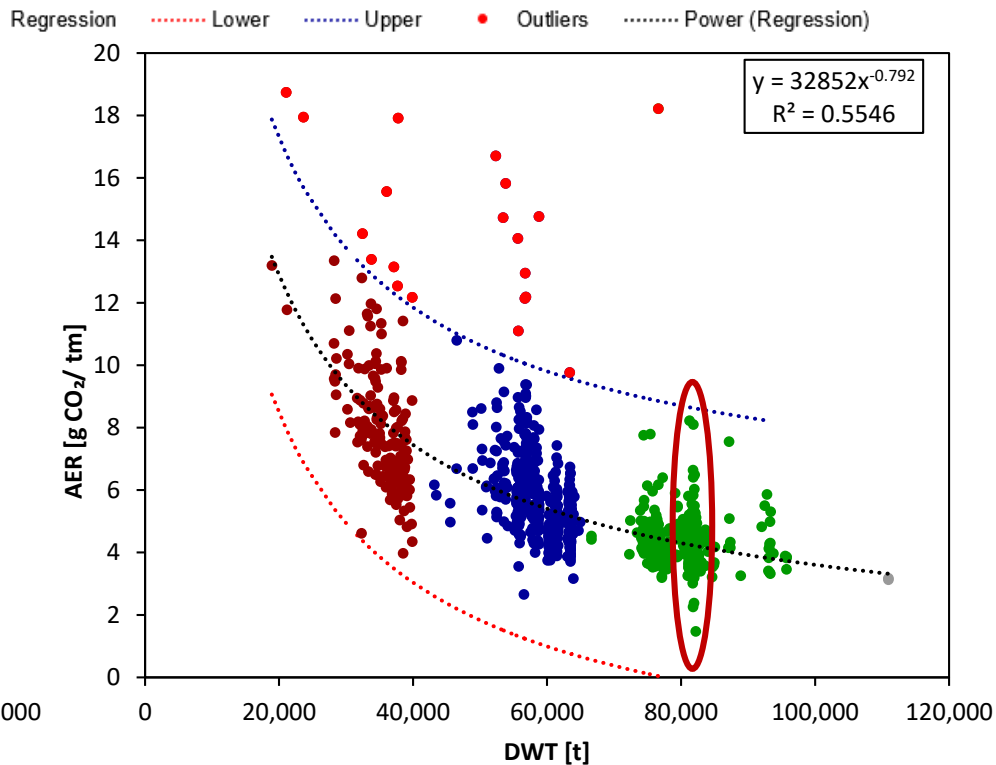
	Ship category	DWT [tonnes]	TEU capacity [TEU]	N° of ships [unit]	Share in the segment	
Dry Bulk Carriers	Handysize	10,000 < DWT < 40,000	-	204	19.4%	1,051 ships
	Handymax	40,000 < DWT < 65,000	-	476	45.3%	
	Panamax	65,000 < DWT < 100,000	-	365	34.8%	
	Capesize	DWT > 100,000	-	6	0.6%	
Tankers	Handysize Tanker	10,000 < DWT < 45,000	-	36	34.0%	106 ships
	Medium Range	45,000 < DWT < 55,000	-	70	66.0%	
Container Ships	Feeder	DWT < 70,000	TEU > 5,000	153	17.6%	349 ships
	Post Panamax	60,000 < DWT < 95,000	5,000 < TEU < 7,500	51	5.2%	
	7,500 < TEU < 10,000	90,000 < DWT<115,000	7,500 < TEU < 10,000	66	39.4%	
	New Panamax	120,000 < DWT < 130,000	10,000 < TEU < 12,500	25	9.8%	
	VLCS	148,600 < DWT < 178,400	12,500 < TEU < 15,000	16	5.2%	
	ULCS 1	174,300	15,000 < TEU < 17,500	8	4.1%	
	ULCS 2	194,100	17,500 < TEU < 19,000	20	10.4%	
	ULCS 3	206,800	TEU > 19,000	10	8.3%	
Roll-on / Roll-off Ships	Small Ro-Ro	DWT < 10,000	-	3	8.1%	35 ships
	Medium Ro-Ro	10,000 < DWT < 13,000	-	9	24.3%	
	Large Ro-Ro	DWT > 13,000	-	5	13.5%	
	Small Ro-Pax	DWT < 5,000	-	8	21.6%	
	Medium Ro-Pax	DWT > 5,000	-	10	27.0%	
	General cargo	7,500	-	2	5.4%	
TOTAL						1,543 ships

Dry bulk carriers

EEOI – Ship level



AER – Ship level



- 2.7% of the sample lies outside the limits.
- Quite wide variation among ships of the same size:
80,000 DWT tonnes ship: from 2.6 up to 14.1 gCO₂/tm

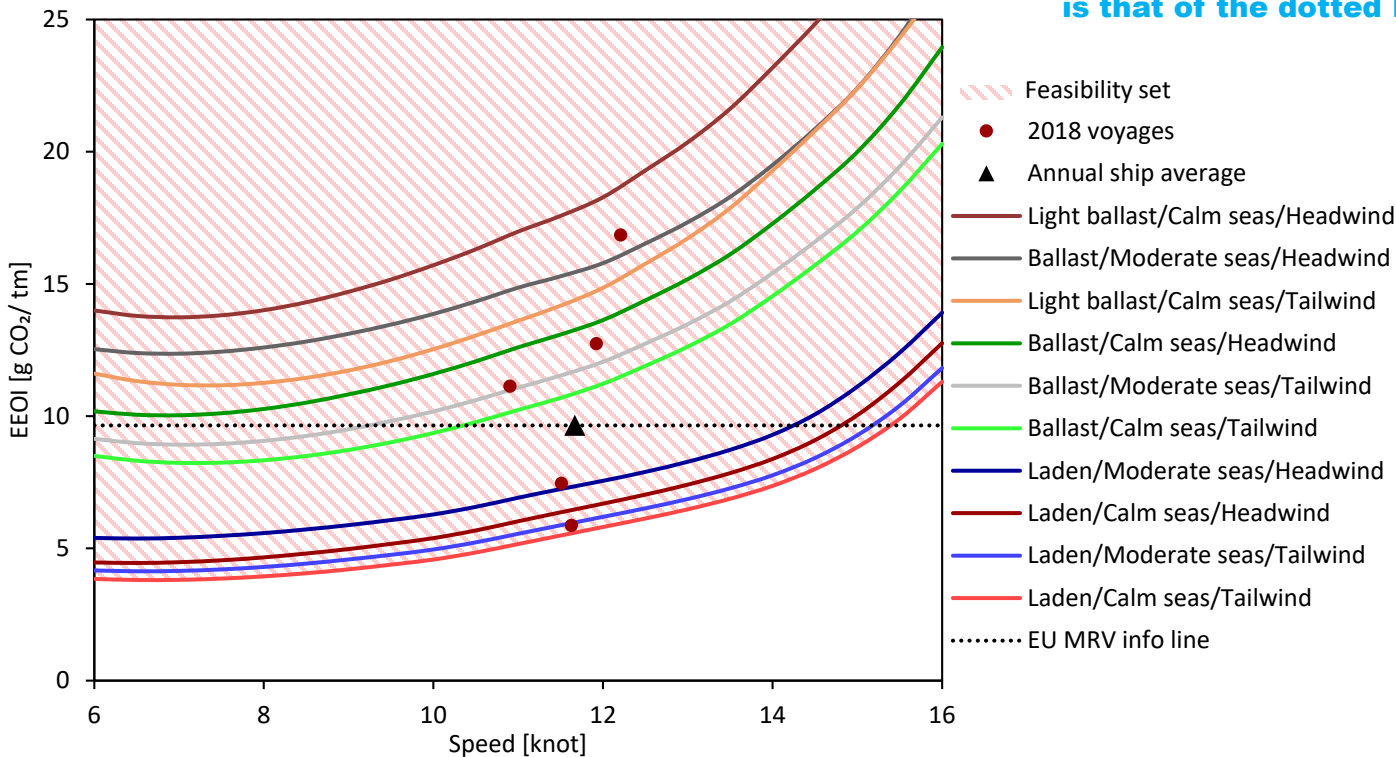
- Lower values, since the transport work is the maximum possible one.
- Inferior variation among ships of the same size:
80,000 DWT tonnes ship: from 1.5 up to 8.2 gCO₂/tm



Case I – A single ship

Single ship of about 36,800 DWT tonnes

EEOI – The effect of weather condition

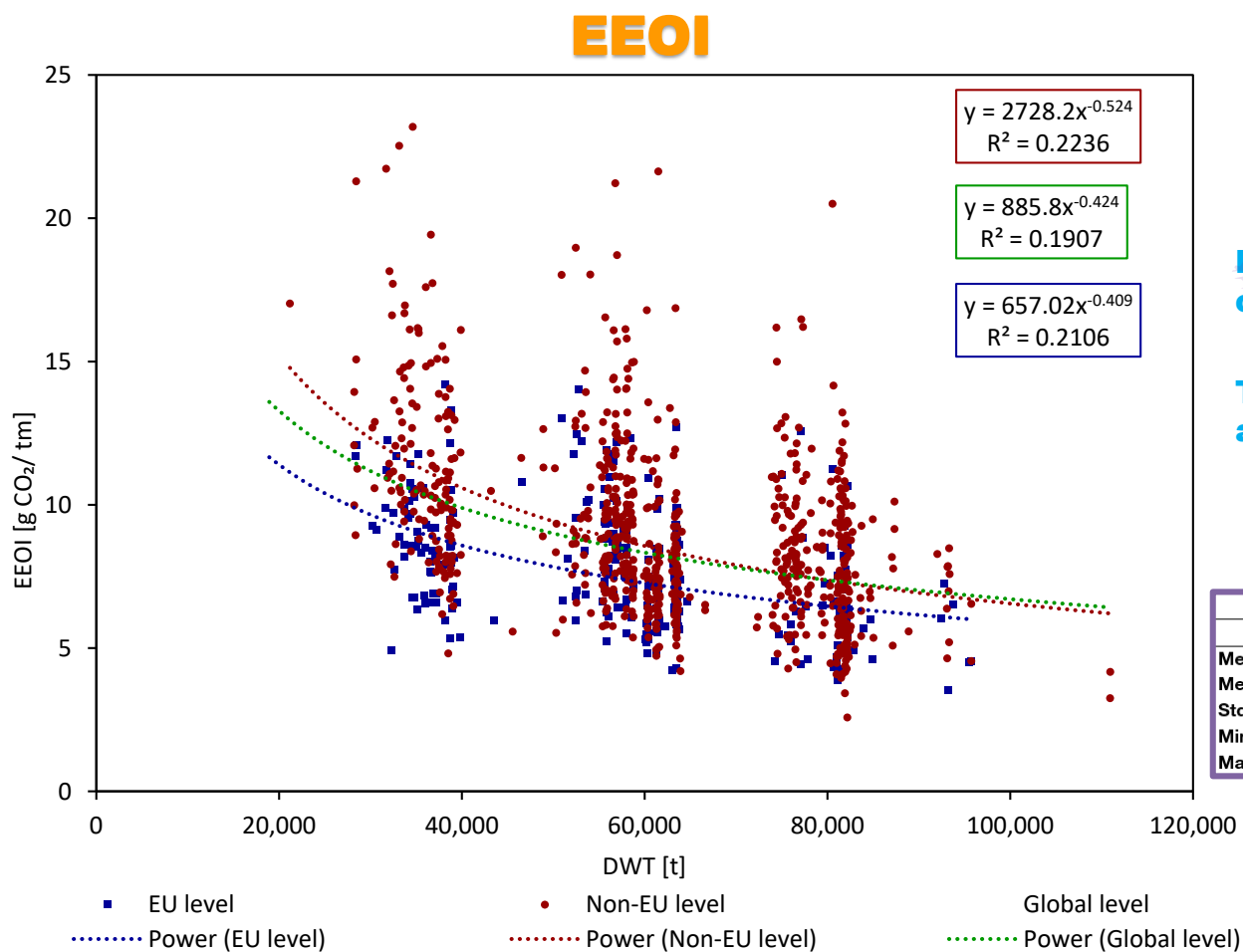


Given that the average speed is not known, the only information that an average EEOI value can convey is that of the dotted line

- Can this dotted line say anything about the energy efficiency of this ship?
- How good approximation of this curve the dotted line is?
- How rational is the decision of chartering a ship based on a dotted line a little lower than the one presented?



Geographical coverage



Europe is a major consumer of bulk commodities

The legs of the higher load factors are those destined to EU ports

	Load Factor			EEOI		
	Global	Non-EU	EU	Global	Non-EU	EU
Mean	0.66	0.65	0.74	8.7	9.0	7.8
Median	0.67	0.65	0.76	8.3	8.4	7.5
Std. Dev.	0.16	0.17	0.14	2.6	3.1	2.1
Minimum	0.28	0.19	0.30	2.6	2.6	3.5
Maximum	0.99	0.99	0.97	19.7	23.2	14.2

Conclusion

Effectiveness of the proposed performance indicators



None of the indicators examined is robust enough to provide reliable information on the fuel efficiency of ships.



The AER is more robust than EEOI.
But it is significantly underestimated.



Emissions at berth affect the value of the indicators.



The EEOI would be suitable for monitoring the efficiency of individual ships if properly normalised to nullify the influences of speed, load and possibly weather conditions.



Factors influencing the indicator values:

- . Speed;
- . Load conditions;
- . Weather conditions.



A specific and correct metric for transport work for each ship segment add flexibility at the company level but create compatibility problems across the industry.

Comparison between the EU and IMO approaches



Dry bulk carriers

Significance differences between EU and Non-EU.



The geographic restrictions of the EU scheme introduce an additional exogenous bias.



Appendix



GHG emissions regulation policies

The EU MRV Regulation



“Regulation (EU) 2015/757 of the European Parliament and of the Council on the Monitoring, Reporting and Verification (MRV) of carbon dioxide emissions from maritime transport and amending Directive 2009/16/EC” (29 April 2015)



[7]

Objectives

Produce accurate information on the CO2 emissions of large ships using EU ports;

Incentivize energy efficiency improvements by making this information publicly available;

Secure more time to discuss emission reduction targets and relevant measures in IMO.

[7] gograph.com



GHG emissions regulation policies

The EU MRV Regulation



Market barriers

Lack of reliable information on fuel efficiency of ships

Split incentives between ship owners and ship operators



Scope

Applies to ships above 5,000 GRT regardless of flag

Only concerns the CO₂ emissions

Only voyages to, within, or from an EU port

[8] CSI - Methodology and Reporting Guidelines 2018



GHG emissions regulation policies

The IMO DCS



“Resolution MEPC.278(70) Amendments to MARPOL Annex VI (Data collection system for fuel oil consumption of ships)” (28 October 2016)



[9]

Step 1
Data collection

Step 2
Data analysis

Step 3
Further measures, if required

Scope [4]

Applies to ships above 5,000 GRT regardless of flag

Ships performing international voyages

Cargo carried is not considered

[4] MEPC.278(70) Amendments to MARPOL Annex VI (Data collection system for fuel oil consumption of ships)

[9] IMO What it is

