Long-term potential for increased shipping efficiency through the adoption of industry-leading practices

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Outline

- Background
  - Carbon intensity, shipping activity, and climate impacts of international shipping
- Global in-use ship efficiency assessment
  - Method and data
  - Findings: Factors that influence operational efficiency
- Conclusions and next steps

Background

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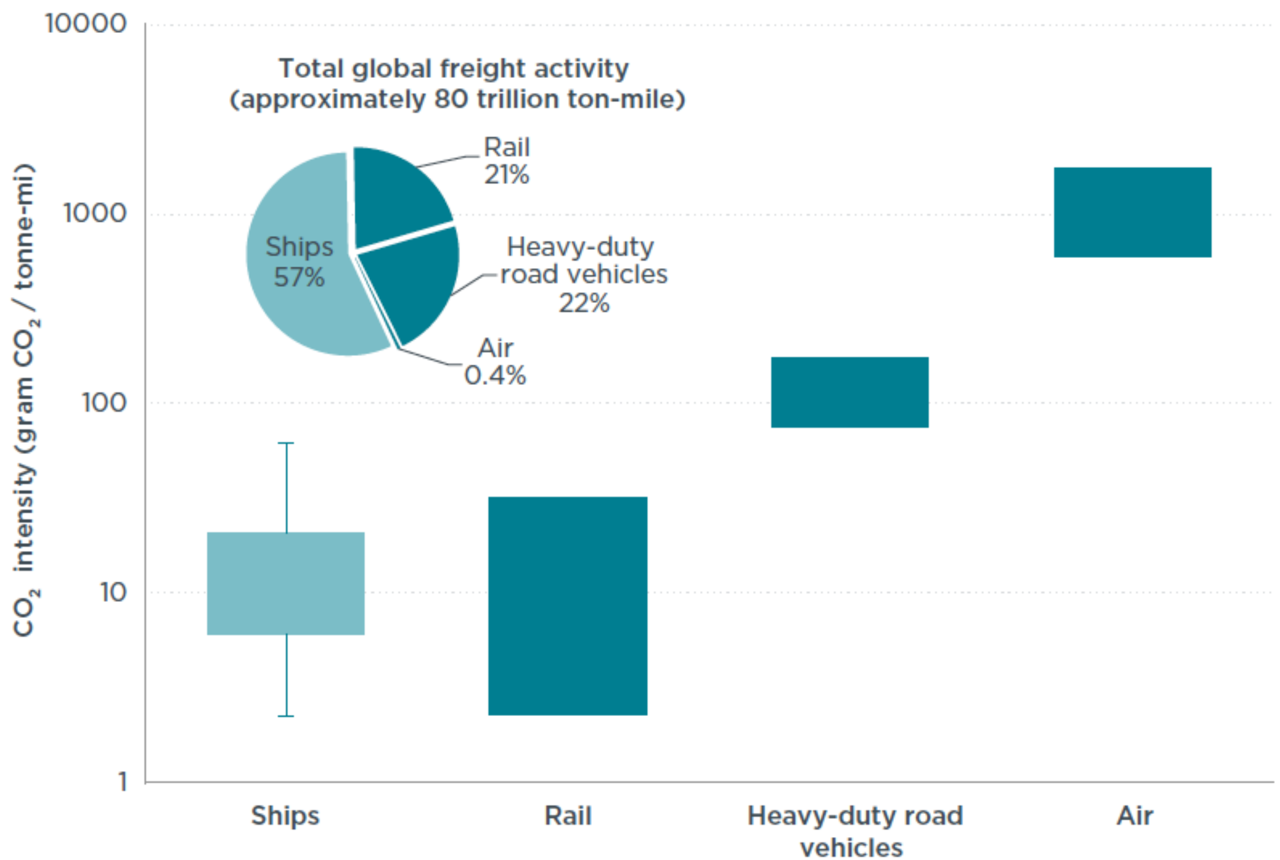
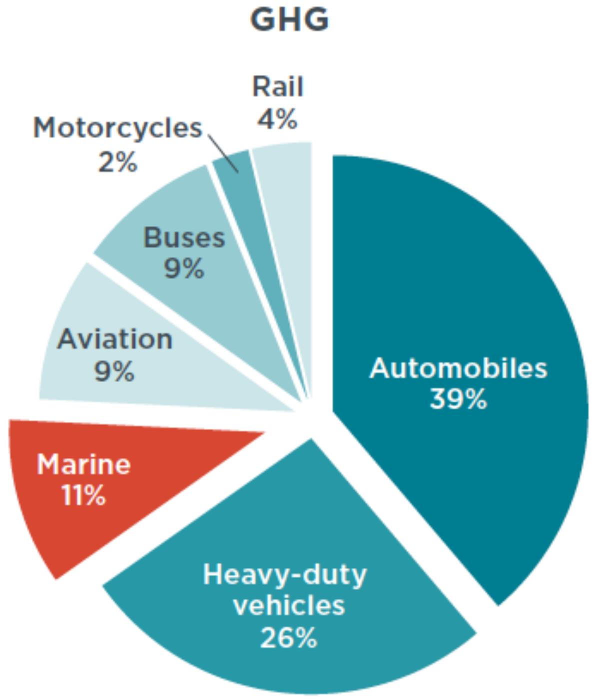
Carbon intensity and transport activity of international shipping

- Ocean-going vessels are the most carbon efficient freight mode
- They also account for over half of global freight activity

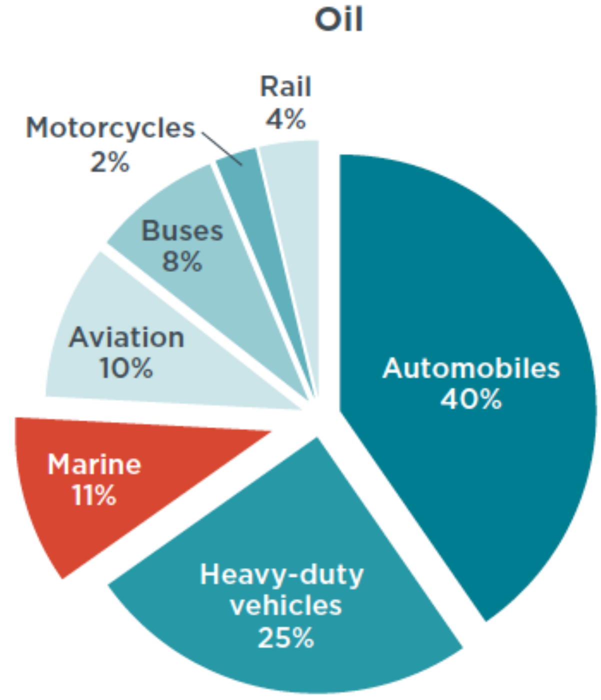


Climate Impacts of International Shipping

- International shipping accounts for 11% of GHG emissions and oil consumption in the transportation sector



Transportation carbon dioxide emissions
Marine: 1 gigatonne CO_2 /year



Transportation petroleum use
Marine: 5 million barrels per day

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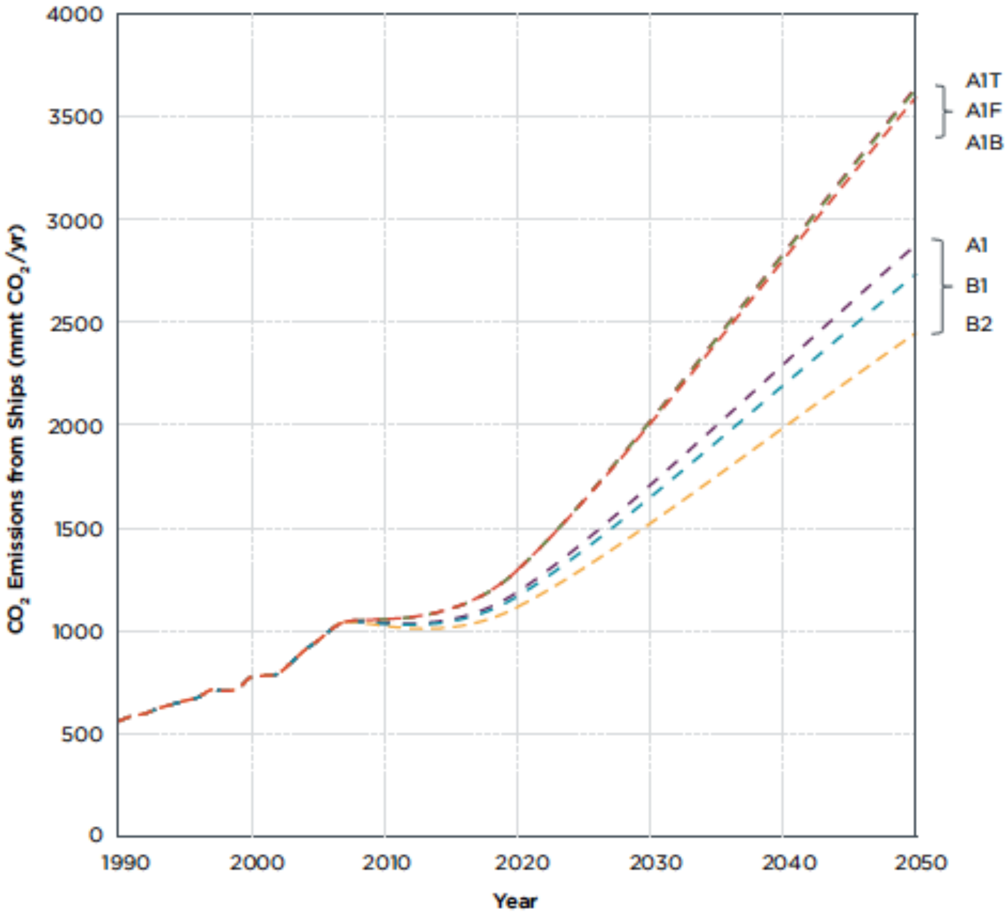
Climate Impacts of International Shipping

- Propelled by the growth of international commerce, CO_2 emissions will continue to grow between now and 2050



ICCT (2011) "Reducing Greenhouse Gas Emissions from Ships" www.theicct.org/reducing-ghg-emissions-ships
Note: A1T, A1F, A1B, A1, B1, and B2 are scenarios based on which IPCC used to project future CO2 emissions

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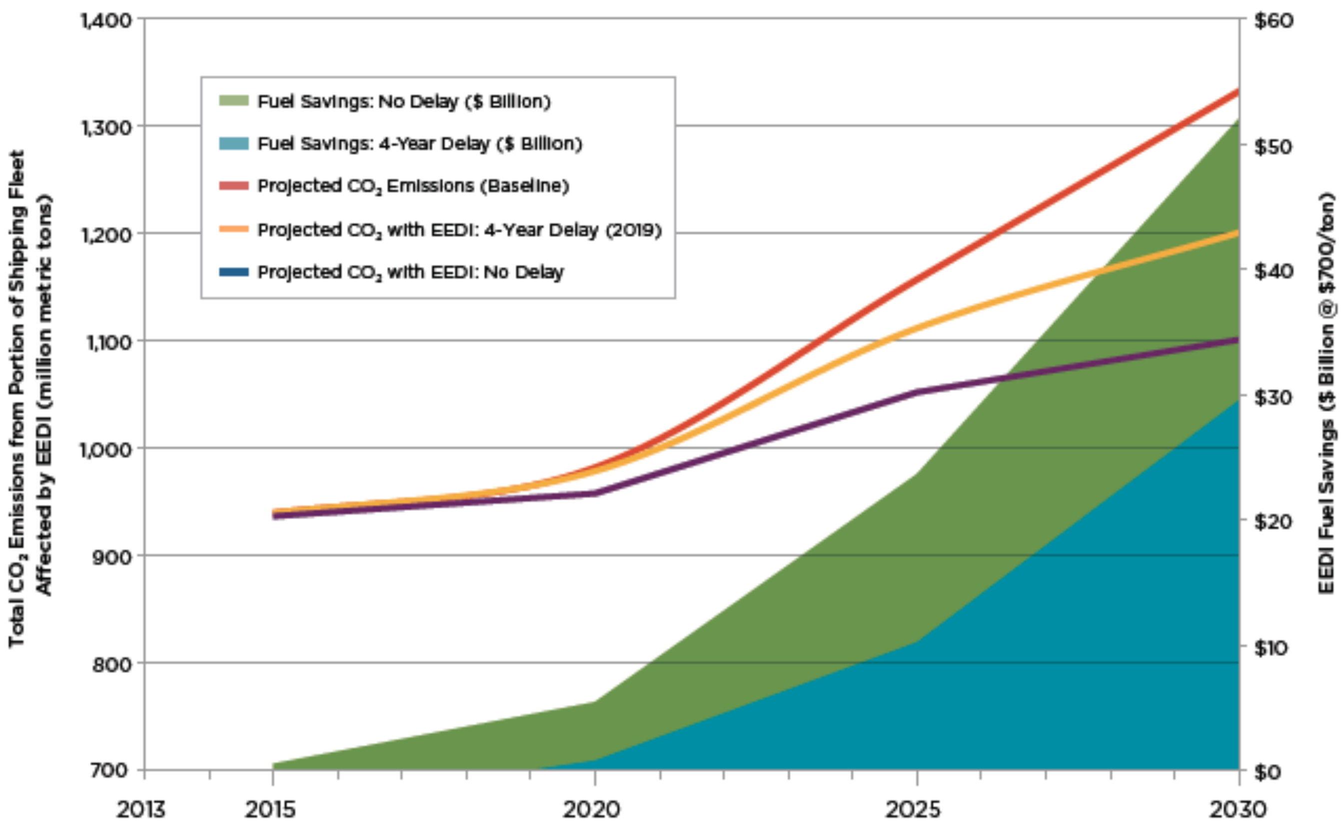
The Energy Efficiency Design Index (EEDI) for new ships

- The EEDI will slow but not reverse the CO_2 growth from international shipping
- On-time implementation would maximize benefits



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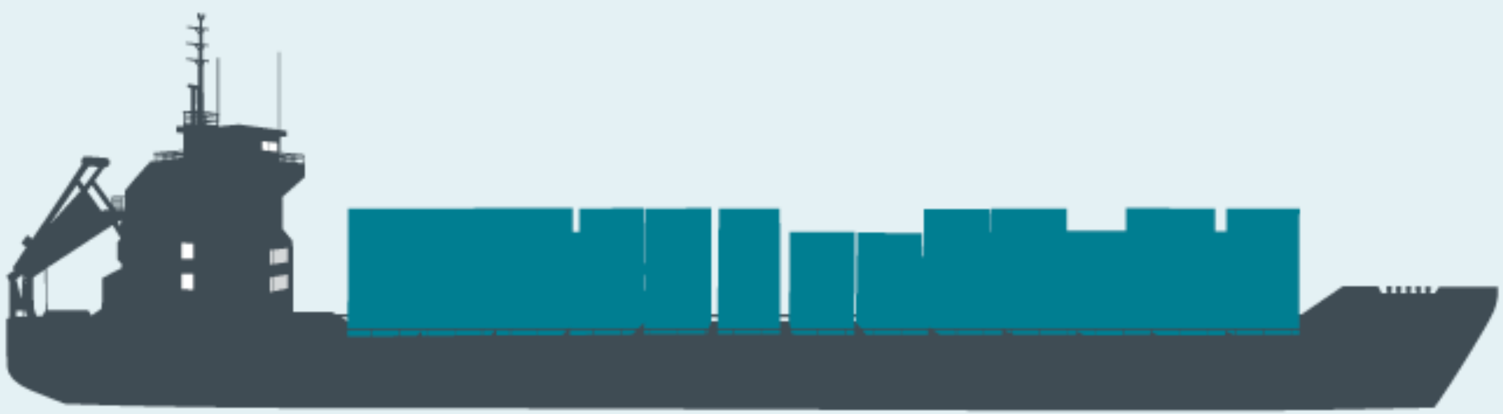
ICCT (2011) "The Energy Efficiency Design Index (EEDI) for New Ships" http://www.theicct.org/eedi-new-ships

Substantial technical and operational potential to increase energy efficiency

Operational
Weather routing **1-4%**
Autopilot upgrade **1-3%**
Speed reduction **10-30%**

Auxiliary power
Efficient pumps, fans **0-1%**
High efficiency lighting **0-1%**
Solar panel **0-3%**

Aerodynamics
Air lubrication **5-15%**
Wind engine **3-12%**
Kite **2-10%**

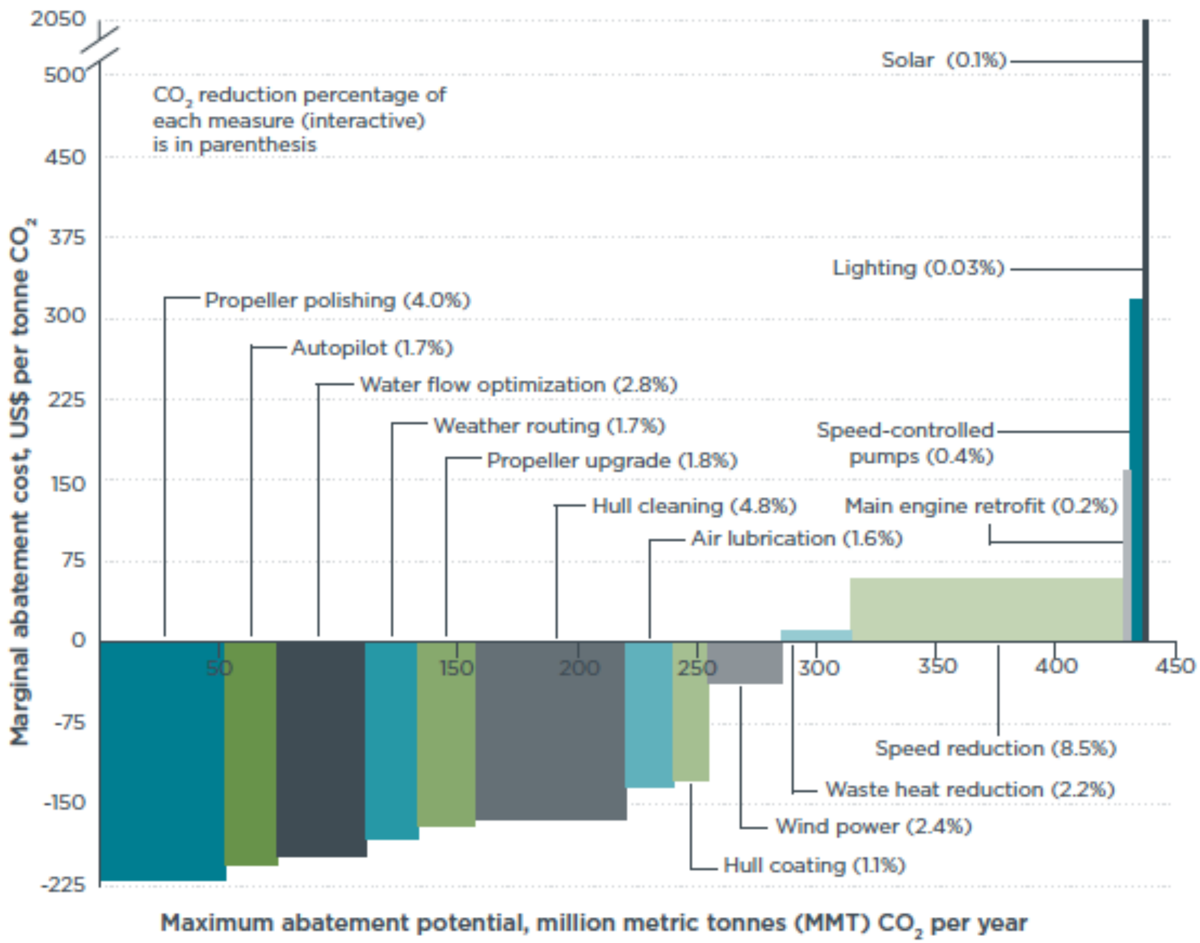


Thrust efficiency
Propeller polishing **3-8%**
Propeller upgrade **1-3%**
Prop/rudder retrofit **2-6%**

Engine efficiency
Waste heat recovery **6-8%**
Engine controls **0-1%**
Engine common rail **0-1%**
Engine speed de-rating **10-30%**

Hydrodynamics
Hull cleaning **1-10%**
Hull coating **1-5%**
Water flow optimization **1-4%**

Significant portions of these opportunities are cost effective



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ICCT (2011) “Reducing Greenhouse Gas Emissions from Ships” www.theicct.org/reducing-ghg-emissions-ships

Global in-use ship efficiency assessment

- The large remaining opportunity for reducing CO_2 emissions in-sector lies in the improvement of energy efficiency for in-use ships
- Overarching questions
  - What are factors that influence ship efficiency?
  - Are there data available to assess these factors?
  - If the fleet achieves higher efficiency on par with its leading shipping companies, what are the energy and climate implications for the industry?

Global in-use ship efficiency assessment: Data and Methods

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Data and Methods

- Data
  - 2011 Satellite Automatic Identification System (S-AIS)
  - Smith et al (2013) “Assessment of shipping’s efficiency using satellite AIS data”
  - Clarkson Ship Intelligence (2013)
  - Buhaug et al (2009) “Second IMO GHG Study 2009 update of the 2000 GHG study”
  - UNCTAD “Review of Maritime Transportation”, various years
- Method
  - Global shipping fleet turnover model

Satellite Automatic Identification System

- The S-AIS is installed on every ship larger than 300 gross tonnage for safety reasons
- Signals are transmitted from ships to satellites every few seconds
  - Message 1: vessel location and speed over ground
    - Real time ship speed and shipping routes are two critical improvement from previous studies
  - Message 5: Vessel destination, IMO number, and draught (often input manually)

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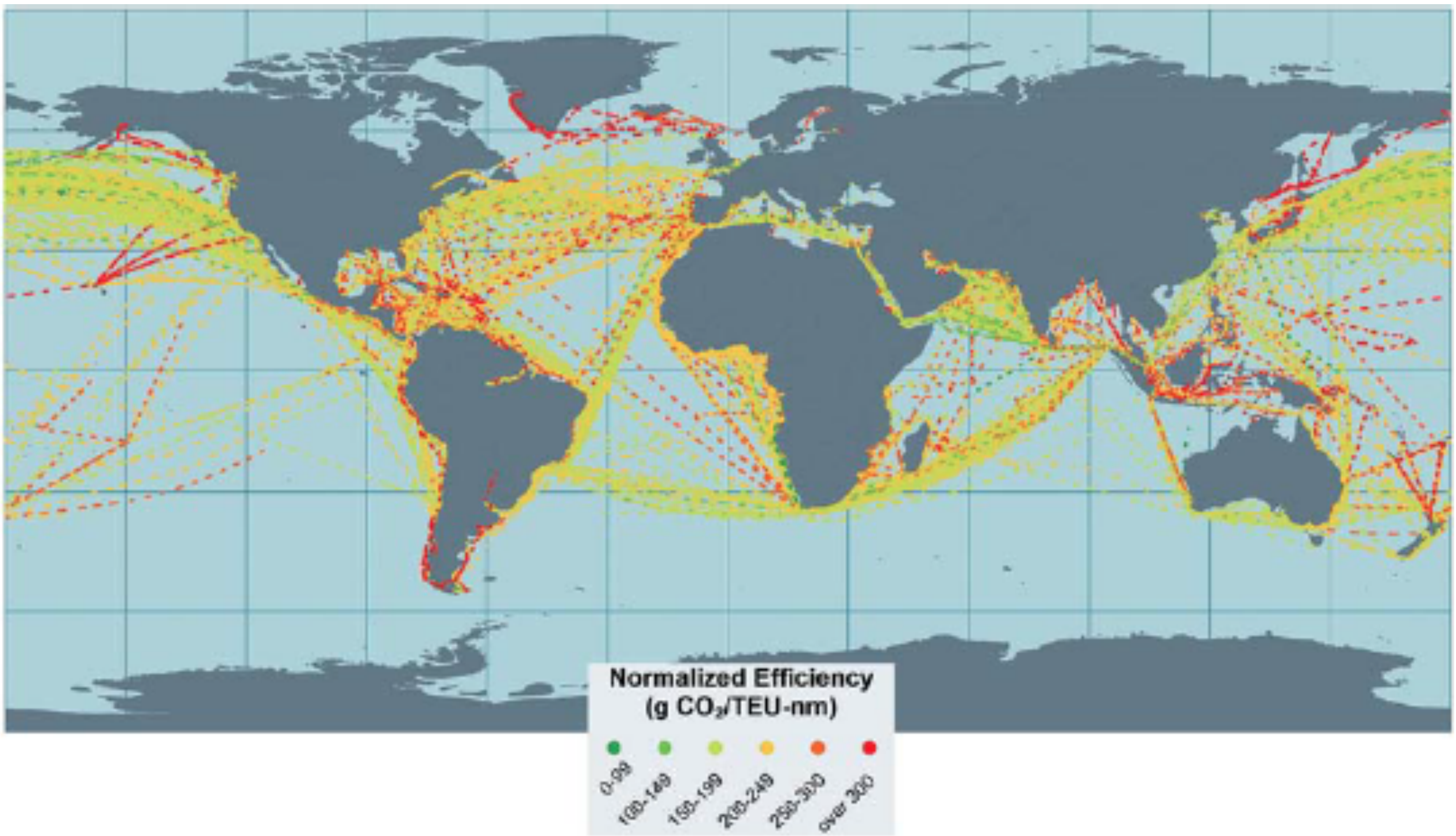
2011 Satellite Automatic Identification System

- Very Large Crude Carrier (VLCC) movement in August 2011
- Containership movement in August 2011

Courtesy of Dr Martin Austwick at CASA in University of College London

2011 Satellite Automatic Identification System (2)



Smith et al (2013) “”Assessment of shipping’s efficiency using satellite AIS data” http://www.theicct.org/assessment-shipping-efficiency-using-ais-data

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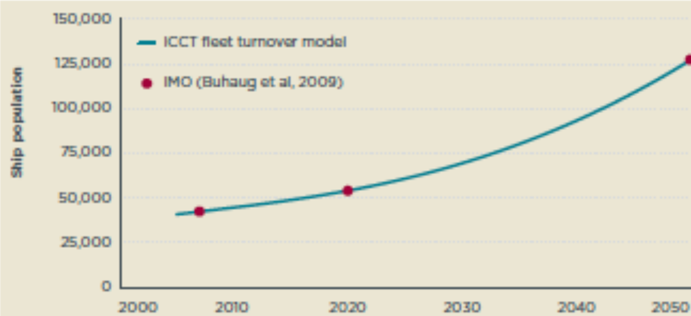
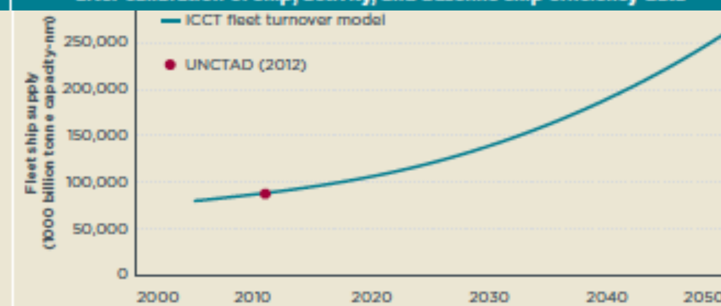
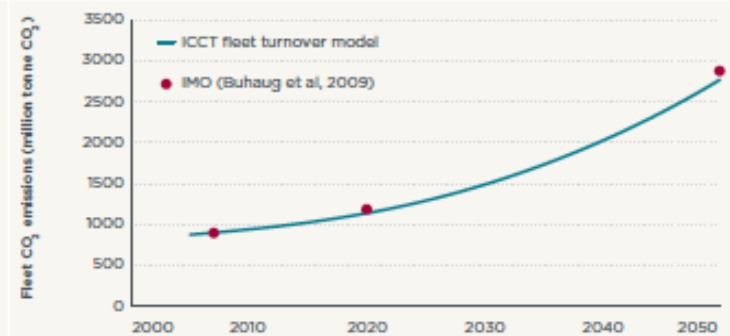
Global Shipping Fleet Turnover Model

- Global Shipping Fleet Turnover Model: use data on ship population, overall ship efficiency, ship activity, and overall CO_2 emissions to backcast and forecast the fleet profile and emissions

Variable	Comparison of ICCT fleet model to external data source, after calibration of ship, activity, and baseline ship efficiency data
Ship population	
Activity per ship by age	

Variable	Comparison of ICCT fleet model to external data source, after calibration of ship, activity, and baseline ship efficiency data
Overall ship fleet activity	
Overall ship fleet CO_2 emissions (without EEDI standards)	

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Global in-use ship efficiency assessment: Findings

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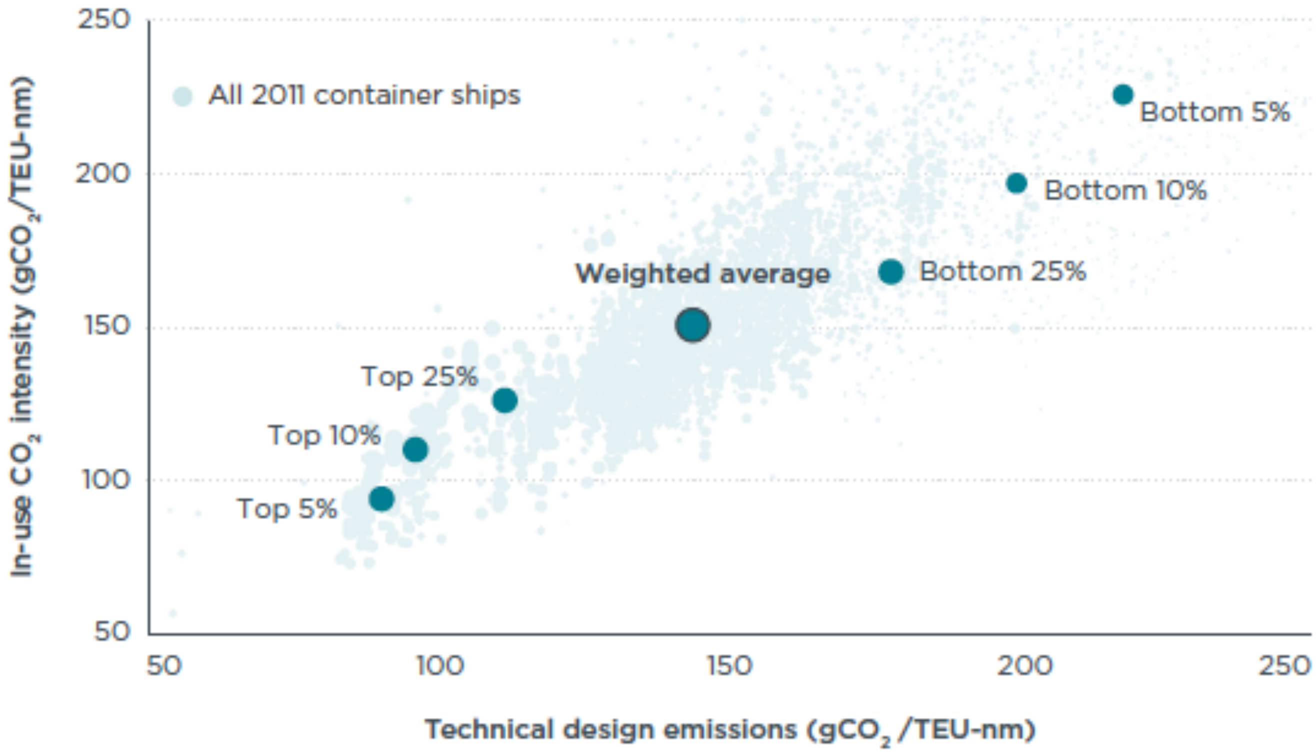
Findings: Technical efficiency and operational efficiency

- Ships with higher technical efficiency (energy efficiency as designed) typically have higher operational efficiency



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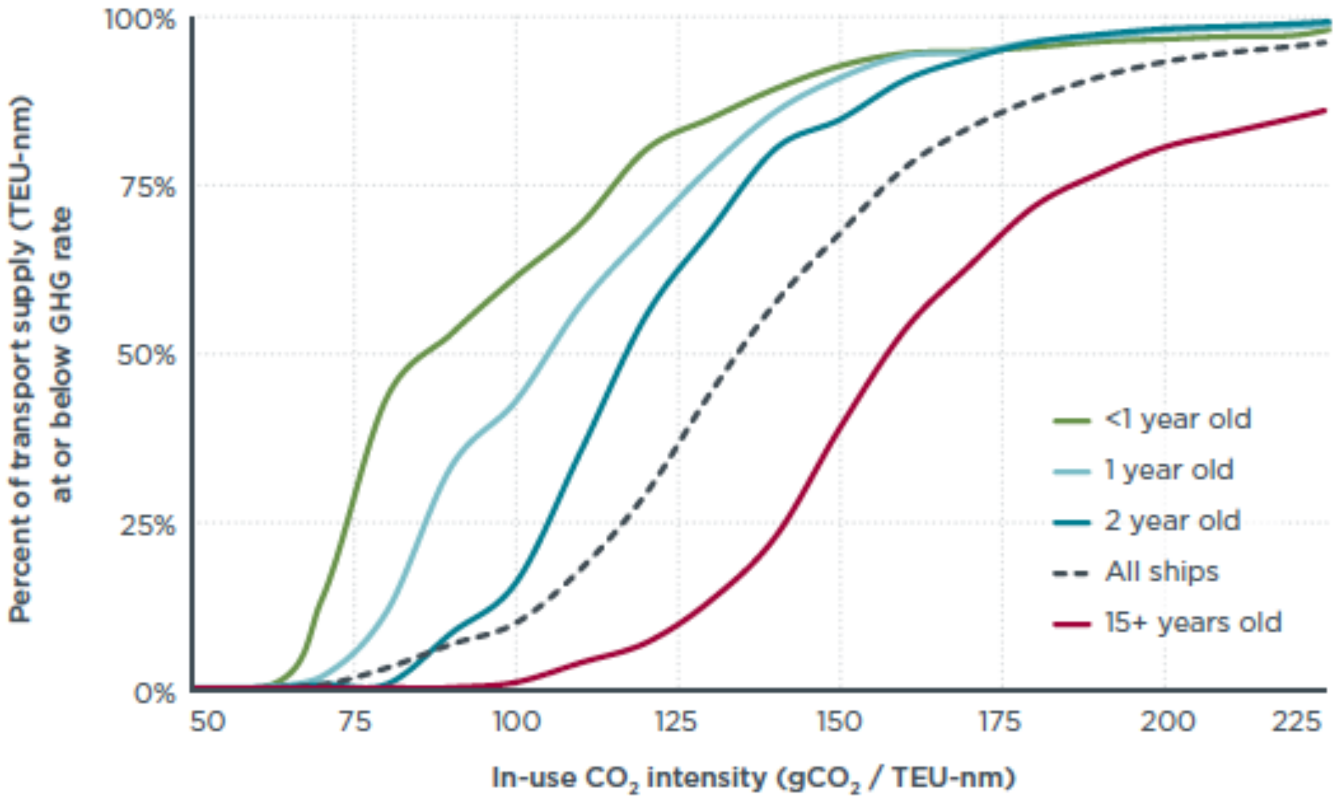
Findings: Ship age and operational efficiency

- Newer ships typically have higher operational efficiency



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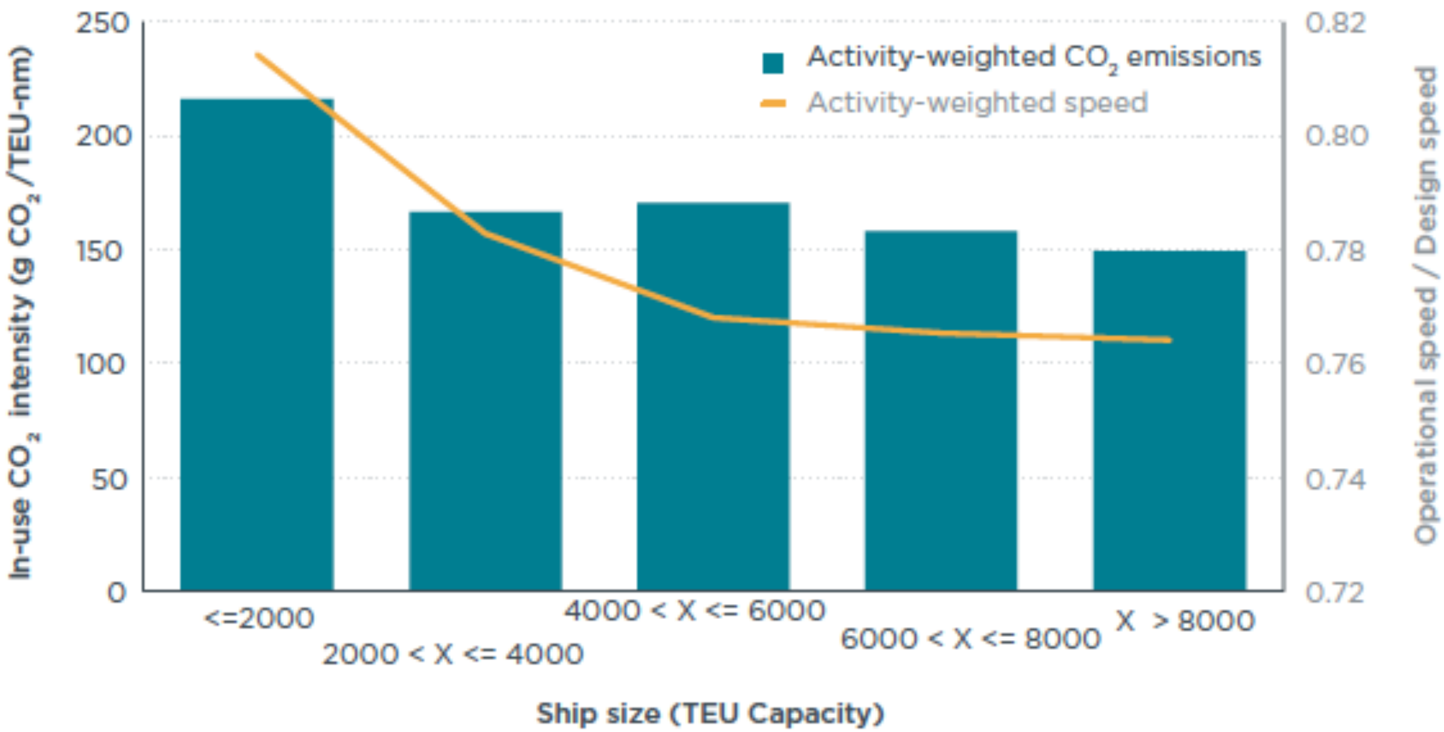
Findings: Ship size, speed, and operational efficiency

- Larger ships typically operate at reduced speed and have higher operational efficiency



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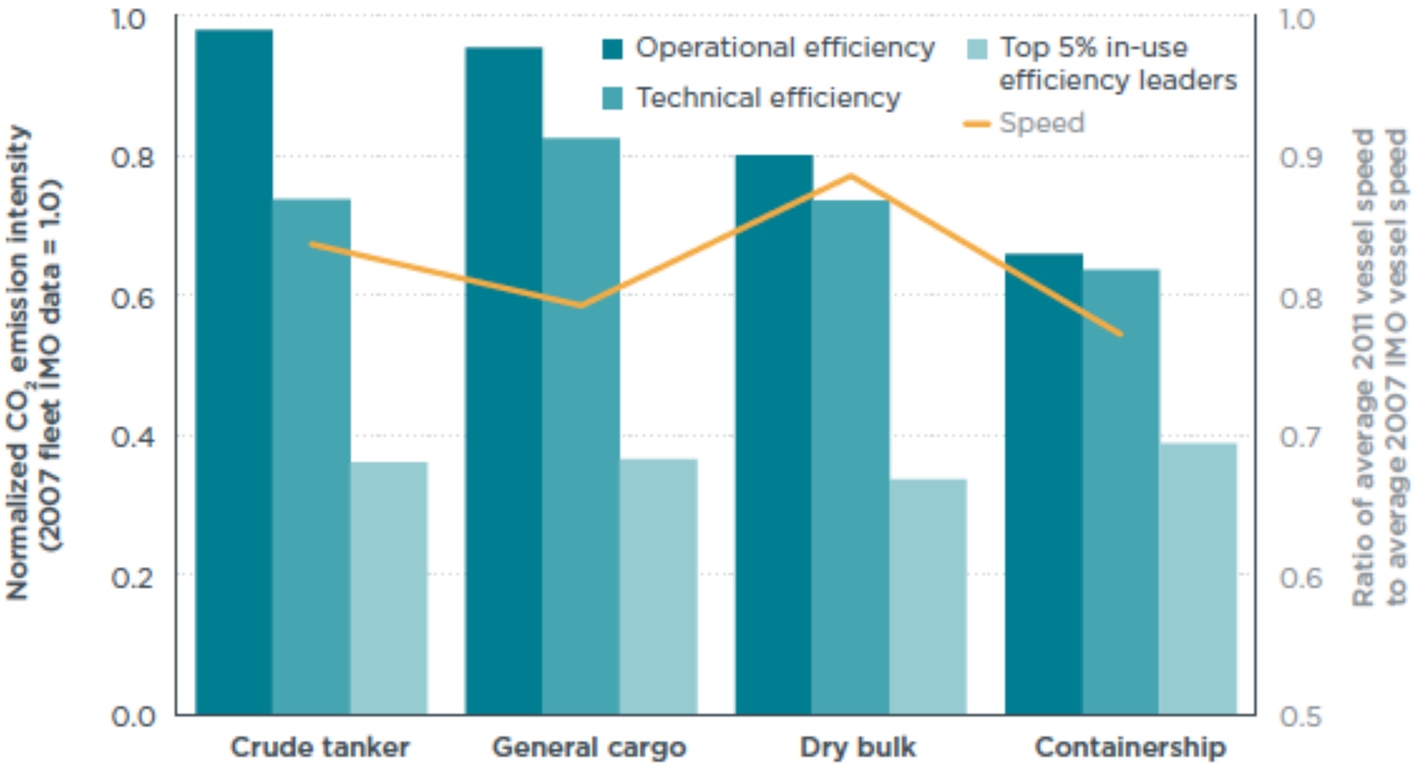
Findings: Top performers

- Top performers of each ship type have much higher operational efficiency than the industry average



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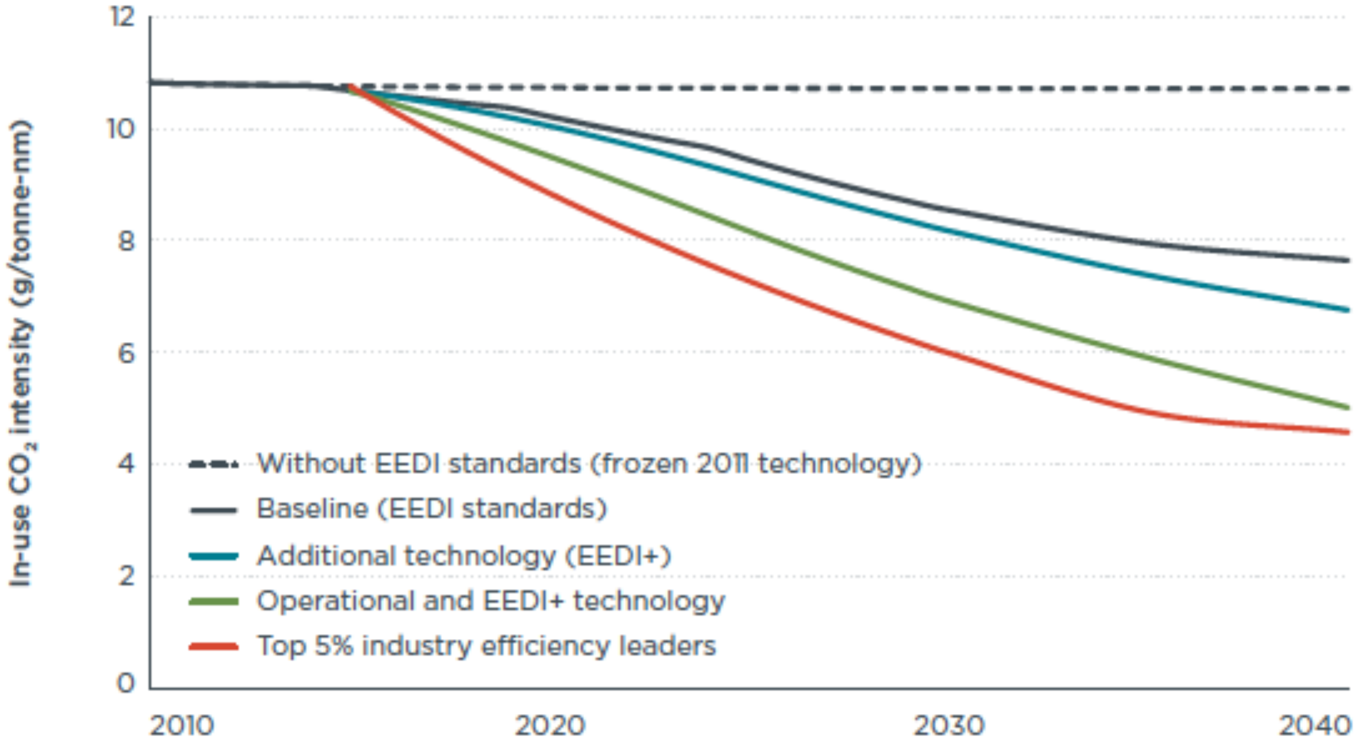
Projection scenarios

Baseline with EEDI standard	Additional technology	Additional measures	Top 5% industry leaders
Incorporation of adopted efficiency standard that increases new ship efficiency	Additional new ship efficiency technology at higher penetration levels than required by EEDI, achieving 1.5% annual reduction	On top of technologies, operational measures achieve another annual efficiency improvement rate of 1.1%	Incorporates fleet shifts in age, design efficiency, operations, and composition, achieving 3.8% annual efficiency improvement

CO_2 intensity until 2040

- Fleet wide CO_2 intensity average will decline between 20% and 54% by 2040



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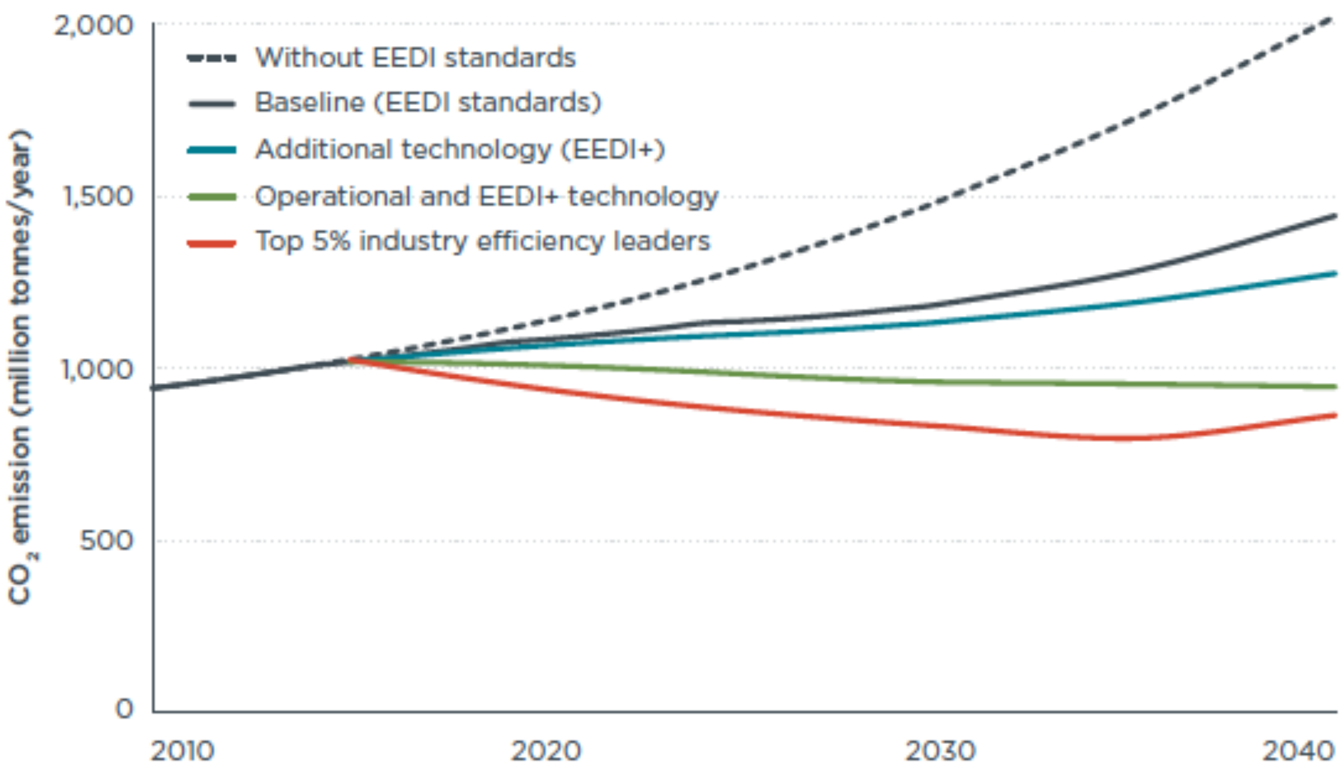
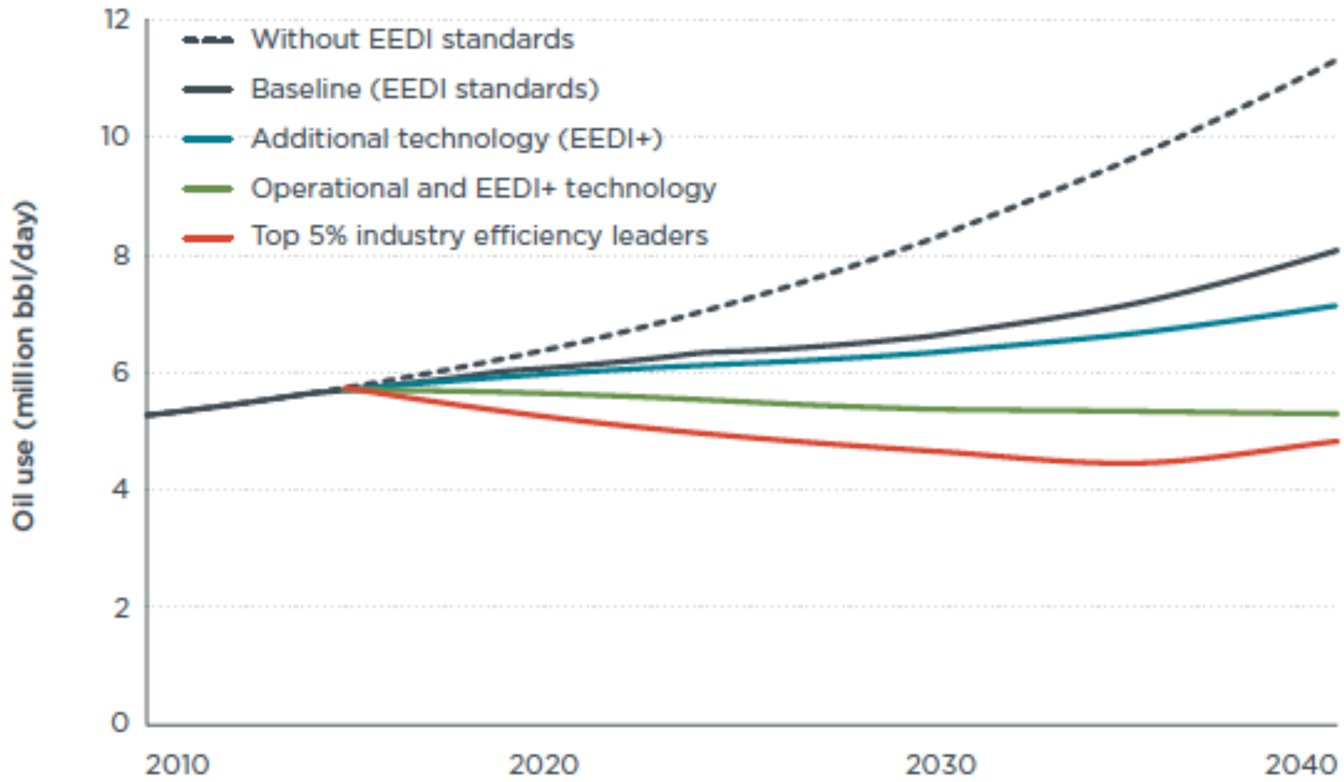
CO_2 emissions until 2040

- Fleet wide CO_2 emissions will be reduced by between 100 million metric tonnes (mmt) and 400 mmt by 2040



Marine fuel consumption until 2040

- Oil consumption from international shipping will be cut by between 0.9 million b/d and 3.2 million b/d in 2040



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Discussion

- Which measures do you think should be used to increase energy efficiency?
- What are the implications of shipping carbon footprint on global supply chain?
- What are major opportunities for improving energy efficiency over the next three decades in international shipping?

Conclusion

- Shipping offers enormous potential to increase efficiency and reduce CO_2 emissions cost effectively
- Significant differences in operational efficiency can be observed across varying ship types, ages, and sizes
- Combining S-AIS data with existing data are critical to understanding how ships operate and why they differ in operational efficiency

Future Work

- Identify differences in operational efficiency within each ship type, age, and size combination
- Collaborate with shipping companies and organizations to examine other factors that influence ship operational efficiency not captured by this methodology
- Integrate satellite data with on-shore AIS to improve data quality

Thank You

www.theicct.org/marine

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