Long-term potential for increased shipping efficiency
船舶增效的长期潜能

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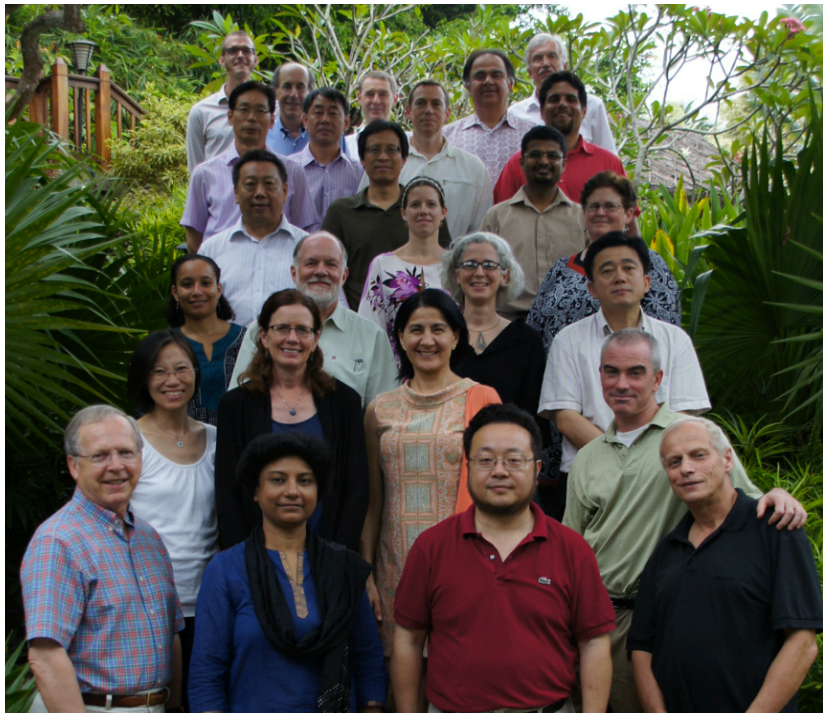

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Outline
大纲

- Background
- 背景
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  - 方法和数据
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Background
背景

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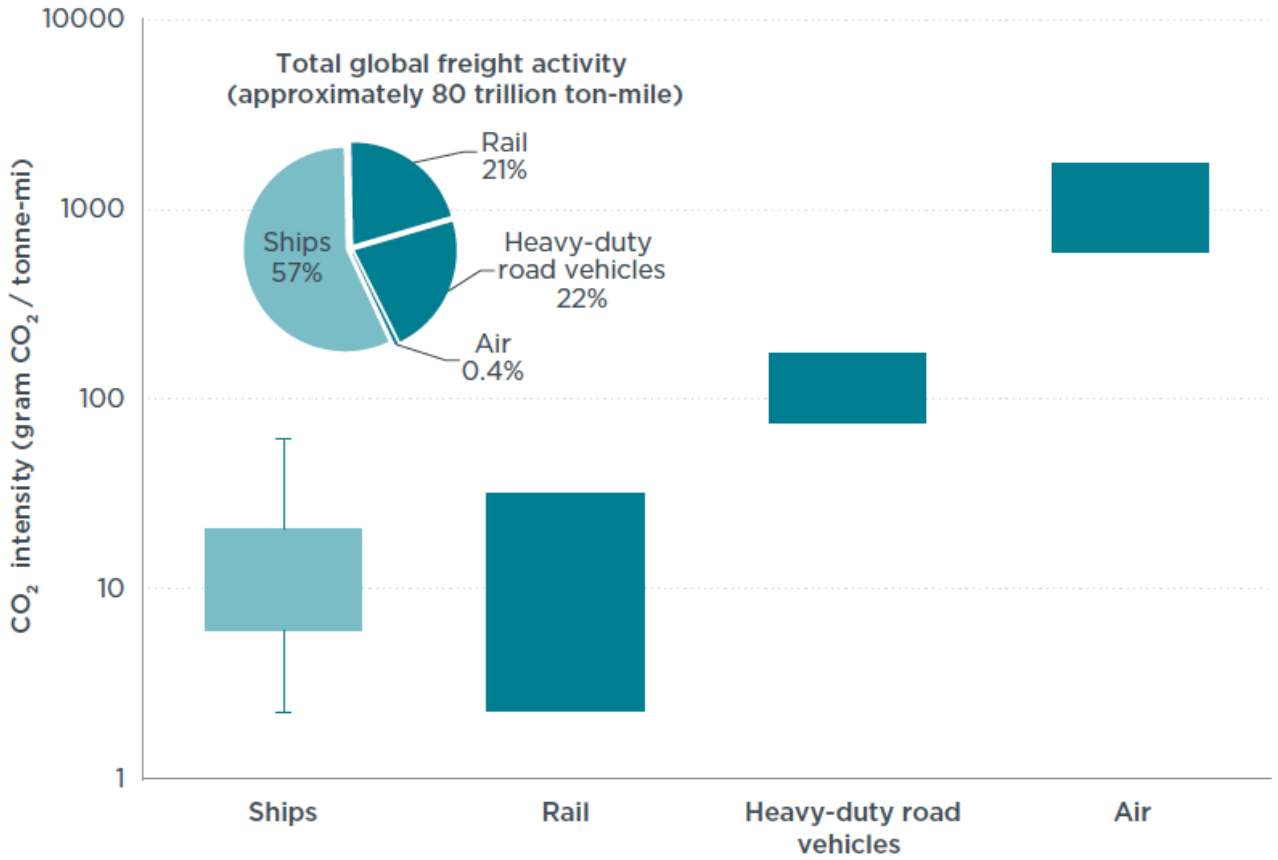
Energy efficiency of international shipping
国际船舶的效能

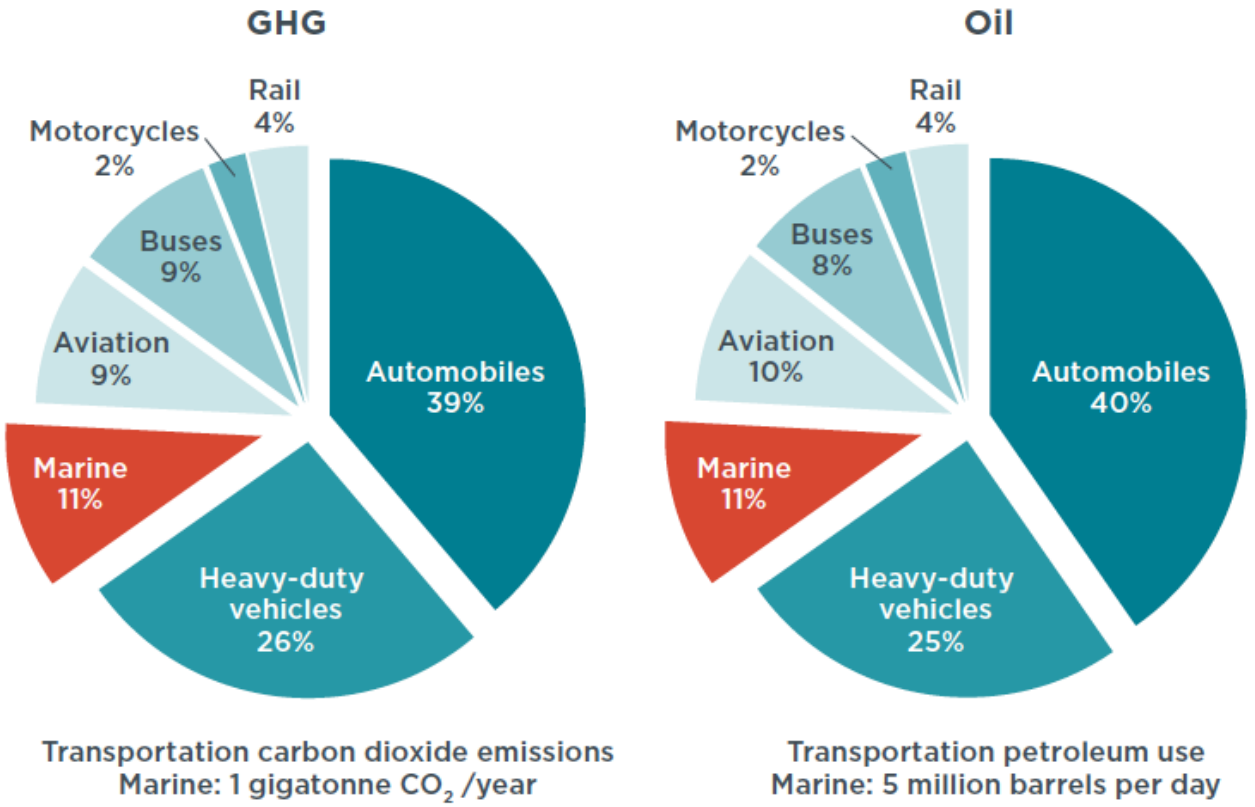
- Ocean-going vessels are the most carbon efficient freight mode
- 国际船舶是效能最高的运输方式



ICCT (2013) "Long-term potential for increased shipping efficiency through the adoption of industry-leading practices"

Climate Impacts of International Shipping
国际船舶的气候影响

- International shipping accounts for 11% of GHG emissions and oil consumption in the transportation sector
- 国际船舶占交通领域温室气体排放和能源消耗量的11%



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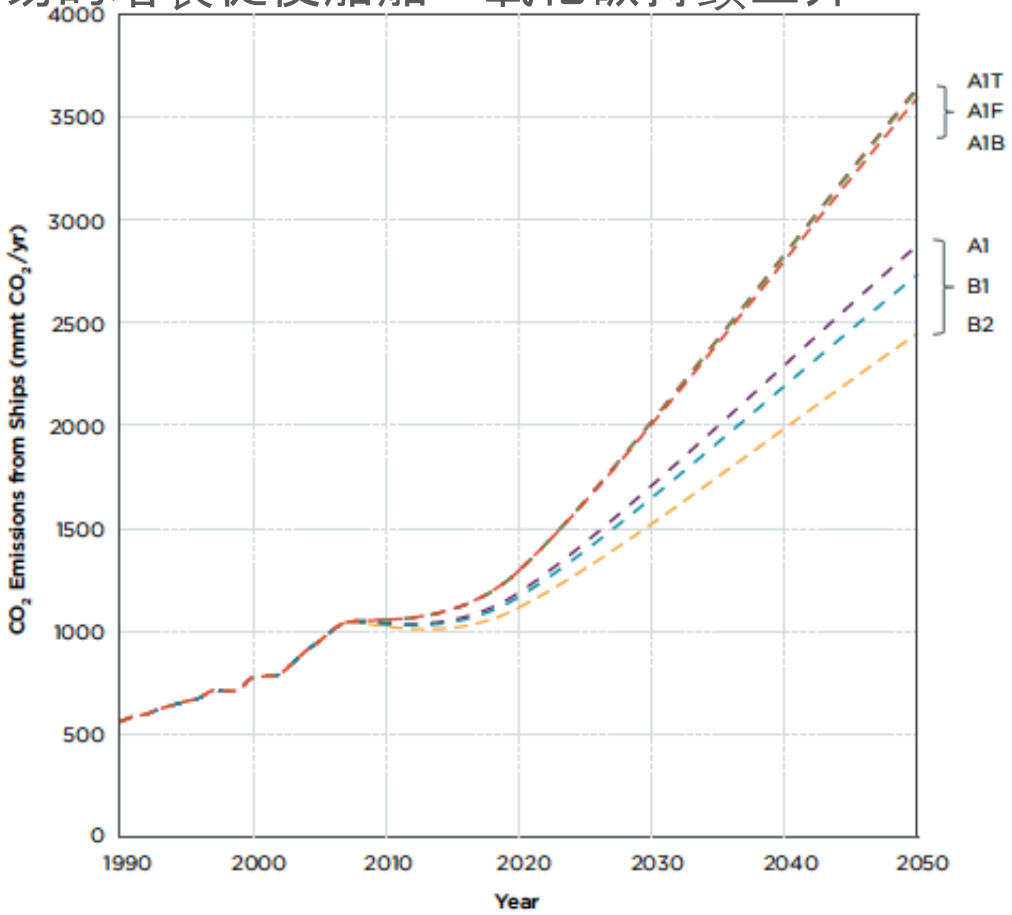
Climate Impacts of International Shipping
国际船舶的气候影响

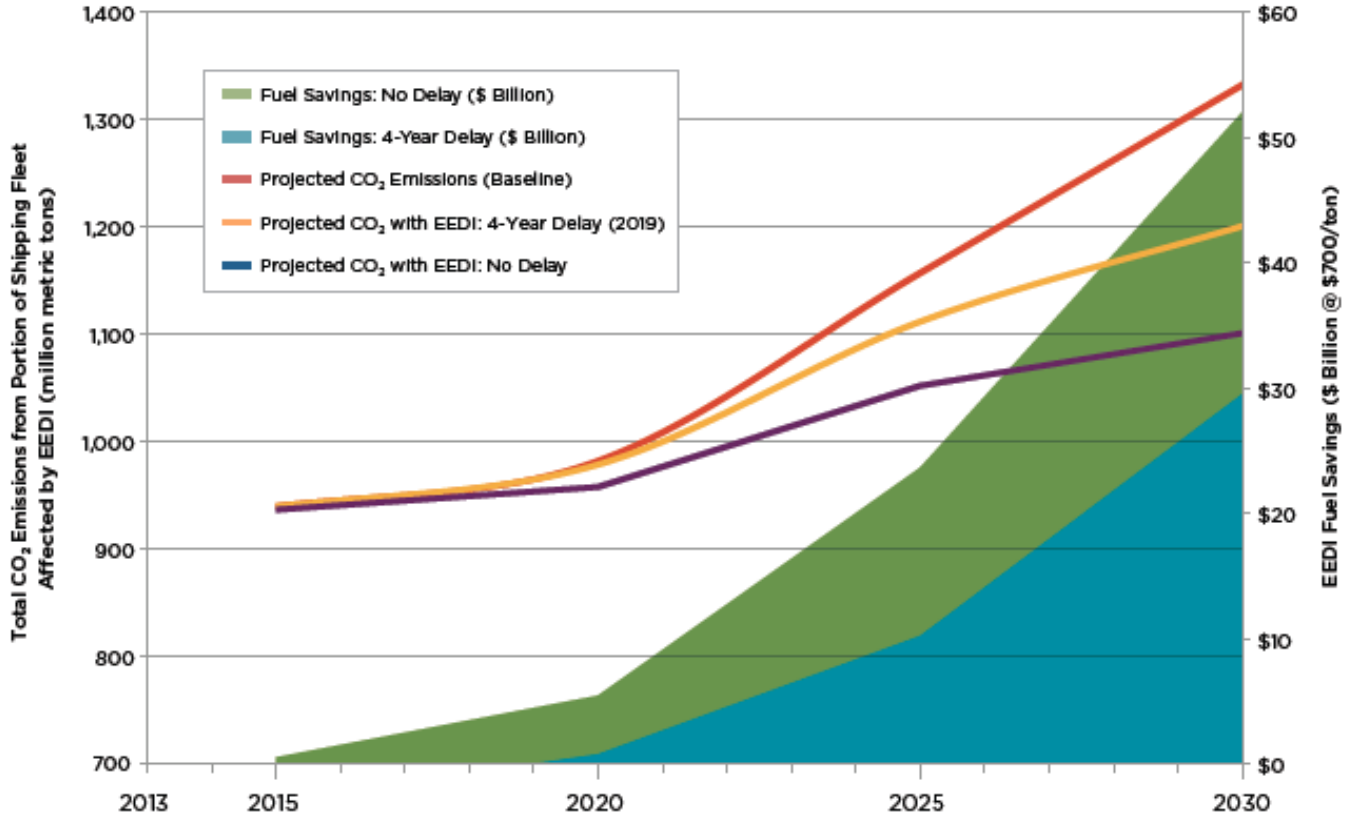
- Propelled by the growth of international commerce, CO_2 emissions will continue to grow between now and 2050
- 国际贸易的增长促使船舶二氧化碳持续上升



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

The Energy Efficiency Design Index (EEDI)
船舶效能设计指数

- The EEDI will slow but not reverse the CO_2 growth from international shipping
- EEDI将会减缓而不是逆转国际船舶的二氧化碳增长



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

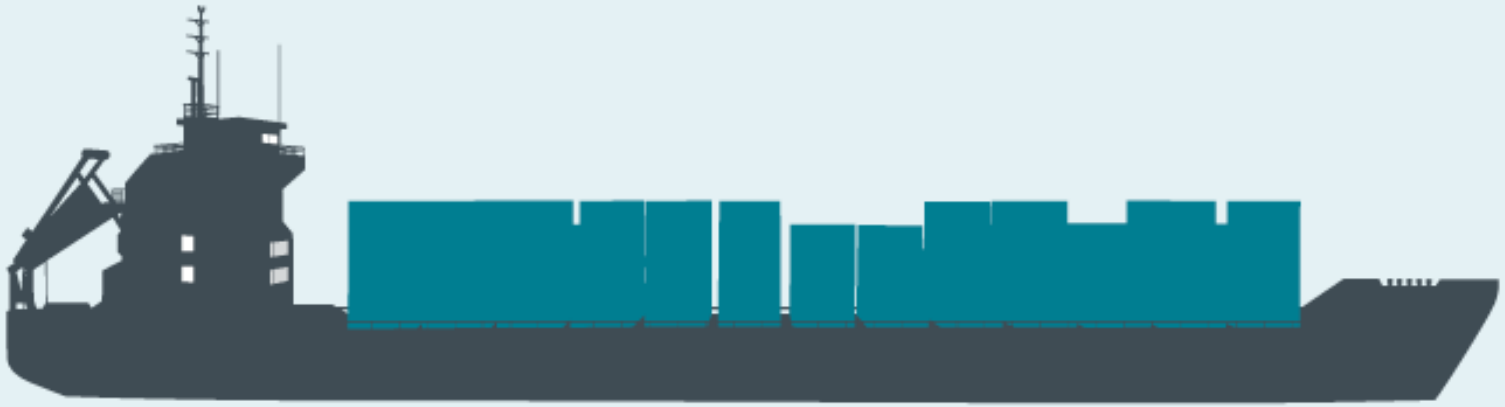
Substantial technical and operational potential to increase energy efficiency

技术和运营可以极大提高效率

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%**



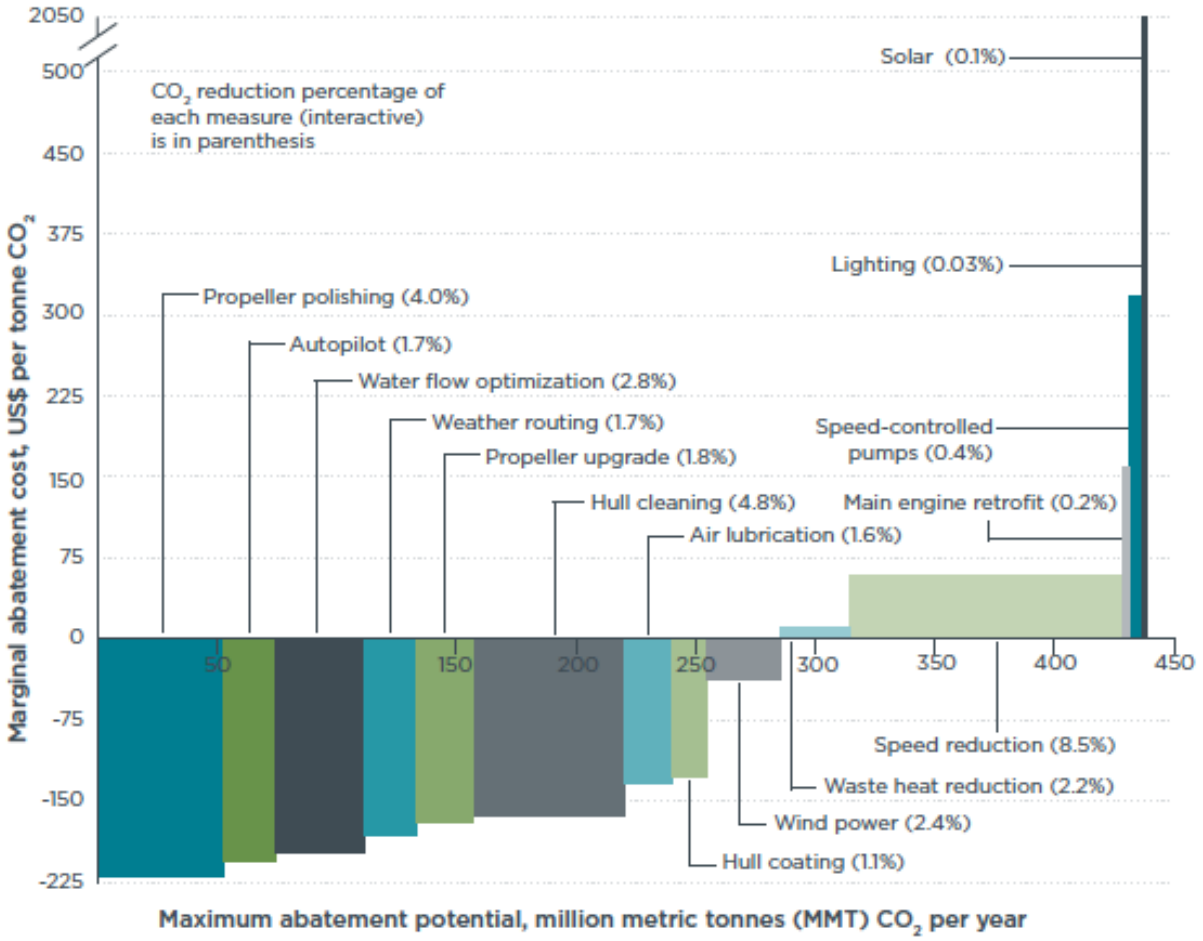
Thrust efficiency
Propeller polishing **3-8%**
Propeller upgrade **1-3%**
Prop/rudder retrofit **2-6%**

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

低成本提高能效的机会普遍存在



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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
全球在用船舶能效分析

- The large remaining opportunity for reducing CO_2 emissions in-sector lies in the improvement of energy efficiency for in-use ships
- 降低船舶温室气体的方法在于提高在用船舶能效
- Overarching questions／根本问题
  - What are factors that influence ship efficiency?
  - 影响船舶能效的因素有哪些
  - Are there data available to assess these factors?
  - 是否有数据可以量化这些因素
  - If the fleet achieves higher efficiency on par with its leading shipping companies, what are the energy and climate implications for the industry?
  - 如果船舶提高能效，对能源和大气的影响是什么

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Global in-use ship efficiency assessment: Data and Methods
全球作用船舶能效分析：数据和方法

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Data and Methods
数据和方法

- Data／数据
  - 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／方法
  - Global shipping fleet turnover model
  - 全球船舶更新模型

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Satellite Automatic Identification System

- The S-AIS is installed on every ship larger than 300 gross tonnage for safety reasons
- S-AIS安装在大于300净吨的船舶上
- Signals are transmitted from ships to satellites every few seconds
- 信号每隔几秒钟从船舶传递到卫星
  - Message 1: vessel location and speed over ground
  - 信息1：船舶位置和速度
    - Real time ship speed and shipping routes are two critical improvement from previous studies
    - 船速实时数据和船舶位置是相较于其他数据最显著的提高
  - Message 5: Vessel destination, IMO number, and draught (often input manually)
  - 信息5：船舶目的地， IMO号码和船深（通常手动输入）

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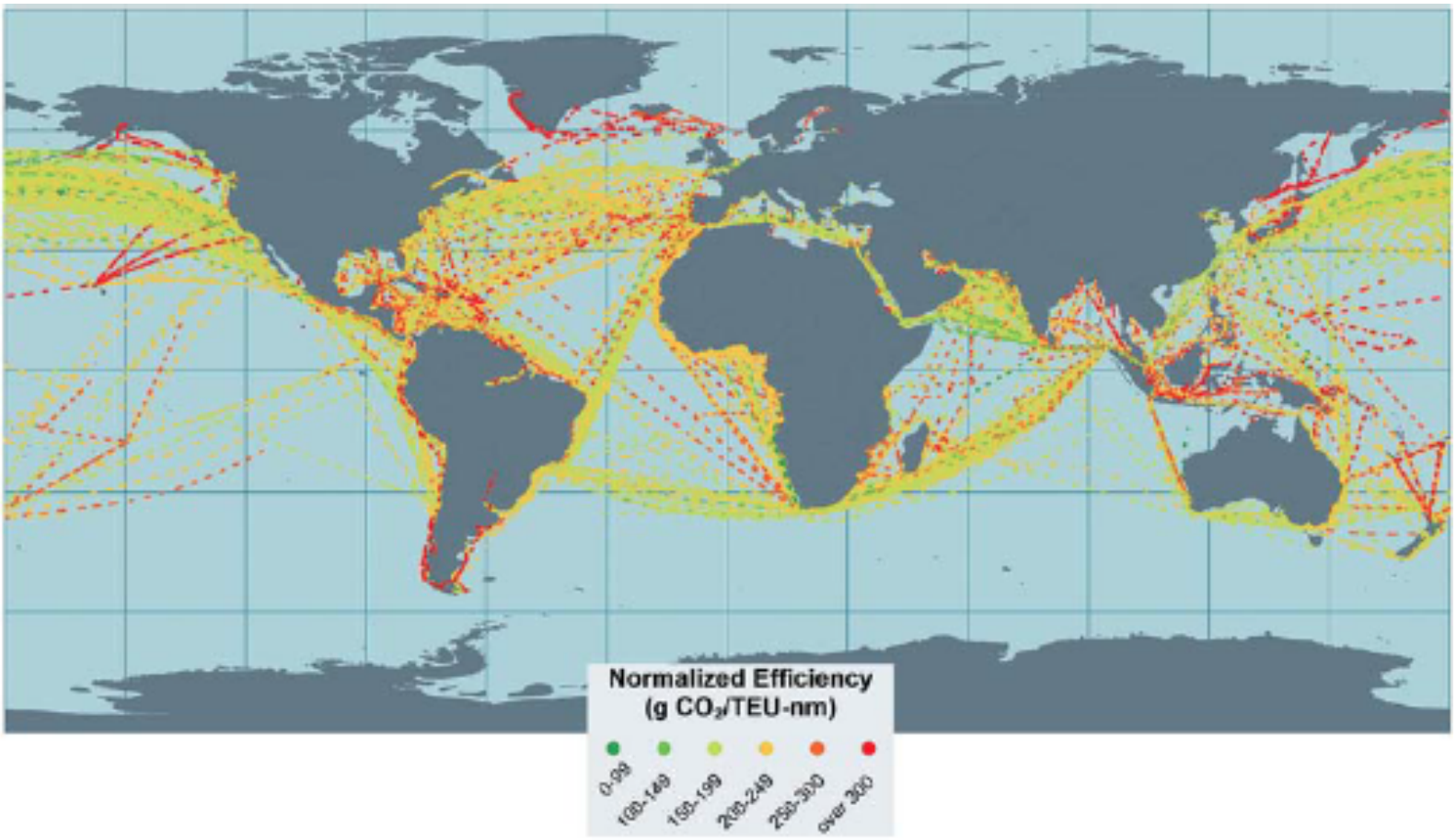
2011 Satellite Automatic Identification System (2)



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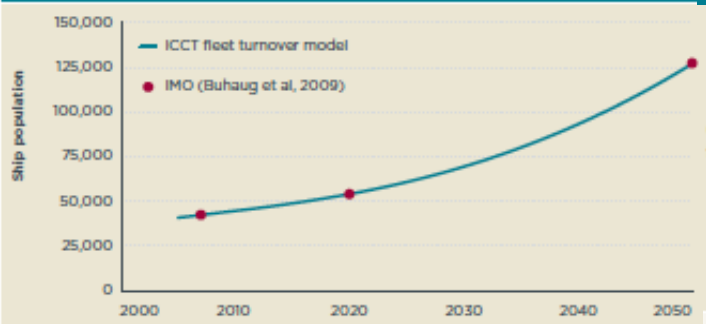
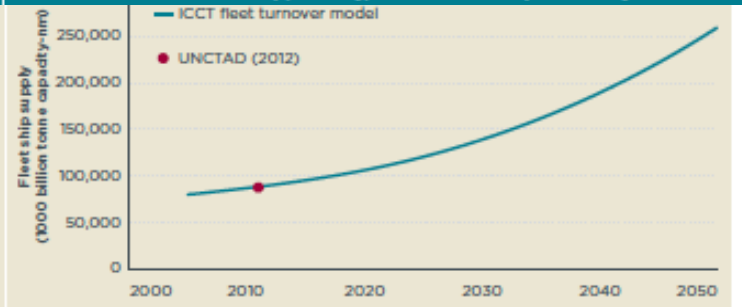
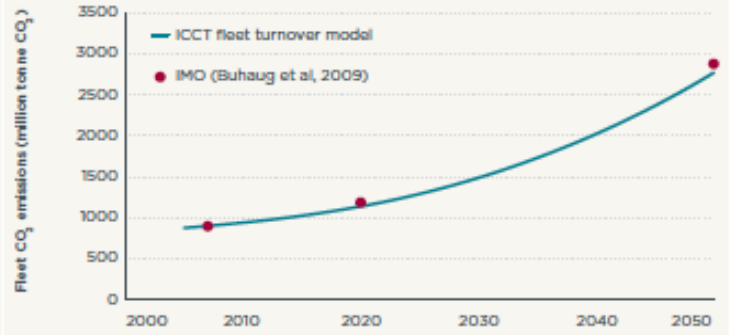
Smith et al (2013) ""Assessment of shipping's efficiency using satellite AIS data" http://www.theicct.org/assessment-shipping-efficiency-using-ais-data

Global Shipping Fleet Turnover Model
全球船舶更新模型

- Use data on ship population, overall ship efficiency, ship activity, and overall CO_2 emissions to backcast and forecast the fleet profile and emissions
- 使用有效数据预测过去和将来船舶的组成和排放

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
全球在用船舶能效分析：发现

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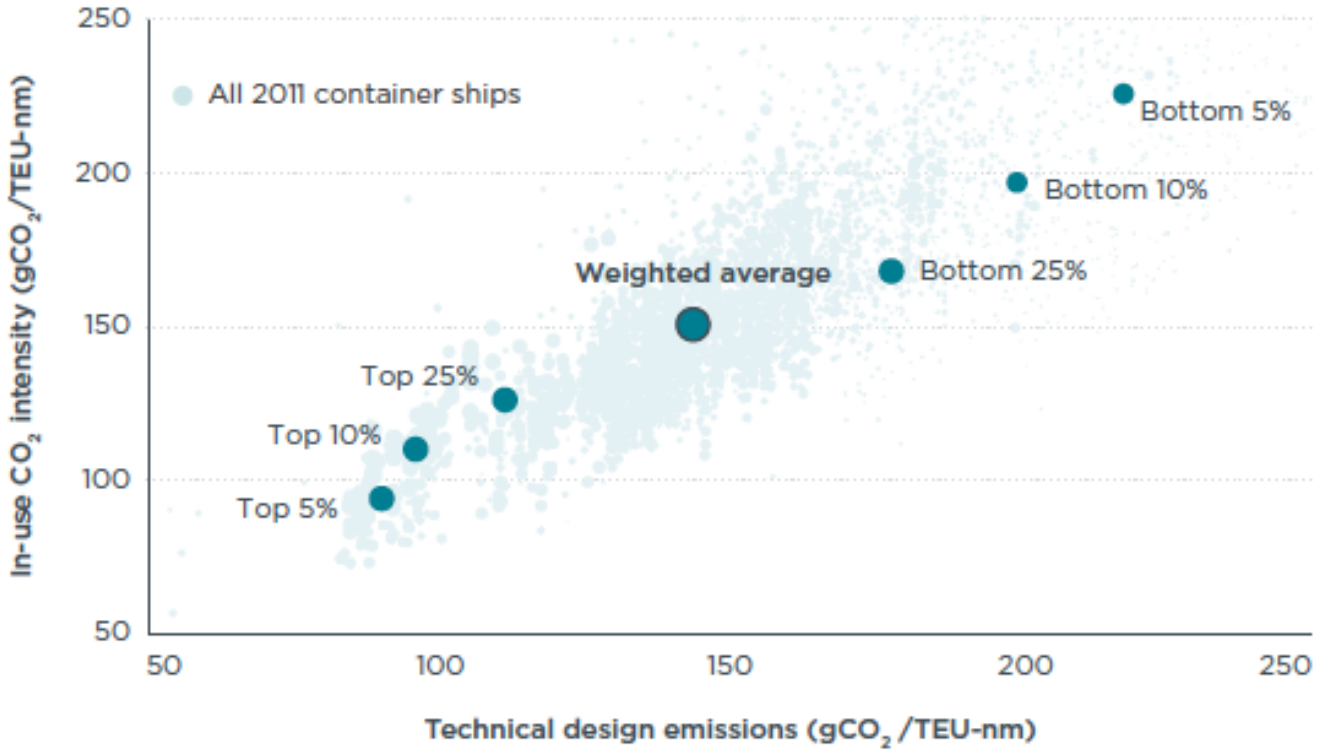
Technical efficiency and operational efficiency
设计能效和运行能效

- Ships with higher technical efficiency (energy efficiency as designed) typically have higher operational efficiency
- 设计能效越高，运行能效越高



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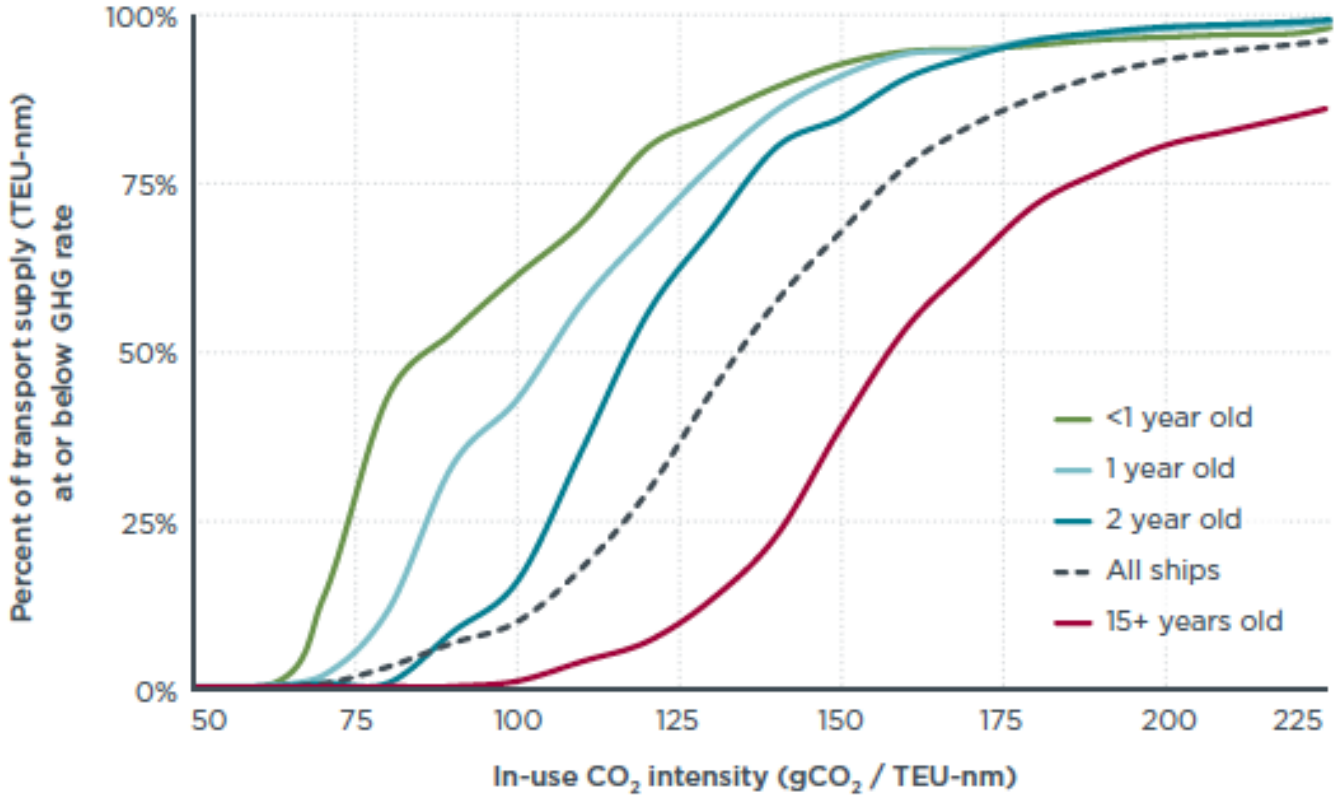
ICCT (2013) "Long-term potential for increased shipping efficiency through the adoption of industry-leading practices"

Ship age and operational efficiency
船舶年龄和运行能效

- Newer ships typically have higher operational efficiency
- 新造船运行能效较高



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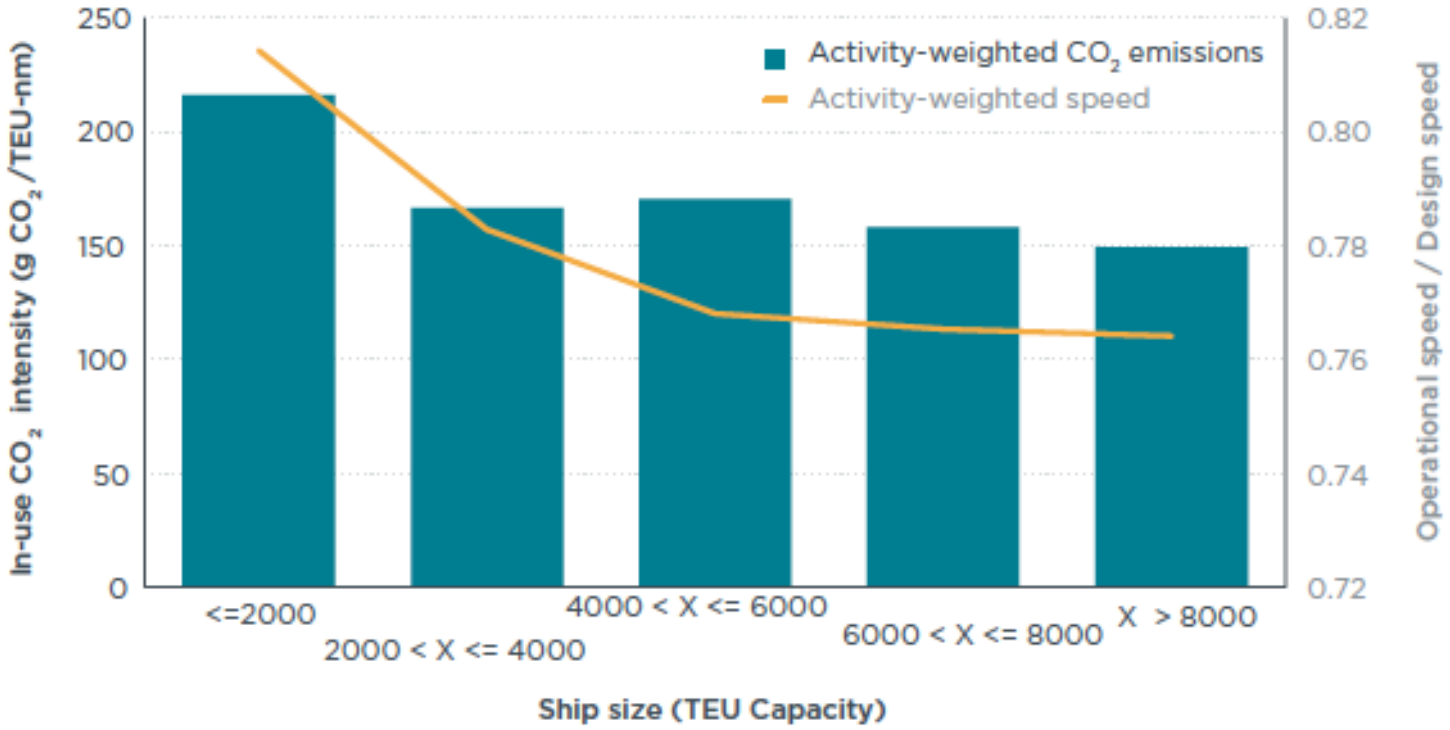
Ship size, speed, and operational efficiency
船舶大小、速度和运行能效

- Larger ships typically operate at reduced speed and have higher operational efficiency
- 较大船舶通常船速较慢且效能较高



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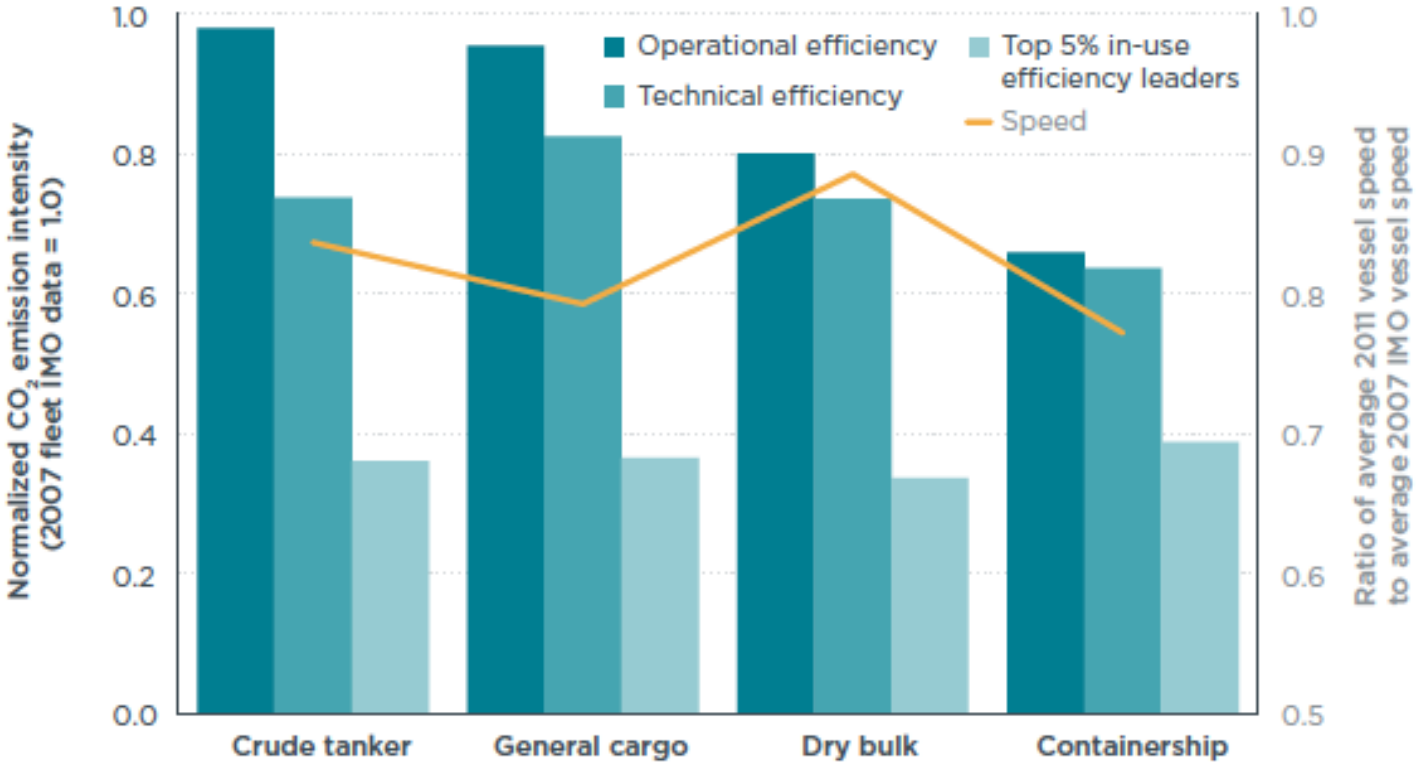
Comparison with the IMO 2nd GHG Study
与国际海事组织第二次温室气体报告的比较

- Top performers of each ship type have much higher operational efficiency than the industry average
- 每种船舶都有一些船有相对高的运行能效



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Projection scenarios
未来温室气体预测的几种情况

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

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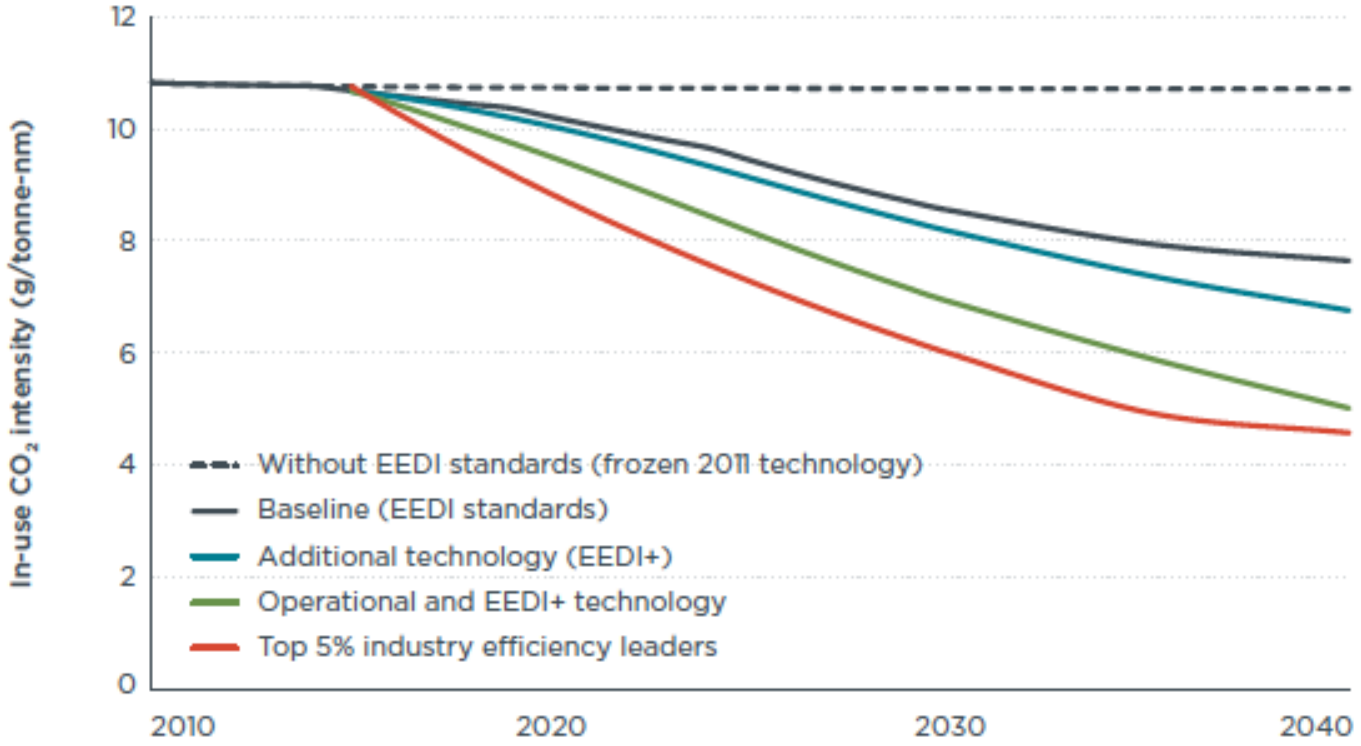
CO_2 intensity until 2040
2040年单位二氧化碳排放

- Fleet wide CO_2 intensity average will decline between 20% and 54% by 2040
- 船舶单位二氧化碳排放量降低20%到54%



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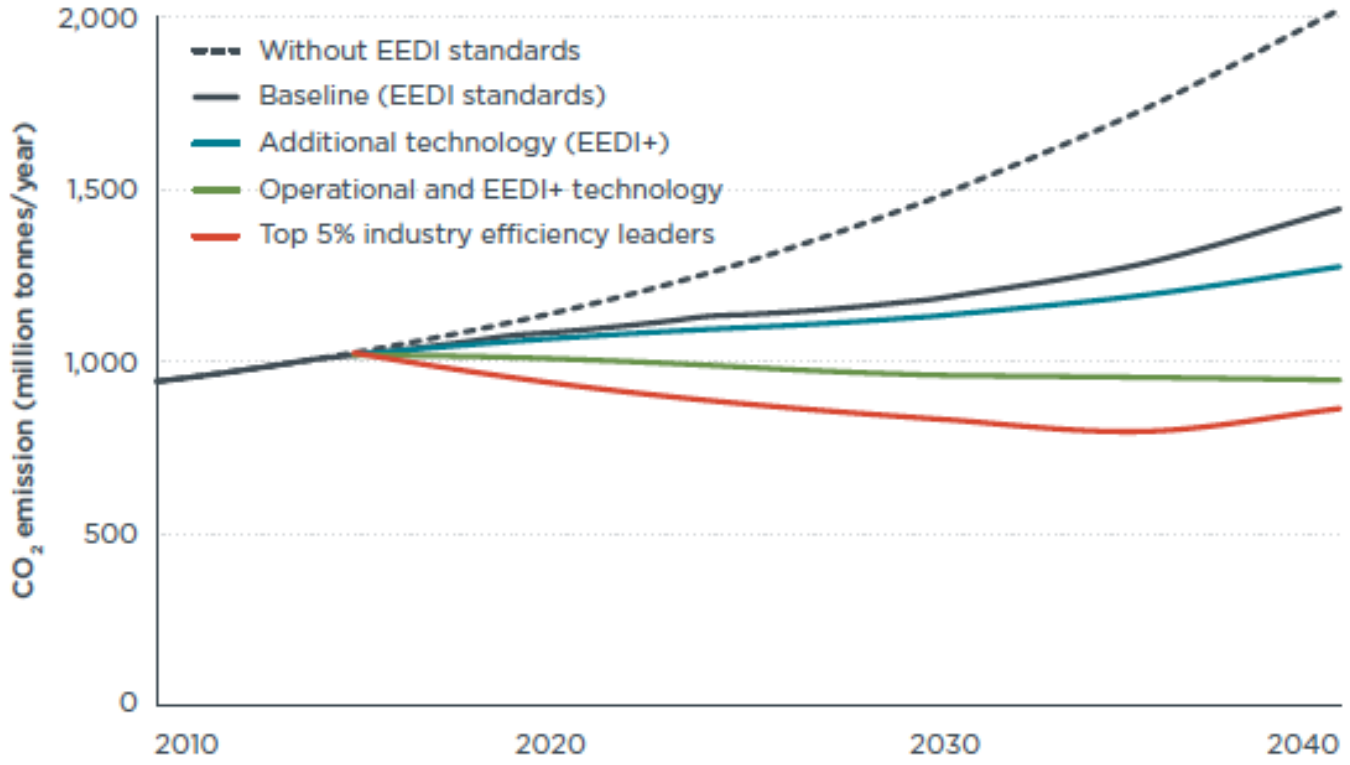
CO_2 emissions until 2040
2040年二氧化碳排放量

- Fleet wide CO_2 emissions will be reduced by between 100 million metric tonnes (mmt) and 400 mmt by 2040
- 船舶二氧化碳排放量降低1亿到4亿吨



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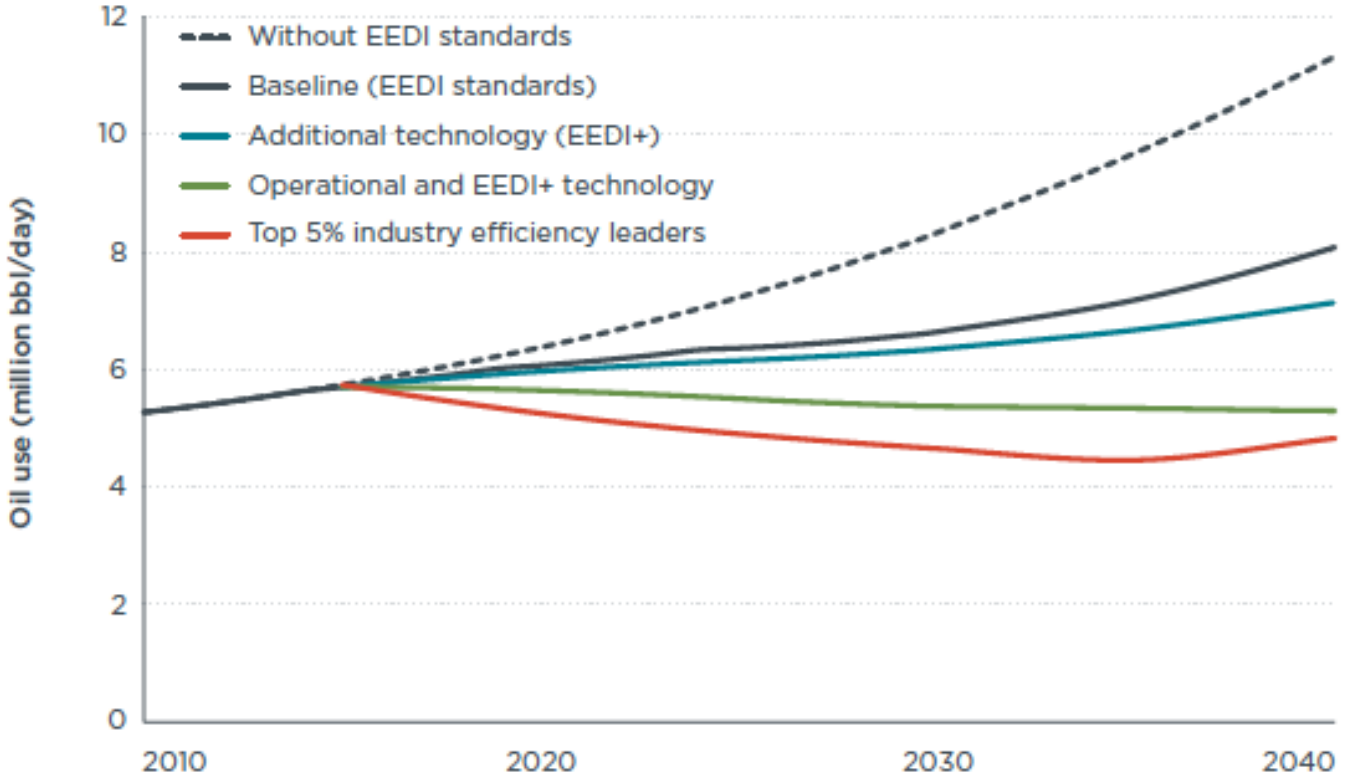
Marine fuel consumption until 2040
2040年船用油消耗量

- Oil consumption from international shipping will be cut by between 0.9 million b/d and 3.2 million b/d in 2040
- 国际船舶船用油消耗量降低90万桶／天到320万桶／天



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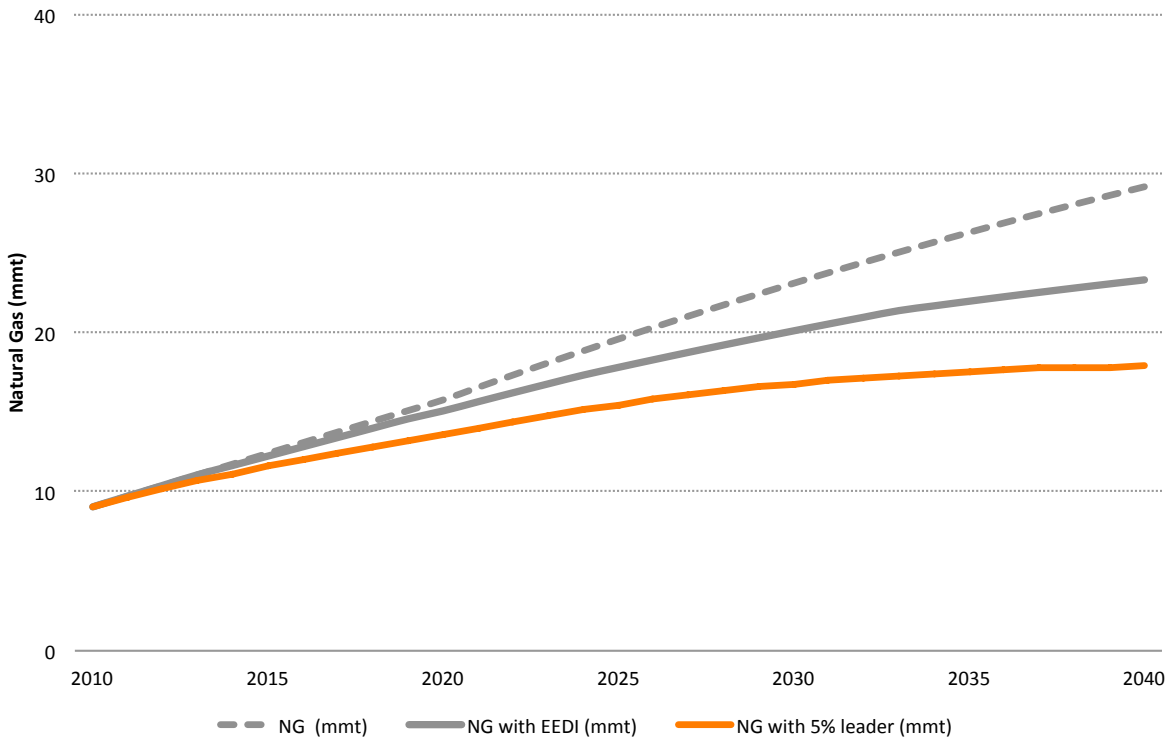
Ship efficiency of individual ship types – LNG carriers
单类船船舶能效

- Energy efficiency will reduce natural gas consumption by 12 mmt per year in 2030 from LNG carriers
- 提高液化天然气船能效可以到2030年节约1200万吨天然气使用



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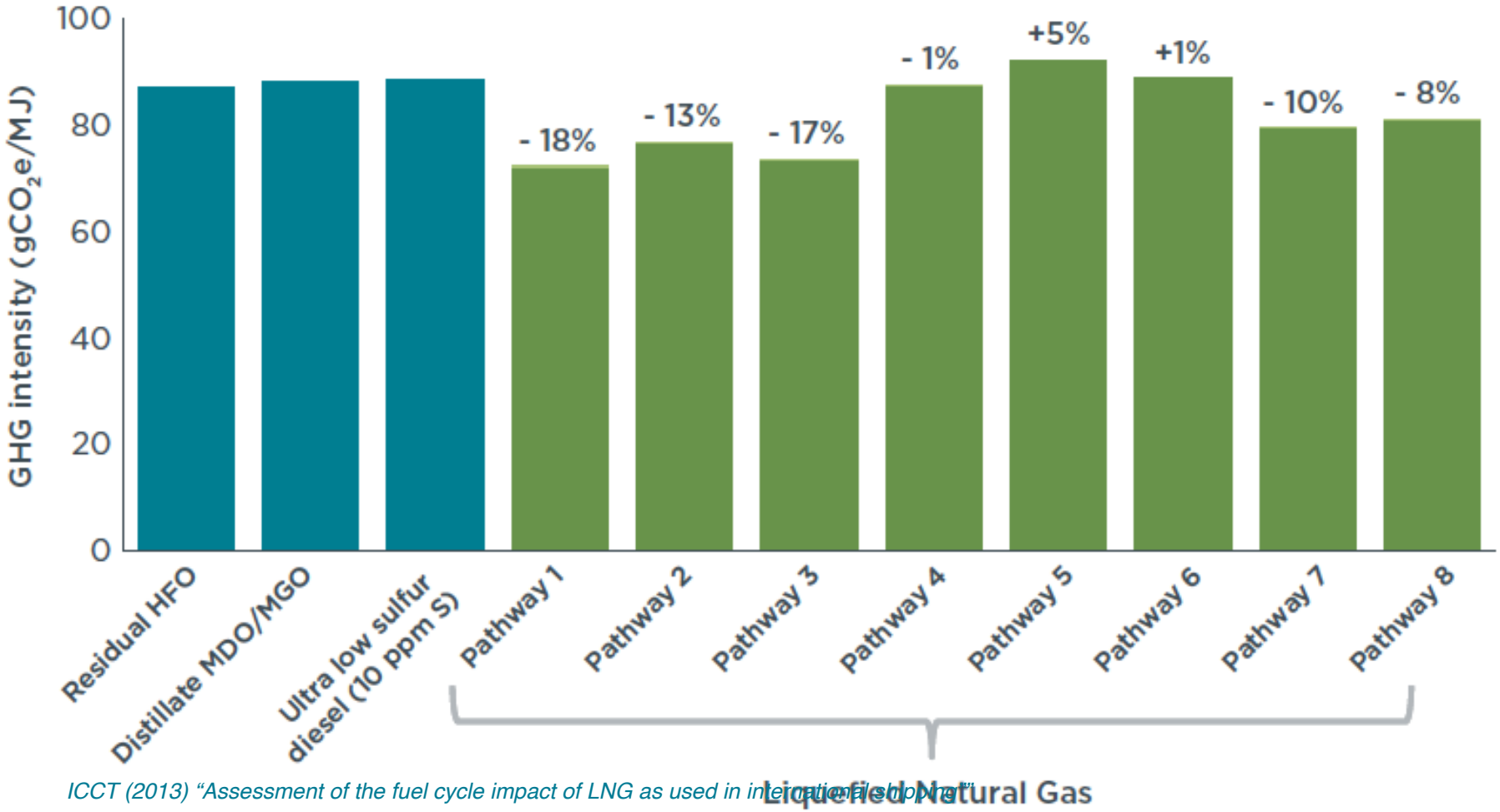
Long term potential to reduce energy consumption and CO2 emissions from LNG carriers (In preparation)

Lifecycle GHG emissions from LNG as a marine fuel
液化天然气生命周期二氧化碳排放

- Using alternative energy has to pay attention to lifecycle emissions
- 使用可替代能源必须注意生命周期排放



ICCT (2013) "Assessment of the fuel cycle impact of LNG as used in international shipping"

Conclusion
结论

- Shipping offers enormous potential to increase efficiency and reduce CO_2 emissions cost effectively
- 船舶可以极大的提升效率并有效降低二氧化碳排放
- Significant differences in operational efficiency can be observed across varying ship types, ages, and sizes
- 船舶效能因船型、船龄和船舶大小而不同
- Combining S-AIS data with existing data are critical to understanding how ships operate and why they differ in operational efficiency
- 将S-AIS和现有数据结合使用有利于对船舶效能的了解

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Future Work
未来工作

- Identify differences in operational efficiency within each ship type, age, and size combination
- 更好的了解船舶效能的不同
- Collaborate with shipping companies and organizations to examine other factors that influence ship operational efficiency not captured by this methodology
- 与船舶企业和组织合作，了解其他影响船舶效能的因素
- Integrate satellite data with on-shore AIS to improve data quality
- 将S-AIS和路基AIS结合以提高数据质量

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Discussion
讨论

- Which measures do you think should be used to increase energy efficiency?
- 您认为应当如何提高效能
- What are the implications of shipping carbon footprint on global supply chain?
- 降低船舶碳足迹会怎样影响供应链
- What are major opportunities for improving energy efficiency over the next three decades in international shipping?
- 未来30年国际船舶效能提高的方法

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Thank You
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