Annual Efficiency Ratio (AER)

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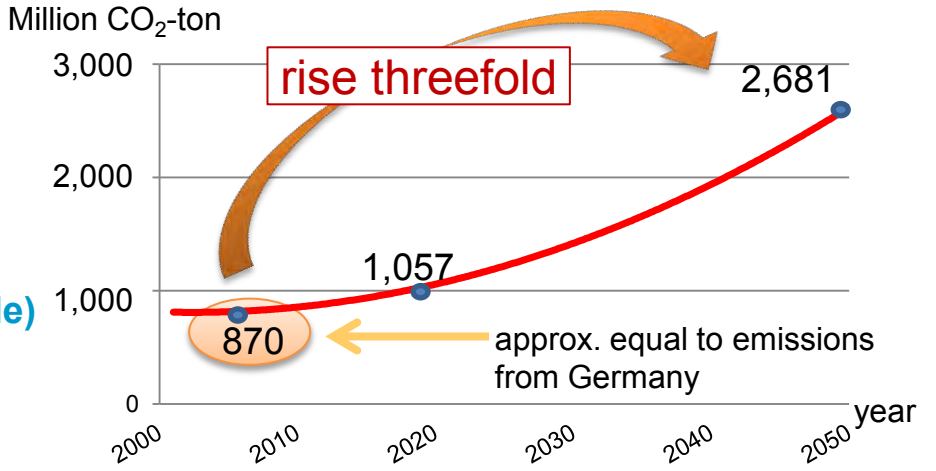
Back to Basic: How to reduce GHG Emissions

- In principle, volume of GHG emissions is determined by two elements only, which are "Activity" and "Energy Efficiency".

Emissions (g)
= Activity (ton mile) x Energy Efficiency (g/ton mile)

Emissions from the International Shipping Sector



Source : Second IMO Greenhouse Gas study 2009

- Thus there are only two ways to reduce emissions from shipping.

A. Reduce Activity level (transport volume)
⇒ Uncontrollable by the maritime industry,
but determined automatically by world economic growth.

⇨ IMO should not seek this way.

B. Improve energy efficiency
⇒ Energy efficiency improvement can be achieved by maritime sector's efforts through the following measures.
- B-1: Technical measures (improving hardware)
- B-2: Operational measures (operating "wisely")

⇨ IMO should focus on this.

Snapshot on CO2 emissions regulations at the IMO

Components of Emissions Reductions

B. Improvement of Energy Efficiency

B-1: Technical Measures B-2: Operational Measures

1st Policy Package ⇒ amendments to the MARPOL Annex VI
(Entry into force on 1 January 2013)

Technical Measures

EEDI

(Energy Efficiency Design Index)

< for New Ships >

- Calculate Attained EEDI values
- Meet Required EEDI values
- Baseline will be lowered in a phased way

Operational Measures

SEEMP

(Ship Energy Efficiency Management Plan)

< for New & Existing Ships >

- Develop a ship specific SEEMP

Is there any room for further efforts ?

Discussion so far on Data Collection System

- IMO/MEPC 62 (July 2011) adopted the amendments to MARPOL Annex VI on EEDI regulation for reducing GHG emissions from international shipping.
  (Entry into force on 1st January 2013)

- For further measures to improve the energy efficiency of ships, at MEPC 65 (May 2013), the US proposed a "Phased approach" for Data Collection System, and many countries including Europeans and Japan supported this approach.

- The MEPC started to discuss this issue, in the first instance, on framework for data collection on the energy efficiency of ships.

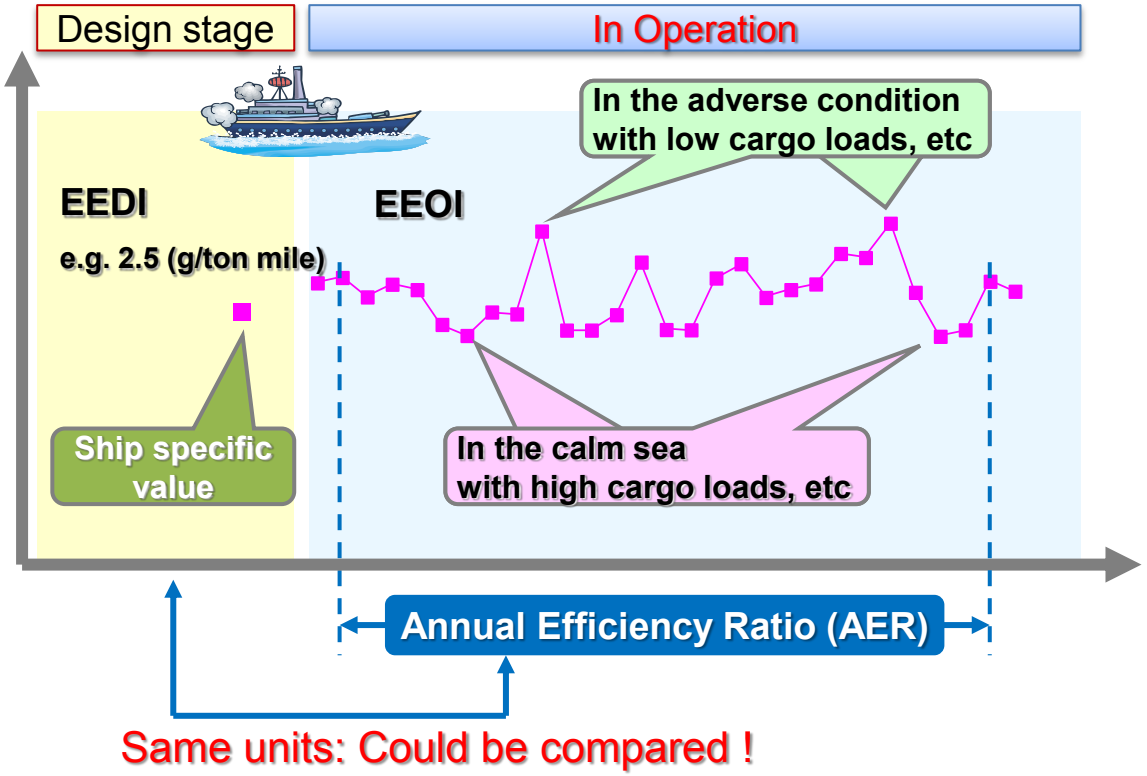
- Also Japan, the US, Germany and EMSA made suggestions on metrics for further improving energy efficiency.

- At MEPC 66 (April 2014), IMO undertook intensive discussions on "Data Collection System", and a Correspondence Group was established.

Japanese proposal

$$\text{Annual Efficiency Ratio (AER)} = \frac{\sum_j FC_j \times C_{Fj}}{DWT \times D} \quad \text{[g-CO2 / ton-mile]}$$

j : the fuel type;
FC_j : the annual mass of consumed fuel j;
C_{Fj} : the fuel mass to CO2 mass conversion factor for fuel j;
DWT : the deadweight;
D : the annual distance sailed in nautical miles;



Example of calculation of the AER

$$\text{AER} = \frac{17{,}381 \times 10^6 \times 3.114}{230{,}000 \times 81{,}984}$$

$$= 2.87 \text{ (g-}CO_2\text{/ton mile)}$$

Where:

Fuel consumption:	17,381 ton/year
	C_F=3.114
Distance sailed:	81,984 mile/year
DWT:	230,000

Analysis on Annual Efficiency Ratio (AER) with real data (MEPC67/5/4)

During the last Session, the suggestion was made by the Committee that a “test” on metrics would be warrant.

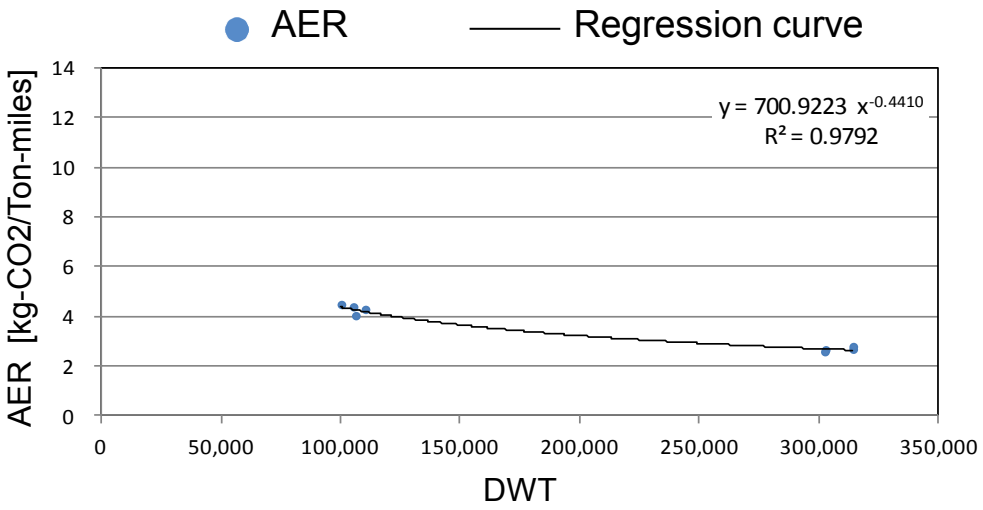
- Japan undertook a brief analysis, based on the real data voluntarily provided by Japanese fleet.
- This analysis intends to seek whether Annual Efficiency Ratio (AER) could be an appropriate metric to capture and enhance energy efficiency from international ships.

Information of the ships which is used for analysis

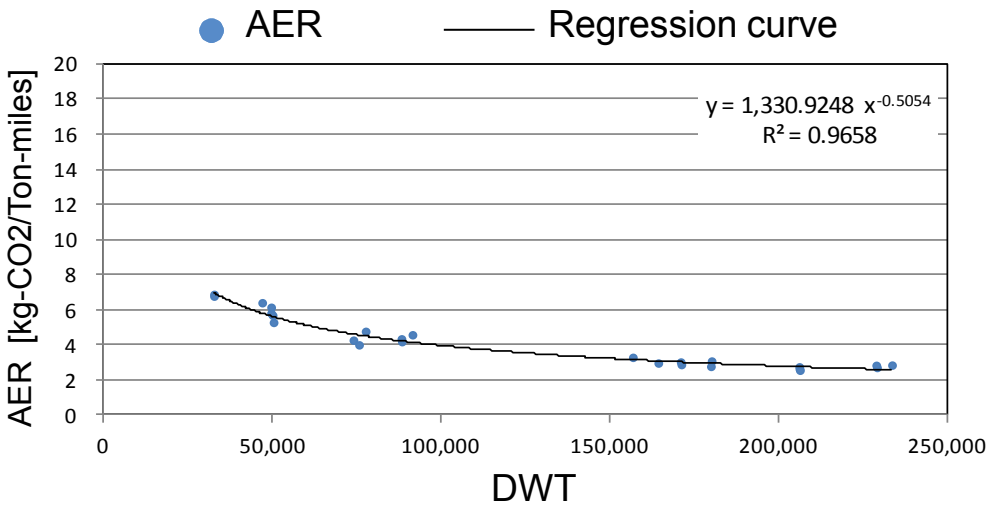
Type of ship	Number of ship
Oil tankers	8
Bulk carriers	25
Container carriers	28

A metric which would be employed by the IMO at a later stage of the data collection, should be that could appropriate capture increasing or decreasing trends of energy efficiencies of individual ships.

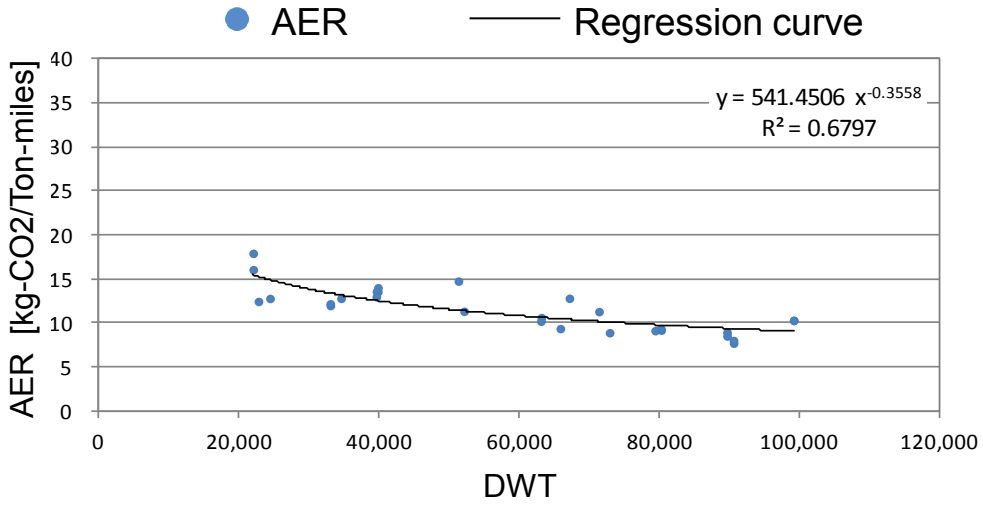
Result 1: AER values calculated and the regression curves



Oil tankers



Bulk carriers



Container ships

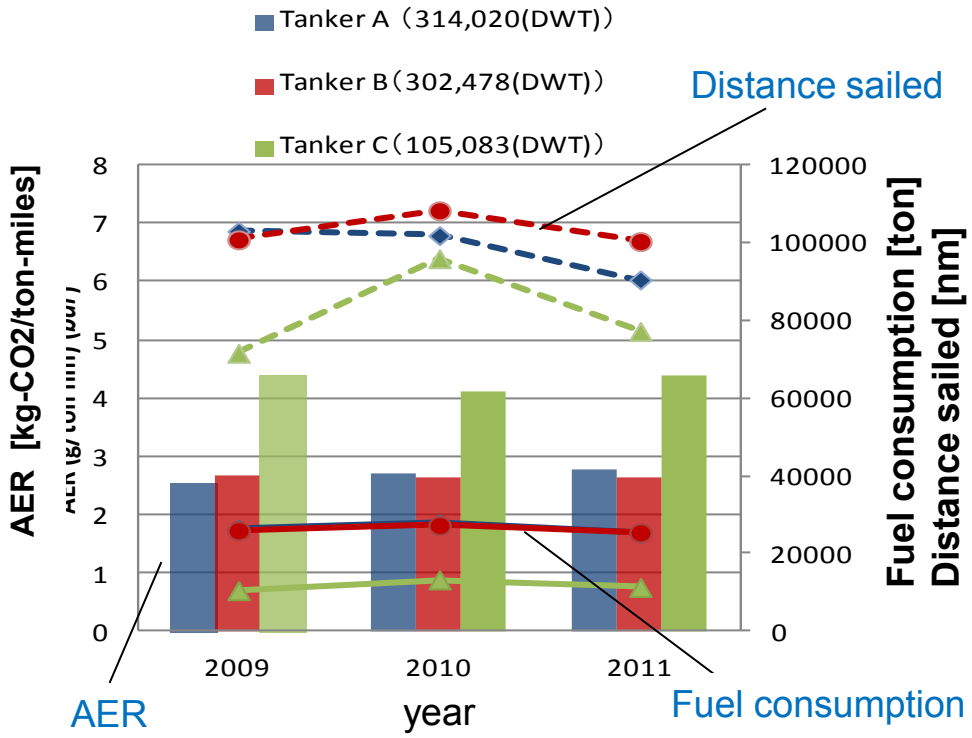
R-Squared values

- oil tankers : approximately 1.0
- bulk carriers : approximately 1.0
- container ships : approximately 0.7

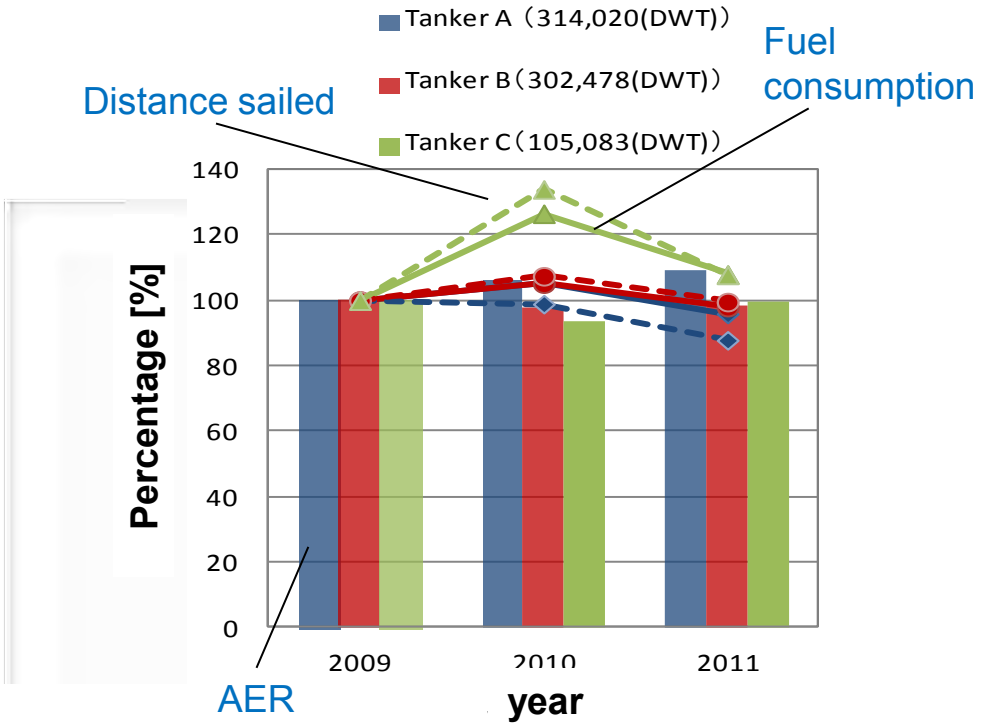
The regression curves and AER values have strong interrelations each other.

Concept of AER could be an appropriate candidate as a metric for this initiative.

Result 2: Appropriateness of AER



Data of three parameters for oil tankers during 2009-2011

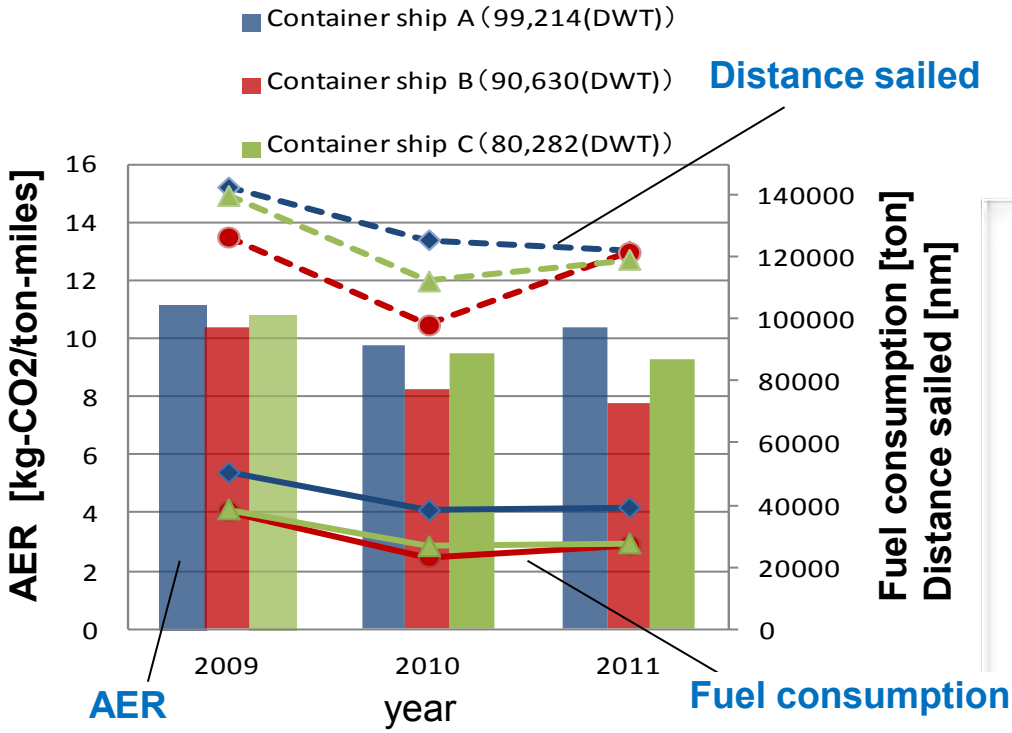


Degrees of changes from 2009 values for oil tankers

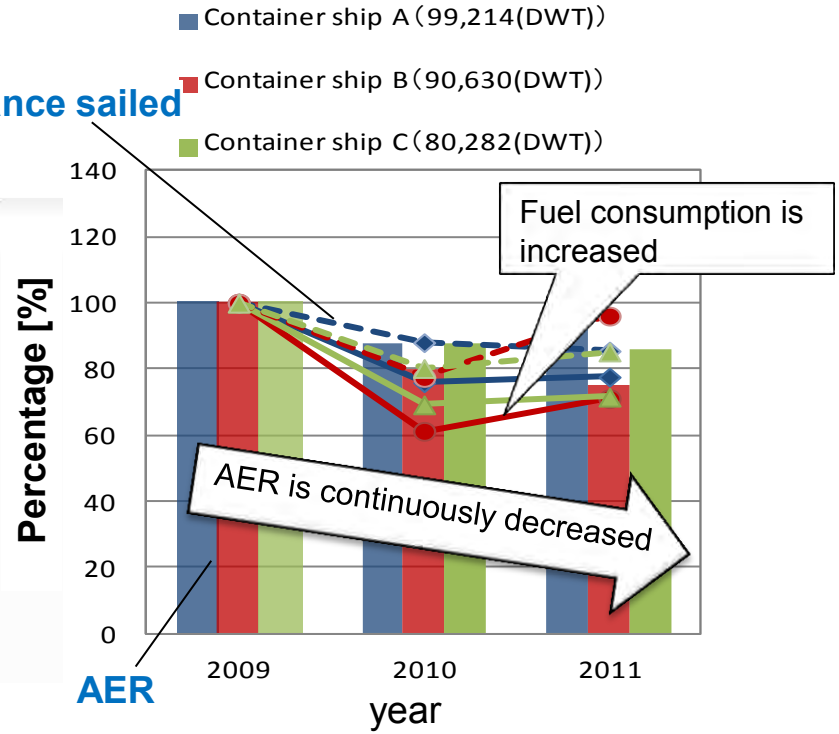
- ✓ Tanker B consumed larger fuels than Tanker C. But...
- ✓ Tanker B achieved a longer distance, carried larger cargoes than Tanker C.
- ✓ Calculated AER value of Tanker B shows a better efficiency ratio than that of Tanker C.

AER is that could appropriate capture energy efficiencies of individual existing ships, taking well into account “transport work”.

Result 3: Importance of Transport work



Data of three parameters for container ships during 2009-2011



Degrees of changes from 2009 values for container ships

- ✓ The data of Ship B for fuel consumptions indicate the decrease in 2009-2010 and then the increase in 2010-2011.
- ✓ The data for the distances of Ship B indicate a decreasing trend to a smaller extent in 2009-2010 and then the increasing trend to a larger extent in 2010-2011.
- ✓ The calculated AER values for Ship B show the constant decrease (namely, the constant improvement of energy efficiency) during 2009-2011.

It would not be appropriate to rely on the fuel consumption figures for the data collection system.

A way forward at IMO on Data Collection System to enhance energy efficiency of international shipping

Data Collection and Analysis Phase (Phase 1) | **Pilot Phase (Phase 2)** | **Full Implementation Phase (Phase 3)**

Data Collection and Analysis

- **Establish** the framework for data collection (fuel consumption, distance sailed, hours of service, DWT, etc) from each ship

Discussion items

- Mandatory or voluntary (necessity of amendments to MARPOL Annex VI)
- Scope of application (ship type, 400GT / 5,000GT, etc.)
- Range of data to be collected
- Data collection and reporting process (frequency of measurement, treatment of ballast condition, data format, etc.)
- Means of enforcement, if it is mandatory, etc.

Ship

- Data collection
- Submit an annual report to the Flag State/RO and IMO
- Keep Certificate on board

Flag State or RO

- Verification of collected data
- Issue Certificate of compliance
- Submit data to IMO, etc.

IMO

Centralized database

- data collection and analysis
- Provide Annual report

Port State

- Port State Control (Check the Certificate)

Establish efficiency metric and baselines

Based on data collected during the Phase 1 period, **consider** an appropriate efficiency metric, and **establish** efficiency baselines.

Details have not been discussed

Japan : Yearly average of $\frac{\text{Fuel Consumption} \times \text{Carbon Factor } (C_F)}{\text{Distance sailed} \times \text{DWT}}$ [g/ton mile]

The US : Yearly average of $\frac{\text{Energy [joule]}}{\text{service hour}}$ [J/hours]

EMSA : Yearly average of $\frac{\text{fuel consumption} \times \text{Carbon factor } (C_F)}{\text{distance sailed}}$ [g/mile]

Germany : annual *Fuel Consumption* [ton]

"Test run" to check

an efficiency metric and a baseline selected

Full Implementation Phase (Phase 3)

- **Full Enforcement**
- **Further consider** flexible measures or MBM

Conclusion

1. The IMO GHG study indicates the strong growth of CO_2 emissions from international shipping, and therefore, the IMO should focus on the energy efficiency improvement of individual ships, but not on capping CO2 emissions in absolute terms.

2. EEDI & SEEMP regulation is a big step forward. But this is not enough and there is a room for all the existing ship to make further efforts.

3. Therefore, the IMO/MEPC should make efforts to establish a Data Collection system.

4. Japanese proposal for a metric, *i.e.*, Annual Efficiency Ratio (AER), has the following characteristics;

   (1) aims at improving energy efficiency of individual ships;

   (2) the same unit with EEDI is employed based on DWT;

   (3) strong correlation and robustness are found;

   (4) appropriately takes into account "transport work"; and,

   (5) only three data (fuel consumption, distance sailed and DWT) are required, and these have been already subject to other mandatory instruments.

Thank you very much for your interests, and any questions?

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