DEMYSTIFYING IMO EEXI & CII

AND THEIR IMPACTS ON SHIPPING

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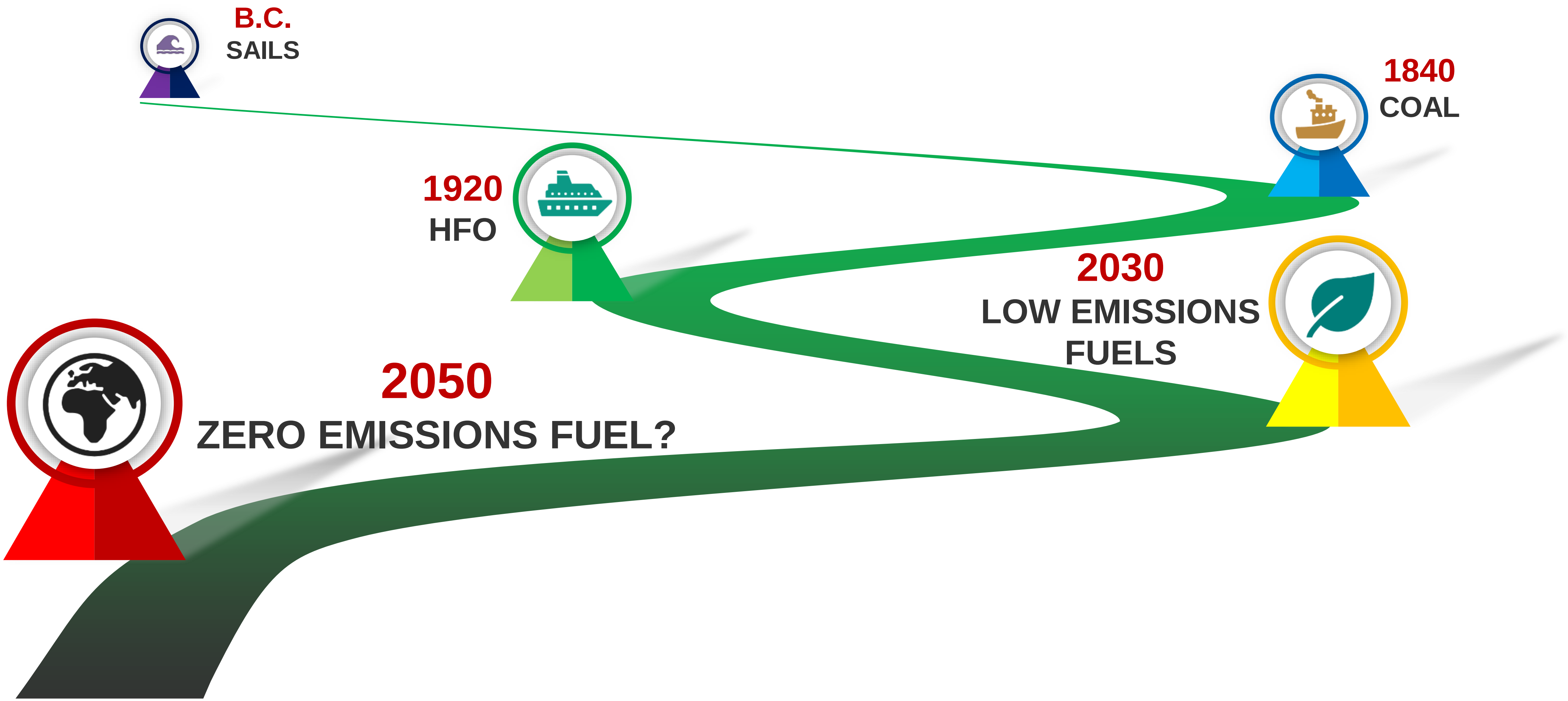
SHIPPING GHG EMISSIONS – FROM ZERO TO ZERO



Emissions from shipping between 2012 and 2018 (thousands tons)

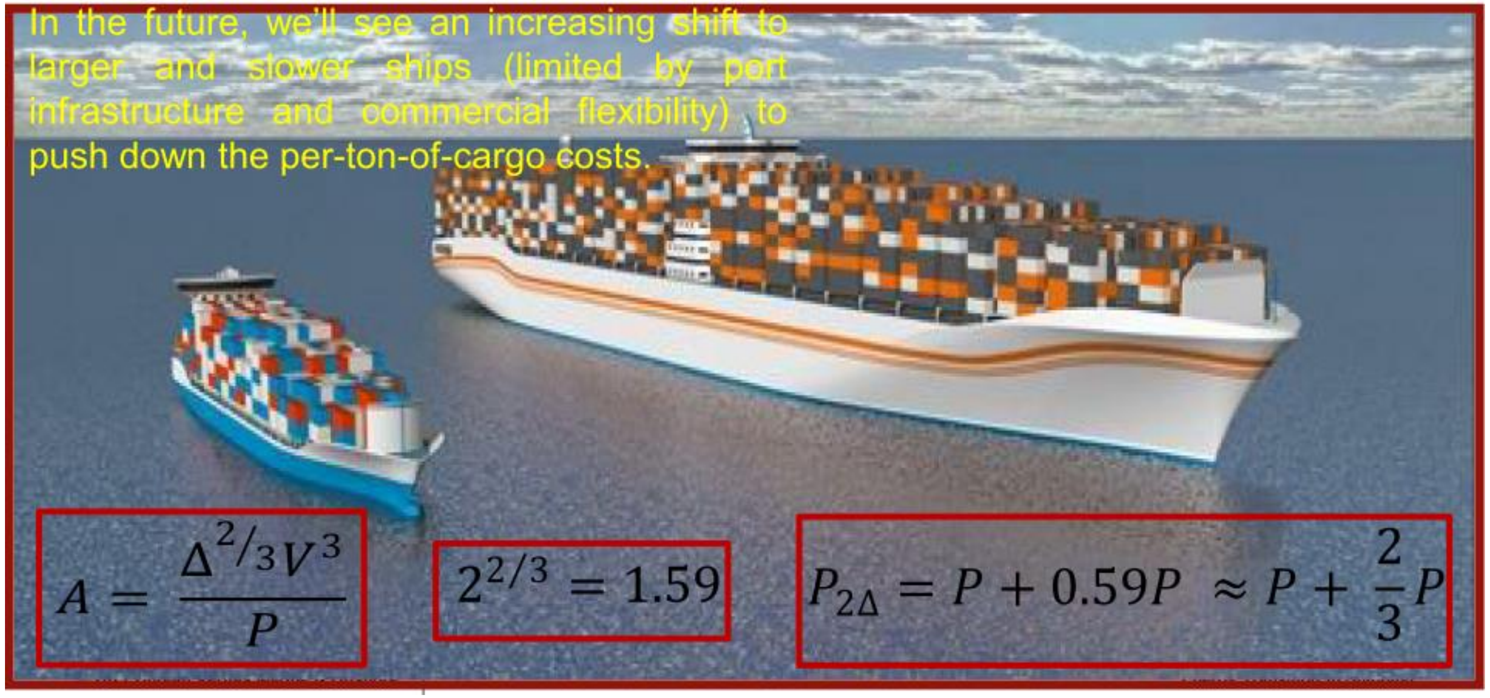
Honeymoon lasted from 2008-2012

Shipping share

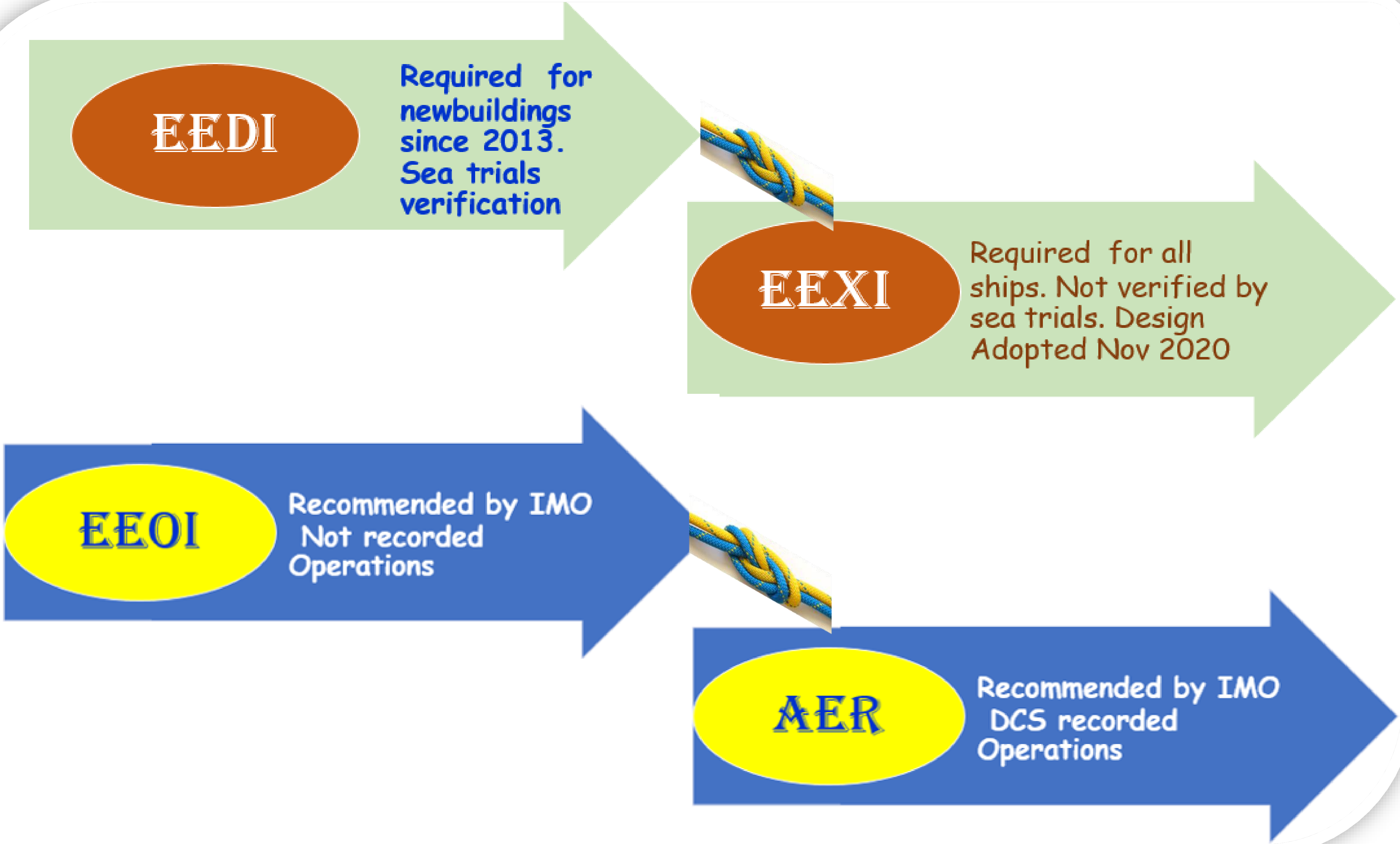
2012: 2.76%

2018: 2.89%

→ Slow steaming- Larger ships



☆	2012	2018
CO_2	848,000	919,000
CH_4	59	148
NO_2	47	51
SO_2	10,800	11,400
NO_x	19,700	20,200
$PM_{2.5}$	1,527	1,589
BC	73	79
VOC	790	861
CO	742	829


EEDI
Required for newbuildings since 2013. Sea trials verification
EEXI
Required for all ships. Not verified by sea trials. Design Adopted Nov 2020
EEOI
Recommended by IMO
Not recorded
Operations
AER
Recommended by IMO
DCS recorded
Operations

Required

DWT dependent

$A(DWT)^B$

Attained

MCR, Capacity, fuel

Speed, Consumption

Attained EEXI formula and correction factors

$$\frac{P_{ME(i)} \cdot C_{FME(i)} \cdot SFC_{ME(i)} + P_{AE} \cdot C_{FAE} \cdot SFC_{AE}}{Capacity \cdot f \cdot V_{ref}}$$

$P_{ME}(i)$: 75% of MCR for each Main Engine
C_F : Emission factor for fuel used in shop tests
$SFC_{ME}(i)$: Specific fuel consumption at 75% MCR from NOx Technical File for Main Engine
SFCAE(i) : Specific fuel consumption at 50% MCR from NOx Technical File for Generator

IF THERE ARE NO DATA: SFC_{ME}=**190** g/kWh and SFC_{AE} = **215** g/kWh

Capacity : Deadweight at scantling draft
V ref : From an approved speed-power curve at scantling draft at 75% MCR

Alternatively: Estimate power-speed curve numerically/CFD or by Statistical Evaluation

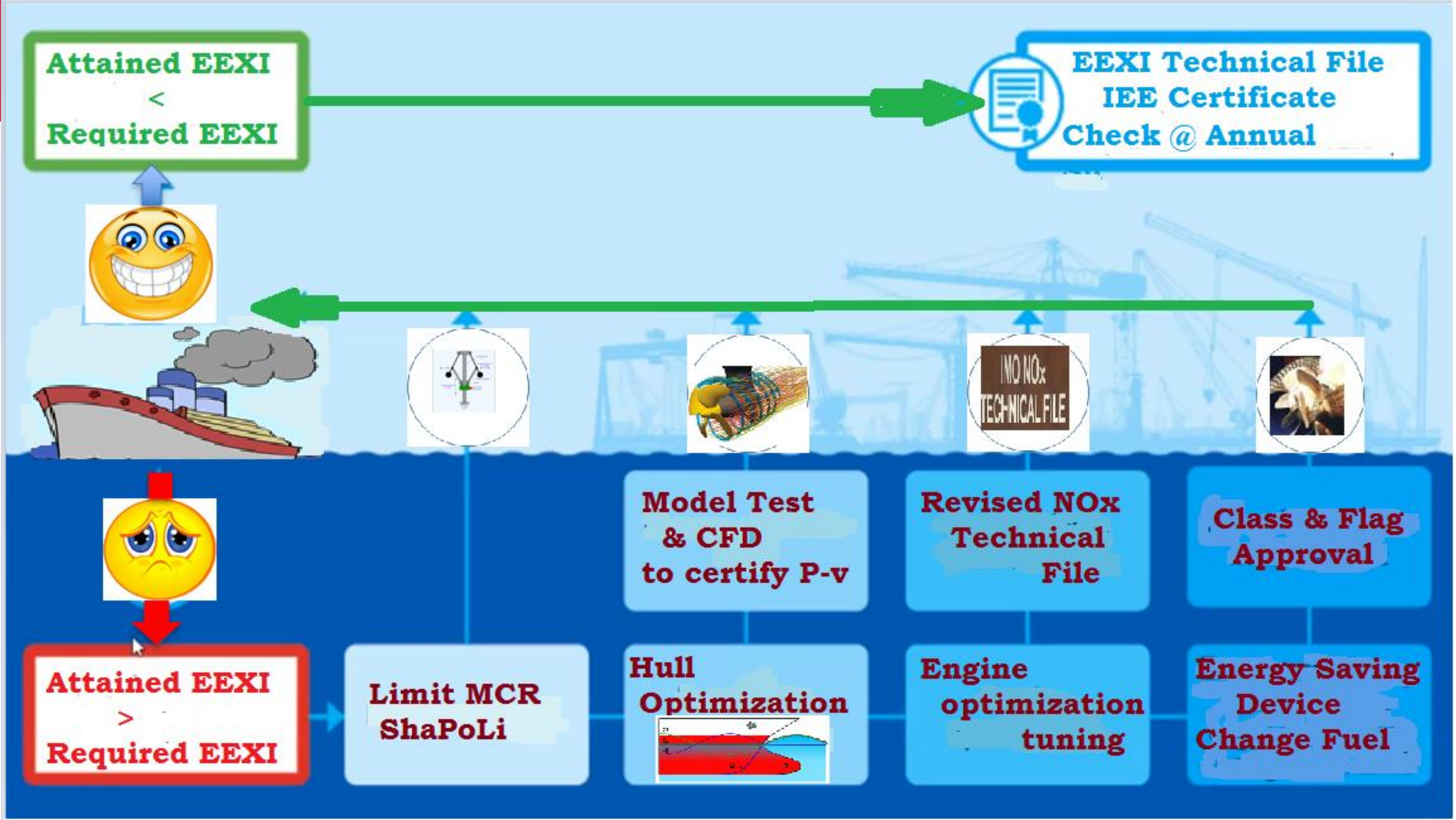
Required EEXI

Ship type	Size	Reduction factor
Bulk carrier	200,000 DWT and Above	15
	20,000 to 200,000 DWT	20
	10,000 to 20,000 DWT	0-20*
Gas carrier	15,000 DWT and above	30
	10,000 to 15,000 DWT	20
	2,000 to 10,000 DWT	0-20*
Tanker	200,000 DWT and Above	15
	20,000 to 200,000 DWT	20
	4,000 to 20,000 DWT	0-20*
Container	200,000 DWT and above	50
	120,000 to 200,000 DWT	45
	80,000 to 120,000 DWT	35
	40,000 to 80,000 DWT	30
	15,000 to 40,000 DWT	20
	10,000 to 15,000 DWT	0-20*
LNG carrier	10,000 DWT and above	30

Ship type	a	b	c
Bulk carrier	961.79	DWT	0.477
Gas carrier	1120	DWT	0.456
Tanker	1218.8	DWT	0.488
Container ship	174.22	DWT	0.201
General cargo ship	107.48	DWT	0.216
Refrigerated cargo carrier	227.01	DWT	0.244
Combination carrier	1219	DWT	0.488
Ro-ro cargo ship (vehicle carrier)	$(DWT/GT)^{-0.7} \cdot 780.36$ where $DWT/GT<0.3$ 1812.63 where $DWT/GT \geq 0.3$	DWT	0.471
Ro-ro cargo ship	1405.15	DWT	0.498
Ro-ro passenger ship	752.16	DWT	0.381
LNG carrier	2253.7	DWT	0.474
Cruise passenger ship having non-conv. prop	170.84	GT	0.214

Required EEXI=EEDI(0)x {1-[Reduction Factor]/100}

Required Phase Zero 2013 $EEDI=a(DWT)^{-c}$



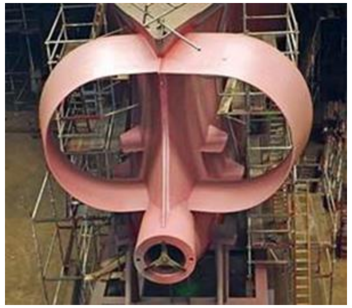
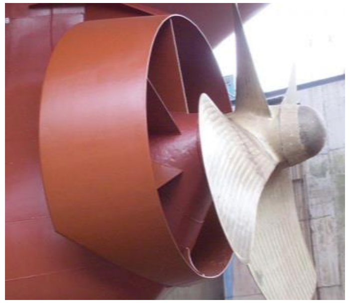
Attained EEXI
<
Required EEXI
EEXI Technical File
IEE Certificate
Check @ Annual
IMO NOx
TECHNICAL FILE
Model Test
& CFD
to certify P-v
Revised NOx
Technical
File
Class & Flag
Approval
Attained EEXI
>
Required EEXI
Limit MCR
ShaPoLi
Hull
Optimization
Engine
optimization
tuning
Energy Saving
Device
Change Fuel

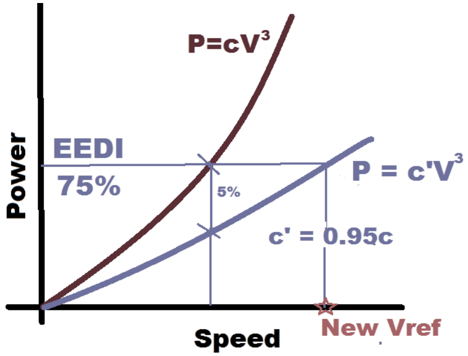
Seal of the mechanical stop screw

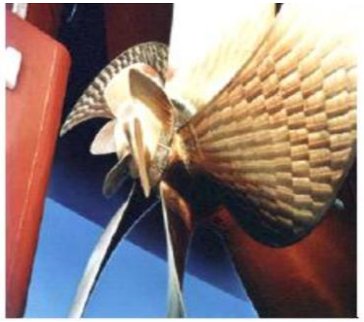

1984
WED (Schneekluth Duct)
0 % / 4 %

Energy saving devices

Improvement of reference speed
with Energy saving devices (easy retrofit)

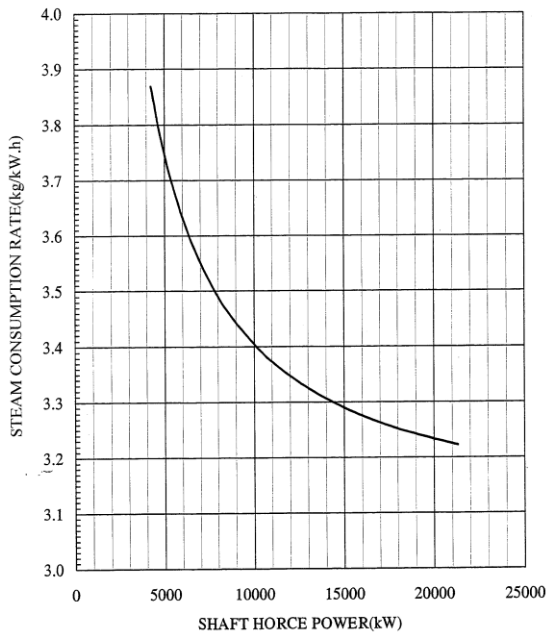


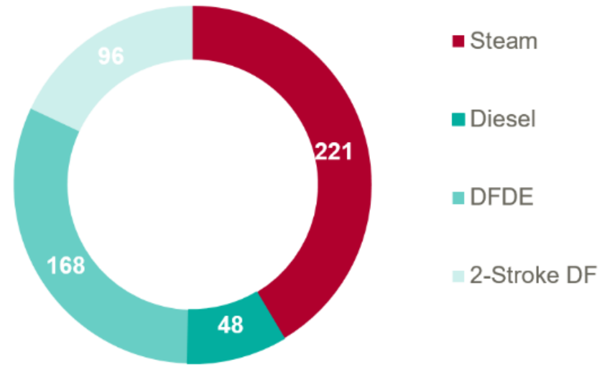
- CFD will be acceptable to document ship specific effect of ESD in EEXI Technical file
- For cases of small EEXI exceedance, ESD may be useful to replace or substantially reduce the EPL
- Larger gains may be achieved by more extensive hull/machinery modifications (e.g. bulbous bow modification, waste heat recover etc.)

The Steam turbine case

Steam Turbine and EEXI – The issues:

- Large margin of non-compliance due to low efficiency of the propulsion system
- Reduction of consumption due to power limitation may reach levels below the natural boil of rate. Regular steam dumping will be required.
- Gas used in steam dumping may not be counted for EEXI as it is a safety measure
- Reduction of service speed due to power limitation is significant
- More than 1/3rd of the world fleet will be operating at reduced speed and low efficiency levels

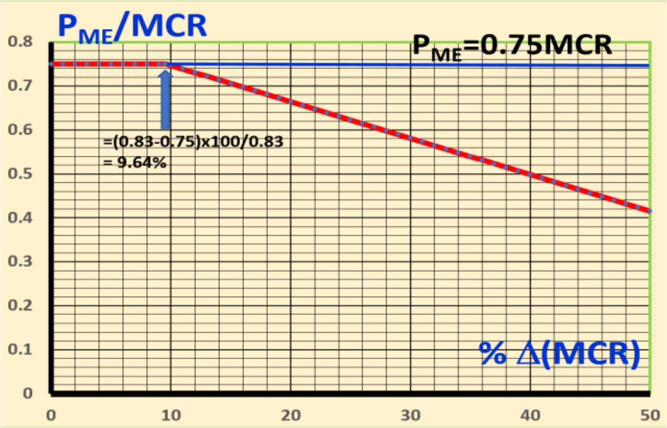


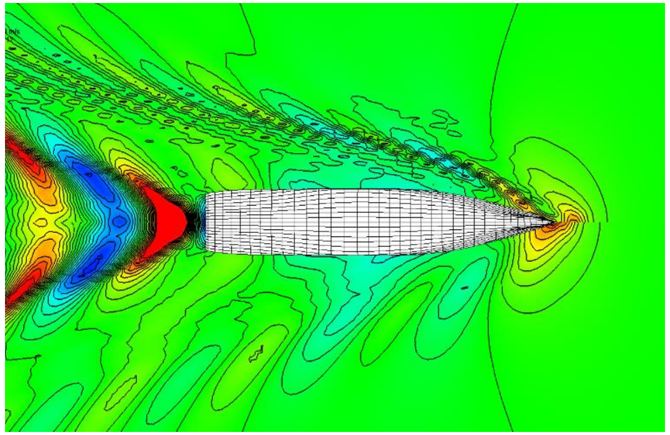


MEPC76 SHORT-TERM MEASURES

	EEXI	CII
01/11/2022 Come into force	**ONCE** For ships in service	**ANNUALY** For ships in service
01/01/2023 Come into effect	**>400GT**	**>5000GT**

EEXI KEY DECISIONS





- ✓ **Engine power in the EEXI calculation (PME) should be the lower of**
  - 83% of the maximum limited power (MCRlim)
  - 75% of maximum power (MCR)

P_{ME} =min {0.75MCR, 0.83MCR-Δ(MCR)}

- ✓ **Numerical calculations are accepted** as an alternative to tank tests when calculating the speed in the EEXI calculation (vref)
- ± **Additional options for calculating v_{ref}** using in-service speed measurements will be further discussed and may be included at a later stage.

- ✓ An **additional capacity correction factor for ro-ro cargo ships** (vehicle carrier) was agreed.

CII FORMULA
OPERATIONAL CARBON INTENSITY

Actual annual CO_2 Emissions

$$CII = f\frac{CO2\ Emissions}{CapacityxDistance}$$

Actual annual Transport work

Possible CIIs:

MEPC76 expected outcome: AER most probable CII due to high variability of EEOI and compatibility with IMO DCS

$$AER = \frac{\sum CO_2}{DWT_{max} \times Distance}$$

Supply Based

$$EEOI = \frac{\sum CO_2}{Cargo_{actual} \times Distance}$$

Demand Based

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MEPC76 KEY DECISIONS

CII REFERENCE LINES $CII_{ref} = aCapacity^{-c}$

- ✓ **CII reference lines: no changes vs CG and ISWG GHG 8**

Ship type		Capacity	a	c
Bulk carrier		DWT*	4977	0.626
Gas carrier	65,000 and above	DWT	2384E7	1.910
	less than 65,000 DWT	DWT	8032	0.638
Tanker		DWT	5118	0.607
Container ship		DWT	1963	0.487
General cargo ship	20,000 DWT and above	DWT	61293	0.854
	less than 20,000 DWT	DWT	361	0.336
Refrigerated cargo carrier		DWT	6736	0.599
Combination carrier		DWT	151991	0.930
LNG carrier	100,000 DWT and above	DWT	9.860	0
	less than 100,000 DWT	DWT**	1966E10	2.498
Ro-ro cargo ship (vehicle carrier)		GT	5831	0.633
Ro-ro cargo ship		DWT	15958	0.677
Ro-ro passenger ship		GT	7691	0.586
Cruise passenger ship		GT	904	0.380

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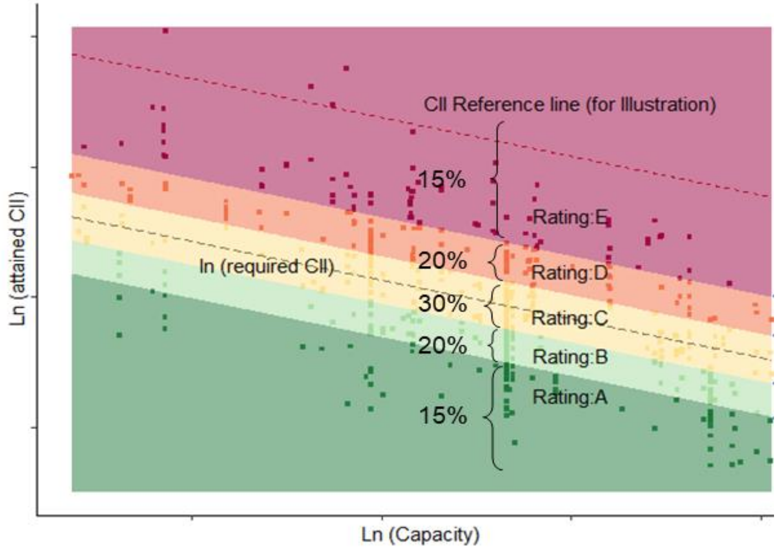
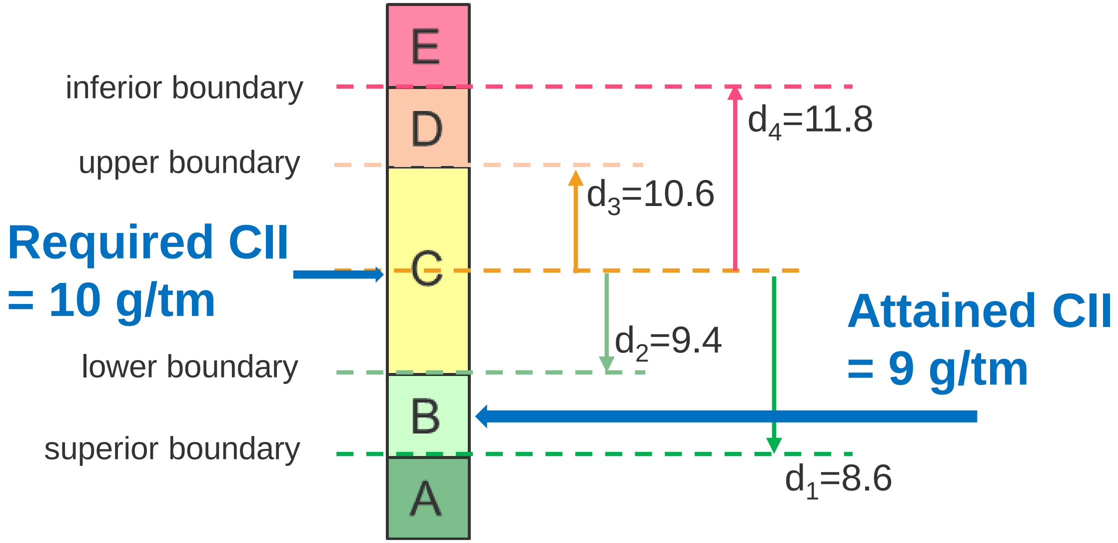
CII RATING METHODS
PRINCIPLES AND EXAMPLE ILLUSTRATION

Principles



- Symmetry in C rated vessels
- D rated vessels occupy wider limits than B rated vessels
- Differences amplified in the smaller vessels
- The distribution is skewed towards the C, D & E rated ships

Worked example for "B" bulk carriers:



$\exp(d_1)$	$\exp(d_2)$	$\exp(d_3)$	$\exp(d_4)$
0.86	0.94	1.06	1.18

MEPC76 KEY DECISIONS
CII ANNUAL REDUCTION FACTOR

New Reduction Factors

Year	Annual CII Reduction
2020	1.00%
2021	1.00%
2022	1.00%
2023	2.00%
2024	2.00%
2025	2.00%
2026	2.00%
2027	?
2028	?
2029	?
2030	?

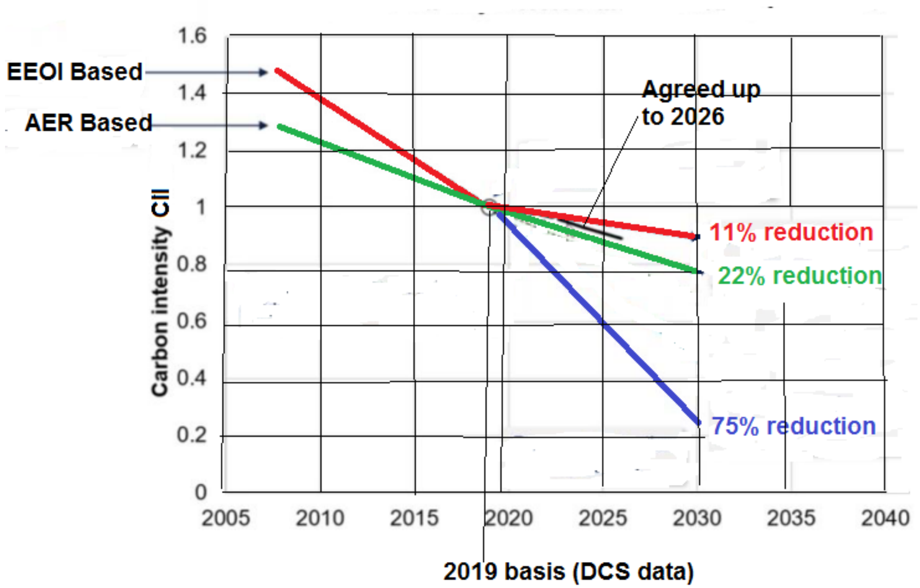
The CII reduction rates were set to increase by 1 percentage point (pp) per year for 2020–2022 (BAU), followed by 2 pp per year for 2023–2026.

Last phase will be further strengthened and developed taking into account the review of the short-term measure by January 1st 2026.

End of Year	Total CII Reduction vs 2019
2023	5.00%
2024	7.00%
2025	9.00%
2026	11.00%
2027-2030	?

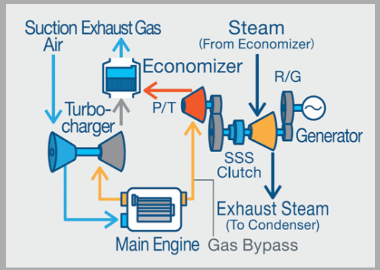
Amendment implies that from 2019 to 2026 ships must reduce their greenhouse gas emissions by a total of 11%.

Comparison with previous scenarios



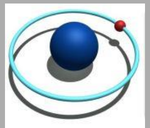
MEPC76 agreed-up scenario
Demand-Based scenario
Supply-Based scenario
Scenario for temperature rise 1.5°C

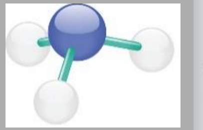
HOW TO IMPROVE CII

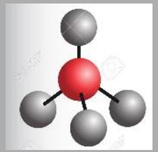


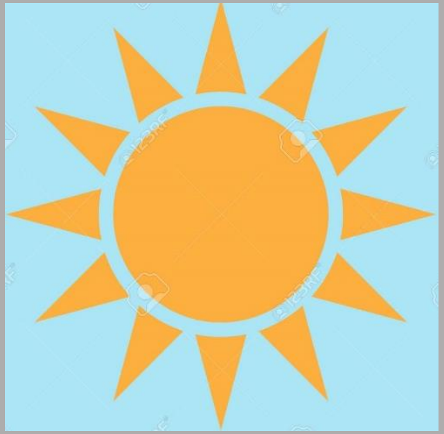
Waste Heat Recovery System

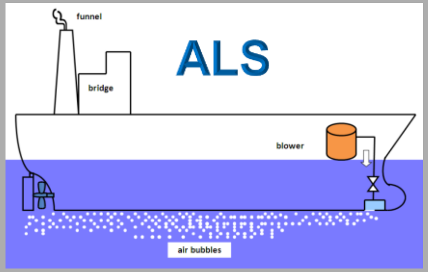
Alternative Fuels



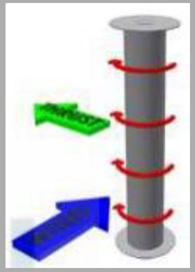






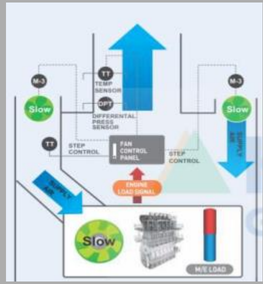


WAPS



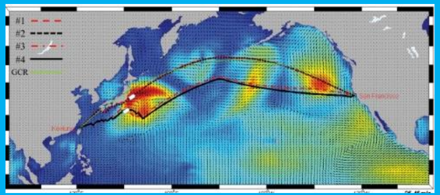
ESD

VFD Control



DESIGN

Improved logistics



Weather routing

Hull cleaning/coating

LED Lighting

OPERATIONS

- Several Solutions exist
- Both design and operational
- Some are easy to apply good practices
- For retrofit decisions, vessel and operational profile needs to be carefully evaluated to confirm suitability and establish CAPEX and ROI
- Alternative fuels will ultimately be needed

ENHANCED SEEMP

± **The draft SEEMP guidelines were not finalized due to time constraints and were sent to a Correspondence Group for further work and adoption at MEPC 78 in 2022 at the latest.**

- From 1 January 2023, evidence of carbon intensity reduction must be recorded in a new section of the vessel's existing Management System for Carbon Intensity (SEEMP)
- On or before January 1st 2023, ships of 5,000 gt and above will need to revise their SEEMP to include

  A. Description of the methodology to calculate attained CII and process of reporting value to Administration

  B. Required annual CII for the next three years

  C. An implementation plan on how the Required CII will be achieved during the next three years

  D. A procedure for self-evaluation and improvement

- ENGINE/PROPELLER OPTIMIZATION
- WEATHER ROUTING
- SPEED OPTIMIZATION
- HULL COATINGS
- VOYAGE LOGISTICS

ALTERNATIVE FUEL

$$AER\ (or\ cgDIST) = \frac{Fuel\ consumed\ x\ emission\ factor}{Capacity\ x\ Distance\ traveled}$$

INCREASE DWT OR GT

INCREASE COMMERCIAL UTILIZATION

Thank you for your attention

IMO

SEPTEMBER 2021:ISWG GHG 9

OCTOBER 2021:ISWG GHG 10

NOVEMBER 2021:MEPC 77

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