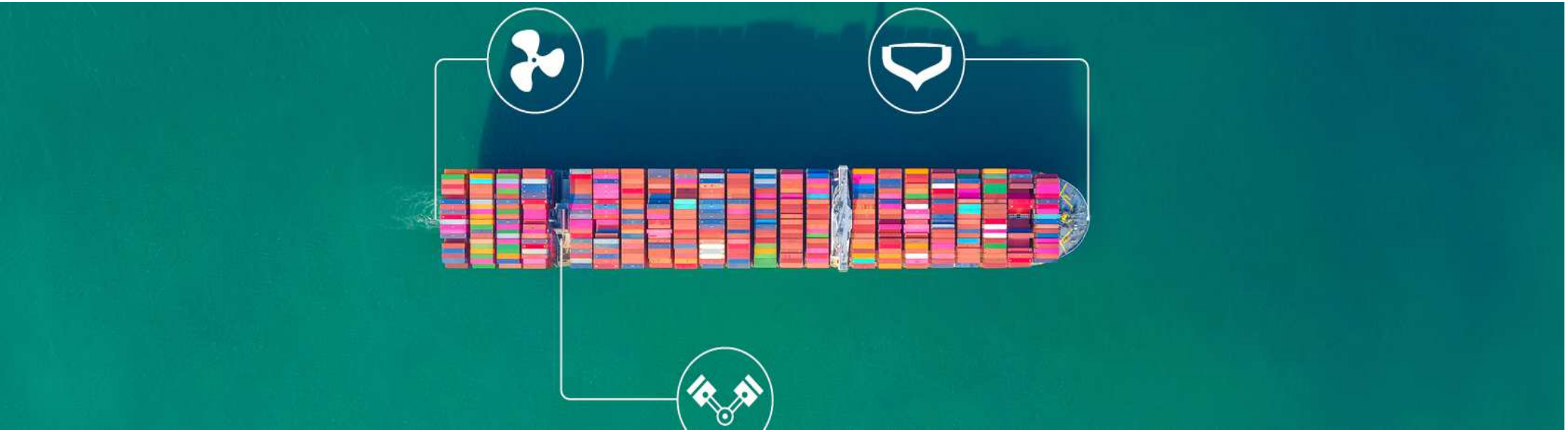

Energy Efficiency Existing Ship Index

EEXI – what you need to know

20 January 2021

The webinar presenters on EEXI

Fabian Kock

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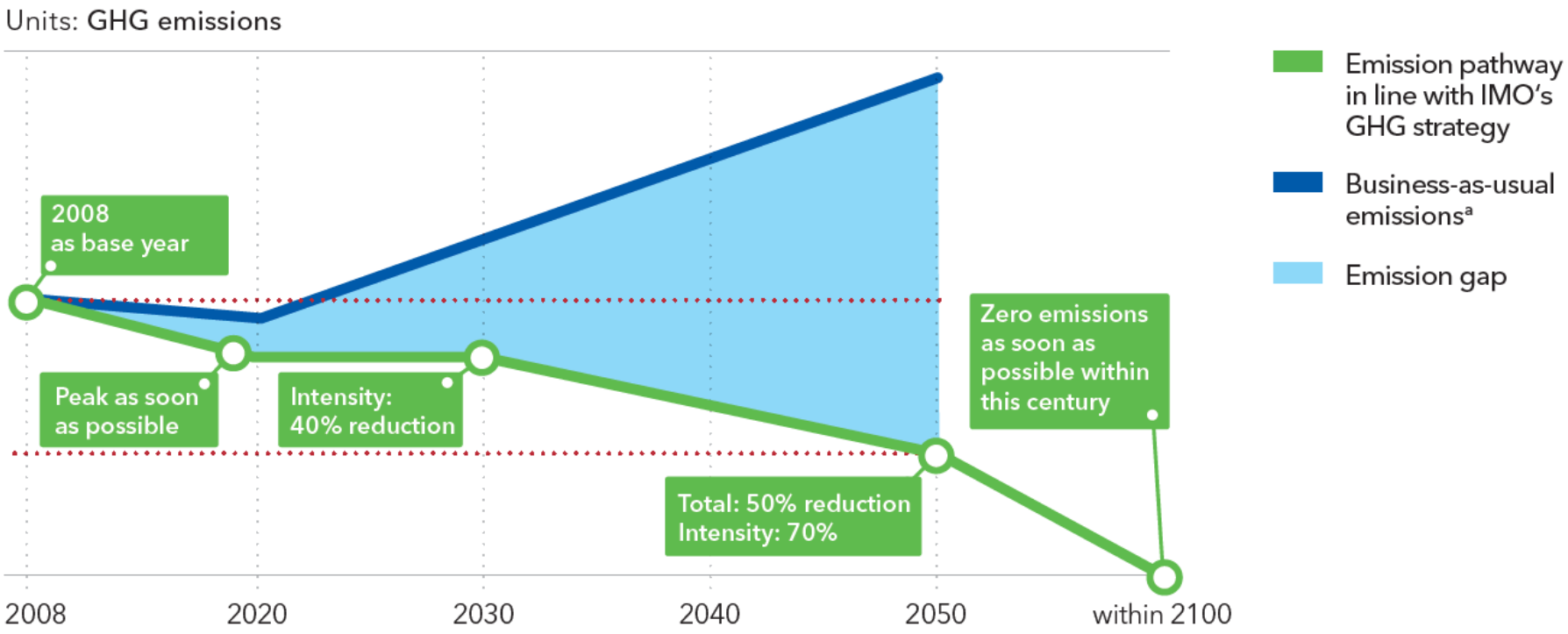
Webinar host

AGENDA

- **Statutory view on EEXI and future certification**
- EEXI explained
- EEXI compliance process - support by DNV GL

IMO strategy on GHG reductions – vision and ambitions



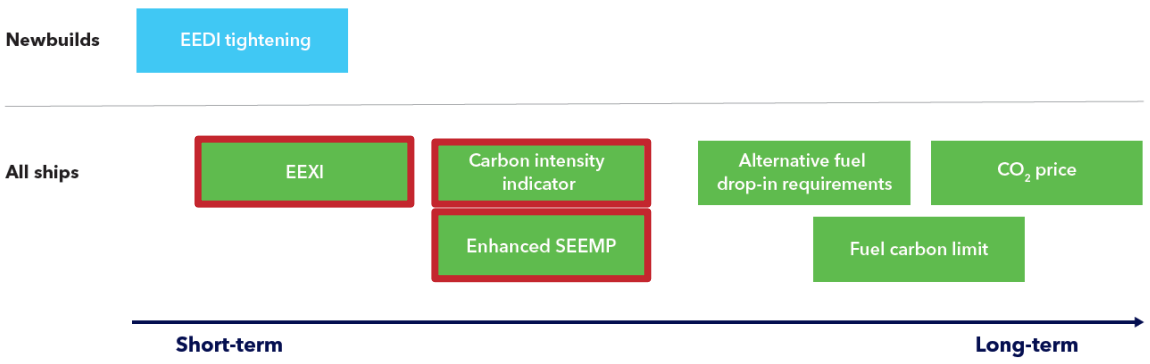
Total: Refers to the absolute amount of GHG emissions from international shipping.
Intensity: Carbon dioxide (CO_2) emitted per tonne-mile.
[a] Note that the the business-as-usual emissions are illustrative, and not consistent with the emissions baseline used in our modelling (Chapter 6).

Outcome of MEPC 75 (November 2020): New short-term measures for GHG

Two new short-term measures have been introduced for all ships (NB and ships in operation):

1. **Energy Efficiency Existing Ship Index (EEXI)**
2. **Operational carbon intensity reduction requirements, based on a new operational Carbon Intensity Indicator (CII)**

Indicative timeline for developing and implementing possible global policy measures - the list of measures is not exhaustive.



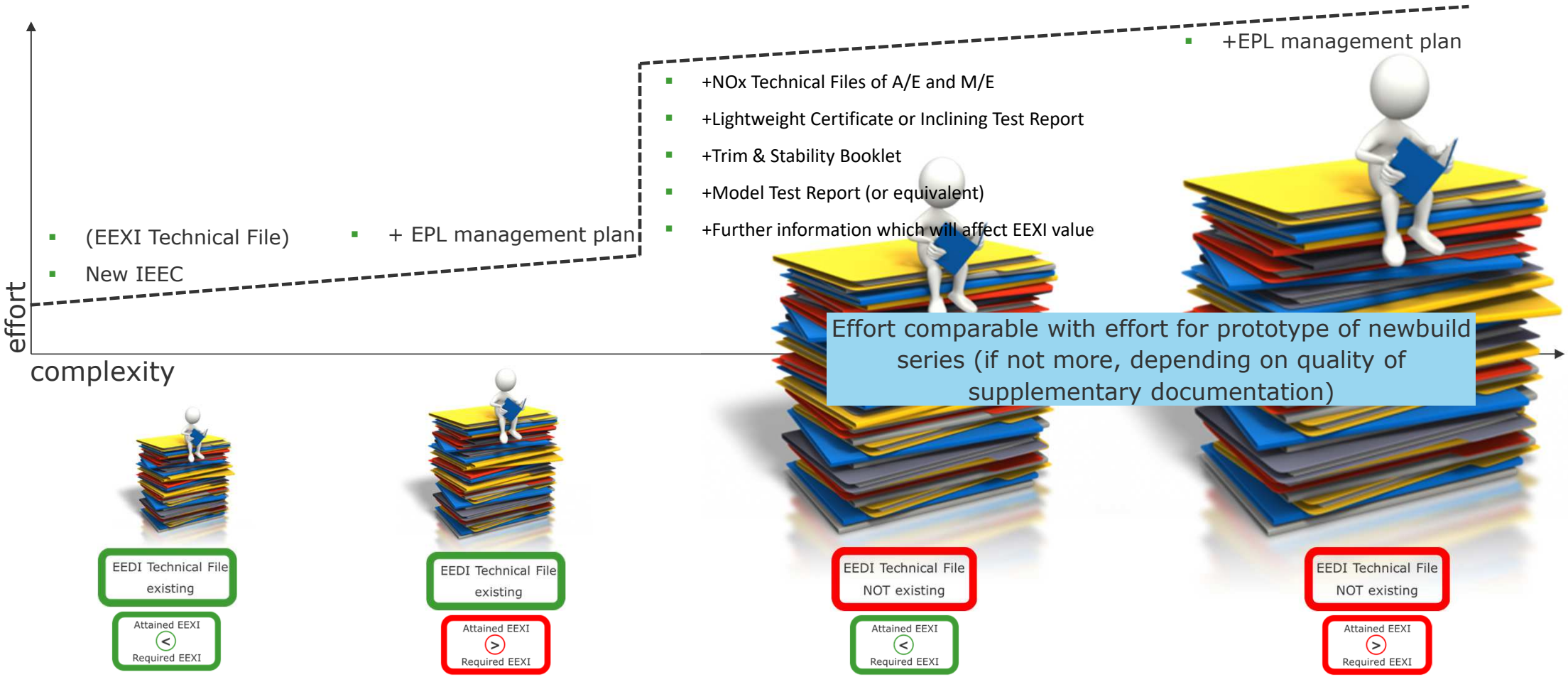
EEDI: Energy Efficiency Design Index
EEXI: Energy Efficiency Design Index for Existing Ships
SEEMP: Ship Energy Efficiency Management Plan

Mandatory for each vessel from 2023:

Compliant EEXI value & EEXI Technical File to be approved by class
Classification Survey (first annual survey) – new IEEC certificate

	EEXI	CII
Limits/reduction rates	Agreed	Work in progress
Calculation guidelines	Work in progress	Work in progress

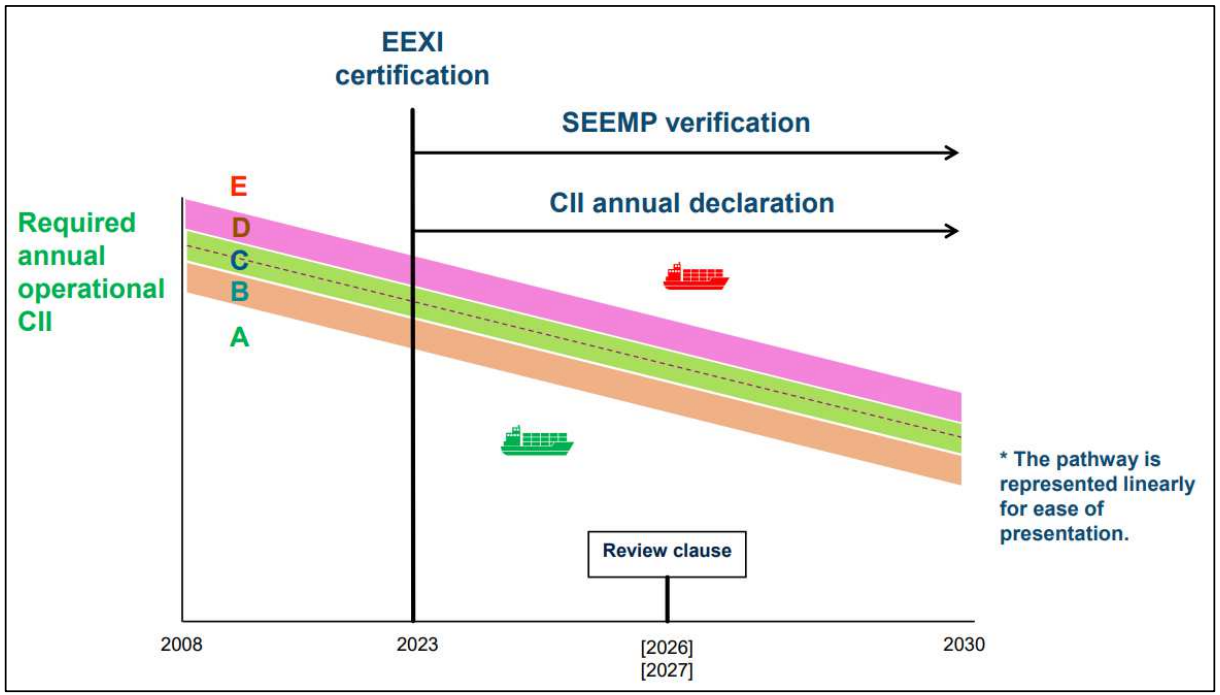
EEXI: Effort for approval/survey depends on status of vessel



Pending adoption by MEPC 76 in Jun1

Operational measure: Enhanced SEEMP

- Mandatory elements added to the SEEMP
  - Measuring a **Carbon Intensity Indicator (CII)** (e.g. EEOI, AER)
  - Setting a **mandatory CII target** in line with IMO ambitions
- Operational: Enhanced SEEMP with mandatory CII rating scheme (A-E)



- Ships must document the CII and at verification audits prove that they are **compliant with reduction trajectory** towards ~40% in 2030
- Application scope & handling of **inferior ships** to be resolved
- **Technical guidelines** to be developed – these include definitions, the ship specific reduction rates and calculation guidelines

AGENDA

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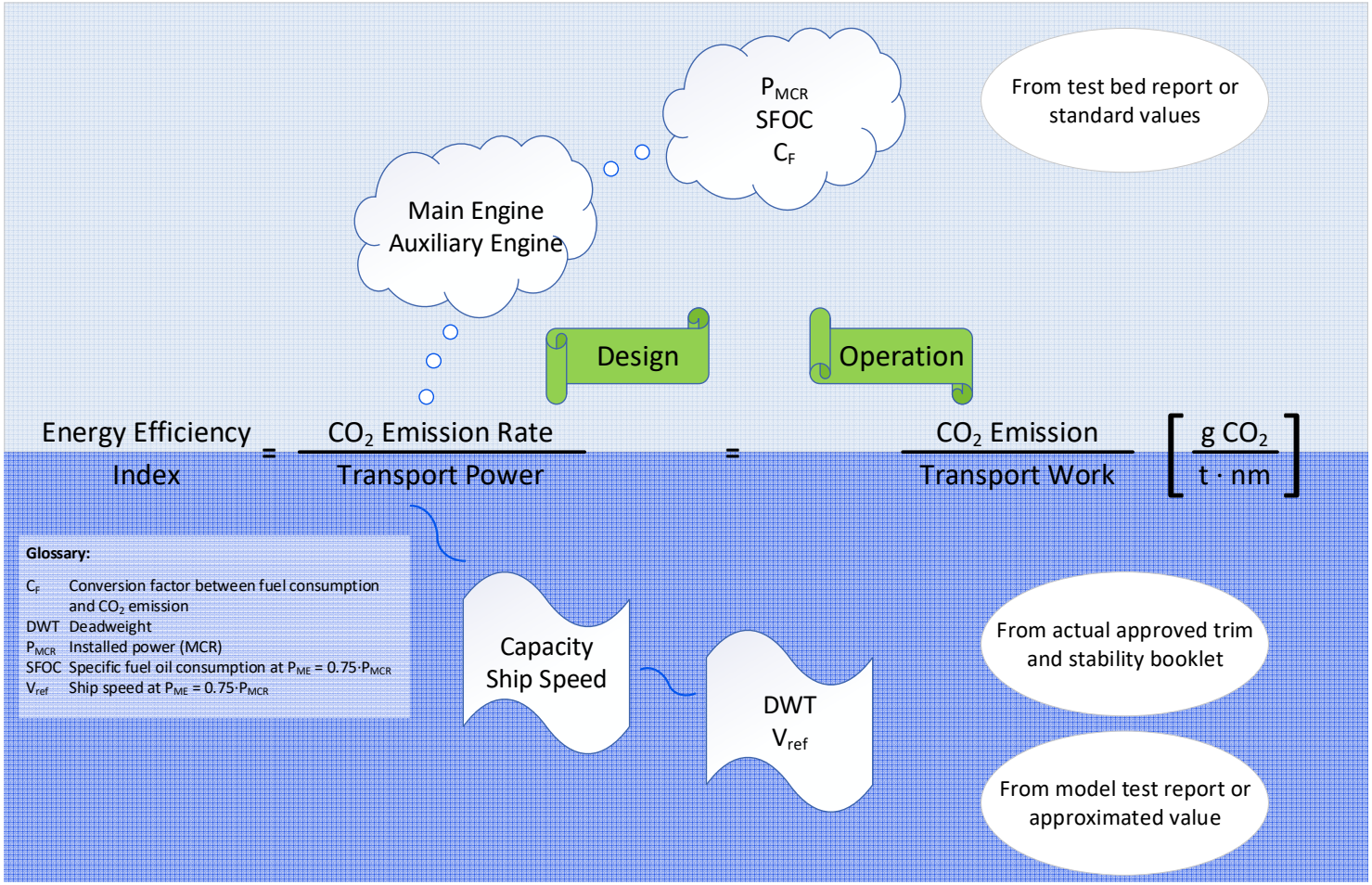
- **EEXI explained**
- EEXI compliance process - support by DNV GL

Basic concept of EEXI



Complex final EEXI formula

The **attained Energy Efficiency Existing Ship Index (EEXI)** is a measure of ship's energy efficiency (g/t*nm) and calculated by the following formula:

$$\frac{\left(\prod_{j=1}^{n} f_j\right)\left(\sum_{i=1}^{nME} P_{ME(i)} \cdot C_{FME(i)} \cdot SFC_{ME(i)}\right) + \left(P_{AE} \cdot C_{FAE} \cdot SFC_{AE}*\right) + \left(\left(\prod_{j=1}^{n} f_j \cdot \sum_{i=1}^{nPTI} P_{PTI(i)} - \sum_{i=1}^{neff} f_{eff(i)} \cdot P_{AEeff(i)}\right) C_{FAE} \cdot SFC_{AE}\right) - \left(\sum_{i=1}^{neff} f_{eff(i)} \cdot P_{eff(i)} \cdot C_{FME} \cdot SFC_{ME}**\right)}{f_i \cdot f_c \cdot f_l \cdot Capacity \cdot f_w \cdot V_{ref} \cdot f_m}$$

- Main engine part
- Auxiliary engine part
- Shaft motor
- Innovative energy efficiency technology for reduction of main engine power
- Innovative energy efficiency technology for reduction of auxiliary engine power
- Ship-type specific correction factors

Bulk carrier

- Correction for Common Structure Rules (implemented in 2006)
- Minimum propulsion power requirement for operation in adverse weather conditions
- Cubic capacity correction for bulk carriers designed to carry light cargoes
- Strictest (lowest) required EEXI curve of all ship types

Ship Type	Size	Reduction factor
Bulk carrier	DWT ≥ 200,000	15
	20,000 ≤ DWT < 200,000	20
	10,000 ≤ DWT < 20,000	0 - 20

Tanker

- Correction for Common Structure Rules (implemented in 2006)
- Minimum propulsion power requirement for operation in adverse weather conditions
- Partly shaft motor or shaft generator to be considered
- Shuttle tanker with DP and redundancy

Ship Type	Size	Reduction factor
Tanker	DWT ≥ 200,000	15
	20,000 ≤ DWT < 200,000	20
	4,000 ≤ DWT < 20,000	0 - 20

Containership

- Draft for EEXI conditions corresponds to 70% DWT
- Challenge to determine reference speed V_{ref}
- Partly shaft generator to be considered

Ship Type	Size	Reduction factor
Containership	DWT ≥ 200,000	50
	120,000 ≤ DWT < 200,000	45
	80,000 ≤ DWT < 120,000	35
	40,000 ≤ DWT < 80,000	30
	15,000 ≤ DWT < 40,000	20
	10,000 ≤ DWT < 15,000	0 - 20

General cargo ship

- Large variation around reference line
- Different designs (e.g. design speed, ballast tank volume) with different purposes
- Correction factor f_j dependent on ship dimensions and Froude number (ship speed)
- Correction factor f_l to consider cranes
- Partly shaft generator to be considered

Ship Type	Size	Reduction factor
General cargo ship	DWT ≥ 15,000	30
	3,000 ≤ DWT < 15,000	0 - 30

Gas carrier

- As for all other ship types correction for ice-classed ships to be considered
- Correction for power and capacity as well for ice-classed ships
- Additional correction factor for ice-classed ships having IA Super and IA giving another 5% improvement
- Last update of EEDI calculation guideline for ice-class in 2019

Ship Type	Size	Reduction factor
Gas carrier	DWT ≥ 15,000	30
	10,000 ≤ DWT < 15,000	20
	2,000 ≤ DWT < 10,000	0 - 20

LNG carrier

- Conventional and non-conventional propulsion
- Steam and gas turbine ships with high specific fuel oil consumption
- Boil-off gas to be considered
- Additional auxiliary power need for reliquefaction system to be considered
- Reference line for LNG carrier defined in 2014
- Before considered as gas carrier (only conventional propulsion) with correction factor

Ship Type	Size	Reduction factor
LNG carrier	DWT ≥ 10,000	30

Ro-ro passenger ship

- Correction factor f_j dependent on ship dimensions and Froude number (ship speed)
- This correction factor might prevent improvement by limitation of engine power
- Cubic capacity correction factor f_c dependent on DWT/GT ratio
- Additional hotel load to be considered (Electric power table)

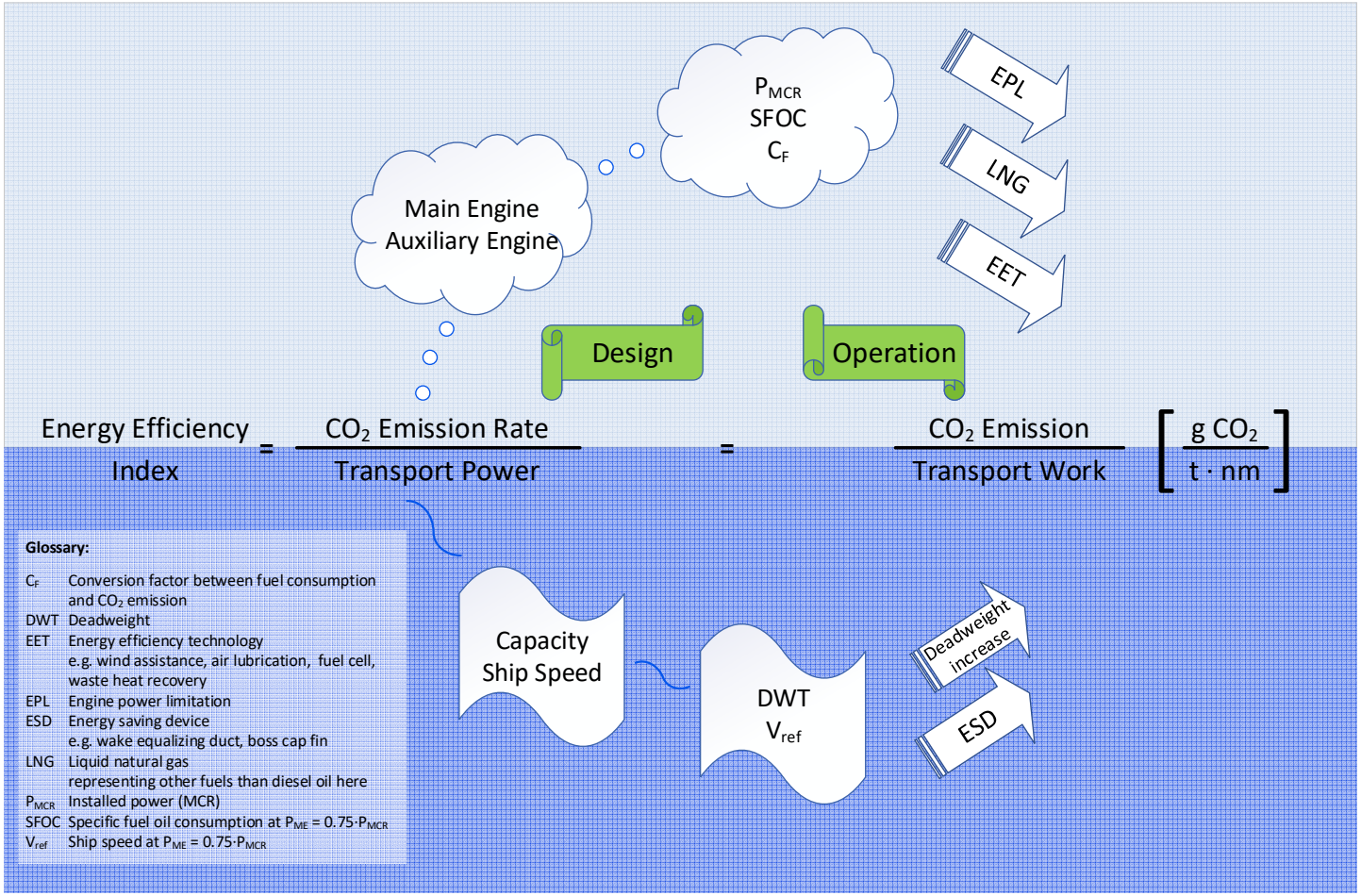
Ship Type	Size	Reduction factor
Ro-ro passenger ship	DWT ≥ 1,000	5
	250 ≤ DWT < 1,000	0 - 5

Cruise passenger ship

- Capacity dependent on GT
- Only non-conventional propulsion (diesel-electric propulsion, electric motors with shaft lines, PODs)
- Efficiencies of generators and electric motors to be considered
- Additional hotel load to be considered (Electric power table)

Ship Type	Size	Reduction factor
Cruise passenger ship having non-conventional propulsion	GT ≥ 85,000	30
	25,000 ≤ GT < 85,000	0 - 30

Different options to improve EEXI



Potential of different improvement measures

Description	Power limitation [% rel. to MCR]	Ship speed loss [% rel. to V_S]	EEXI Improvement [%]
Engine power limitation	up to 50	~21	~37
Description	**SFOC Improvement [%]**	**Different C_F [%]**	**EEXI Improvement [%]**
Fuel change from MDO to LNG	10	15	25
Description	**Power reduction [% rel. to P_{ME}]**	**Ship speed reduction [% rel. V_{ref}]**	**EEXI Improvement [%]**
Rotor sails (2 units) on Long Range 2 tanker	4		3.8
Installation of shaft generator	6	1.7	5.6
Combination of both installations	10	1.7	9.5
Description	**DWT increase [%]**	**att. EEXI gain [%]**	**EEXI Improvement [%]**
Deadweight increase	5	3.7	1.5
	10	7.1	3.0
Description	**Power reduction [% rel. to P_{ME}]**	**Ship speed increase [% rel. V_{ref}]**	**EEXI Improvement [%]**
Energy saving device (e.g. PBCF, duct)	1	0.3	0.3
	4	1.4	1.3
	7	2.4	2.3
	10	3.5	3.3

Conclusions

- **Recommendation:** If ship does not comply with required EEXI
  → consider engine power limitation
  → if speed drop with limited power not acceptable
  → check energy efficiency technologies

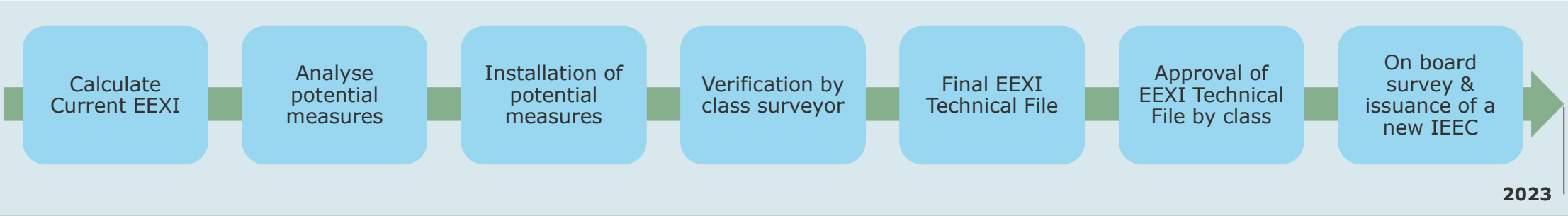
- **Limitation:** Engine optimization (e.g. variation of fuel injection time and pressure, change of fuel valves) not considered in EEXI calculation (test bed values)
  Restrictions to keep NOx Technical File valid

- **Outlook:** From regulatory side there is the urgent need to review the consideration of energy efficiency technologies (planned to start in summer 2021)

AGENDA

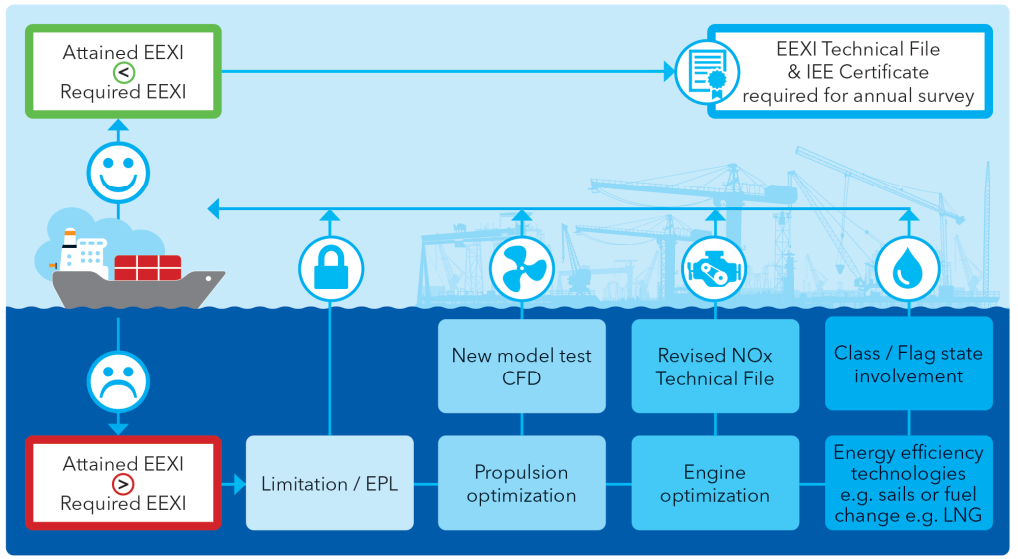
- Statutory view on EEXI and future certification
- EEXI explained
- **EEXI compliance process - support by DNV GL**

EEXI compliance process (simplified)



Summary - EEXI in a nutshell:

- It's a new statutory requirement
- All cargo and cruise ships above size thresholds on first annual survey after 1 January 2023 (vessel types according to MARPOL ANNEX VI Reg. 2)
- EEXI as a goal based measure, different improvement options possible
- EEXI Technical File has to be submitted to class for approval
- Formular could be become complex depending on vessel type and technologies installed on board



EEXI compliance process (simplified)

Calculate current EEXI → Analyse potential measures → Installation of potential measures → Verification by class surveyor → Final EEXI Technical File → Approval of EEXI Technical File by class → On board survey & issuance of a new IEEC

2023

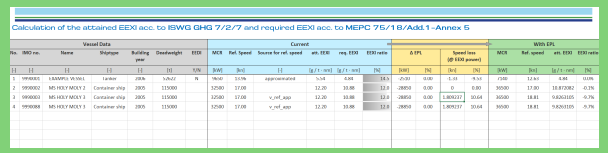
Actions required:

- EEXI calculation guideline will be introduced at MEPC. 76
- EEXI calculation –draft- guideline ISWG GHG 7-2-7
- Ref. is made to EEDI calculation guideline MEPC.308(73)
- **Collect all documentation needed e.g.**
  - NOx Technical Files of A/E and M/E
  - Lightweight Certificate or Inclining Test Report
  - Trim & Stability Booklet
  - Model Test Report
  - Speed test from Sea Trial Report
  - EEDI Technical File (if available)

$$\frac{\left(\prod_{j=1}^{n} f_j\right)\left(\sum_{i=1}^{nME} P_{ME(i)} \cdot C_{FME(i)} \cdot SFC_{ME(i)}\right) + \left(P_{AE} \cdot C_{FAE} \cdot SFC_{AE}\,*\right) + \left(\left(\prod_{j=1}^{n} f_j \cdot \sum_{i=1}^{nPTI} P_{PTI(i)} - \sum_{i=1}^{neff} f_{eff(i)} \cdot P_{AEeff(i)}\right) C_{FAE} \cdot SFC_{AE}\right) - \left(\sum_{i=1}^{neff} f_{eff(i)} \cdot P_{eff(i)} \cdot C_{FME} \cdot SFC_{ME}\,**\right)}{f_i \cdot f_c \cdot f_i \cdot Capacity \cdot f_w \cdot V_{ref} \cdot f_m}$$

How can DNV GL Maritime Advisory support?

- Guidance on EEXI calculation
- Calculation of the attained EEXI based on vessels' particulars as per draft guidelines on method of calculation of the attained EEXI (ISWG-GHG 7/2/7).
- Calculation of the required EEXI based on vessel type and size according to amendments to MARPOL Annex VI, Regulations 19-21 as accepted by MEPC 75 but still to be adopted by MEPC 76 in June 2021.
- EEXI calculation for the complete fleet – independent from class society


Calculation of the attained EEXI acc. to ISWG GHG 7/2/7 and required EEXI acc. to MEPC 75/18/Add.1-Annex 5

Vessel Data								Current												With EPL			
No.	IMO no.	Name	Shiptype	Building year	Deadweight	EEDI		MCR	Ref. Speed	Source for ref. speed	att. EEDI	req. EEDI	EEXI ratio	Δ EPL		Speed loss (@ 15% power)		MCR	Ref. speed	att. EEXI	EEXI ratio
[-]	[-]	[-]	[-]	[-]	[t]	Y/N		[kW]	[kn]	[-]	[g / t · nm]	[g / t · nm]	[%]	[kW]	[%]	[kn]	[%]	[kW]	[kn]	[g / t · nm]	[%]
1	9998001	LIBAMPIS VIVIAL	Tanker	2006	149632	N		19640	15.96	approximated	5.548	8.84	18.5	25.00	0.00	1.43	9.10	25.00	12.60	8.84	0.0%
2	9998002	MS HOLY MOLY 2	Container ship	2005	115000			32500	17.00		12.20	10.88	12.0	280.00	0.00	0	0.00	300.00	17.00	10.87/2082	-0.1%
3	9998003	MS HOLY MOLY 3	Container ship	2005	115000			32500	17.00	v_ref_app	12.20	10.88	12.0	280.00	0.00	1.809237	10.64	300.00	18.81	9.82/63105	-0.7%
4	9998088	MS HOLY MOLY 3	Container ship	2005	115000			32500	17.00	v_ref_app	12.20	10.88	12.0	280.00	0.00	1.809237	10.64	300.00	18.81	9.82/63105	-0.7%

The way to EEXI compliance (simplified)

Calculate current EEXI → **Analyse potential measures** → Installation of potential measures → Verification by class surveyor → Final EEXI Technical File → Approval of EEXI Technical File by class → On board survey & issuance of a new IEEC

2023

Actions required:

Decide how to achieve the EEXI target based on your previous EEXI calculation:

- Propulsion optimizations (e.g., DUCT, rudder)
- Engine optimizations
- Energy efficiency technologies e.g., sail or fuel change
- Engine Power Limitation (EPL)

Attained EEXI > Required EEXI

Key Criteria:

- Time of installation
- Cost and payback time of improvement option
- Vessel age
- Speed Loss

How can DNV GL Maritime Advisory support?

- Assessment of options for individual ship to comply with EEXI requirements (retrofitting ESDs and review of existing hull forms)
- Comparison of different improvement solutions with respect to investments, future operation and planned service life
- Assessment of alternatives for fleet development
- In case of EPL -> speed loss can be calculated
- (preliminary Technical File for DNV GL clients)

The way to EEXI compliance (simplified)

Calculate current EEXI → Analyse potential measures → Installation of potential measures → Verification by class surveyor → Final EEXI Technical File → Approval of EEXI Technical File by class → On board survey & issuance of a new IEEC

2023

Actions required:

Retrofit

- Contact manufacturer
- Check your docking schedule for installation
- Sea trial acc. to ISO 15016
- Invite class for survey

Engine Power Limitation

- Contact engine manufacturer
- Manufacturer will calculate new SFoC and provide an EPL report
- Create an **EPL management plan** (according to guideline)
- Date for installation needs to be fixed
- Invite class for survey

Additional costs for OEMs, yard, survey have to considered!

The way to EEXI compliance (simplified)

Calculate current EEXI → Analyse potential measures → Installation of potential measures → Verification by class surveyor → **Final EEXI Technical File** → Approval of EEXI Technical File by class → On board survey & issuance of a new IEEC

2023

Actions required:

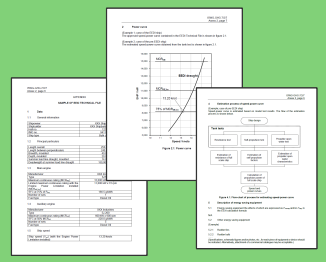
- EEXI calculation according to calculation guideline
- EEXI Technical file according to EEXI calculation guideline
- Collect all documentation from improvement measure and add to the EEXI Technical File
  (survey statement of EPL, survey statement of retrofit)

$$\frac{\left(\prod_{j=1}^{n} f_j\right)\left(\sum_{i=1}^{nME} P_{ME(i)} \cdot C_{FME(i)} \cdot SFC_{ME(i)}\right) + \left(P_{AE} \cdot C_{FAE} \cdot SFC_{AE}*\right) + \left(\left(\prod_{j=1}^{n} f_j \cdot \sum_{i=1}^{nPTI} P_{PTI(i)} - \sum_{i=1}^{neff} f_{eff(i)} \cdot P_{AEeff(i)}\right) C_{FAE} \cdot SFC_{AE}\right) - \left(\sum_{i=1}^{neff} f_{eff(i)} \cdot P_{eff(i)} \cdot C_{FME} \cdot SFC_{ME}**\right)}{f_i \cdot f_c \cdot f_l \cdot Capacity \cdot f_w \cdot V_{ref} \cdot f_m}$$

How can DNV GL´s maritime advisory support?

Guidance on:

- Calculate EEXI according to calculation guideline
- Establish EEXI Technical File for submission to the respective classification society



The way to EEXI compliance (simplified)

Calculate current EEXI → Analyse potential measures → Installation of potential measures → Verification by class surveyor → Final EEXI Technical File → **Approval of EEXI Technical File by class** → On board survey & issuance of a new IEEC

2023

Actions required:

- Submission of the vessel specific EEXI Technical File
- Approved EEXI Technical File to be on board after approval (wait till survey guideline will be published)

$$\frac{\left(\prod_{j=1}^{n} f_j\right)\left(\sum_{i=1}^{nME} P_{ME(i)} \cdot C_{FME(i)} \cdot SFC_{ME(i)}\right) + \left(P_{AE} \cdot C_{FAE} \cdot SFC_{AE}*\right) + \left(\left(\prod_{j=1}^{n} f_j \cdot \sum_{i=1}^{nPTI} P_{PTI(i)} - \sum_{i=1}^{neff} f_{eff(i)} \cdot P_{AEeff(i)}\right) C_{FAE} \cdot SFC_{AE}\right) - \left(\sum_{i=1}^{neff} f_{eff(i)} \cdot P_{eff(i)} \cdot C_{FME} \cdot SFC_{ME}**\right)}{f_i \cdot f_c \cdot f_l \cdot Capacity \cdot f_w \cdot V_{ref} \cdot f_m}$$

The way to EEXI compliance (simplified)

Calculate current EEXI → Analyse potential measures → Installation of potential measures → Verification by class surveyor → Final EEXI Technical File → Approval of EEXI Technical File by class → **On board survey & issuance of a new IEEC**

2023

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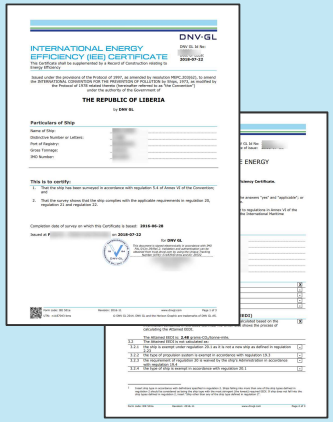
- Approval of the EEXI Technical File by the **Administration or the Recognized Organization**
- Applicable on **first annual, intermediate or renewal IAPP survey** or the **initial IEE survey** after 1 January 2023.
- New IEEC will be issued



The way to EEXI compliance (simplified)

Calculate current EEXI → Analyse potential measures → Installation of potential measures → Verification by class surveyor → Final EEXI Technical File → Approval of EEXI Technical File by class → On board survey & issuance of a new IEEC

2023

Get support by DNV GL´s maritime advisory

- **Global DNV GL´s maritime advisory network on experts**
- **Calculation and documentation support independent from classification**
- **No Approval of documents**

Contact:

eexi@dnvgl.com

DATE (for DNV GL customers only)

Regional DNV GL Point of Contact

www.dnvgl.com/eexi

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