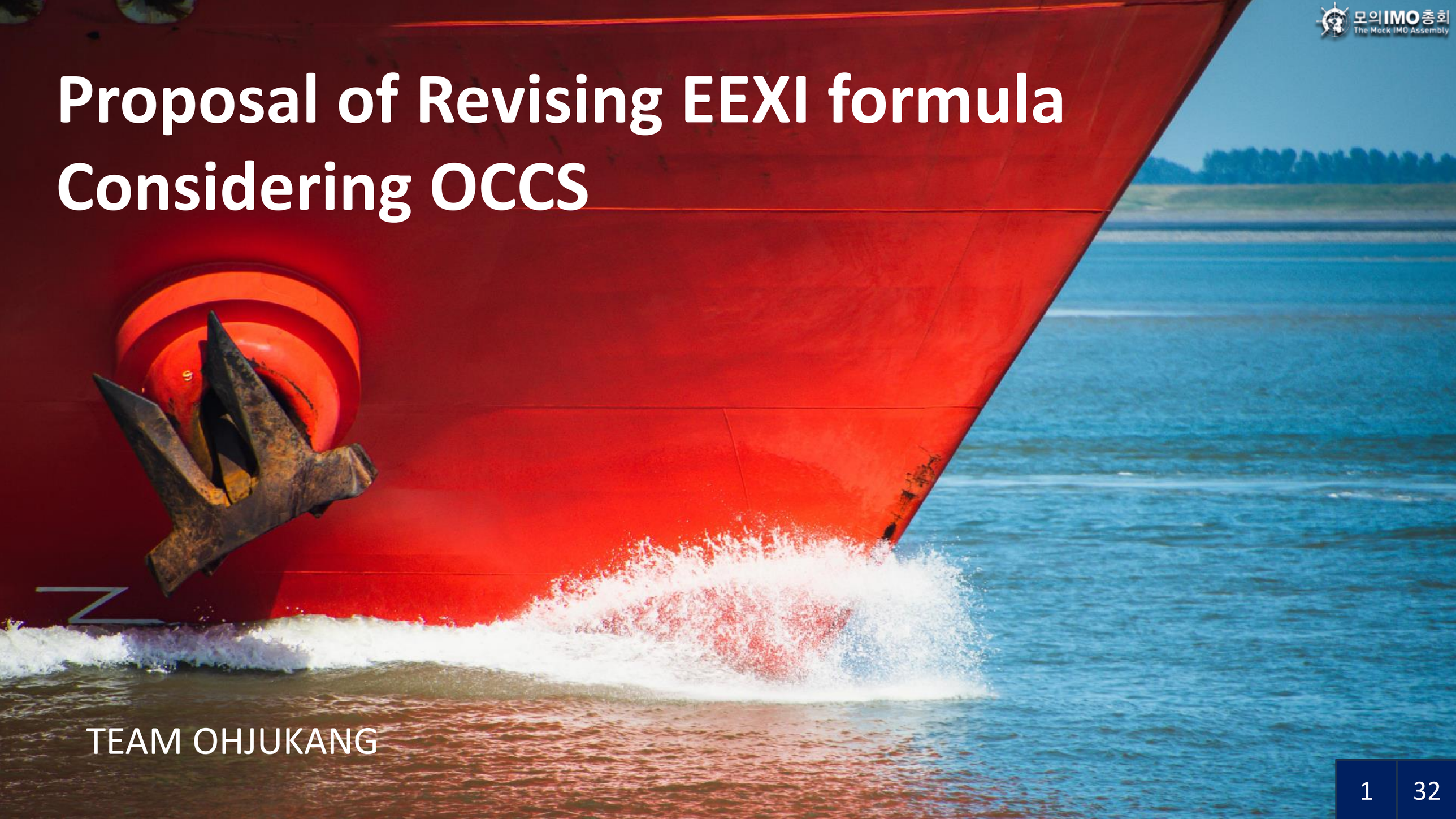
Proposal of Revising EEXI formula Considering OCCS



TEAM OHJUKANG

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1.Background
2.Problem
3.Solution
4.Conclusion

INTRODUCTION

INTERNATIONAL MARITIME ORGANIZATION

E

MARINE ENVIRONMENT PROTECTION COMMITTEE
80th session
Agenda item 7

MEPC 80/INF.39/Add.1
6 June 2023
ENGLISH ONLY
Pre-session public release: ☒

REDUCTION OF GHG EMISSIONS FROM SHIPS

Report of the ad-hoc Expert Workshop on comparative analysis of candidate mid-term GHG reduction measures

Preliminary expert review of the technical and economic elements, and their possible combinations, of the proposals for candidate mid-term GHG reduction measures

INTRODUCTION

Strategy direction

	2.23 (New)	Development of a goal-based instrument for maritime autonomous surface ships (MASS)	2025	MSC		
SD 3 Respond to climate change	3.1	Treatment of ozone-depleting substances used by ships	Annual	MEPC		
	3.2	Further development of mechanisms needed to achieve the reduction of GHG emissions from international shipping	Annual	MEPC		

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A.1149(32)
Annex, page 16

Reference to SD, if applicable	Output number	Description	Target completion year	Parent organ(s)	Associated organ(s)	Coordinating organ(s)
	3.3	Reduction of the impact on the Arctic of emissions of black carbon from international shipping	2023	MEPC	PPR	
	3.4	Promotion of technical cooperation and transfer of technology relating to the reduction of GHG emissions from ships	2023	MEPC		
	3.5	Revision of guidelines concerning Chapter 4 of MARPOL Annex VI	2023	MEPC		
	3.6	EEDI reviews required under regulation 21.6 of MARPOL Annex VI	2023	MEPC		

01. BACKGROUND

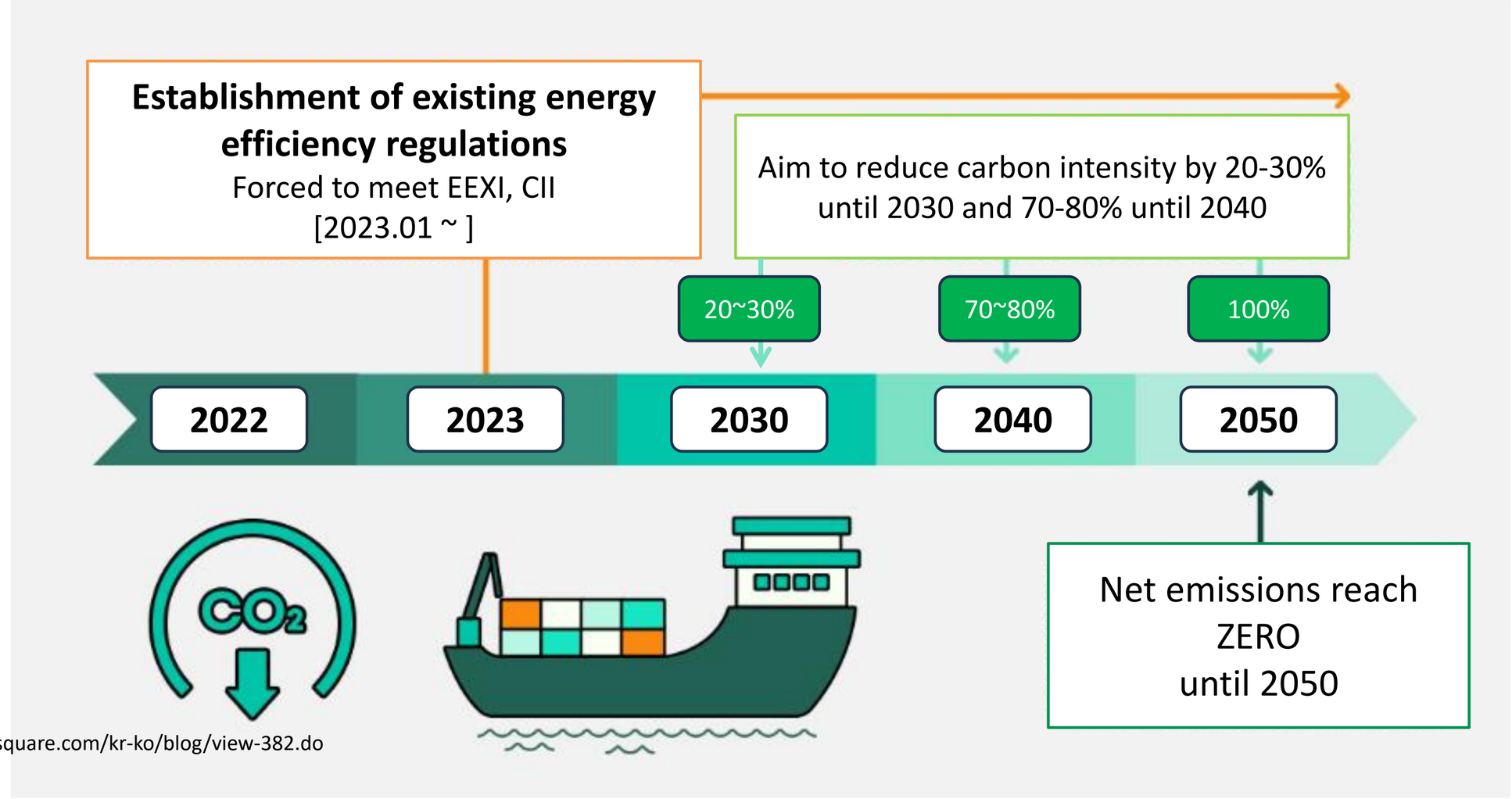
IMO GHG Strategy

EEXI Regulatory

Well to wake (LCA)

01. BACKGROUND

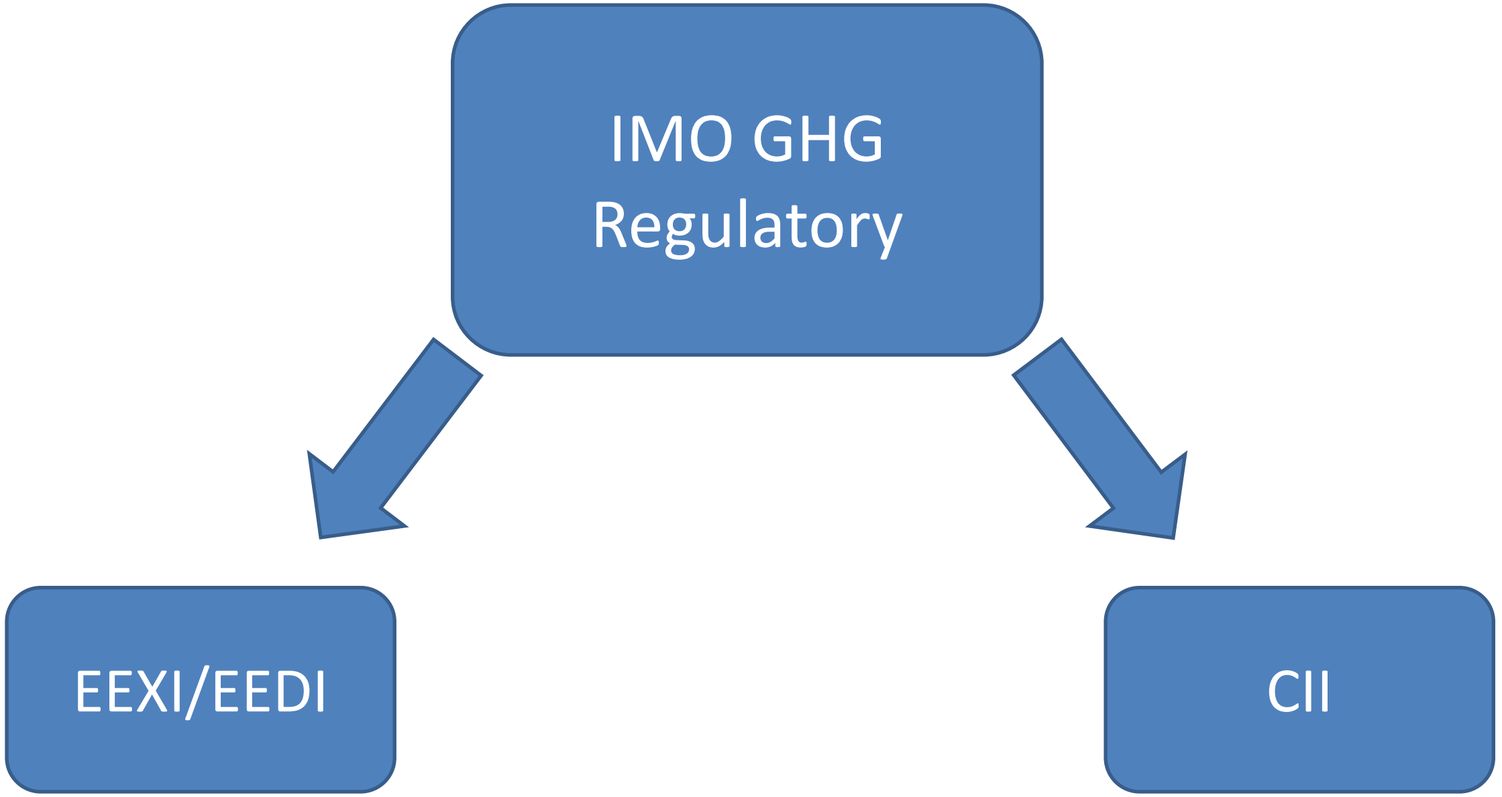
IMO GHG Regulatory



https://www.cello-square.com/kr-ko/blog/view-382.do

01. BACKGROUND

IMO GHG Regulatory



01. BACKGROUND

IMO GHG Regulatory

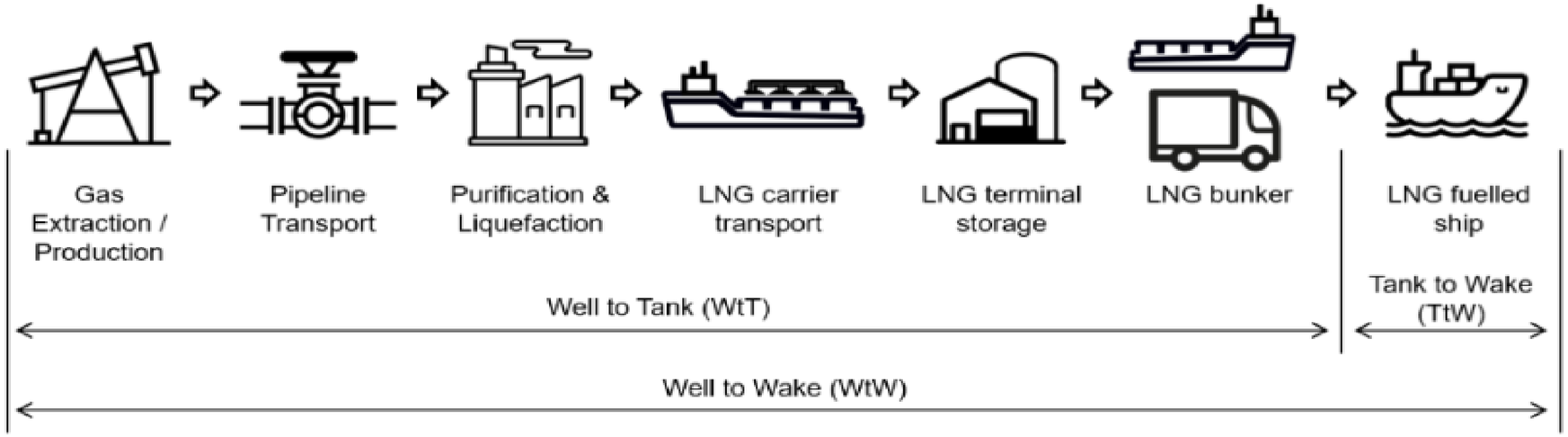
MEPC 80/WP.1/Rev.1
Page 48

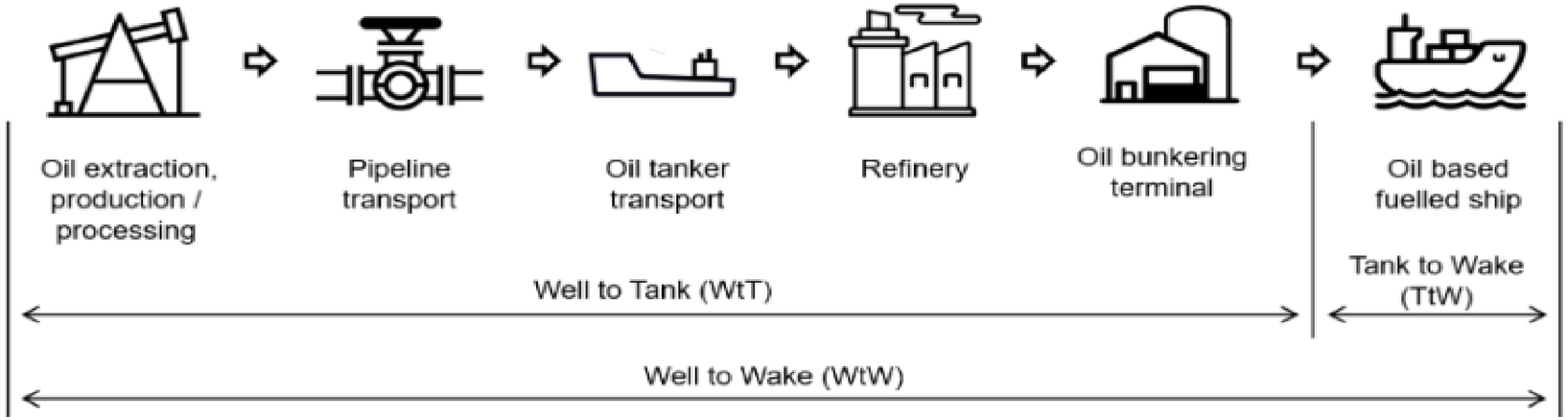
.2 outcome of ISWG-GHG 14 and ISWG-GHG 15, including the consideration of the revision of the IMO GHG Strategy, the development of the basket of mid-term measures and the life-cycle analysis (LCA) guidelines;

Even evaluates the fuel production process

01. BACKGROUND

What is LCA ?





https://www.mdpi.com/journal/jmse

01. BACKGROUND

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:

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

- 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

https://thefreemero.tistory.com/entry/EEXI-EEDI

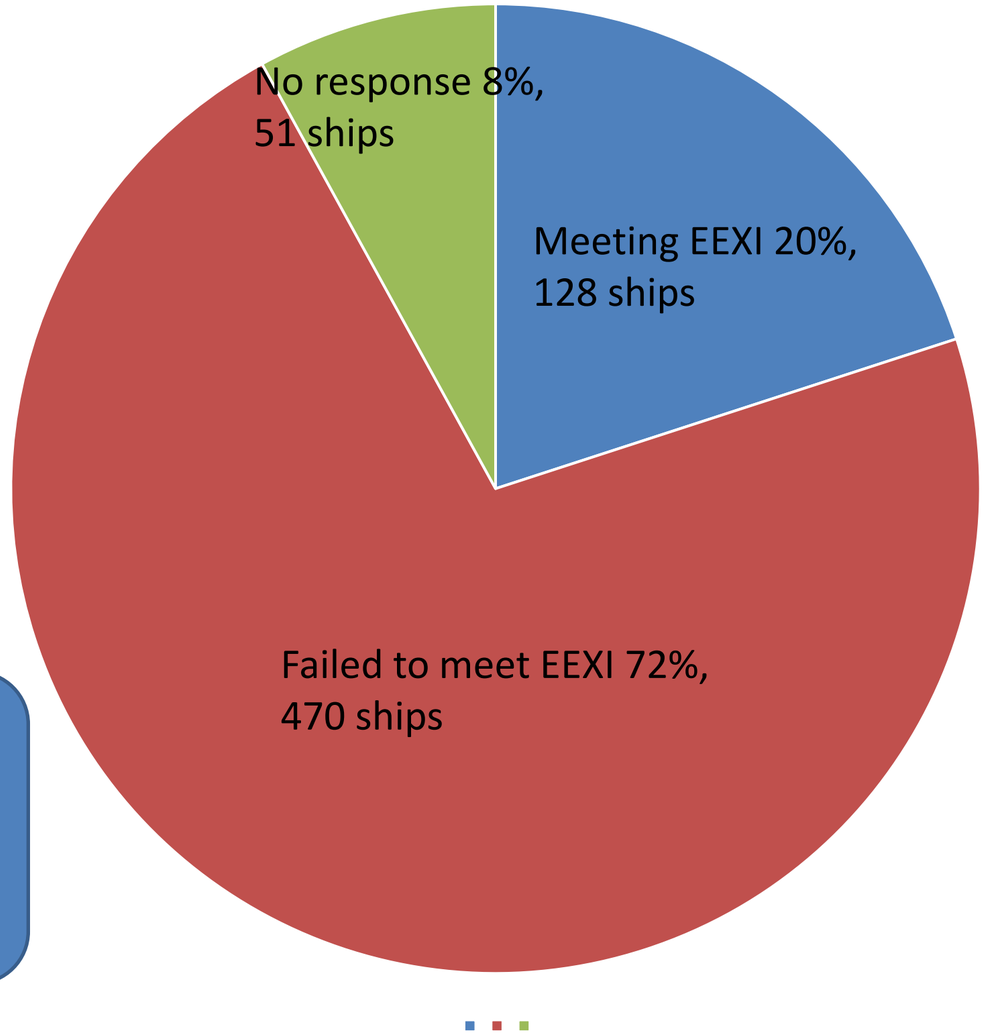
01. BACKGROUND

Current status of Korea

Currently 470 out of 649 ships (72.4%) failed to meet EEXI regulatory.

* According to Ministry of Oceans and Fisheries

Status of meeting EEXI regulations on domestic nationality shipping companies



These are the reason why Team OHJUKANG claims that
‘Revison of EEXI formula considering OCCS’

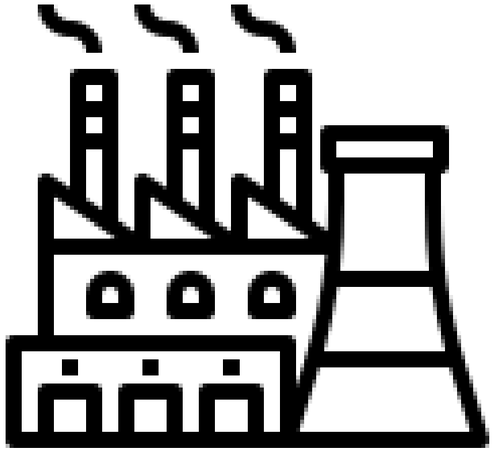
02. PROBLEM

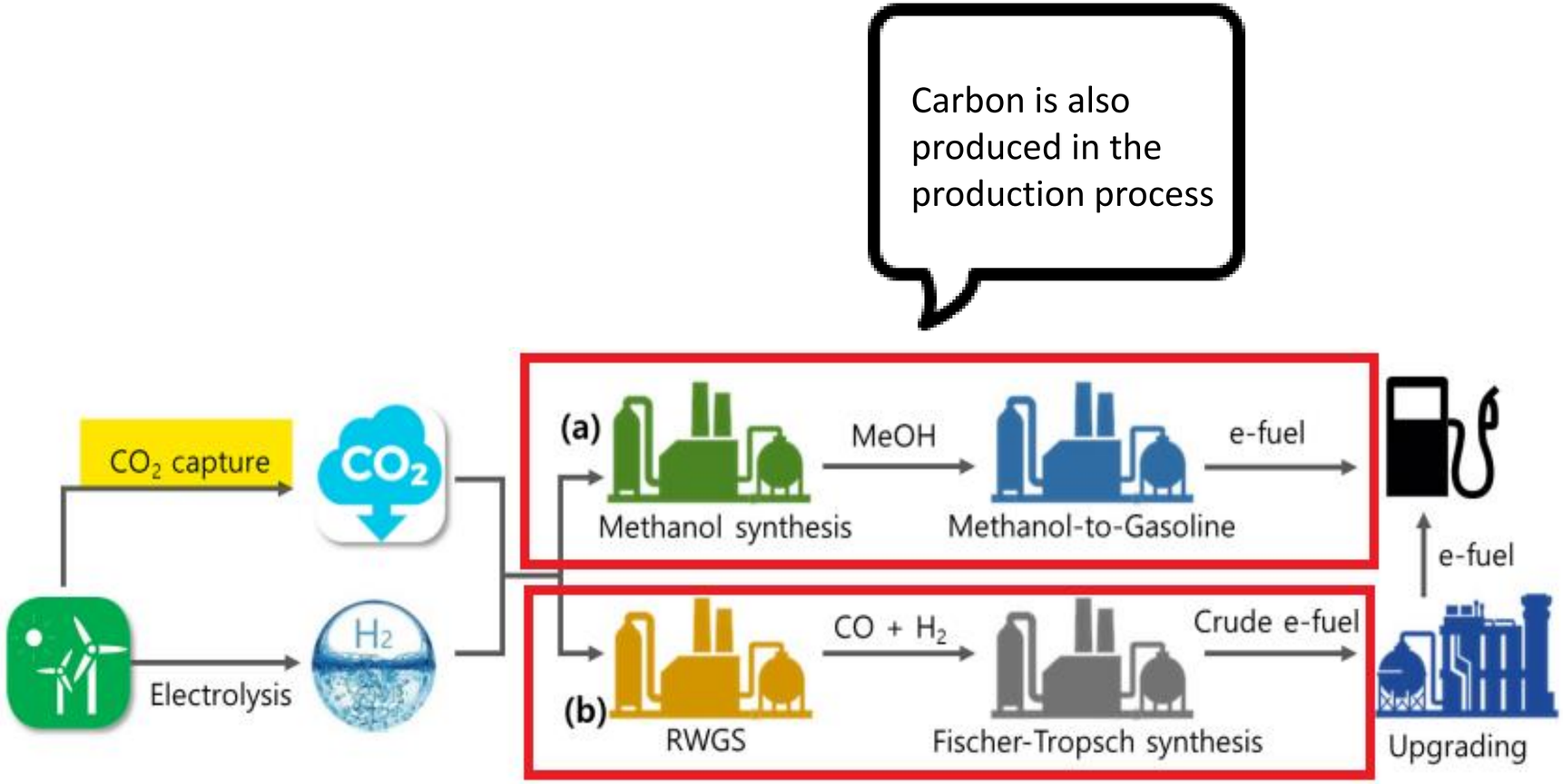
Carbon generation in the process of producing alternative fuels

Lack of supply and infrastructure

LNG ships remain important

02. PROBLEM

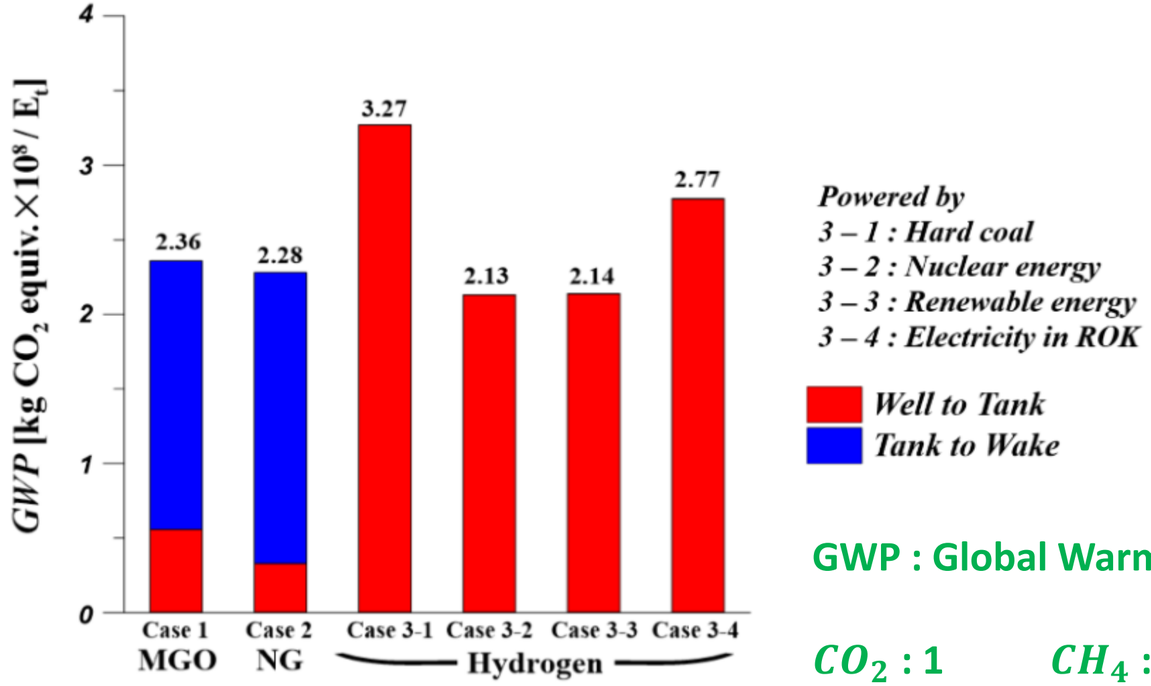




Power-to-Liquids Process Development Technology Trends
Kim Seok-ki, Korea Institute of Chemistry

02. PROBLEM

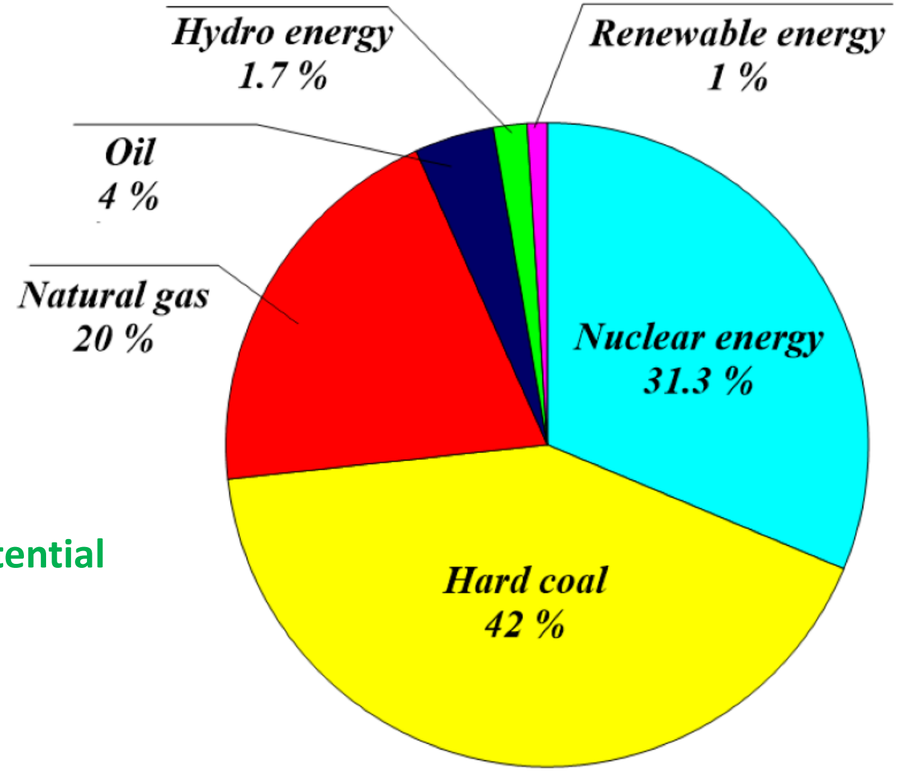
GWP evaluation by LCA (Life Cycle Assessment)



GWP in the Well-to-Wake phase from MGO, natural gas, and hydrogen

GWP : Global Warming Potential

CO_2 : 1 CH_4 : 25

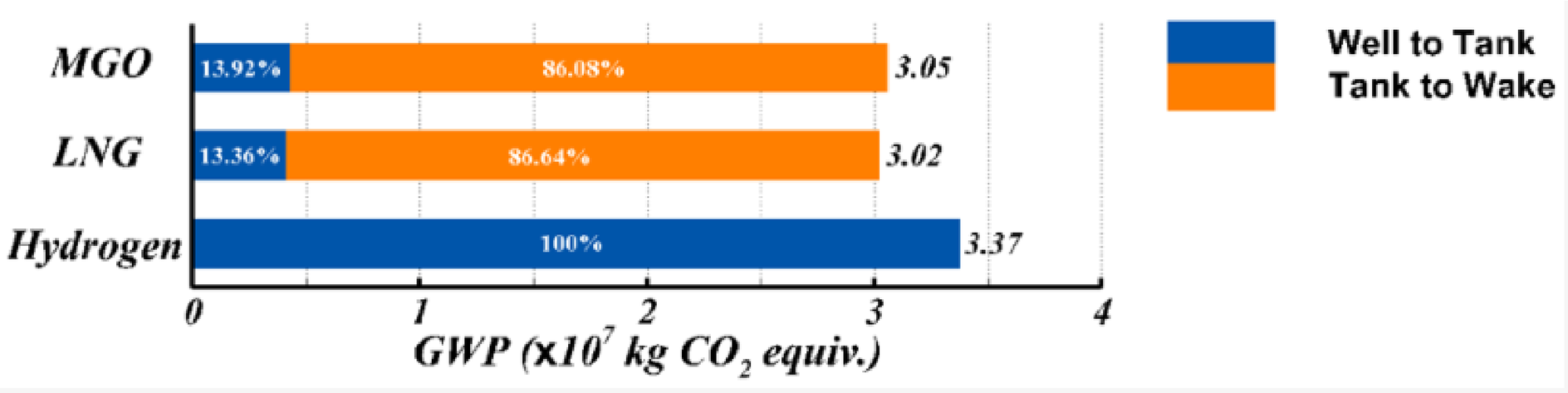


Energy source fractions of electricity in Republic of Korea

Life cycle assessment of alternative ship fuels for coastal ferry operating in Republic of Korea
SS Hwang, SJ Gil, GN Lee, JW Lee, H Park, KH Jung, SB Suh
Journal of Marine Science and Engineering, 2020

02. PROBLEM

GWP evaluation by LCA (Life Cycle Assessment)

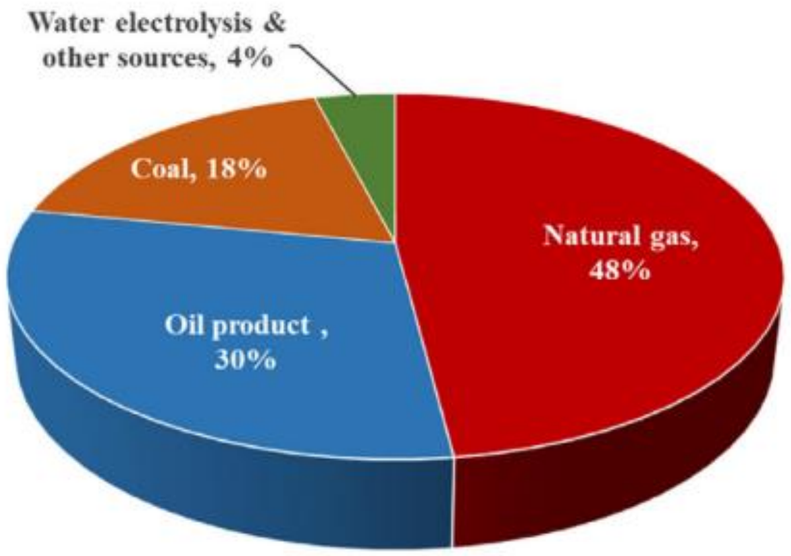


LNG generates the least amount of GWP among the above fuels

Environmental life-cycle assessment of eco-friendly alternative ship fuels (MGO, LNG, and hydrogen) for 170 GT nearshore ferry
GN Lee, JM Kim, KH Jung, H Park, HS Jang, CS Lee, JW Lee
Journal of Marine Science and Engineering, 2022

02. PROBLEM

Hydrogen fueled ship



Hydrogen produce sources

Tank to Wake : Close to 0 emission of carbon

Grey - Hydrogen is not a truly clean fuel because it emits 10kg of CO2 for every 1kg produced

Survey on Research and Development of E-Fuel
Jongyoon Lee*and Bok Jik Lee*†*
Department of Aerospace Engineering, Seoul National University
(Received 15 February 2022, Received in revised form 2 March 2022, Accepted 11 March 2022)

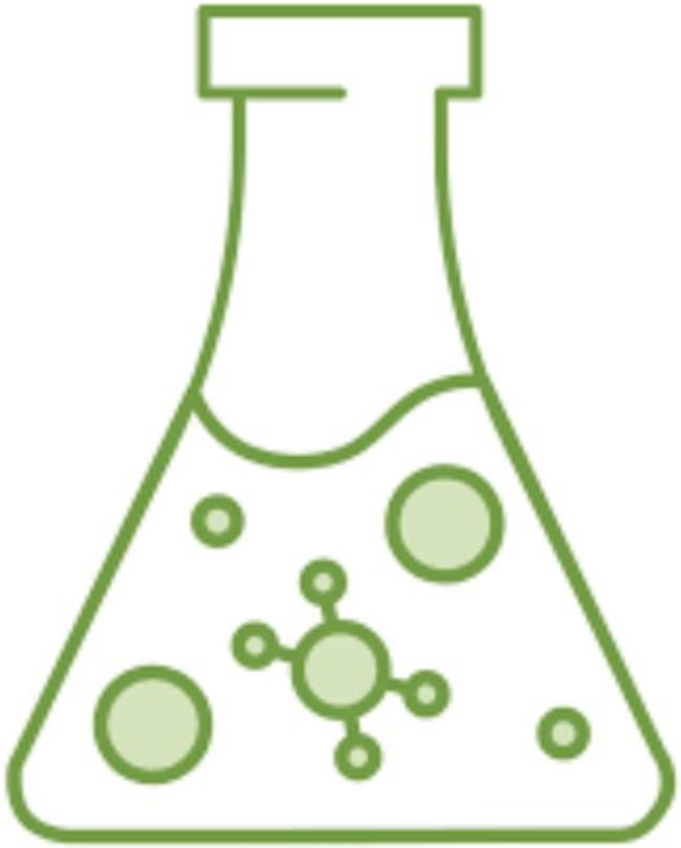
02. PROBLEM

7.42 In the ensuing discussion, several delegations, whilst recognizing in general that onboard CO_2 capture could play an important role in the reduction of GHG emissions, and noting that while some parts of the industry were already actively considering and trialing the use of onboard CO_2 capture, expressed the view that, overall, the technology was still at a

7.43 Several other delegations, in emphasizing the rapid development of onboard CO_2 capture technology, supported the proposal to initiate a dedicated workstream to ensure the timely development of a suitable regulatory framework by the Organization to further support the further development and uptake of the technology through a global level playing field. Several of these delegations also referred to IPCC reports which recognized CO_2 removal and storage as one of the means to achieve carbon neutrality, especially in hard to abate sectors, such as shipping.

Many nations recognize the importance of onboard CO_2 capture

02. PROBLEM Lack of supply



Methanol

- 16,000 TEU container ships consume 30,000 to 40,000 tons of methanol every year.
- Methanol demand could rise further to 6-8 million tons / year

*Reuters from Methanol Institute

Green methanol

● Expensive
- Twice expensive than Methanol

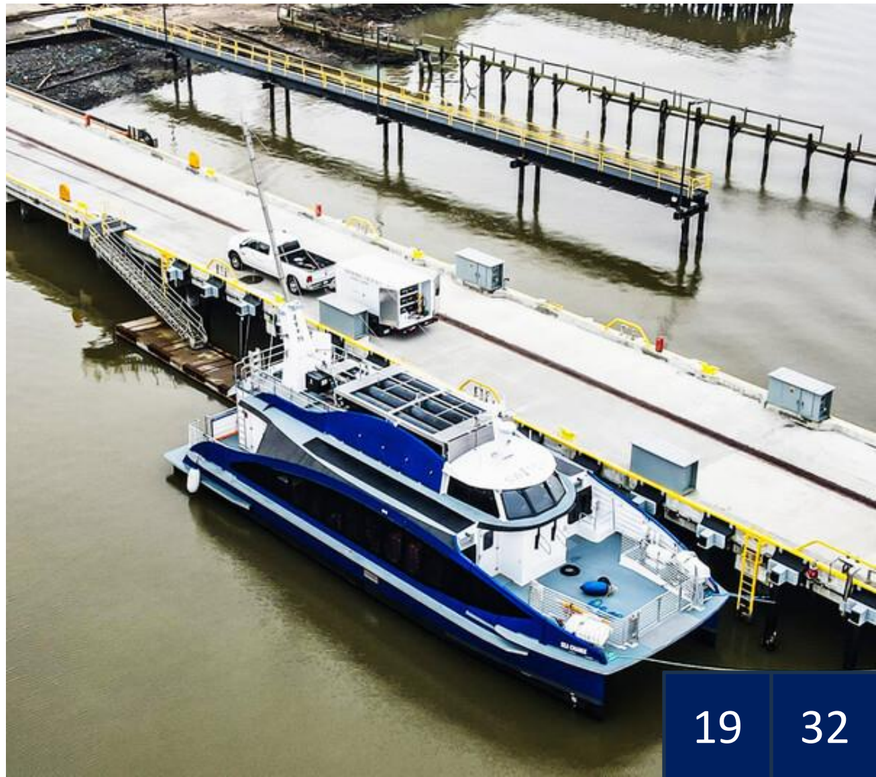
● Scarce
- International demand : 100 millions tons / year
- **Less than 1% of total global methanol production** (300,000 ~ 40,000 tons)

02. PROBLEM Lack of infrastructure

Lack of bunkering infrastructure

There is **No legal definition and grounds the actual condition** of ***'Hydrogen bunkering' in Korea***

According to the NGV Journal, Switch Maritime said on the 18/NOV/2021 that **the world's first commercial marine ship's hydrogen fuel injection was successfully completed** at the All-American Marine Shipyard



02. PROBLEM LNG is still on the spotlight

The number of **LNG fueled Ships** (operating + ordering) :
increased by **129 ships (16.6 %)** over the past year (April, 2023)

According to DNV,
LNG fuel propulsion ships are expected to increase **154%**
from 356 in 2022 to 904 in 2028,

LNG bunkering ships are in operation in 2022, but are expected
to **more than double** to 64-85 by 2025

In other words, the shipping industry has no choice but to rely on existing fuels for the time being.

02. PROBLEM LNG is still on the spotlight

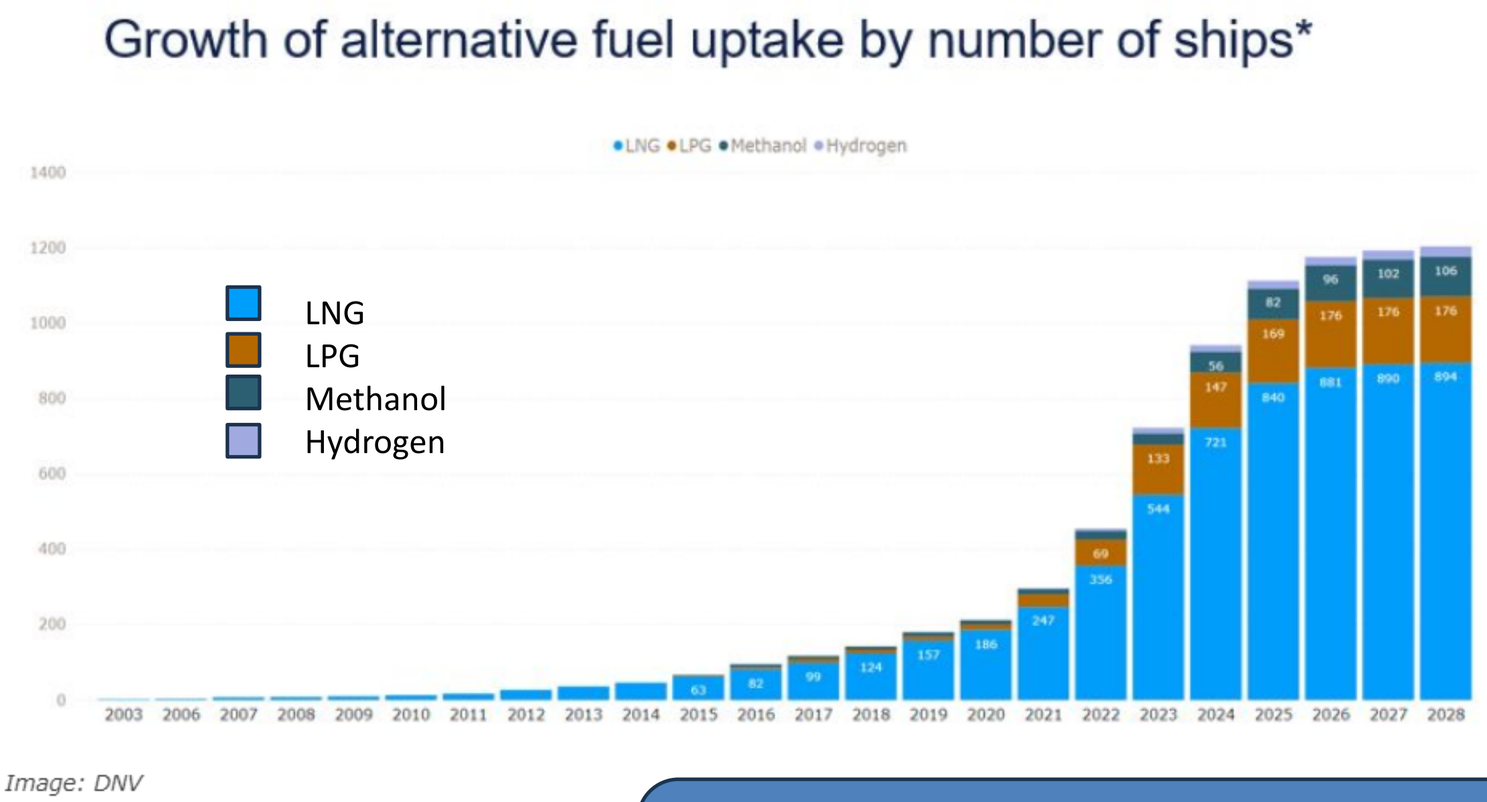


Image: DNV

Anticipating the Increasing Trend of LNG Ships

In other words, the shipping industry has no choice but to rely on existing fuels for the time being.

https://lngprime.com/lng-as-fuel/dnv-says-8-lng-powered-vessels-ordered-in-march/78057/

03. SOLUTION

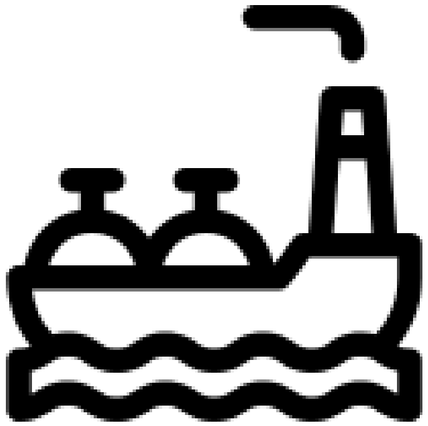
OCCS in existing ship and ship under building as a short term

OCCS operating cost VS Fuel cost when ship slows down

Revision of EEXI equation

03. SOLUTION

Existing ship and Ship under building



In a short term, encourage to install **Onboard Carbon Capture Storage** system to meet EEXI regulatory.

Install OCCS to minimize carbon emission during the road to 2050 carbon close to ZERO.

03. SOLUTION

OCCS installing and operating cost VS Cost when ship slows down

OCCS installing and operating cost

It costs about $50 to capture and store a ton of carbon dioxide

Payback 2~3 years

Cost when ship slows down

ex) Container ship

(Net income per container) * (Number of containers that can be loaded on a container ship)

Our opinion is that the introduction of OCCS technology is better in terms of price

http://www.ksocean.or.kr

03. SOLUTION

Including the amount of Onboard captured Carbon into EEXI formula

EEXI = CO_2 emissions per DWT-miles

= Fuel conversion factor × fuel consumption per hour / DWT-speed

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

− Innovative energy efficiency technology for reduction of OCCS

http://ksoe.or.kr/ksoe/files/news/news_12.pdf

03. SOLUTION

Maintaining existing systems (HFO, LNG) in the short term with Onboard CCS

+

Building alternative fuel bunkering infrastructure
Ex) Hydrogen, Methanol

↓

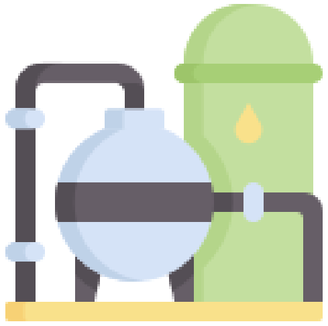
2050 carbon emission Net-zero

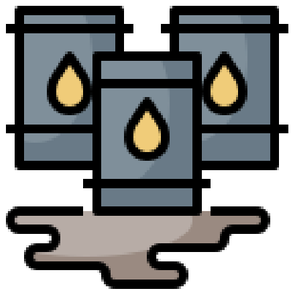
04.
CONCLUSION

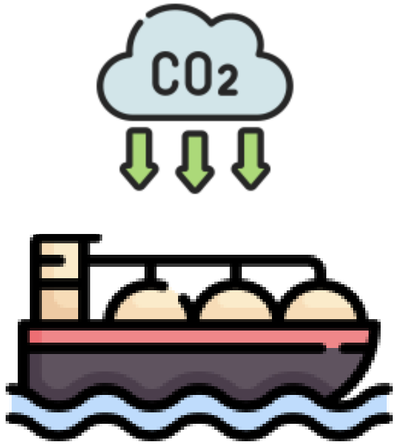
04. CONCLUSION

PROBLEM

1. Status of Korean nationality ships
2. Lack of alternative fuels' supply and infrastructure
3. LNG propulsion ships are still active
4. OCCS is rapidly growing and successfully completed performance verification loaded on an actual LNG carrier







04. CONCLUSION

Investment and research are needed to **switch to alternative fuels**, but in that transition, the transition period should be resolved by collecting carbon on board on existing fuel system ships.

To this end, We claim the amount of **Carbon removed by OCCS in the EEXI formula can be included in the term.**

Reference

1) https://www.cello-square.com/kr-ko/blog/view-382.do

2) https://www.mdpi.com/journal/jmse

3) https://thefreemero.tistory.com/entry/EEXI-EEDI

4) Power-to-Liquids Process Development Technology Trends
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8) https://lngprime.com/lng-as-fuel/dnv-says-8-lng-powered-vessels-ordered-in-march/78057/

9) http://www.ksocean.or.kr

10) http://ksoe.or.kr/ksoe/files/news/news_12.pdf

Q & A

Thank You

TEAM OHJUKANG