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Europe-Korea Conference on Science and Technology

KSOE

- Pathways of Shipbuilding and Offshore Industry to Carbon Neutral era

탄소중립시대 조선해양산업의 미래 준비

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미래기술연구원 미래선박연구랩 신현준 상무

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Transformation into a Carbon Neutral Society

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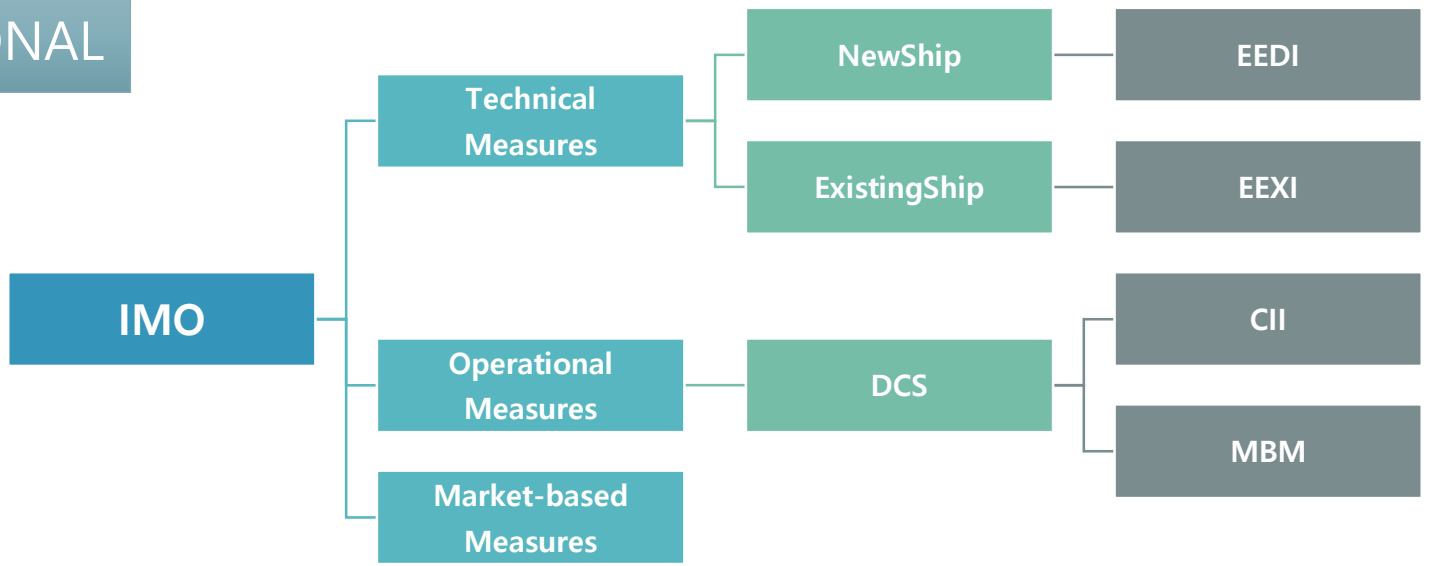
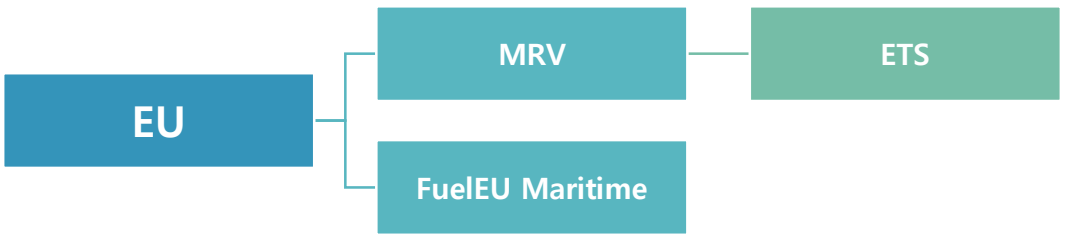
SUMMARY – Emissions + Efficiency + Finance + Fuels

INTERNATIONAL



Regional



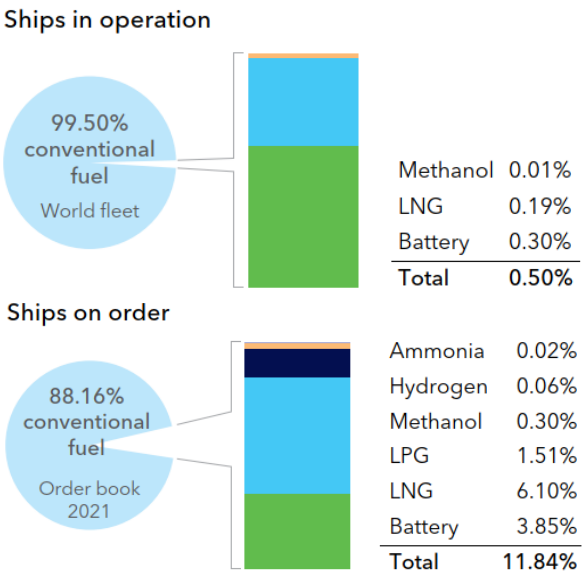
Transformation into a Carbon Neutral Society : Change in ship fuel selection

Korea Shipbuilding & Offshore Engineering

Changes in ship fuel have already begun, and commercialization of decarbonized fuel is expected after 2030

conversion of ship fuel

- Increasing the application of alternative fuel for new-order ships
- Alternative fuel ship construction rate : abt. 12%, More than 20 times the ship in service (0.5%).
- Methanol, LNG, Battery, LPG, Hydrogen, Ammonia



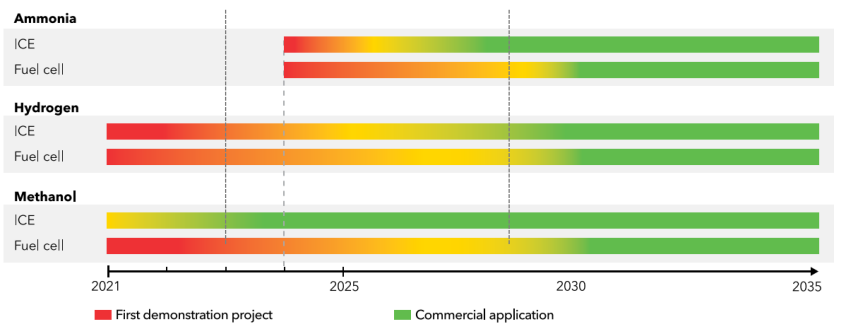
Source: DNV Maritime Forecast to 2050

[Percentage of global ships by fuel('21.06)]

Development of Decarbonized Fuel Technology

The commercialization of Alt. fuel technology after 2030

- Methanol 2 stroke engine has already been developed and 4 stroke engine is currently under development
- Hydrogen is expected to be commercialized in 2030 only after securing separate storage space and insufficient safety regulations
- Ammonia must overcome problems such as toxicity and nitrous oxide emissions, and is currently identified as TRL 5 levels



ICE: Internal Combustion engine

Source: DNV Maritime Forecast to 2050

[Time to Commercialize Decarbonized Alternative Fuel Technology]

Transformation into a Carbon Neutral Society : Change in ship fuel selection

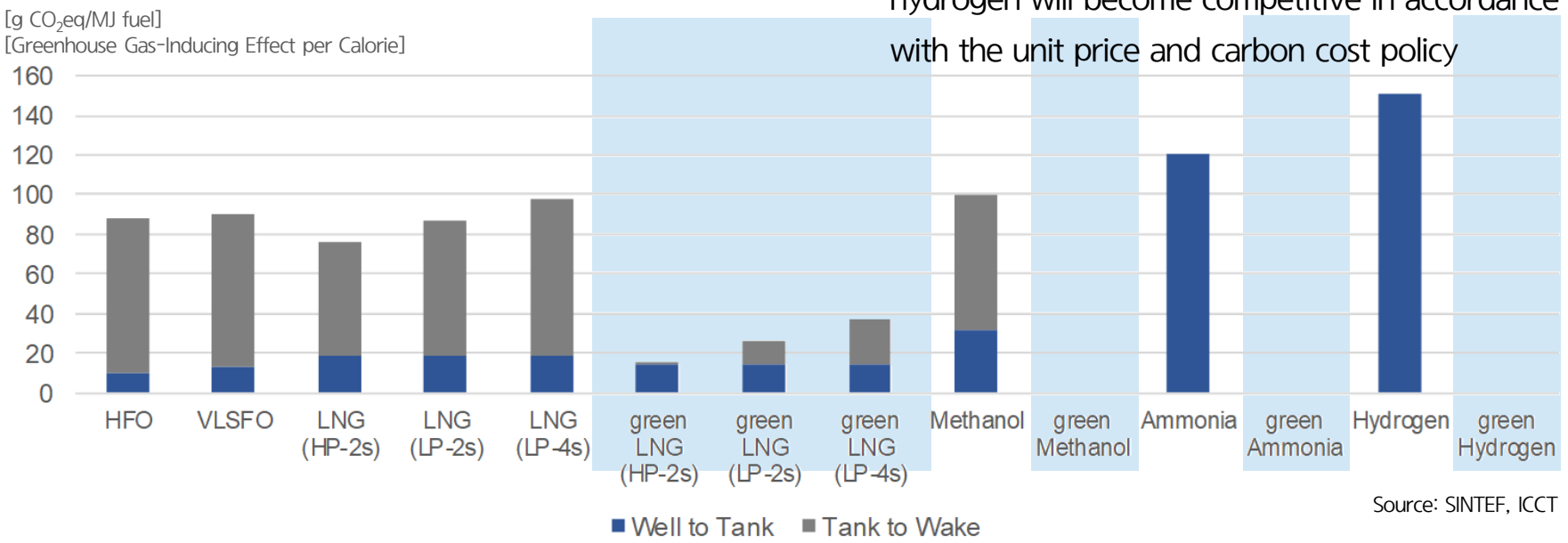
LNG in the short term, to green fuel (biofuel, ammonia/hydrogen) in medium/long term

LNG is a current major low-carbon solution

- Low greenhouse gas inducement effect per calorie
  - LNG (2 stroke high pressure/low pressure) has the lowest greenhouse gas-causing effect per calorific value
  - Demand for LNG propulsion to be continued in the short term

Green fuel use will expand in the future

- conversion to green fuel
  - The use of decarbonized fuel will expand due to the strengthening of environmental policies and the development of bio/renewable energy technologies
  - It is expected that biofuels, ammonia, and hydrogen will become competitive in accordance with the unit price and carbon cost policy



Source: SINTEF, ICCT

[Effect of causing greenhouse gases per unit of energy]

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Present and Future of the Shipbuilding & Marine Engineering for Carbon Neutrality

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Current Shipbuilding & Marine Products/Technology for Carbon Neutrality

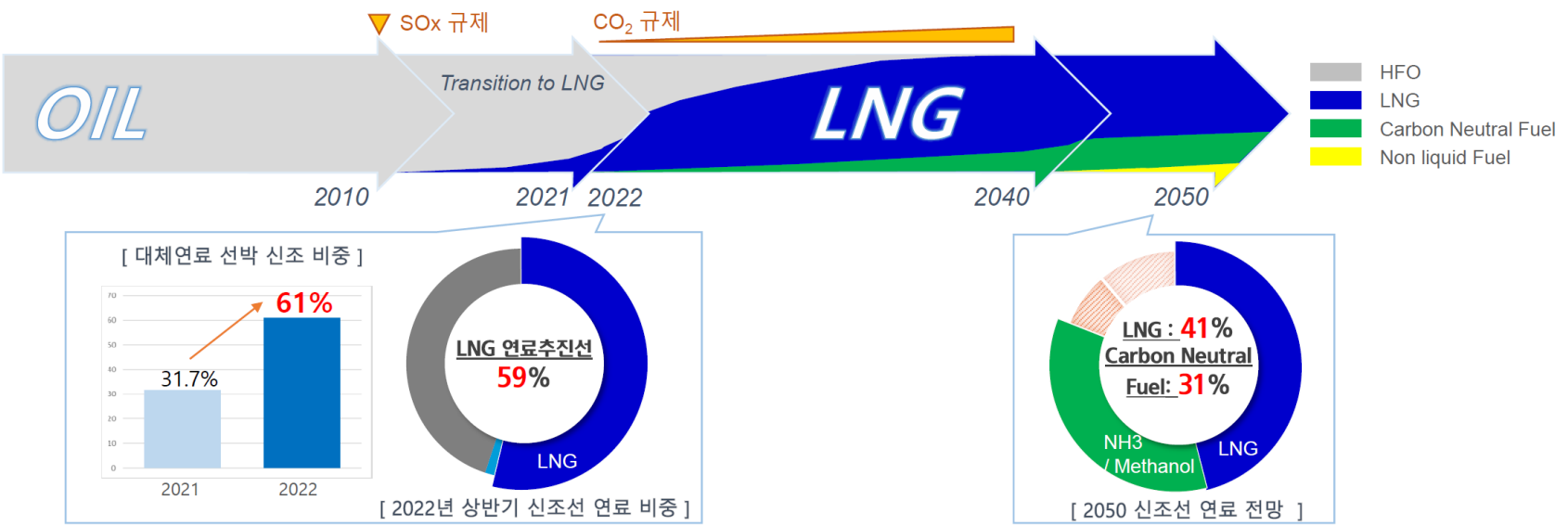
Continued consumption of natural gas, regional differences in production and consumption create demand for LNG carriers

Change in natural gas demand

- Continued consumption of natural gas
  - Even if Net Zero is to be realized in 2050, natural gas consumption is expected to be above the current level over the next 10 years.
  - Natural gas is expected to continue to be needed in areas such as transportation and blue hydrogen production.

LNG Carrier Demand to be continued

- LNG carriers required to move from production to consumption
  - LNG export : USA, Middle East, Russia
    LNG import : China, India, Korea, Japan, etc
  - LNG carriers needed to transport LNG from major exporting countries to importing countries.



Current Shipbuilding & Marine Products/Technology for Carbon Neutrality

Korea Shipbuilding & Offshore Engineering

Korean shipbuilders have responded to the market with the world's best ship LNG technology

LNG Carrier

- Single Mixed Refrigerant System
  - Re-liquefying system the Boil Off Gas from the LNG storage tank and returning it to the tank
  - First order received in 2017 and applied to about 70 ships so far



[HHI LNG Carrier]

LNG fueled Ship *Jacket Cooling Water

- Hi-eGAS (JCW* Vaporized LNG Fuel Supply System)
  - Fuel savings by vaporizing LNG with engine coolant
  - Compact Structural Design with Simplified Heat Exchanger SKID
  - 1.5% reduction in atmospheric CO2 emissions
  - Launch with shipowner offer option in 2022

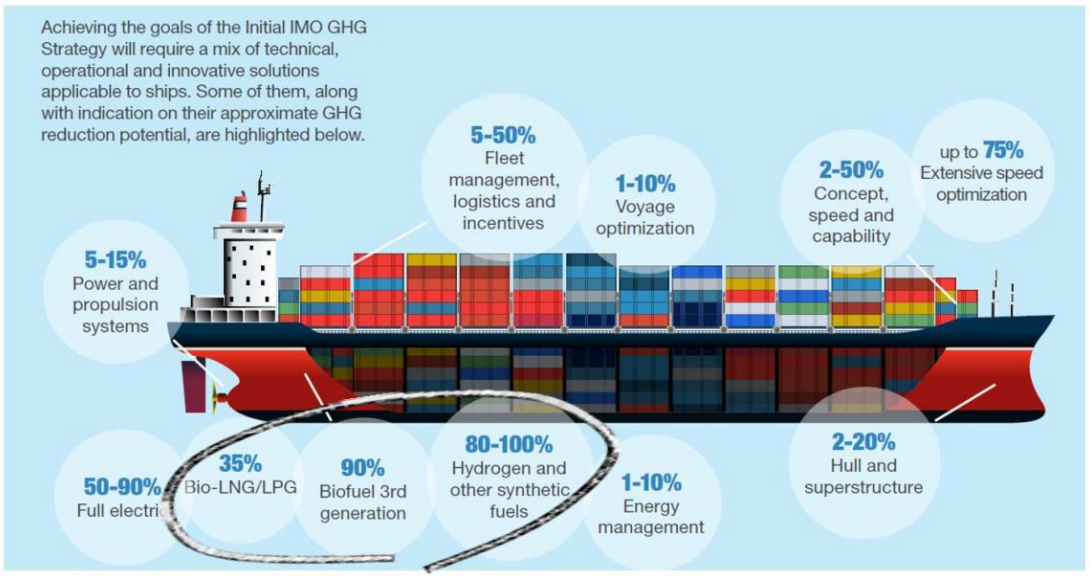


[Hyundai Samho Heavy Industries
World's Largest LNG Fuel Propulsion Container Ship]

Current Shipbuilding & Marine Products/Technology for Carbon Neutrality

However, due to stricter environmental regulations, LNG fuel use is reaching technical limitations

Hydrodynamics	Max. 20% →	Hull form optimization, air lubrication systems, energy saving devices, hull painting, etc
Machinery	Max. 20% →	Engine efficiency improvement, hybrid electric propulsion, waste heat recovery, etc
After Treatment Measure	Max. 30% →	Carbon Capture and Storage



Source: IMO action to reduce greenhouse gas emissions from international shipping, IMO

The Future of the Shipbuilding and Marine Industries for Carbon Neutral Era

We are preparing various measures to keep our best position in the future after 2030

	current	~ 2030	~ 2050
Technology	• Energy Saving Devices/Hull form improvement • LNG/NH3/ Methanol Dual Fuel Engine • Scrubber, Methane slip reduction equipment	• Carbon Capture & Storage • Ammonia fueled Ship • Floating offshore wind power generation • Green Hydrogen production Platform • Zero-carbon fueled engine	• Hydrogen Carrier/fueled Ship • Hydrogen Fuel cell propulsion • CO2 carrier/platform • Nuclear Powered Ship • Electric propulsion Ship
Limitations	• GHG reduction limitations • Zero-Carbon based Well to Wake • Limitation as a traditional response after 2030	• Economic Feasibility/Compact Onboard Equipment • Toxic, corrosion etc • Mega-scale Turbine/Floating structure development • Large-scale water electrolysis equipment technology • Advanced combustion system	• L- BOR of Cryogenic Cargo/Insulation • MW class large Fuel Cells • Large Vessels and Materials for H-pressure and L-Temperature • Social acceptability • Compact battery with small weight & volume

Future Engineering for Carbon Neutrality-Summary

Technical Challenges for Shipbuilding & Marine Engineering(LNG/NH3/H2/CO2/CCS/SOFC/Electric Propulsion)

LNG

- Limits of carbon reduction(Not zero solution)
  - The technical limit has been reached by the efficiency/optimization of ship equipment with LNG.
  - Due to equipment installed to reduce carbon generation, there is also a decreasing fuel efficiency.

Ammonia

- Material properties
  - Corrosion, Toxic
  - When using ship fuel, it is necessary to design an internal combustion engine considering low viscosity/heat generation.
  - Expensive Green Ammonia by Well to Wake

Hydrogen

- Cryogenic substance
  - Liquefied hydrogen is -253℃ more difficult to handle than LNG
  - Cargo Storage Tank with High Insulation Performance
- Short Infrastructure
  - Need to build value chain and infrastructure
  - Lack of technology to design/manufacture large facilities (water electrolysis/storage tanks, etc.)

CO_2

- Large Scale Storage tank Manufacturing
  - Due to High pressure and density, it is difficult to build beyond 40K medium ship.
- Safety issues
  - Risk of choking, etc. in case of CO2 leakage
  - Need to suppress occurrence of dry ice/hydrate during CO2 injection

HHI Group's Digitalization Vision

Korea Shipbuilding & Offshore Engineering

- Based on AI, Hyundai Heavy Industries Group presents autonomous ships and smart construction machines/energy/robot as its future vision
- In addition, based on AI technology, smart yard construction and business operation are promoted

The Future of Group Products











The future of yards and services/operations





World's First 'Commercial' Autonomous Operation Solution-CES 2022 Exhibited

Korea Shipbuilding & Offshore Engineering

- Group's first in-house startup Avikus launches ('21.1)
- Autonomous Navigation Solution for Leisure Boat HiNAS CES 2022 Exhibited



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