

Development of GHG reduction regulations and green shipping

CCS
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• GHG reduction regulations and impact

IMO Initial GHG Strategy Revision

IMO Initial GHG Strategy

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2023 IMO GHG Strategy

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Level of ambitions

DRAFT 2023 IMO STRATEGY ON REDUCTION OF GHG EMISSIONS FROM SHIPS

1 carbon intensity of the ship to decline through further improvement of the energy efficiency for new ships

to review with the aim [to strengthen] [to improve] the energy efficiency design [requirements] for ships , as appropriate;

2 [carbon][GHG] intensity of international shipping to decline

to reduce [CO2] [GHG] emissions per transport work, as an average across international shipping, by at least [40%] **[65%]** by 2030, compared to 2008;

3 uptake of [low-carbon and zero-carbon] [zero or near zero GHG emissions] fuels to accelerate

[strive] to ensure that **[low-carbon and zero-carbon] [zero or near-zero GHG emissions] fuels [represent] [are used to operate] at least 5% of the [energy used] [world] [global] fleet [measured by fuel mass consumed on-board] by international shipping by 2030;]**

4 ensuring progress towards [phasing out] [reaching] [net zero] [zero] GHG emissions from international shipping

[to reduce the total annual GHG emissions from international shipping **by at least [[x%] [37%] by 2030 and by at least] [50%] [x%] [96%] by 2040**, compared to 2008] [to determine a GHG reduction target for 2040 in the 2028 review of this Strategy];]

5 GHG emissions from international shipping [to peak and [phase out] [reach [net-zero] [zero]

to peak GHG emissions from international shipping as soon as possible whilst [pursuing efforts towards,] [as well as to aim for **net zero GHG emissions preferably around mid-century** and before the end of this century] [[on the basis of equity, and in the context of sustainable development and efforts to eradicate poverty] [taking into account different national circumstances] [phasing them out] [reaching [net-zero] [zero] GHG emissions] [by 2050 at the latest]] on a pathway of GHG emission reductions consistent with the Paris Agreement temperature goals [and the aim to limit global temperature rise to 1.5° C above pre-industrial levels] [of holding the increase in the global average temperature to well below 2° C above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5° C above preindustrial levels, recognizing that this would significantly reduce the risks and impacts of climate change].

Work Plan for development of mid- and long-term measures

Phase I

Collation and initial consideration of proposals for measures

Purpose: To table various proposals for measures in order to be able to understand and compare their main features and implications.

Phase II

Assessment and selection of measure(s) to further develop;

Purpose: To identify (a) candidate measure(s) to develop further as a priority.

Phase III

Development of (a) measure(s) to be finalized within (an) agreed target date(s).

Purpose: In the case of amending existing legal instruments, prepare amendments as appropriate. In the case of developing a new legal instrument, prepare a framework for consideration by the Committee in order to decide on the way forward.

2021 *spring* — **2022** *spring* — **2023** *spring*

Target date(s) to be agreed in conjunction with the IMO Strategy on Reduction of GHG Emissions from Ships.

Candidate Mid- And Long-Term Measures

• *A global GHG levy or feebate system*

a carbon price on a tonne of CO_2 or GHGs emitted as measured through defined conversion factors for the amount of a given fuel consumed in a given year

Strengths

- Simple to establish and administer
- Emissions are priced directly with ships emitting
- Technology neutral
- Designed to encourage deployment of zero- and near-zero ships

Challenges

- Highly dependent on the quantum of the levy
- Requires agreement on the appropriate quantum of the levy
- Added cost to transportation to SIDS and other remote locations



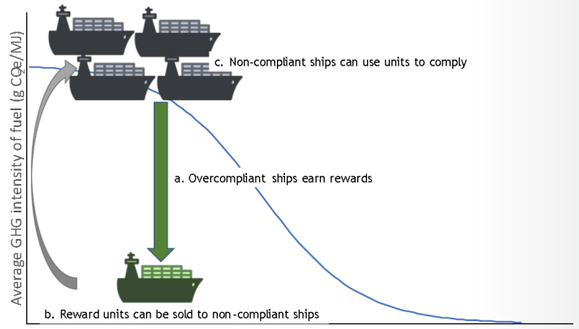
Candidate Mid- And Long-Term Measures

• *GHG Fuel Standard (GFS)*

A regulatory instrument that stipulates the amount of carbon or GHG equivalent allowed in marine fuels at a given period, based on lifecycle GHG emission with flexible implementation approach

Strengths

- Directly addresses the core issue
- Less dependent on economic element
- Does not directly require explicit payments
- Technology neutral
- Fleet averaging/pooling mechanism



Challenges

- Fuel's availability
- Depend on a reasonable pre-standard

• *Emission trading systems (ETS)*

Widely used market-based mechanism for pricing carbon and limiting allocation of various emission

Strengths

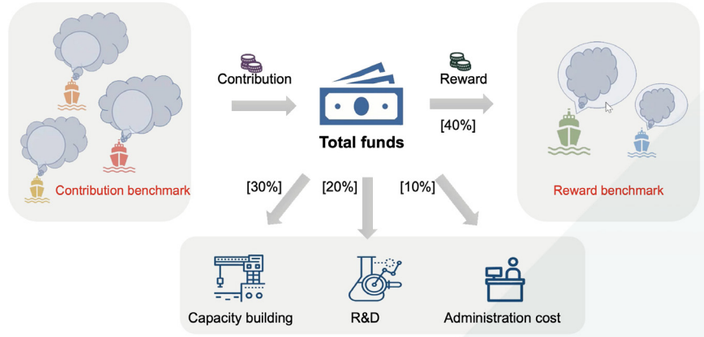
- Direct carbon price applicable to all emissions
- Can be integrated into other sectors
- Allows market factors to determine price
- Fuel and technology neutral

Challenges

- Establish a single ETS in global scale
- Volatility of the carbon price can be significant
- Faces overlapping rules and national/regional caps
- Complex unit system support is required



• *CII benchmarking – IMSF&R proposal*



Strengths

- Address a broad range of concerns
- Allows for the use of fleet averaging
- Provides funding for R&D and technical cooperation
- Based on an agreed metric and baseline

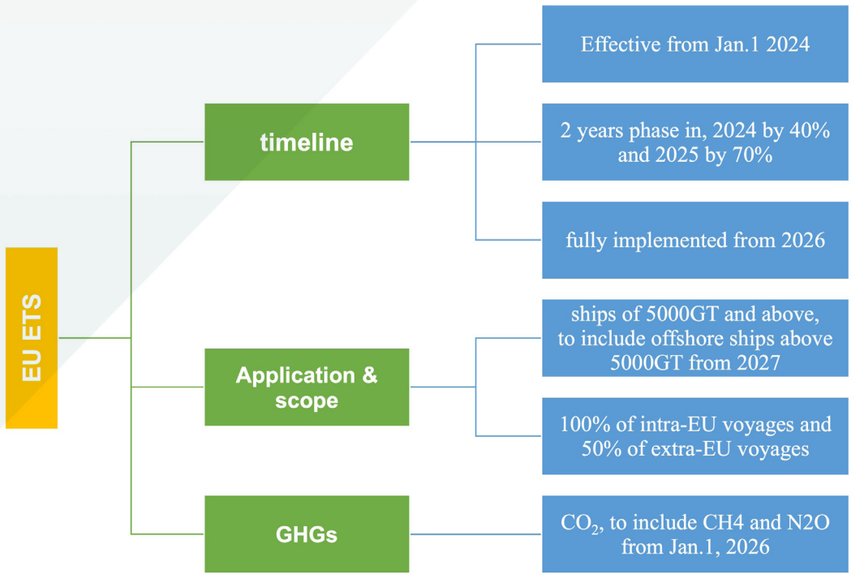
Challenges

- Lack of ambition
- Complex mechanism
- Risk of introducing high WtW emissions

Way forward and key issues

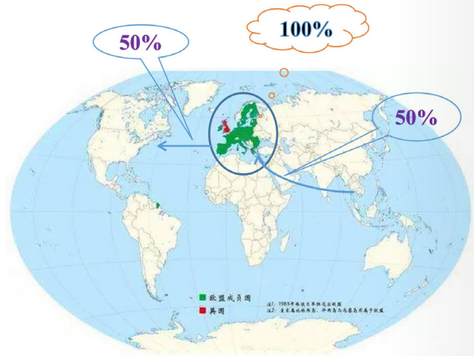


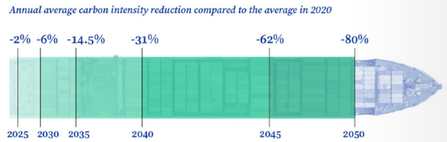
EU ETS to include shipping industry (to be finally adopted)



FuelEU Maritime

- ships of and above 5000GT (all flags)
- 100% of intra-EU voyages and 50% of extra-EU voyages
- GHGs: CO_2, CH_4 and N_2O
- Baseline (based on 2020 data) reduced in every 5 years.
- Shore power supply shall be connected for container vessels and passenger ships from Jan.1, 2030, except for some special cases.

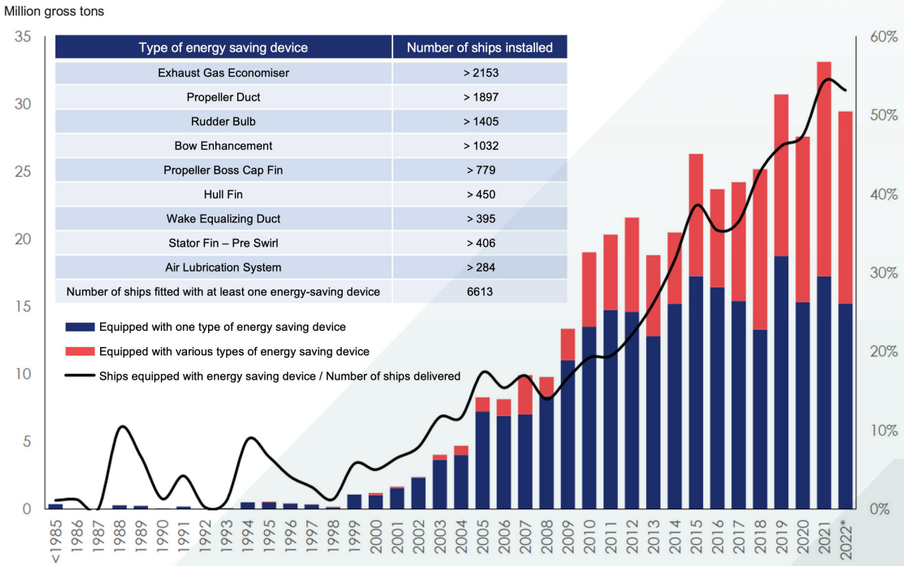




• Development of green shipping

Energy saving device becomes more and more popular

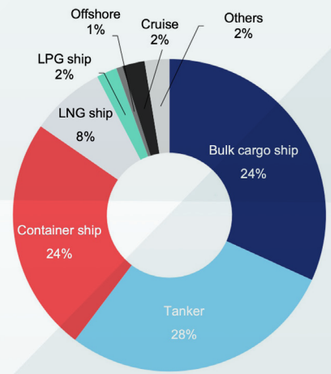
• Distribution of ship using energy saving device in the global fleet, gross tonnage



Type of energy saving device	Number of ships installed
Exhaust Gas Economiser	> 2153
Propeller Duct	> 1897
Rudder Bulb	> 1405
Bow Enhancement	> 1032
Propeller Boss Cap Fin	> 779
Hull Fin	> 450
Wake Equalizing Duct	> 395
Stator Fin – Pre Swirl	> 406
Air Lubrication System	> 284
Number of ships fitted with at least one energy-saving device	6613

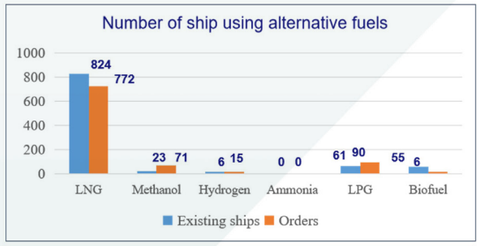
Sources: Clarkson

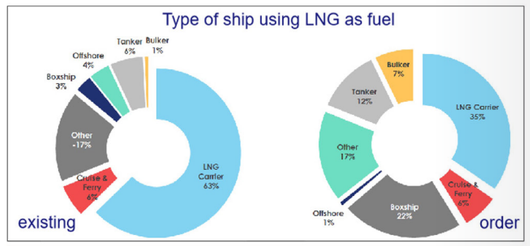
• Type of ship using energy saving device, by gross tonnage

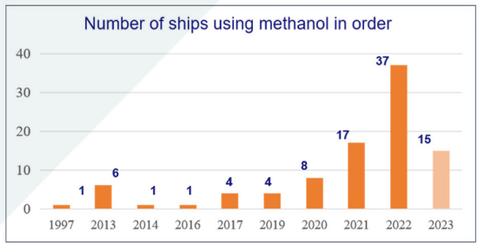


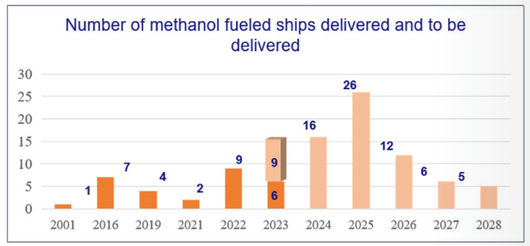
Pathway becoming clearer but uncertainties still remain

- For deep sea ships, methanol is becoming the new favorite.
- R&D on ammonia is accelerating, onboard carbon capture system (OCCS) also attrack attentions.



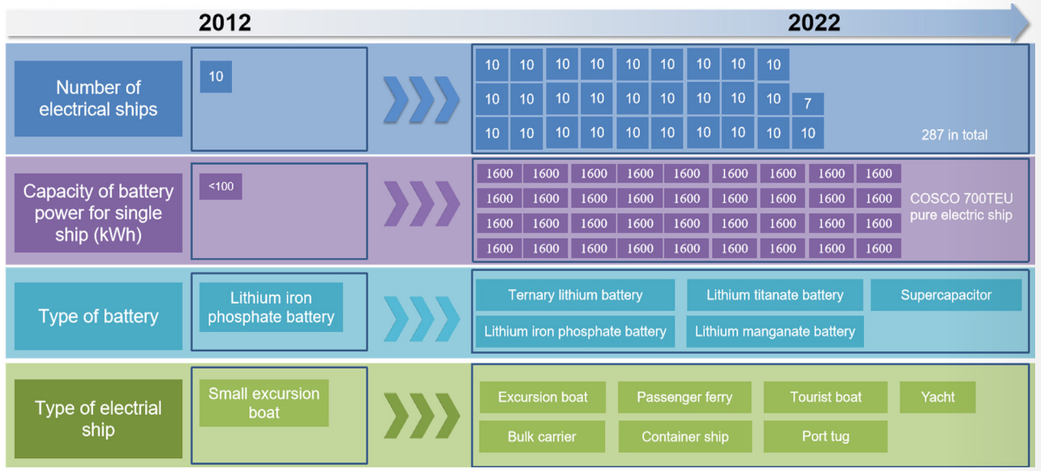




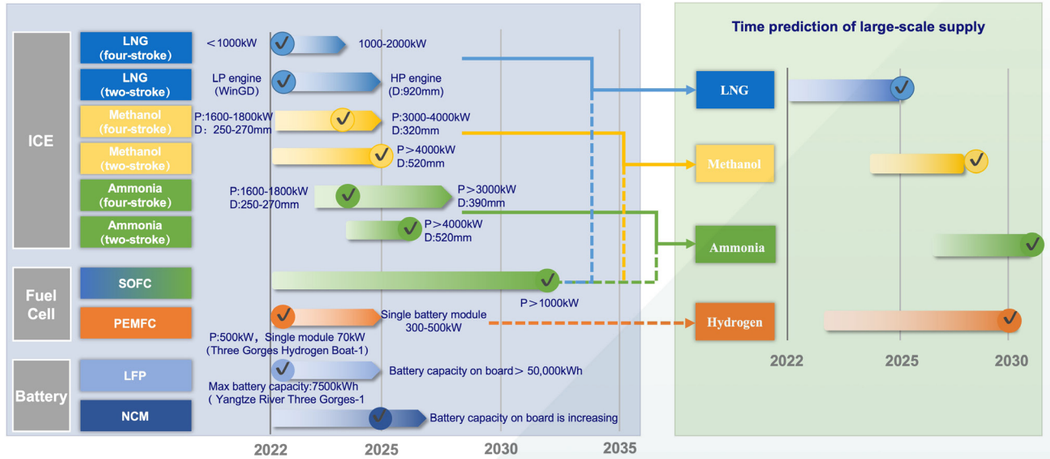


Sources: Clarkson

- For domestic ships,battery power, including fixed charging type and swappable electricity storage container, is rapidly developing.

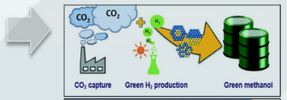


Energy converters and infrastructures are developing

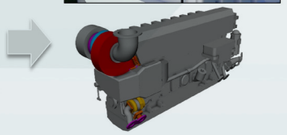


Different alternative fuels facing different challenge

- The momentum of using alternative fuel in shipping industry is gathering, but different alternative fuels facing different challenges
  - The main challenge for methanol solution is the availability of **green methanol**.
  - While for hydrogen, the problem is **onboard storage** due to low volume energy density.
  - For ammonia fuel, the **availability of main engine and the concern on its toxicity** is the biggest challenge.
  - For battery power, the challenge comes from the **safety** due to large capacity onboard.







- Methanol shows more resilience due to less modification/easier design and construction, mature technology and flexible solution in terms of choosing “different color” methanol.

Some typical alternative fuel ships

The world's first LNG-powered VLCC
"Yuan rui yang"



- Length：333m
- Breadth：60m
- Depth：30.5m
- LNG fuel tank：Type C：3,500m³×2
- Class: CCS

The first hydrogen-powered ship in China
"Three Gorges Hydrogen Boat 1"



- Length：49.9m
- Breadth：10.4m
- Depth：3.2m
- Power：500kW
- Cylinder volume：320L×32
- Class: CCS

The world's largest capacity pure electric ship
"Yangtze River Three Gorges 1"



- Length：100m
- Breadth：16.2m
- Depth：3.2m
- Power：7,500kWh
- Endurance：100km
- Class: CCS

The world's largest type C LNG carrier
"HaiYangShiYou 301"



- Length：184.7m
- Breadth：28.1m
- Depth：18.7m
- LNG tank: 30,000 m³
- Bunkering speed: 1,650 m³/h
- Class: CCS

Methanol dual fuel power VLCC



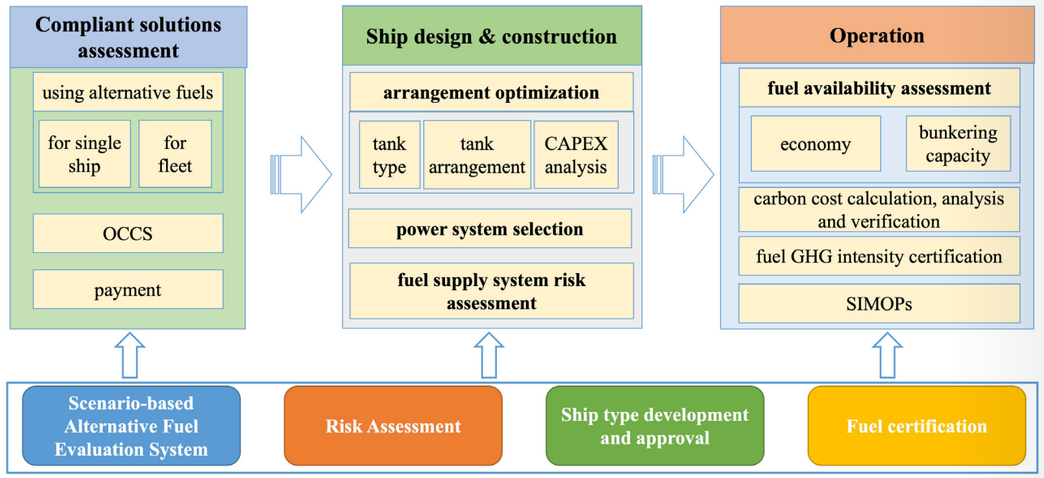
- Length: 332.9m
- Breadth: 60m
- Depth: 30m
- Methanol fuel tank：7,000 m³
- Methanol endurance:16,000 n mile
- Design approved by CCS

Ammonia fuel VLCC

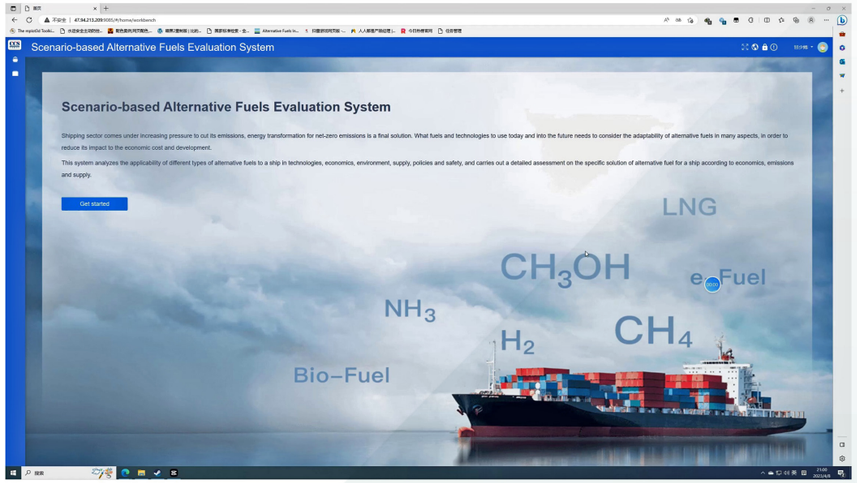


- Length：333m
- Breadth：60m
- Depth：30m
- Ammonia fuel tank：Type C：6,000 m³×2
- Design approved by CCS

• Solutions



Scenario-based alternative fuels evaluation system



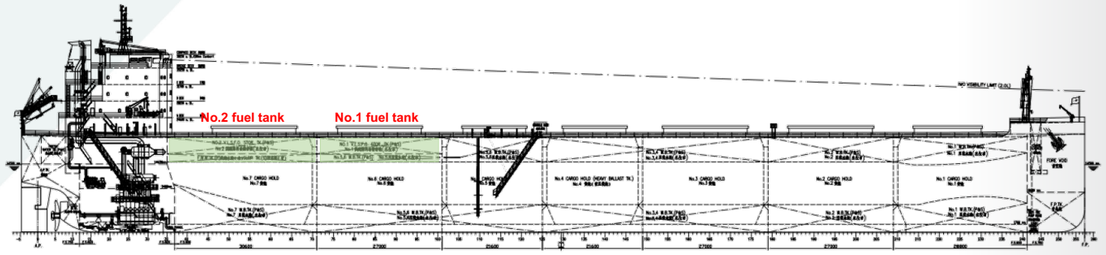
Scenario-based Alternative Fuel Evaluation System



Case study: 82K DWT bulk carrier using methanol as fuel

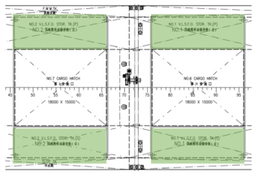
- **82K DWT bulk carrier**
  - Length: 229m
  - Breadth: 32.26m
  - Depth: 20.35m
  - Main engine: MAN B&W 6S60ME-C10.5
  - MCR: 9000kW × 84r/min
  - Fuel oil tank: 1987m^3
  - Endurance: 25000n.miles





■ **Option 1 :** Same volume as oil tank

- The overall retrofit cost of the fuel tank is about $80,000.

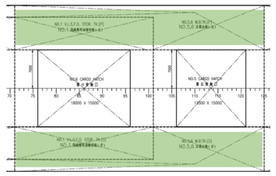


Type	Volume (m^3)	Endurance (n.miles)
Methanol	1785	11708

Note: volume of fuel tank will be lost by about 10%.

■ **Option 2 :** Add extra fuel tank

- The overall retrofit cost of the fuel tank is about $150,000.

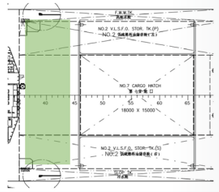


Type	Volume (m^3)	Endurance (n.miles)
Methanol	3405 (1785+1620)	18763

Note: volume of fuel tank increases about 1620m^3

■ **Option 3 :** Remains endurance

- The overall retrofit cost of the fuel tank is about $220,000.



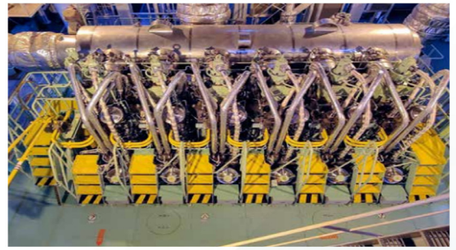
Type	Volume (m^3)	Endurance (n.miles)
Methanol	4838 (1785+1620+1433)	25000

Note: the loss of cargo space: 1874m^3; the loss of carrying heavy cargo (ore) is about $0.22 million / year, and the loss of light cargo (soybean) is about $0.32 million / year.

Power system

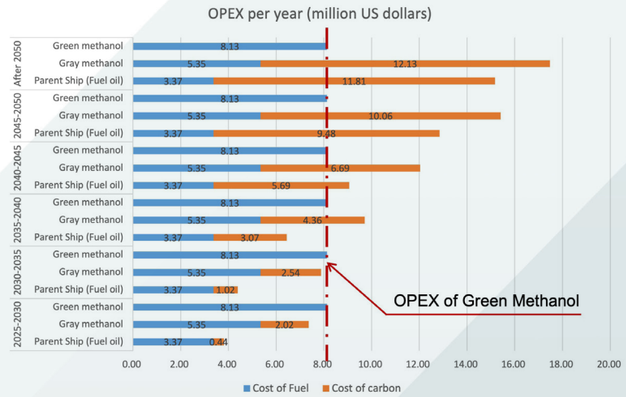
- **Newbuilding**
  - Selection of ME-LGIM series engine
  - Total cost is abt. $6.17 million

- **Retrofit**
  - **Plan A: Replaced by new engine**
    - ◎Same as newbuilding plan above
  - **Plan B: Retrofit on original engine**
    - ◎As ME series engine can be directly retrofit
    - ◎Total cost is abt. $2.02 million



Economy analysis—OPEX

OPEX of using fuel oil, gray methanol, and green methanol



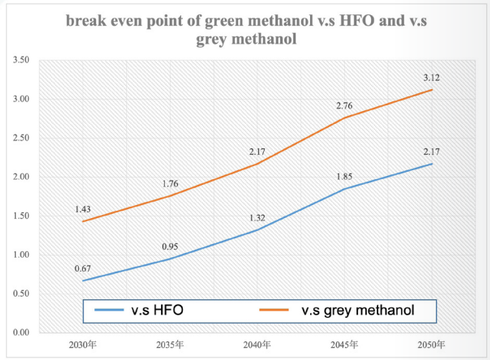
Assumption

- Oil consumption is calculated based on the actual operating speed within one year (5741t);
- Mainly consider fuel cost and carbon cost;
- The cost of oil fuel is based on the Hong Kong market (LSFO: $ 575.5/t; MGO: $ 809.50/t);
- The cost of delivered gray methanol is 1.2 times that of factory price (gray methanol: $ 457.14/t);
- The cost of delivered green methanol is 1.5 times that of gray methanol (green methanol: $ 705.89/t);
- The carbon cost is based on Fuel EU policy.

Economy analysis

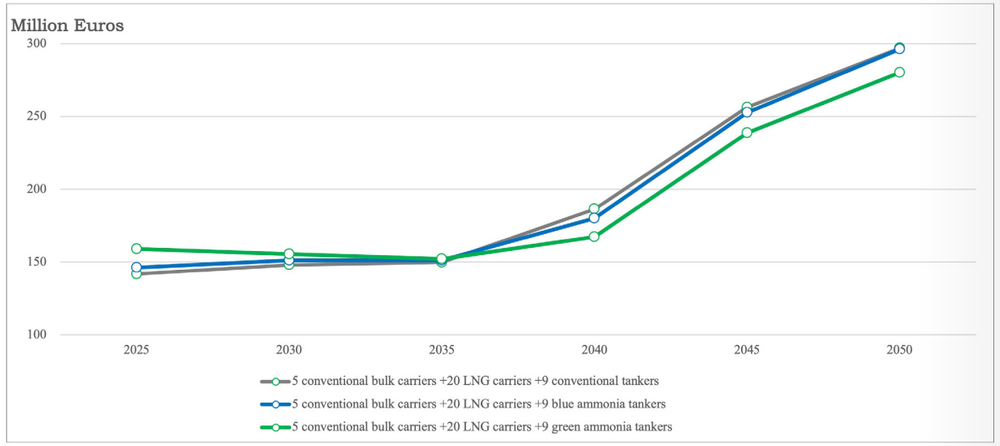
- If carbon emission accounted solely based on tank to wake, methanol fuel is not competitive in terms of economy.
- It's envisaged that in future the ship emission will be accounted based on life cycle assessment (LCA), the economy of using green methanol will gradually emerge.

Break even point: When the price is higher than the multiple of HFO or grey methanol, the OPEX of green methanol is higher than HFO or gray methanol



Economy analysis for a simulated fleet under ETS + FuelEU

• The cost variation of a simulated fleet with different fuel choice (assue ETS: 100 Euro/ton)

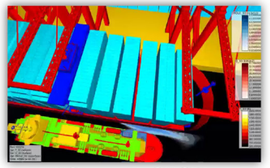


- Introducing low-carbon fuel ships too early is not the best choice to reduce the cost, and 2035-2040 may be a good period based on calculation result under current regulation assumption.
- Through the implementation of the joint pool can effectively control the overall operating expenditure.
- Under the condition of limited compliance quota, priority will be given to low GHG intensity fuel vessels.

Risk based solution and equivalent design

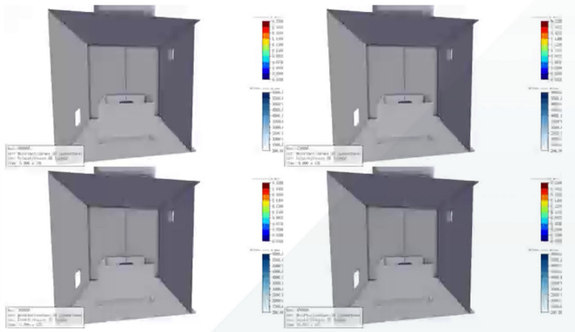


LNG fueled ship passing lockage



LNG bunkering SIMOPs

Example: is the 30 times air change per hour requirement reasonable for methanol?



methanol dispersion simulation and assessment

Joint development of novel ship types

Case: energy saving, high efficient and environment friendly methanol bunkering vessel

input

- Demand investigation on the methanol bunkering vessel;
- Bunkering opeartion mode analysis;

assessment

- Preliminary arrangement of bunkering vessel
- Tank capacity evaluation;
- Main dimension evaluation;
- Bunkering and propulsion solution

basic design

- GA;
- Hydrodynamic and mooring analysis;
- Model test;
- Bunkering system design
- QRA
- AIP



complex operation environment



mutual influence

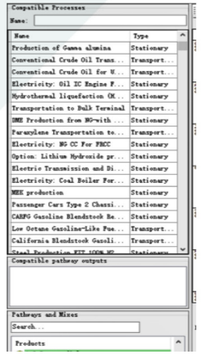
Green fuel certification

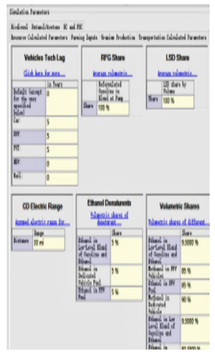
- CCS released the Guidelines for assessment and certification of lifecycle GHG intensity of marine fuels.
- CCS is the accredited body by ISCC for fuel certification

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船用燃料全生命周期标签
MARINE FUELS LIFECYCLE LABEL

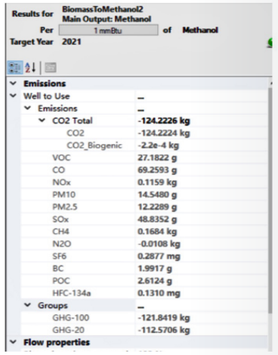
燃料名称	原料属性*	产地	WTT排放强度（gCO_{2eq}/MJ）（基于GWP20/GWP100得到）	核定方式**	数据来源（如适用）	混合占比***

Fuel Lifecycle Label









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APR, 2023