OUR OCEAN
BUSAN, KOREA, 28-30 APRIL 2025

2025 Our Ocean Conference

Seminar on Ammonia as Clean shipping fuel towards Shipping Decarbonization

Busan, Korea, 30 April 2025

UPA ULSAN PORT AUTHORITY

PACIFIC ENVIRONMENT

Seminar on Ammonia as Clean shipping fuel
towards Shipping Decarbonization

Contents

Seminar on Ammonia as Clean shipping fuel
towards Shipping Decarbonization

Program

Title	Seminar on Ammonia as Clean shipping fuel towards Shipping Decarbonization
Date/Venue	30 April, 2025 / Conference Room 212, Exhibition Hall 1, BEXCO, Busan, Korea
Organizer	Ulsan Port Authority, Pacific Environment
Official Language	English

Time	Program	Speaker
14:00-14:30	Registration	
	Opening Session	
14:30-14:35	Opening Remarks	**Soonyo, Jeong** Vice president Ulsan Port Authority
	Session 1. Presentation _ The State of International Shipping Green Fuel Policies	
	MC	**Jeongheon, Moon** Deputy Manager Ulsan Port Authority
14:35-14:45	International Shipping Green Fuels and Bunkering Policies and Implications for Asia	**Davina, Hurt** California Climate Director Pacific Environment
14:45-14:55	Plan to transform Ulsan Port into a Leading Green Energy Logistics Hub	**Jinwon, Choi** Deputy General Manager Ulsan Port Authority
14:55-15:05	United Kingdom's Maritime Decarbonisation strategy	**Lola, Fadina** Director of Maritime Department for Transport
15:05-15:15	Current status of green-fuel bunkering at the Port of Yokohama, Japan	**Hitoshi, NAKAMURA** Director Port and Harbor Bureau, City of Yokohama
	Session 2. Panel Discussion _ Challenges of Green Fuel, Ammonia	
	Moderator	**Boram, Kim** Senior Researcher Korea Maritime Institute
15:15-15:20	Presentation 1	**Jeongmin, Cheon** Responsibility Researcher Fire Insurers Laboratories of Korea(FILK)
15:20-15:25	Presentation 2	**Oliver Yasuhito, Imaizumi** Project Manager Fonden Maersk Mc-Kinney Moller Center for Zero Carbon Shipping
15:25-15:30	Presentation 3	**Samuel, Soo** Regional Director (Japan & Korea) Singapore Maritime and Port Authority
15:30-15:50	<Panel Discussion Topic> • What are the biggest challenges to enabling clean ammonia fuels in shipping? • What are the important public and private measures to secure and promote the availability and utilization of clean ammonia fuel and infrastructure? • What do you think is an alternative to the safety issues that come with the promotion of clean ammonia fuels?	
	Closing Session	
15:50-15:55	Closing Remarks	**Grace, Healy** Deputy Director, Climate Campaign Pacific Environment
15:55-	Group Photo	

OUR OCEAN
Busan, KOREA, 28-30 April 2025

Seminar on Ammonia as Clean shipping fuel towards Shipping Decarbonization

Session 1

Presentation

The State of International Shipping
Green Fuel Policies

Session 1. Presentation _ The State of International Shipping Green Fuel Policies

International Shipping Green Fuels and Bunkering Policies and Implications for Asia

Davina, hurt
California Climate Director
Pacific Environment

Biography

Davina Hurt serves as the California Climate Policy Director at Pacific Environment, where she leads efforts to accelerate maritime decarbonization and advance climate justice.

A distinguished public servant, attorney, and former mayor, Davina brings decades of experience in environmental governance, clean air policy, and consumer protection. Davina was appointed by Governor Gavin Newsom of California to serve on the California Air Resources Board (CARB) enacting landmark decision such as ACC2, ACT, locomotive Initiatives, ACF, Commercial Harbor Craft, LCFS and chaired the Bay Area Air Quality Management District (BAAQMD) board of directors– the United States' first regional air pollution control agency. Davina championed California's transition to zero-emission transportation, having served on the public policy board of Veloz and chairing BAAQMD's inaugural Community Health Equity and Justice Committee.

Davina's public service spans local, state, and regional levels. She served three consecutive terms on a California Department of Consumer Affairs board, focusing on policy reform and court justice. A senior public policy fellow and frequent keynote speaker, she also contributes her expertise to the non-profit boards of the Legal Aid Society of San Mateo County and Santa Clara University's Government Ethics Council at the Markkula Center.
Davina holds a Juris Doctorate from Santa Clara University School of Law, where she earned a specialized certificate in international public law and externed with the United States District Court for the Northern District of California. She also pursued advanced studies in human rights law at the University of Strasbourg and the René Cassin International Institute for Human Rights in Geneva, Switzerland. Davina earned her B.A. in history and political science, with a minor in biology, from Baylor University.

Based in San Francisco, California, Davina is committed to bold, equity-driven leadership in addressing the world's most urgent environmental and social challenges.

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The Green Shipping Fuels that Shape the Future: Global Policy and Pacific Action Will Decarbonize the Ocean

Davina Hurt Esq.
California Climate Policy Director, Pacific Environment
Our Oceans Conference Busan, South Korea - April 2025

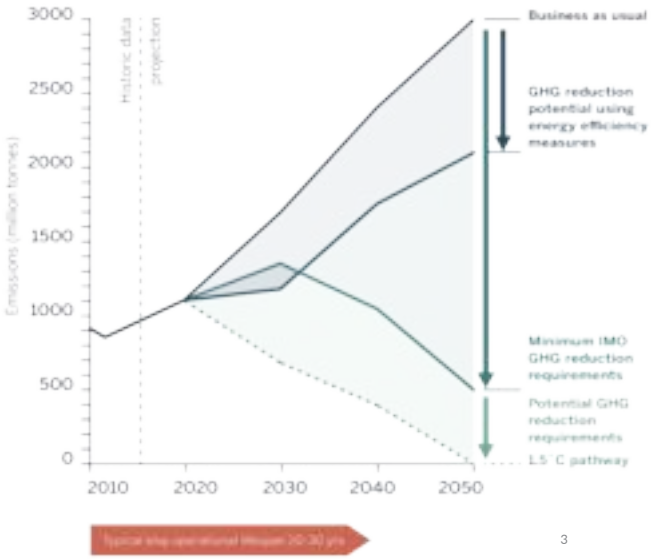
Our Oceans Connect Us...

Across continents, cultures, economies, and generations.
Carrying commerce, memory, and the promise of shared prosperity.

The True Cost of Global Trade

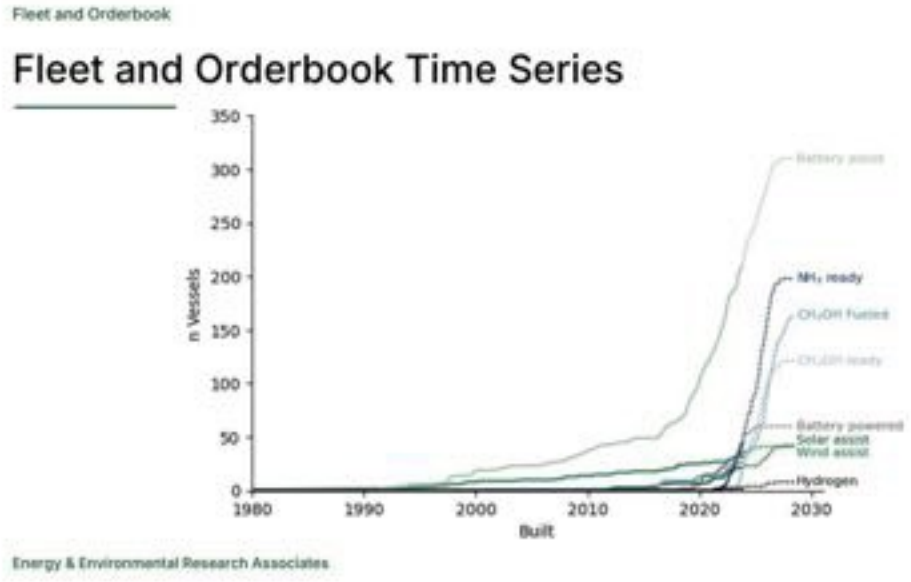
- If International Shipping Were A Country, It Would Be The Sixth-largest Emitter On Earth — Producing As Much Pollution As All U.S. Coal Plants Combined, And Outpacing Most Industrialized Nations.
- Globally, ~265,000 Premature Deaths Were Projected For 2020 (~0.5% Of Global Mortality) Attributable To Global Shipping-sourced Emissions.
- Nearly 31 Million People In The US Live Within 3 Miles Of A Port – And Ships Are A Major Source Of Fossil Fuel Pollution In These Communities.

748 MILLION PEOPLE, OR ABOUT 10% OF THE GLOBAL POPULATION, LIVE WITHIN 5 KILOMETERS OF THE COAST.

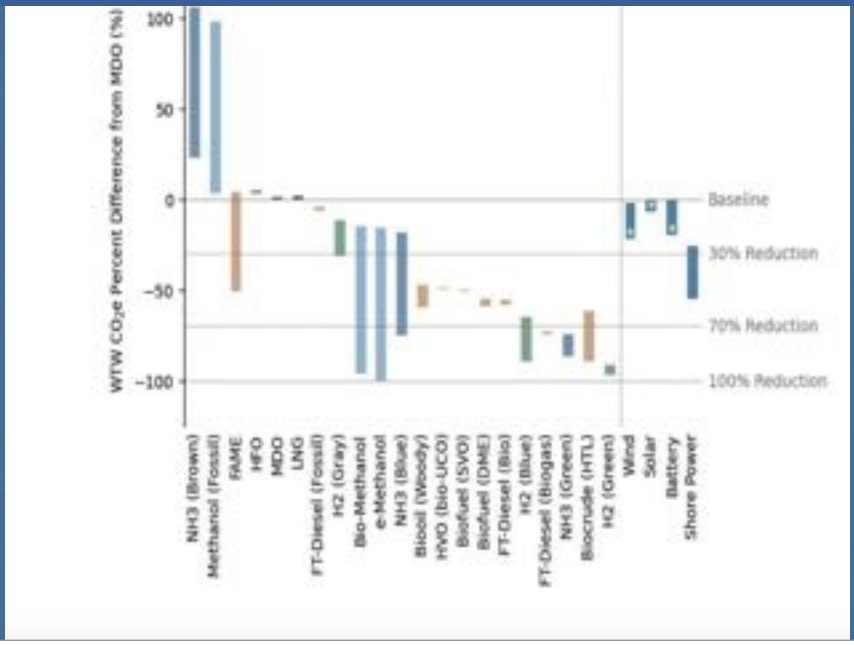


Pacific Environment

Shipping's Fuel Future: Fleet and Orderbook Insights



Decarbonization Potential of Marine Fuels Compared to MDO



Satellite Vessel Tracking + HFO/VLSFO Impacts

Climate Impacts

Air Pollution & Public Health

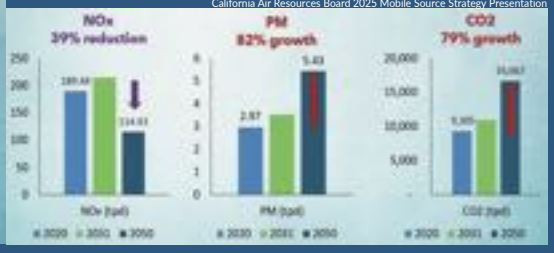
Oceanic Spills

The vast majority — roughly 70 to 80% — of the ships you see here are still fueled by heavy fossil fuels like HFO or VLSFO. These fuels contribute directly to air pollution, climate change, and oceanic spill risks — creating invisible damage every day.

Ocean-Going Vessels

- Equipment: Container, Cruise, Refrigerated Cargo, Bulk Cargo, Tankers, and Auto Carriers (roro)
- Fuel: 100% Marine Diesel Oil (MDO) - distillate grade, 0.1% sulfur in 2020
- Population: 1,470 unique vessels per year, roughly 7,800 vessel visits per year

California Air Resources Board 2025 Mobile Source Strategy Presentation



-Policy Options Report- -Technical Assessment-

May 2024

Pacific Environment campaigns to stop climate change by working to fast-track key industries toward zero carbon emissions.

We focus on major global industries that have received less public attention but whose carbon emissions are significant and still growing: the maritime shipping and the petrochemical (plastics) industries. Both industries also cause large-scale damage to our region's ecosystems and produce extensive pollution that harms people and all living things.

Investments Are Just Beginning…

Alternative Fuel Readiness and Supplemental Power Systems on Oceangoing Vessels

October 2023	Built	Orderbook	Total
Battery Assist	209	101	310
Battery Power	36	24	60
CH_3OH Fueled	26	138	164
CH_3OH Ready	16	105	121
Hydrogen	2	6	8
NH_3 Ready	44	154	198
Solar Assist	21	21	42
Wind Assist	32	9	41
Total	**141**	**433**	**574**

"The ships that built globalization must now fuel global survival."

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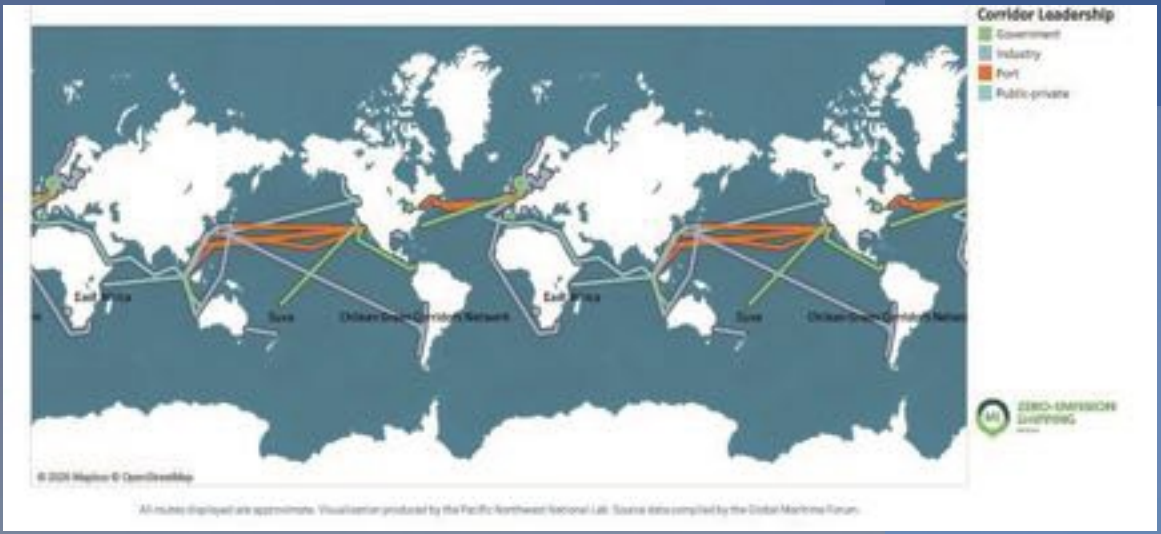
Green Shipping Corridor Routes Expanding…

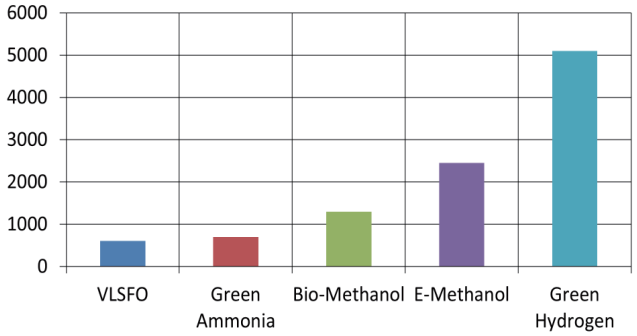


Fueling the Transition: Hydrogen, Methanol, and Ammonia in Clean Shipping

Category	Green Hydrogen	Green Methanol	Green Ammonia
Production	Electrolysis of water using renewable energy	CO_2 capture + green hydrogen, or biomass gasification	Green hydrogen + nitrogen from air (Haber-Bosch process)
Storage & Handling	Compressed gas (350–700 bar) or liquid at -253°C; requires cryogenic tanks	Liquid at ambient temps (~65°C boiling point); easy storage	Liquid at -33°C or mild pressure (~10 bar); requires specialized materials
Engine Compatibility	Mature for fuel cells; hydrogen ICEs emerging	Usable now in modified ICEs; dual-fuel and methanol fuel cells emerging	Engines under development (MAN, Wärtsilä); can also power solid oxide fuel cells
Safety Considerations	Extremely flammable; prone to leaks; requires strict detection and ventilation	Flammable and toxic; manageable with established industrial practices	Highly toxic and corrosive; strict protocols similar to LPG handling
Energy Density	~5.6 MJ/L (compressed) or ~8.5 MJ/L (liquid); very low	~15.8 MJ/L (~43% of MGO); moderate	~11.5 MJ/L (~31% of MGO); better than hydrogen but lower than methanol
Current Production	95% fossil-based ("gray"); green production growing but costly	Mostly fossil-based today; green methanol scaling up	Today's ammonia is fossil-derived; green ammonia production is early but gaining momentum

Estimated Marine Fuel Prices (2025)

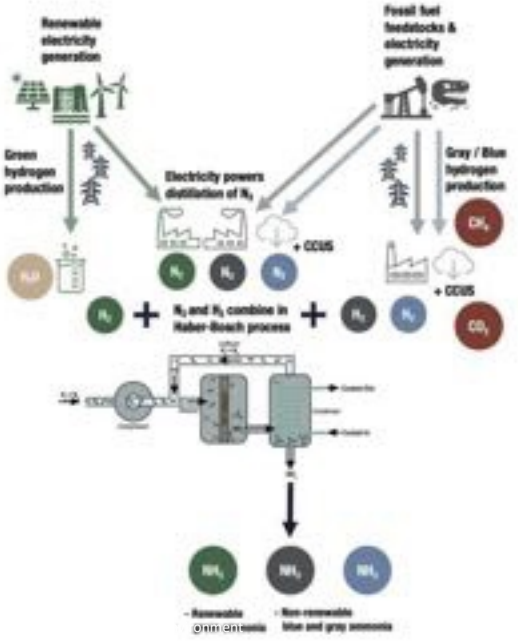
Price per Metric Ton (USD)



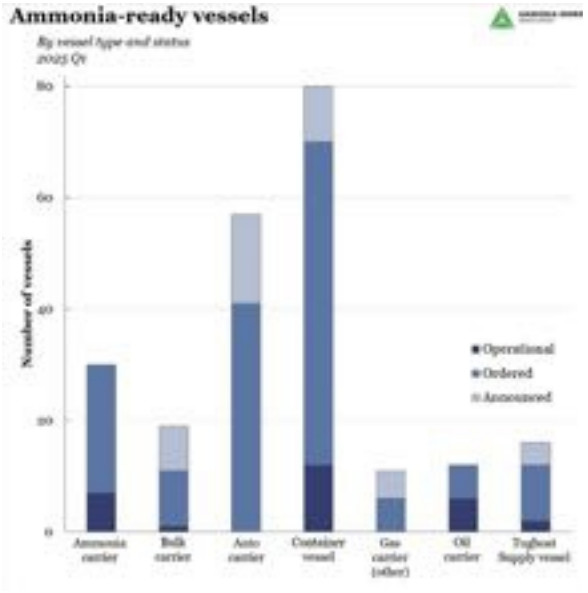
~$700 - **Green Ammonia** - Zero-carbon fuel; prices expected to decrease with scale-up.
$4,840–$5,370 - **Green Hydrogen** - Produced via electrolysis; costs vary by region .
€1,193 (~$1,300) - **Bio-Methanol** - Produced from biomass; price influenced by EU regulations .
€2,238 (~$2,450) - **E-Methanol Synthesized using renewable energy**; higher production costs .
$585–$650 - Very Low Sulfur Fuel Oil (VLSFO) - Widely used conventional marine fuel; subject to EU ETS costs .
Note: Currency conversions are approximate and based on exchange rates at time of snapshot.

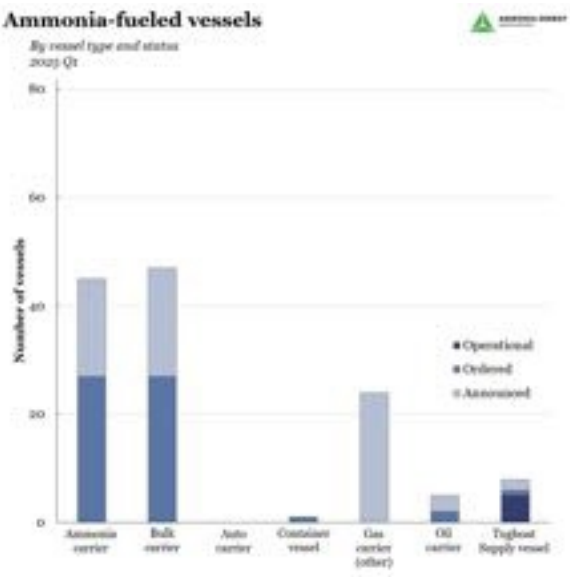
Marine Fuels

Ammonia

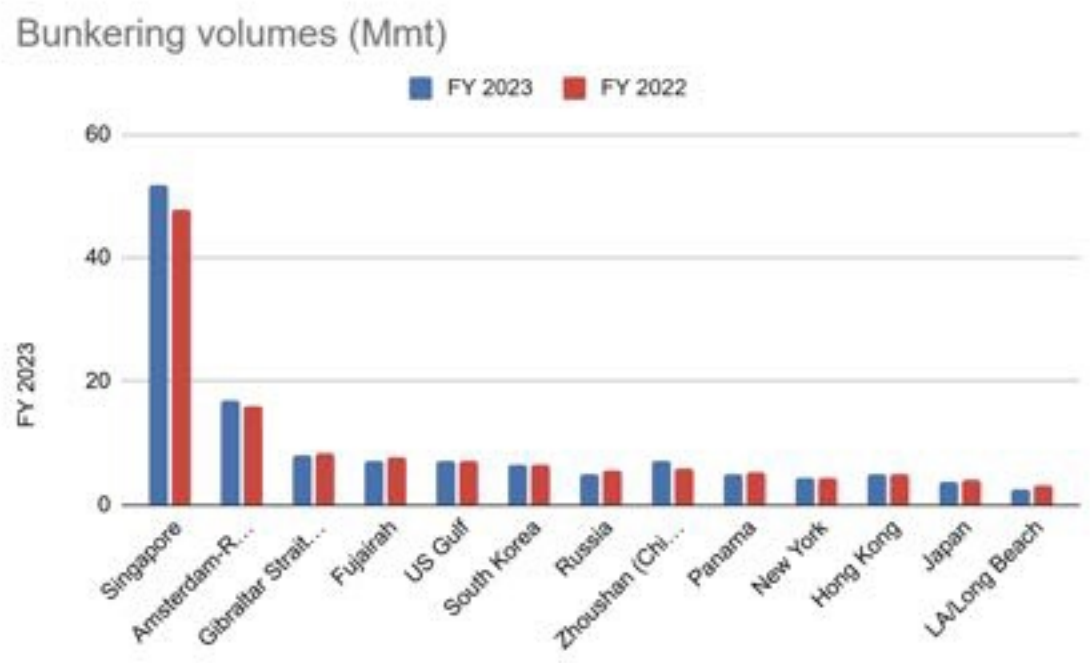


Energy & Environmental Research Associates

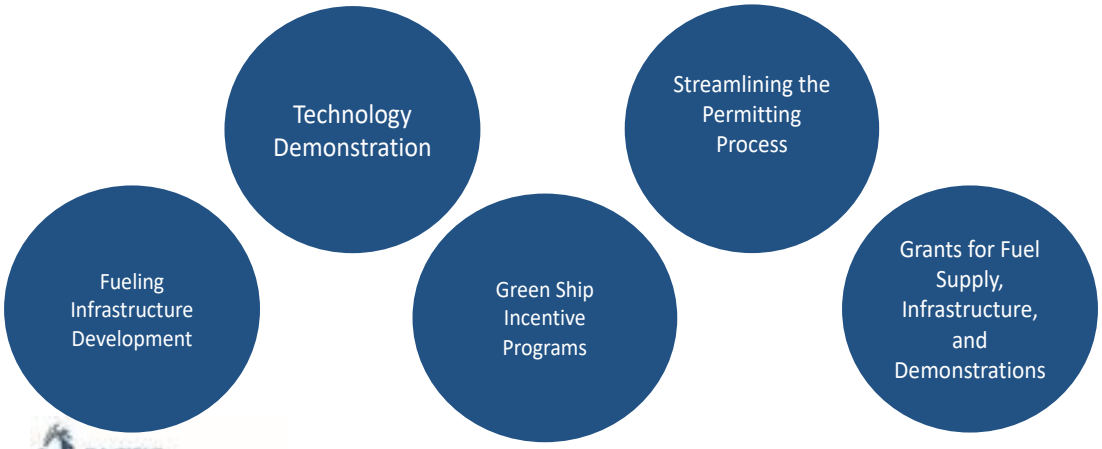

Ammonia-ready vessels
By vessel type and status
2025 Q1
Number of vessels
Operational
Ordered
Announced
Ammonia carrier
Bulk carrier
Auto carrier
Container vessel
Gas carrier (other)
Oil carrier
Tugboat Supply vessel


Ammonia-fueled vessels
By vessel type and status
2025 Q1
Number of vessels
Operational
Ordered
Announced
Ammonia carrier
Bulk carrier
Auto carrier
Container vessel
Gas carrier (other)
Oil carrier
Tugboat Supply vessel


Annual Bunker Demand Change, 2024 vs 2023
At key global bunkering locations
Net Change in Demand 4.0%
ARA 3%
Russia 13%
New York 16%
LA / Long Beach 10%
Gibraltar Strait 2%
Turkey 10%
South Korea 12%
Japan 14%
Zhoushan 2%
USGC 1%
Canary Islands 29%
Fujairah 7%
Hong Kong 5%
Panama 4%
West Africa 13%
Singapore 5%
South Africa 23%
Ship&Bunker
2050 Marine ENERGY
2024 - Q1 Volumes | Q2 Volumes | Q3 Volumes | Q4 and Full Year 2024 Volumes



Recommendations to accelerate adoption of clean marine fuels -
Clear policy mandates, combined with government and private investment, and sustained industry commitment, will be critical to accelerating progress and securing the long-term sustainability of maritime operations.



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Presentation name here, shorten if needed

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First Movers Have an Advantage...

1. Early leadership in **ZECV shipbuilding** = **greater market share** and **export opportunities**.
2. Countries investing early in clean technologies are **positioned to capture first-mover benefits**.
3. Continued investment in **green fuels and zero-emission technologies** is crucial to securing long-term advantages.

Source: ICCT, Zero-Emission Vessels: Market Opportunities and Revenue Impacts for Shipbuilders (2024).

Thank you !

Davina Hurt
California Climate Policy Director
Pacific Environment

dhurt@pacificenvironment.org

OUR OCEAN
Busan, KOREA, 28-30 April 2025

Session 1. Presentation _ The State of International Shipping Green Fuel Policies

Plan to transform Ulsan Port into a Leading Green Energy Logistics Hub

Jinwon, Choi
Deputy General Manager
Ulsan Port Authority

Biography

Career :

2024 - Present	Ulsan Port Authority, Sustainable Energy Team
2018 - 2024	Ulsan Port Authority, Strategy Planning Department
2013 - 2018	Ulsan Port Authority, Logistics Strategy Team

Education :

2009 - 2013	B.A. in English Literature/Business Administration, Kyungpook National University
2003 - 2007	Macleans College

울산항만공사 ULSAN PORT AUTHORITY

Plan to Transform Ulsan Port into a Leading **Green Energy Logistics Hub**

Vision and Development Direction of Ulsan Port

Contents

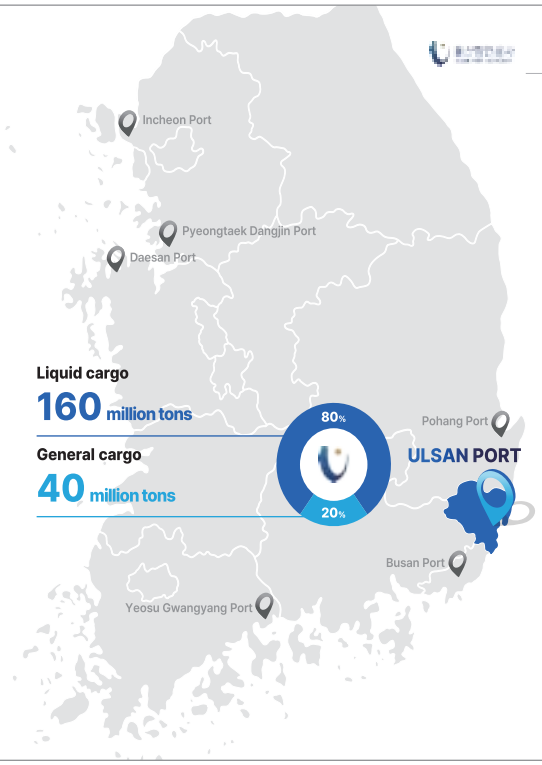
울산항만공사 ULSAN PORT AUTHORITY

Ulsan Port Overview

Location and Cargo Volume

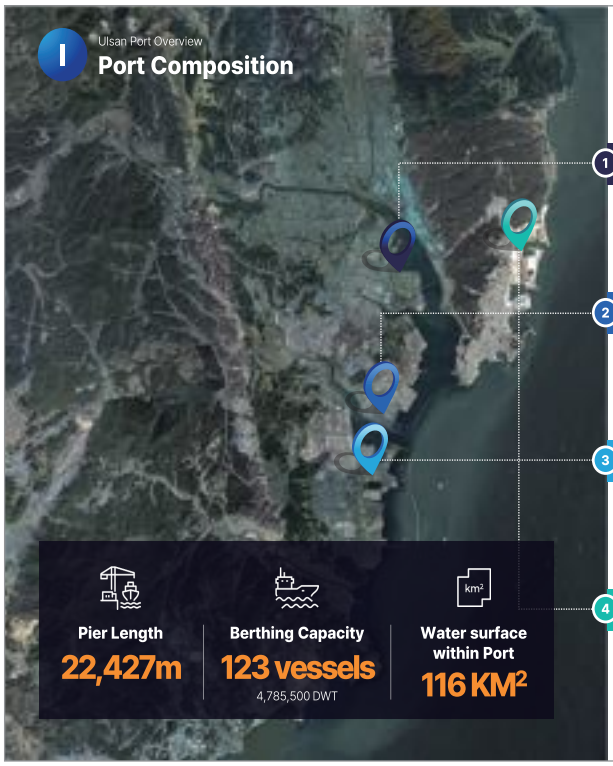
Unit : million tons

Busan Port	463
Yeosu Gwangyang Port	274
ULSAN PORT	**200 million tons**
Incheon Port	148
Pyeongtaek Dangjin Port	117
Daesan Port	90
Pohang Port	48
Other Ports	245
Nationwide	**1,585**



Ulsan Port Overview

Port Composition



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1 Main Port

Length	10,085m
Berthing Capacity	60 vessels(1,815,500 DWT)
Cargo Type	Automobiles, General Cargo

2 New Port

Length	7,059m
Berthing Capacity	29 vessels
Cargo Type	LNG, Petroleum Products, Containers

3 Onsan Port

Length	5,073 m
Berthing Capacity	33 vessels(1,807,000 DWT)
Cargo Type	Petrochemical Products

4 Mipo Port

Length	210 m
Berthing Capacity	-
Cargo Type	Ship building Industry

I Ulsan Port Overview

History of Ulsan Port

1963 September 25th
Port Inauguration

1973 1976
Opening of Onsan and Mipo Ports

2007
Establishment of Ulsan Port Authority

2012
Opening of New Port

2013~
Energy Hub Phase 1 Completion

2014 2017
Completion of Ulsan Port Hinterland

2023
Designation as a Green Fuel Bunkering Hub Port

Since 1963
62
YEARS
of History

Tank Terminal Capacity
No.1 in Korea
4.5 Million Kℓ

Liquid Cargo Exports Volume
No.1 in Korea
160 Million tons

Gateway for Korea's Exports
13% of the nation's total exports
88 Billion USD

Added Value Created
Impact of Regional Economy
17 Billion USD

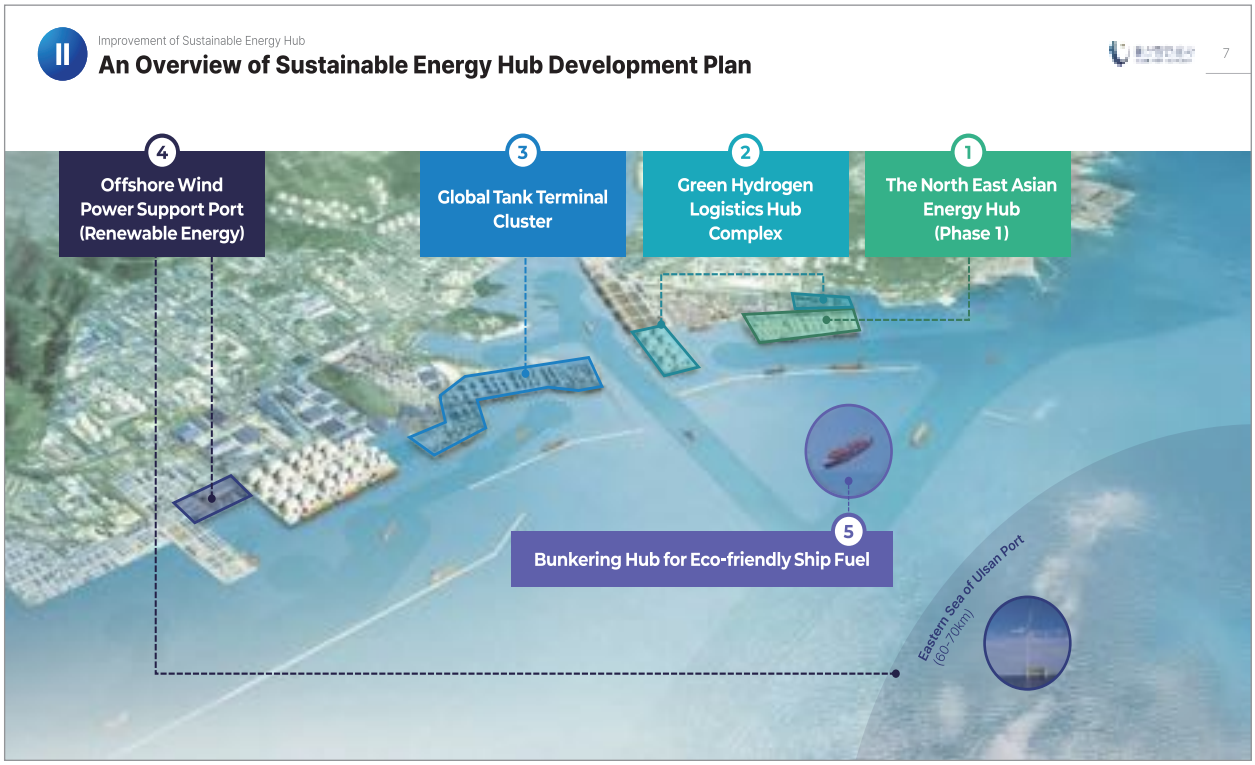
I Ulsan Port Overview

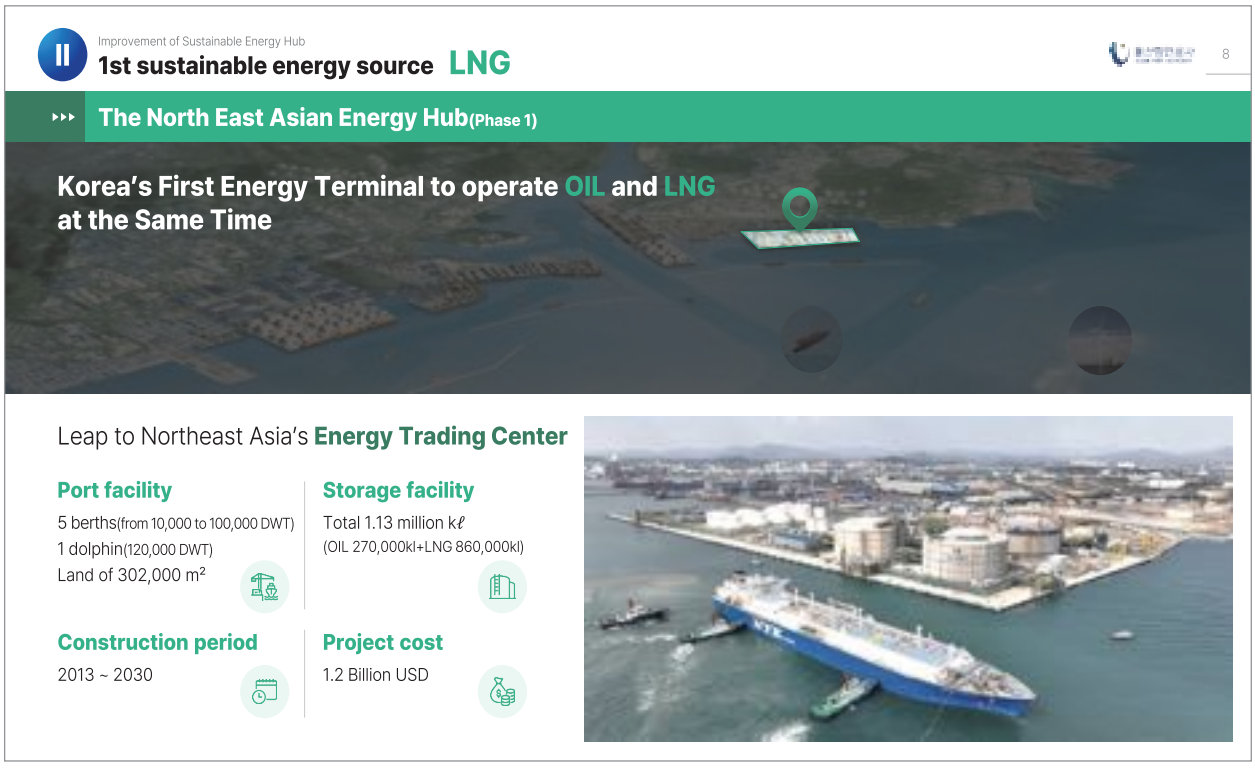
Value Chain of Ulsan Port Authority

UPA	Korean Government	UPA	UPA		
Development Planning	Policy Approval and Licensing	Port Construction	Cargo Marketing	Port Management and Operations	Facility Maintenance

Development Planning Policy Proposal and Recommendation	Implementation of National Policy Permits and Approvals	Planning and Design Construction	Selection of Operators Cargo Marketing	Port Operation Management of Port Facility	Facility Inspection And Repair Facility Performance Improvement

① Port Logistics | **② Port Operation** | **③ Port Construction And Maintenance**


II
Improvement of Sustainable Energy Hub
An Overview of Sustainable Energy Hub Development Plan
7
4
Offshore Wind Power Support Port (Renewable Energy)
3
Global Tank Terminal Cluster
2
Green Hydrogen Logistics Hub Complex
1
The North East Asian Energy Hub (Phase 1)
5
Bunkering Hub for Eco-friendly Ship Fuel
Eastern Sea of Ulsan Port
(60~70km)


II
Improvement of Sustainable Energy Hub
1st sustainable energy source LNG
8
The North East Asian Energy Hub(Phase 1)
Korea's First Energy Terminal to operate OIL and LNG at the Same Time
Leap to Northeast Asia's Energy Trading Center
Port facility
5 berths(from 10,000 to 100,000 DWT)
1 dolphin(120,000 DWT)
Land of 302,000 m²
Storage facility
Total 1.13 million kℓ
(OIL 270,000kl+LNG 860,000kl)
Construction period
2013 ~ 2030
Project cost
1.2 Billion USD

II Improvement of Sustainable Energy Hub

2nd sustainable energy source Ammonia & Green Hydrogen

Green Hydrogen Complex

2-1 Ulsan new port(Northern area)

Green Hydrogen Logistics Hub

Ammonia Import, Storage and Hydrogen Cracking Terminal

- **Site area** 349,000m²
- **Construction period**
  Phase1 : ~2030 | **Phase2** : ~2040

PHASE 1
Ammonia storage tank/cracking plant

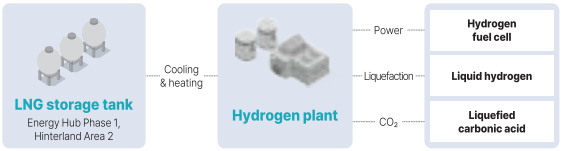
PHASE 2
Hydrogen Related Industry

2-2 Ulsan New Port Hinterland

LNG + Hydrogen Complex Plants

Production and supply of hydrogen by using LNG cooling and heating

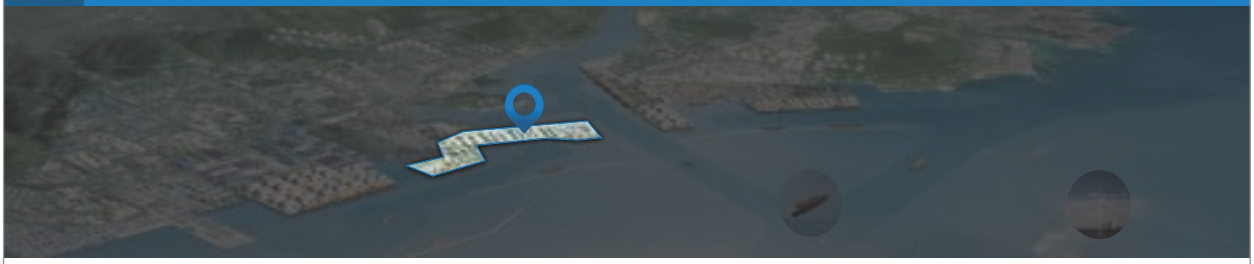
- **Site area** 181,000m²
- **Construction period** 2024 ~ Currently Undergoing Construction



II Improvement of Sustainable Energy Hub

3rd sustainable energy source Methanol

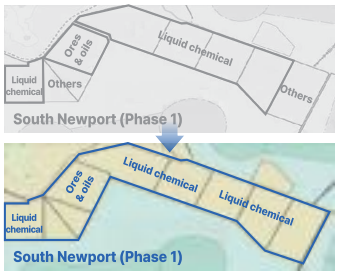
Global Tank Terminal Cluster Expansion Plan



Korea's Largest Commercial Tank Terminal Cluster to be Expanded
By Transforming Ulsan new port into an Exclusive Port For Liquid Chemical Cargo Cluster

	2024	2030
Storage capacity	750 units / 4.5M Kℓ	820 units / 5M Kℓ
Cargo Volume	24 Million tons	29 Million tons
Cargo Type	Petrochemical products	Low-carbon energy (Methanol & Ammonia)

Tank Terminal Cluster Project



II Improvement of Sustainable Energy Hub

4th sustainable energy source Offshore Wind Farm

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One of Korea's Largest Offshore Wind Farm Project

The Renewable Energy Project Capitalizes On **Abundant Wind Resources In Ulsan's Sea** And **The High Power Demand From The Hinterland Complex**

WHY ULSAN

- **IDEAL LOCATION** for developing port facilities powered by wind farms
- **WORLD-CLASS TECHNOLOGIES** for shipbuilding and offshore plants
- **VAST WIND RESOURCES** with an average wind speed of 8.5 m/s ↑
- **LARGEST ELECTRICITY DEMAND** from the hinterland complex powered by renewable energy support

Pier facility

Ulsan new port(Southern area)	
Pier facility	2 berths (up to 50k DWT) in 170,000 m²
Construction period	2025 ~ 2030
Project cost	100 Million USD

Windfarm facility

The eastern sea of Ulsan Port (60km away from inland)	
Windfarm facility	A floating type with 6.0 GW generation capacity
Construction period	2028 ~
Project cost	25 Billion USD

III Establishment of Green Ship Fuel Supply Chain

Roadmap to Achieve Carbon Neutrality with Green Ship Fuel

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To achieve carbon neutrality, **energy conversion to low-carbon and carbon-free fuels is essential** in domestic and international industries.

International Community

Paris Agreement
2050 Carbon Neutrality Adoption (2015)

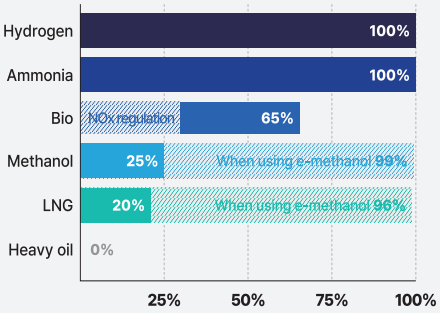
International Maritime Organization
2050 Carbon Neutrality Agreement (2023)

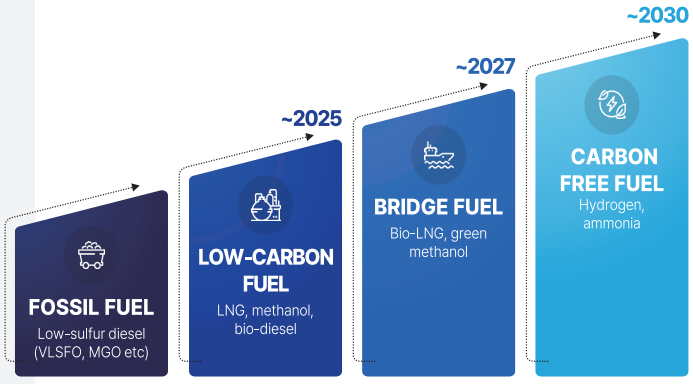
Korean Government

Declaration of Achieving Carbon Neutrality by 2050 (2020)

International Shipping Carbon Neutrality Target 2050 (2023)

Greenhouse gas reduction by fuel





Best Practice Case Study :
World's first Green Methanol Bunkering to a Container Vessel in 2023

UPA – Odfjell terminal, marketing for Methanol Tank investment

UPA – KR, Technical cooperation on Methanol bunkering

UPA – Hyundai Oil terminal, MOU for Methanol Tank investment

UPA, Methanol bunkering Seminar With specialists

UPA, a group of experts in methanol And shipping was formed for bunkering

UPA – KOR MOF, Terminal inspection of methanol bunkering

① Methanol Value Chain Development → **② Deregulation** → **③ Planning and Safety Manual** → **④ Execution of Methanol Bunkering**

The First Step Towards Methanol Bunkering Industry

UPA – HD HHI, Methanol value chain & bunkering MOU

UPA- AP Moller –Maersk, OCI Global, Attracts Green Methanol Bunkering

The world's first green methanol PTS Bunkering to a container vessel

Green Methanol STS Bunkering for the World's first Ultra-large Container ship

1st Green Methanol PTS Bunkering (Jul 2023)

1,000 tons of Green Methanol were successfully supplied to a 2,100 TEU container vessel ordered by A.P. Moller - Maersk

1st Super Container Ship STS Methanol Bunkering (Nov 2023)

1,000 tons of Green Methanol Bunkering successful for a 16,200 TEU container vessel ordered by A.P. Moller - Maersk

III Establishment of Green Ship Fuel Supply Chain

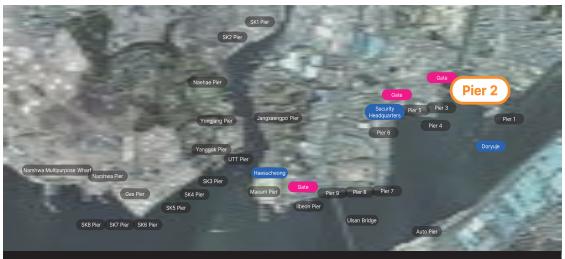
Establishment of Green Ship Fuel Supply Chain

Ammonia Bunkering

Strengths of Ulsan Port In Ammonia Handling

Government 4th Hydrogen Economy Committee(Nov 2021)
- Ulsan Port is selected as the Leading Port for Hydrogen

- Ulsan Port 2 Pier imports 700,000 tons of ammonia per year(60% of domestic imports)
- Accident-free operation for more than 40 years



Ulsan Main Port

World's First Clean Ammonia Import to Ulsan

- World's First Commercial Production of Clean Ammonia
- 50,000 tons of Blue Ammonia Imported to Ulsan(2022)

Clean Ammonia Ulsan Port Entry Ceremony

Thank You!
Q & A

OUR OCEAN
Busan, KOREA, 28-30 April 2025

Session 1. Presentation _ The State of International Shipping Green Fuel Policies

United Kingdom's Maritime Decarbonisation strategy

Lola, Fadina
Director of Maritime
Department for Transport

Biography

Career :

2024 - Present	Director of Maritime at the Department for Transport
	UK Department for Transport Representative on the LISW25 Advisory Board
Former	Interim Joint Deputy Director for Maritime Safety and Environment, UK Department for Transport
	International Maritime Relations Officer, EU Commission
	Deputy Director for International Travel, UK Department for Transport
	Deputy Director for Investment and Digital Trade at the Department for International Trade, UK, and previously responsible for environment, clean fuels and vehicles, and aviation affairs

Department for Transport

UK Maritime Decarbonisation

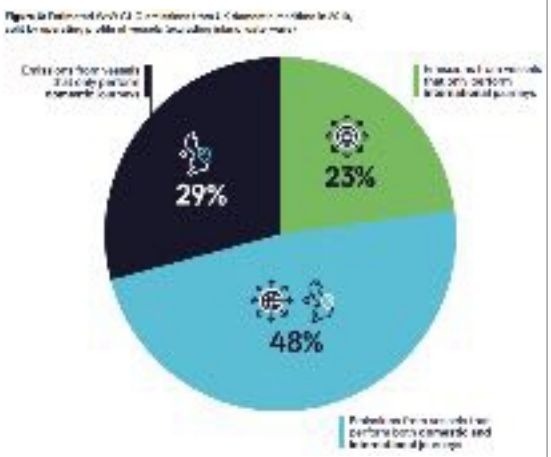
Lola Fadina

OFFICIAL SENSITIVE

Maritime Decarbonisation Crosses International Boundaries

The Maritime sector is inherently international, and international action has impacts on domestic emissions.

- The UK is taking action to reduce emissions on both a global and domestic level.
- The UK pushed for high ambition at the IMO in April. The landmark deal agreed should meaningfully reduce the greenhouse gas emissions from international shipping, raise significant revenues to kickstart the sector's decarbonisation and support a just and equitable transition.
- We are now working to understand what the recently agreed IMO measures mean for our domestic plans and much will still depend on the outcome of MEPC in October.
- It is clear that international and domestic policy is linked. Action addressing international GHG emissions directly affects domestic GHG emissions - only 29% of the well-to-wake GHG emissions from the UK's domestic maritime sector came from **domestic only vessels**
- National action can also have international impacts, and domestic plans, such as our new **UK Maritime Decarbonisation Strategy**, play an important role.



OFFICIAL-SENSITIVE

Domestic Decarbonisation Goals

The UK published its Maritime Decarbonisation Strategy in March 2025, setting decarbonisation goals for 2030, 2040 and 2050 in alignment with the highest ambition of the 2023 IMO GHG Strategy

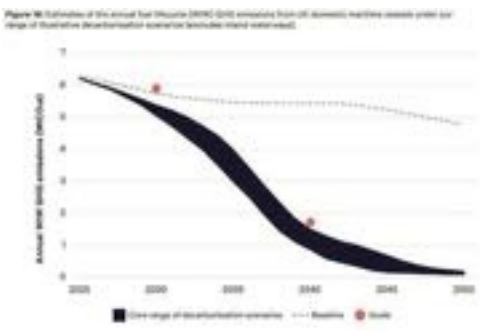
OFFICIAL-SENSITIVE

OFFICIAL-SENSITIVE

Overview of policies

The package of measures in the Strategy delivers an ambitious UK domestic emissions

- The goals we have set are stretching but achievable, through **five key policies:**
  - **Fuel Regulation**
    - UK fuel regulation, to be designed taking international measures into account
  - **Emissions pricing**
    - The UK Emissions Trading Scheme (UK ETS) will be extended to the maritime sector
  - **Emissions at berth**
    - Considering options to reduce emissions at berth, potentially through regulation
  - **Emissions from smaller vessels**
    - Exploring a range of options to reduce emissions from smaller vessels, which are not likely to be included in the above measures
  - **Energy Efficiency**
    - increasing the efficiency of maritime operations
- Supporting the UK Government's **Clean Energy**, **Growth** and **Health** Missions.



Notes:

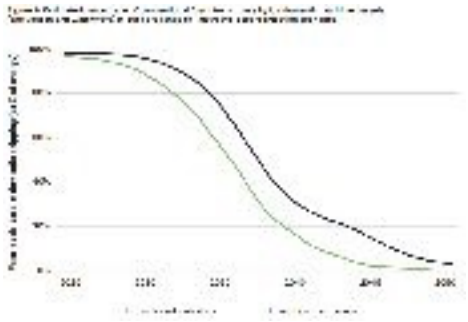
- A range of scenarios has been modelled to reflect various uncertainties, rather than a single central pathway
- Emissions from inland waterways are not included in modelling, so they are assumed to decline at the same rate as the rest of the sector

OFFICIAL-SENSITIVE

Common Themes for Decarbonisation

There are several areas where countries can learn and develop best practice together

- Reducing the use of conventional fuels (*right, fossil fuel use in UK domestic shipping*) will require scaling up the production of **zero, and near-zero, GHG emission fuels** and energy sources.
- There are huge **economic benefits** in the transition to clean shipping, but technological uncertainty and a lack of policy certainty can hold back investment in solutions to **scale up supply** of new fuels and technologies.
- **Research & development** is essential - there are a number of best practice demonstrations that we can learn from, in the UK supported through the UK Government's **UK SHORE Programme**
- For some zero, and near-zero, GHG emission fuels, such as Ammonia, we will also need to consider the **non-GHG impact** that increased production, transportation, storage and use could have on the environment.
- We also need to think about **people, skills and safety** to work with new kinds of fuels.



Session 1. Presentation _ The State of International Shipping Green Fuel Policies

Current status of green-fuel bunkering at the Port of Yokohama, Japan

Hitoshi, NAKAMURA

Director
Port and Harbor Bureau, City of Yokohama

Biography

Career :

City of Yokohama, Japan

2021 - Present	Director for Carbon Neutral Port Promotion Policy Coordination Division, Port and Harbor Bureau
2018 - 2021	Senior Manager of Planning Division Yokohama-Kawasaki International Port Corporation (A subsidiary of Port and Harbor Bureau, City of Yokohama)
2015 - 2018	Deputy Manager of Policy Coordination Division Port and Harbor Bureau
2011 - 2015	Deputy Manager of Planning Division Climate Change Policy Headquarters
2003	Joined City of Yokohama

Marubeni Corporation, Tokyo Japan

1999	Joined Marubeni Corporation, Food Division

Education :

1999	Tokyo University, Bachelor of Agriculture

Our Ocean Conference 2025 -Side Event-
Seminar on Ammonia as clean shipping fuel towards Shipping Decarbonization

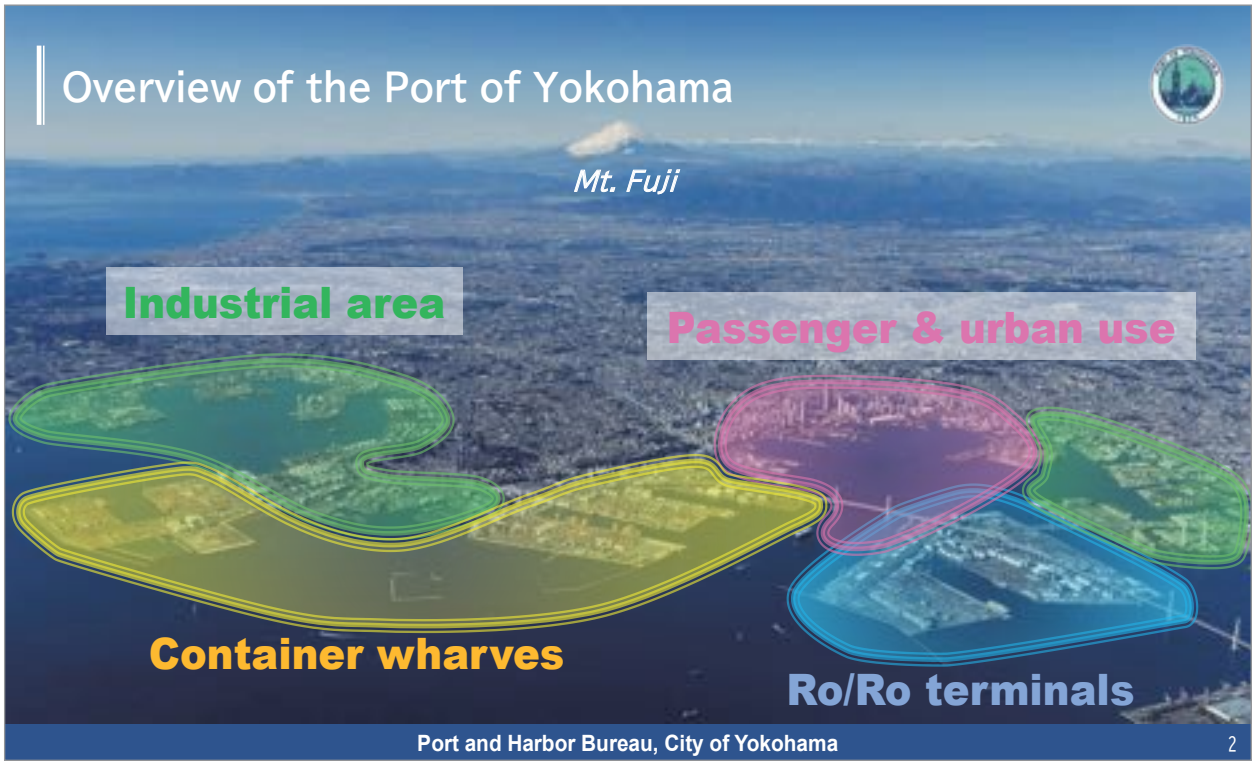
Current status of green-fuel bunkering at the Port of Yokohama

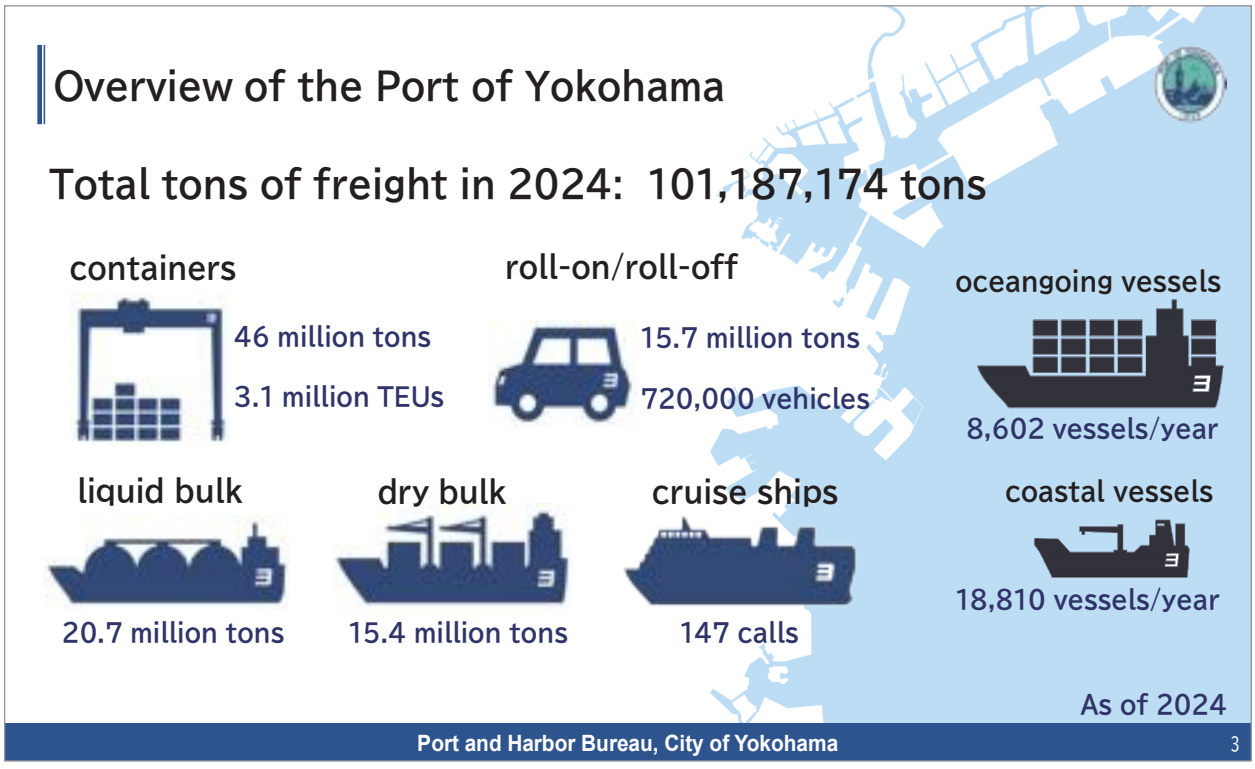
30th April 2025

Hitoshi NAKAMURA (Mr.)
Director for Carbon Neutral Port Promotion
Port and Harbor Bureau, City of Yokohama

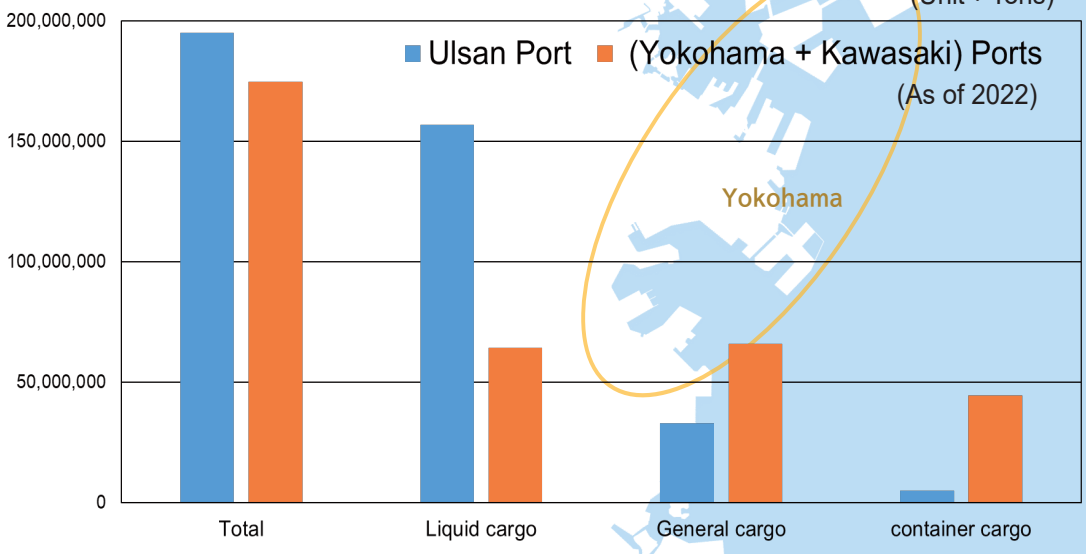
Overview of the City and Port of Yokohama

- International port city: port opened in 1859
- Second largest city in Japan
- Gross production: 97.6 billion USD (JPY150/USD)
- Population: 3.77 million
- 30 minutes from Tokyo Haneda Airport


Overview of the Port of Yokohama
Mt. Fuji
Industrial area
Passenger & urban use
Container wharves
Ro/Ro terminals
Port and Harbor Bureau, City of Yokohama
2


Overview of the Port of Yokohama
Total tons of freight in 2024: 101,187,174 tons
containers
46 million tons
3.1 million TEUs
roll-on/roll-off
15.7 million tons
720,000 vehicles
oceangoing vessels
8,602 vessels/year
liquid bulk
20.7 million tons
dry bulk
15.4 million tons
cruise ships
147 calls
coastal vessels
18,810 vessels/year
As of 2024
Port and Harbor Bureau, City of Yokohama
3

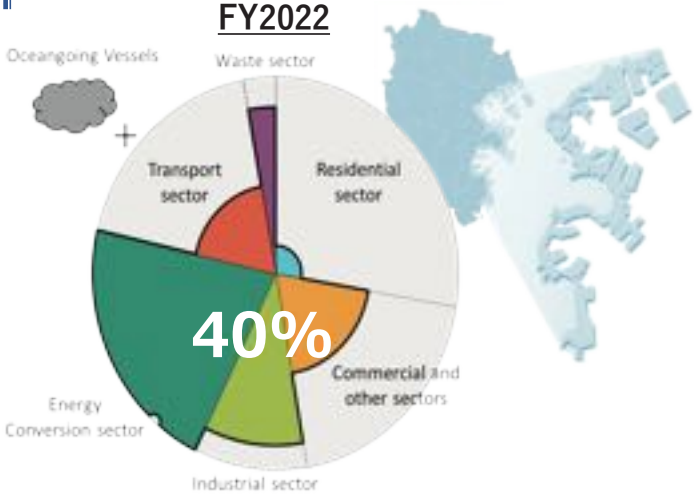
Comparison with Ulsan Port in Total Throughput



Port and Harbor Bureau, City of Yokohama 4

40% of CO2 emissions in Yokohama are from the waterfront area

FY2022



Inner: CO_2 emissions from the waterfront area (6,394kt-CO2)
Outline: CO_2 emissions from the city (16,209kt-CO2)

CO2 emissions from oceangoing vessels are not covered by the national GHG inventory of Japan and are not included in the emissions from the city.

Port and Harbor Bureau, City of Yokohama 5

Port and Harbor Decarbonization Plan for the PoY

Port and Harbor Bureau, City of Yokohama 6

Port of Yokohama CNP Sustainable finance framework

Driving the cycle for achieving a Carbon Neutral Port

①A project is added to the Decarbonization Plan

②Utilize Sustainable FW made by the City of Yokohama

③Access to sustainable financing

Port and Harbor Bureau, City of Yokohama 7

First Financing Agreement Utilizing Sustainable FW

The tugboat operator Daito Corporation and Mizuho Bank made the first contract to utilize the Port of Yokohama CNP Sustainable Finance Framework.

Borrower	Daito Corporation
Lender	Mizuho Bank
Contract amount	950 million yen
Date of Contract	March 25, 2025
Use of funds	Electric tugboat construction fund

Ammonia Bunkering

Ammonia Bunkering to an Ammonia Fueled Tugboat at the Port of Yokohama
～World's first Truck to Ship Method～ (July 2024～)

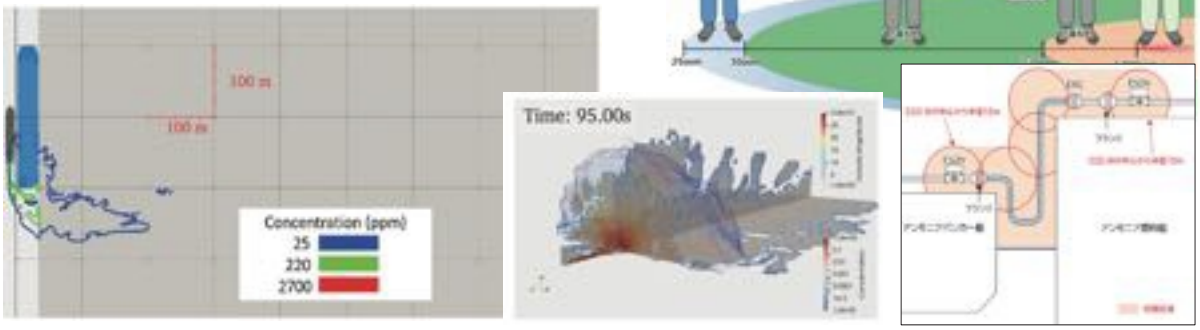
This is the world's first ammonia-fueled vessel for commercial use*.
Resonac Corporation has supplied its environmentally friendly low-carbon ammonia produced by "recycling used plastics".

*The "world's first" as of July 2024, according to research by NYK.

Ammonia Bunkering

Study Committee for the Implementation of Safe and Smooth Bunkering of Ammonia Fueled Vessels by MLIT Maritime Bureau (Jan 2024- March 2025)

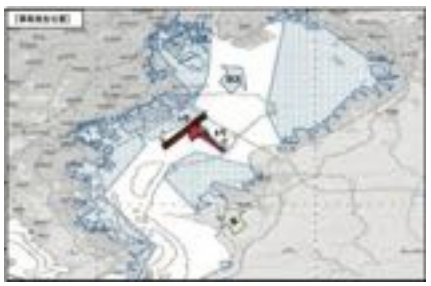
MLIT Maritime Bureau has finished its study and is preparing to release "Ammonia Bunkering Guidelines".

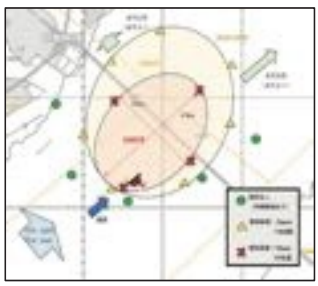


Ammonia Bunkering

Tokyo Bay Disaster Prevention Network - Information Transmission Training (Oct 2024)

- Example of accident;
  Collision between an ammonia fuel ammonia carrier and a chemical tanker within Tokyo Bay
- Organizations participating in the training are;
  3rd Regional Coast Guard Headquarters,
  City of Yokohama, City of Kawasaki, City of Chiba
  Tokyo Metropolitan, Kanagawa Prefecture, Chiba Prefecture





Methanol Bunkering(Green Methanol, e-Methanol)

Methanol bunkering simulation at the Port of Yokohama (Sep 2024)

MAERSK MITSUBISHI GAS CHEMICAL KSK idemitsu UYENO

LNG Bunkering

Our subsidiary JV company prepares LNG bunkering service in Tokyo Bay.

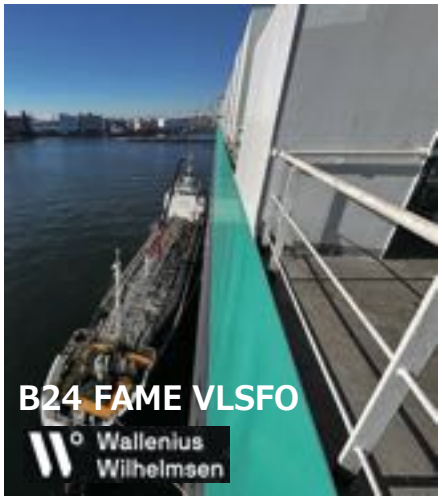
Planned mooring location @Honmoku-Pier

Onshore Power Supply for LNG Bunkering Vessel

*EBS is a second-tier subsidiary of the City of Yokohama.

Biofuel Bunkering

Biofuel supply is increasing for both STS and TTS methods.



Harbor Craft's Electrification

In Yokohama, tugboats are starting to be converted to electric power.

Tokyo Kisen Co., ltd. "TAIGA"

Daito Corporation "YOKOHAMA EV-TUG".


Thank you for your attention!
Carbon-Neutral Port Initiatives of the Port of Yokohama
https://www.city.yokohama.lg.jp/lang/overseas/port/kankyo/cnp/initiatives.html

OUR OCEAN
Busan, KOREA, 28-30 April 2025

Seminar on Ammonia as Clean shipping fuel towards Shipping Decarbonization

Session 2

Panel Discussion

Challenges of Green Fuel, Ammonia

Session 2. Panel Discussion _ Challenges of Green Fuel, Ammonia

Moderator

Boram, Kim
Senior Researcher
Korea Maritime Institute

Biography

Boram Kim earned her B.Sc. in Marine System Engineering from Korea Maritime and Ocean University in 2011, followed by an M.Sc. in the same field in 2016. She completed her doctoral coursework in Environmental Engineering at the University of Seoul in 2022.

Her early career began at Sungdong Shipbuilding & Marine Engineering, where she spent four years in engine room outfitting design, coordinating with shipowners and classification societies to ensure regulatory compliance and energy efficiency.

She later served on the academic staff at Korea Maritime and Ocean University, contributing to maritime officer training. Since joining the Korea Maritime Institute (KMI), she has been instrumental in shaping national policies related to maritime decarbonization, eco-friendly vessels, maritime safety, and mobility.
Since 2016, Ms. Kim has participated in the Republic of Korea's delegation to the IMO, contributing to MSC, MEPC, and the Assembly. Notably, she played a key role in the development of the IMO GHG reduction strategy and participated in the Steering Committee for comprehensive impact assessment of mid-term measure.

Her achievements have been recognized with a Ministerial Commendation (2023), KMI Best Paper and Excellence Awards (2024), and the KMI Distinguished Research Award (2025).

OUR OCEAN
Busan, KOREA, 28-30 April 2025

Session 2. Panel Discussion _ Challenges of Green Fuel, Ammonia

Presentation 1

Jeongmin, Cheon

Responsibility Researcher
Fire Insurers Laboratories of Korea(FILK)

Biography

Career :

2023 - Present	FIRE INSUERS LABORATORIES OF KOREA(FILK)
2015 - 2022	Korea Ocean and Marine Equipment Research Institute (KOMERI)
2010 - 2015	SK shipping 1st Engineer

Good day, everyone.

My name is Jeong- Min Cheon, and I represent the FILK.
First of all, I would like to express my sincere gratitude to UPA and PE for the
kind invitation to this meaningful event.
Today, I would like to share insights into the IMO regulatory developments concerning ammonia fuel as part of our collective efforts toward decarbonization.
Since the 7th session of the IMO's Sub- Committee on Carriage of Cargoes and Containers (CCC) in 2021, I have actively participated in the discussions to develop interim guidelines for ships using ammonia fuel. I would like to highlight key issues that have been discussed and share perspectives on the way forward.
Ammonia is a energy with over 100 years of industrial history, and as such, it is generally considered to have a higher level of technological maturity and safety framework compared to hydrogen.
Particularly in the land- based sector, its widespread usage has provided a solid foundation of experience in accident response and safety regulation
In this regard, the IMO undertook a comprehensive review of approximately 36 international and national standards, including those from IMO, ISO, and classification societies rules, in the process of developing its interim guidelines. Based on this review, the IGF Code was used as the reference document for developing the interim safety guidelines for ammonia- fueled ships.
However, due to the limited experience with ammonia- fueled vessels and time limitation in discussions, the current interim guidelines remain at a high- level framework, rather than addressing detailed technical aspects. As a result, the industry is facing challenges due to the lack of specific and actionable guidance. Recognizing this, the IMO plans to commence a revision process for these interim guidelines starting in 2027.
In addition to safety, the IMO has acknowledged the importance of considering environmental impacts as well.
At CCC8, Repulblic of Korea request to evaluate the environmental effects of ammonia fuel, especially concerning ammonia effluent overboard. Since there are currently no discharge standards for ammonia effluent, overboard discharge is not permitted.

Once these standards are established, they could significantly influence the
size and capacity of treatment systems, and such criteria are crucial for facilitating timely development of relevant equipment.
To address this issue, the Republic of Korea submitted a new work proposal at MEPC 83 to develop ammonia effluent discharge standards. This topic is scheduled for further discussion at the upcoming PPR (Pollution Prevention and Response) meetings, where detailed criteria will be developed.
Of course, establishing discharge standards alone will not resolve all concerns. Other aspects such as storage requirements for ammonia inside engine rooms and the onboard handling of neutralizing agents also require thorough evaluation.
Even today, there remain many unresolved issues in developing comprehensive safety and environmental regulations for ammonia as a fuel.
The current regulatory gaps continue to pose practical challenges for the adoption of ammonia as a viable marine fuel.
Nevertheless, I believe that the operational experience and technological insights gained through shipbuilding and vessel operation must be actively reflected in IMO discussions, to ensure that future guidelines are both practical and effective.
I hope today's session will serve as a valuable opportunity for all of us to share perspectives and work together toward establishing safe and environmentally responsible international regulations for ammonia fuel.
Thank you very much.

Session 2. Panel Discussion _ Challenges of Green Fuel, Ammonia

Presentation 2

Oliver Yasuhito, Imaizumi

Project Manager
Fonden Maersk Mc-Kinney Moller Center for Zero Carbon Shipping

Biography

With over twenty years of experience in the marine fuel industry, he has charted a course through diverse and challenging roles, from overseeing domestic bunker operations in Japan to spearheading international bunker trading. His professional voyage commenced immediately after his university graduation in 2000, leading him to the forefront of groundbreaking projects such as the innovative LNG bunkering supply business in Tokyo Bay.

During his tenure as Bunker Team Leader in Singapore, he managed both the Ex-wharf business and international trading operations from 2008 to 2014. His subsequent role in Tokyo from 2015 to 2018 was characterized by a dedication to decarbonized marine fuel solutions, culminating in the successful inauguration of LNG bunkering initiatives with Yokohama Kawasaki International Port, Uyeno Transtech and Development Bank of Japan.

Confronted with the competitive dynamics of the Singapore market, he remained steadfast in his pursuit of innovation. Returning to Japan, he took the lead in the Next-Generation Marine Fuel venture, focusing on the development of an Ammonia bunkering supply chain, a testament to his commitment to sustainability.

Until 2023, he worked at Sumitomo Corporation, a conglomerate engaged in investment and trading. In February 2023, he began working at the Maersk Mc-Kinney Moller Center for Zero Carbon Shipping, where he played a pivotal role in the Green Corridor projects, conducting a pre-feasibility study and feasibility study in partnership with South Korean and U.S. authorities. Additionally, he has managed Green Corridor projects in multiple other countries, showcasing his global expertise and dedication to eco-friendly initiatives. As we move into 2025, his enthusiasm for driving the feasibility study of this eco-friendly project endures, as he aims to shape the future of marine fuel and make a lasting impact on the maritime industry's environmental footprint.

MMMC is a non-profit organization established in 2020, aiming to sustainably decarbonize the maritime industry by 2050. Our activities are supported by contributions from 110 partner companies, and I have been seconded from Sumitomo Corporation in Japan. Currently, we have approximately 150 staff members, with half of them being seconded from our partner companies.

MMMC has undertaken two significant projects focused on the safe use of ammonia. One of these is the Competencies & Training Project, where we collaborated with 14 partner companies to conduct a comprehensive study. This study aimed to address two fundamental questions through the Ammonia Safety Study Phases 1 & 3: "What are the risks to crew in using ammonia as a marine fuel? What safety measures can be implemented to reduce these risks?"

Our key finding is that regulations need to be updated and finalized to cover the required seafarer competencies for the use of ammonia as a fuel. As a first step, we need interim training guidelines to account for ammonia as fuel. Additionally, flag administrations should consider alternatives to actual experience for seafarer certification, given the current lack of ammonia-fueled vessels.
We have published the study results, which detail what needs to be done and how to achieve it. I encourage you to refer to these results for more information.

Another project is the MAGPIE Project, which consists of ten work packages involving the testing and demonstration of both technical and non-technological innovations. The majority of MMMC's involvement in this project is related to Work Packages 3 and 5, both of which focus on developing pathways for ammonia bunkering at the Port of Rotterdam.

In Work Package 3, we conducted a study on the ammonia supply chain needs, including demand forecasts and future infrastructure requirements. Work Package 5 includes the design of ammonia infrastructure and the demonstration of bunkering. On April 12, 2025, we successfully completed a ship-to-ship ammonia transfer of 800m^3 at the Port of Rotterdam. This work package is also conducting a risk assessment for bunkering and developing bunkering procedures for the Port of Rotterdam. Additionally, we are working to mature the Port Safety Framework to provide a pathway for ammonia bunkering permitting.

Ammonia as clean shipping fuel towards Shipping Decarbonization

Oliver Yasuhito Imaizumi
Fonden Mærsk Mc-Kinney Møller Center for Zero Carbon Shipping

April 30th, 2025

Mærsk Mc-Kinney Møller Center
for Zero Carbon Shipping

Mærsk Mc-Kinney Møller Center for Zero Carbon Shipping
Vision and mission statement

Our vision and mission

Our vision is to sustainably decarbonize the maritime industry by 2050

Our mission is to be an independent and significant driver of a sustainable maritime decarbonization

Our approach to decarbonization

Not-for-profit
Money earned by or donated to the Center is used entirely to finance Center work,

Independent
We are un-biased, solution agnostic and have no vested interest in any technology. We work collaboratively and bring together key players across the value chain.

Science-based
We commit to climate science and use a data driven approach to explore viable decarbonization pathways.

Page 2

Our Partners share the zero-carbon vision and are committed to collaborative climate action

23 Strategic Partners | 17 Knowledge Partners | 4 Academic Partners

Mission Ambassadors are committed to the Center Mission and Vision.

66 Mission Ambassadors

Ammonia as alternative fuel

Competencies & Training Project

Project Partners

bp
MAERSK
Hapag-Lloyd
Stolt Tankers
Cargill
seaspan
MAERSK TRAINING
NYK LINE
ANGLO-EASTERN
MAN
VCF

The Decarb Hub
Mærsk Mc-Kinney Møller Center for Zero Carbon Shipping
THE ROYAL INSTITUTION OF NAVAL ARCHITECTS

Page 5

LR & MMMCZCS is this February publishing a series of reports on "Ammonia as Fuel - Competencies & Training".

- Project summary report
- Technical report #1: Proposed overall framework for competency and training standards
- Technical report #2: Detailed Competency & Training Operational, Maintenance and Emergency Response Scenario Evaluations

Download the report and many other publications on **www.zerocarbonshipping.com**

Page 6

Ammonia as Fuel – Competencies and Training project

Two technical reports published – different audiences

Proposed overall framework for competency and training standards: **Provides minimum competency and training standards for all seafarers.**

This framework is modelled on the International Maritime Organisation's (IMO) International Convention on Standards of Training, Competency and Watchkeeping for Seafarers (STCW) Code relating to the specifications for minimum standards of competence for training for ships subject to the International Code of Safety for Ships Using Gases or other Low-Flashpoint Fuels (IGF Code).

The proposal addresses both basic and advanced training.

The primary audience for this 'proposed overall framework' report is technical teams within regulatory bodies.

Operations, maintenance and emergency response tasks: **Detailed competency requirements and training standards for specific operations, maintenance and emergency response tasks beyond those outlined in a typical STCW framework.**

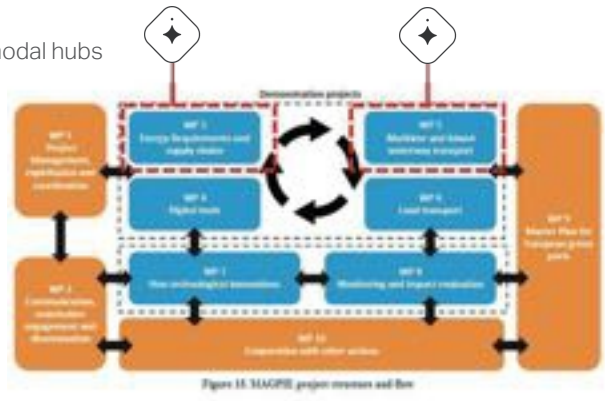
The primary audiences for this 'operations, maintenance and emergency response tasks' report are ship operators/managers and training organisations.

MAGPIE
SMART GREEN PORTS

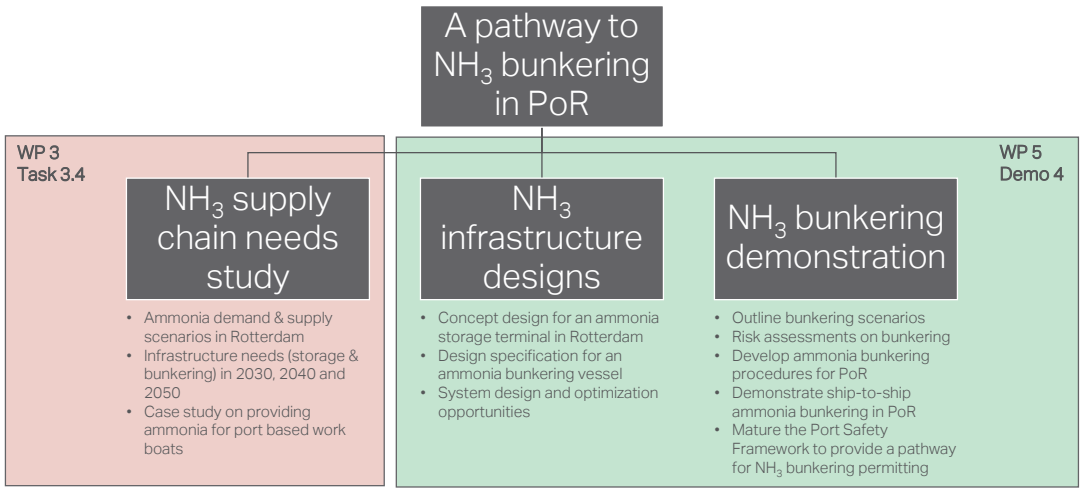
sMArt Green Ports as Integrated Efficient multimodal hubs

The MAGPIE Project consists of ten work packages involving the testing and demonstration of technical and non-technological innovations.

Majority of ZCS involvement in the project will be related to WP3 and WP5. Both of which focusses on developing pathway for NH3 bunkering in Port of Rotterdam

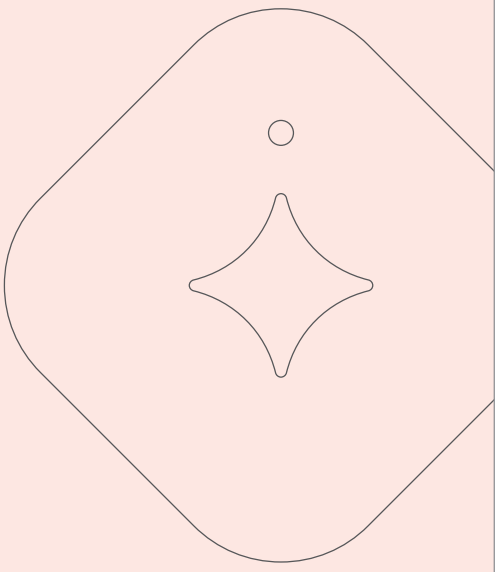


MAGPIE Ammonia bunkering for Shipping



Page 9

Thanks



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OUR OCEAN
Busan, KOREA, 28-30 April 2025

Session 2. Panel Discussion _ Challenges of Green Fuel, Ammonia

Presentation 3

Samuel, Soo

Regional Director (Japan & Korea)
Singapore Maritime and Port Authority

Biography

Samuel is currently the Regional Director (Japan & Korea) at the Maritime and Port Authority of Singapore (MPA), where he works with Japanese and Korean stakeholders to deepen their engagement with Singapore's maritime sector and identify new opportunities for collaboration.

Before that, he was Senior Deputy Director (Marine Services) and oversaw the departments planning for use of alternative marine fuels in Singapore, regulating the bunkering industry, and licensing of harbour craft.

Samuel started his career in the Singapore Government in 2008 with the Sea Transport Division in the Ministry of Transport, and then joined the MPA in 2012, where he has worked in various roles. He was also posted as First Secretary (Maritime) at the High Commission of the Republic of Singapore in London, where he served as one of Singapore's liaison officers to the International Maritime Organization (IMO).

Samuel was trained as a naval architect and also holds a Master of Engineering in Earth System Science and Technology from Kyushu University, Japan.

SEMINAR ON AMMONIA AS CLEAN SHIPPING FUEL TOWARDS SHIPPING DECARBONIZATION
OUR OCEAN CONFERENCE 2025, BEXCO, BUSAN
APRIL 30TH 2.00PM – 3.30PM

Slide 1
- Thank you for the invitation and opportunity to speak.

Slide 2
- MPA's mission is to develop Singapore as a premier global hub port and International Maritime Centre (IMC). MPA also advances and safeguards Singapore's strategic maritime interests on both the regional and international fronts.

Slide 3
- Singapore plays a pivotal role in global supply chains as the largest container transhipment hub, and largest bunkering port, in the world.
- In 2024, Singapore achieved record port and bunker sales performance. In particular, sales of alternative bunker fuels exceeded one million tonnes.

Slide 4
- Today, MPA works closely with industry stakeholders to support the decarbonisation of our port terminals, domestic harbour craft & international shipping.

Slide 5
- As part of Singapore's commitment to a low-carbon future, our port terminals are working to reduce emissions through cleaner energy, automation and digitalisation. By 2030, our port terminal operators aim to cut total emissions from port operations by at least 60% compared to 2005 levels, with the goal of reaching net zero by 2050.

Slide 6
- Domestic harbour craft perform a range of essential marine services within the Port of Singapore, including the delivery of ship supplies and bunker as well as towage and launch services.
- MPA aims for Singapore's 1,600 propelled harbour craft to transit towards net zero in 2050 by adopting full electric propulsion and green fuels. To that end, MPA released 3 calls for collaboration in 2023, to tap on the ideas and solutions from the industry.

Slide 7
- When it comes to international shipping, the maritime sector is heading towards a multi-fuel transition. MPA sees the need to collaborate with industry and academia to enable alternative fuels for international shipping. Let me elaborate in the next few slides.

Slide 8
- As a world-class bunkering hub, Singapore remains committed to providing low- or zero-carbon fuel solutions to meet the future energy needs of the global shipping industry.
- Our efforts to enable a multi-fuel future span a multitude of fuels.

Slide 9
- What are the challenges? Alternative fuels face similar hurdles. These include safety concerns, lack of mature standards and regulations, cross-sector competition for fuels, technology and infrastructure readiness, as well as uncertainties around financing and insurance.

Slide 10
- Let's take a closer look at ammonia. These challenges range from safety and operational readiness, crew competency and emergency preparedness, and broader considerations related to economic, infrastructure & regulatory gaps. This list is by no means exhaustive – it is a merely a starting point for what I hope will be a fruitful panel discussion.

Slide 11
- On this slide, we've outlined MPA's efforts to enable ammonia as a marine fuel.

Slide 12
- In addition, our successful ammonia trials involving the Fortescue Green Pioneer have provided the industry with confidence in ammonia as a viable marine fuel.

Slide 13
- To prepare for the trials, we took many steps to ensure that safety was not compromised.

Slide 14
- Lastly, to address the competency and training needs of the maritime workforce, we have the Maritime Energy Training Facility (METF).
- At Singapore Maritime Week this year, MPA announced METF Digital Platform, an initiative to help provide access in the safe handling of alternative marine fuels and new technologies.
- And with that, I end my presentation. Looking forward toward the panel discussion!

Advancing Maritime Decarbonisation

Presented by:
Samuel Soo
Regional Director (Japan & Korea)
Maritime and Port Authority of Singapore (MPA)

Maritime and Port Authority of Singapore (MPA)
- Our Mission -

Premier global hub port

- Port Authority
- Port Regulator
- Port Planner

International Maritime Centre (IMC)

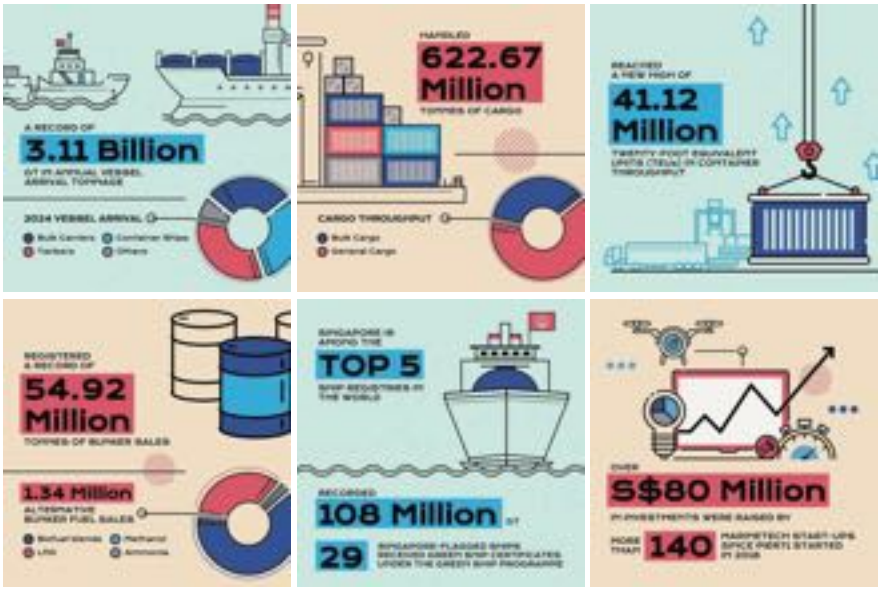
- IMC Promoter
- IMC Developer

Advance & safeguard Singapore's maritime interests

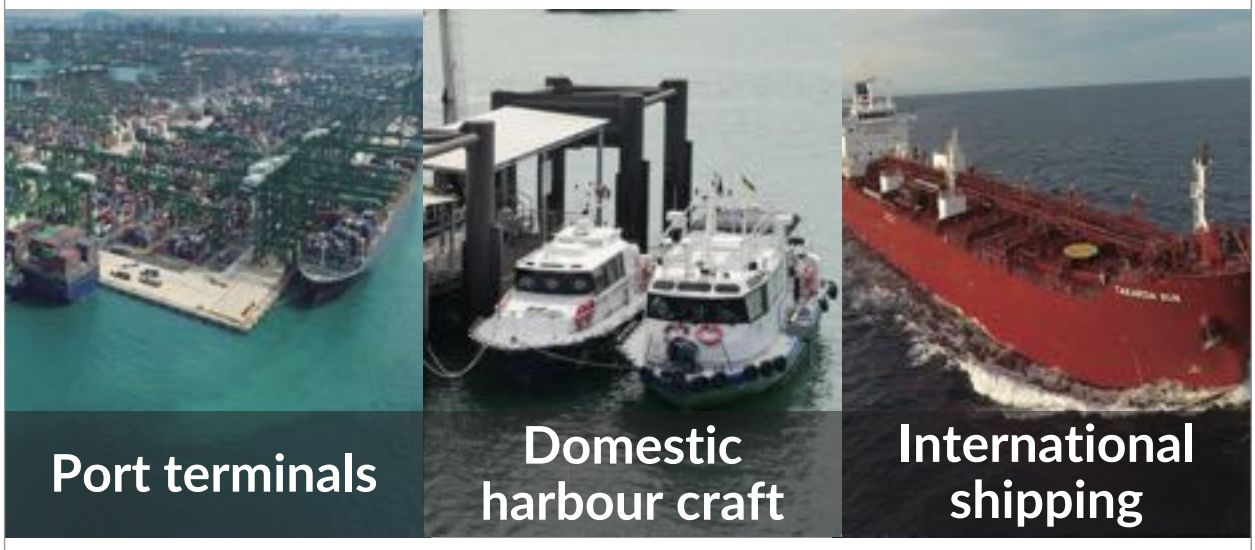
- National Maritime Representative at IMO & regional/international fora

MARITIME SINGAPORE

Overview | 2024



Working with industry stakeholders to support decarbonisation



Port Terminals

Automation at Tuas Container Port

Towards lights-out operations

World's largest Port Solar Facility at Jurong Port

95,000m^2 – 12mil kWh
(60% of needs/year)

MPA

5

Calls for industry collaboration on electric harbour craft

55 proposals received from Industry

11 Design concepts for passenger launch and cargo lighter vessels to be developed

3 concepts to be piloted

Explore competitive financing solutions to lower financial barriers for adoption

Explore insurance solutions to mitigate financial risks

MPA

6

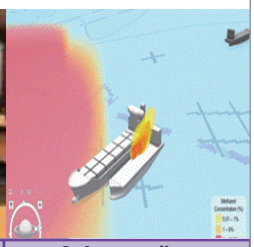
Collaboration with industry and academia to enable alternative fuel bunkering

Trials, Joint Industry Projects

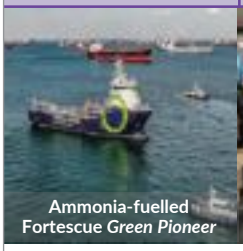
Workshops & Table-Top Exercises

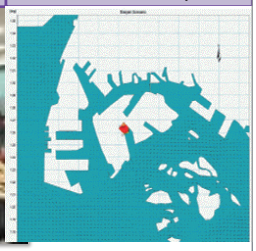
Emergency response training/drills

Working Groups for Standards Development



Safety studies, Modelling & Simulation work with IHL*/RI





**Institutions of Higher Learning (e.g., Maritime Energy and Sustainable Development Centre of Excellence at Nanyang Technological University, National University of Singapore)*

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Efforts by MPA to enable a multi-fuel future

Biofuel

- Ongoing trials of up to B100, with blends of up to B50 available commercially
- Raised limits for conventional bunker tankers to carry blends up to B30
- Developed national standards on marine biofuel (WA 2:2022)

LNG & E/Bio-methane

- Expression of Interest (EOI) to explore solutions for sea-based LNG reloading and supply of E/Bio-methane in Singapore

Successful trials

- LNG bunkering & simultaneous operations of cruise ship *Silver Nova* at Singapore Cruise Centre in Feb 2025

Methanol

- Launched new Technical Reference (TR) 129
- Opened applications for bunkering licences
- EOI for the end-to-end methanol bunkering solutions in Singapore

Successful trials

- Ship-to-ship bunkering, including simultaneous methanol bunkering and cargo operation (SIMOPS)

Ammonia

- Request for Proposals (RFP) to develop an end-to-end solution for ammonia power generation and bunkering
- Ongoing development of a Technical Reference

Successful trials

- World's first use of ammonia as a marine fuel in a dual-fuelled ammonia-powered vessel on the Singapore-flagged *Fortescue Green Pioneer*

Hydrogen

- Studying the use of hydrogen as a marine fuel with industry partners and the research community
- Hosted the world first bulk liquefied hydrogen carrier *Suiso Frontier*

Safety Studies, Modelling & Simulation	• Safety studies with Institutes of Higher Learning (IHLs) and Research Institutes (RIs) • Collaboration with industry partners and A*STAR Institute of High-Performance Computing to conduct simulations on bunkering operations
Training of Maritime Workforce	• Launched Maritime Energy Training Facility (METF), providing training on the safe handling of alternative fuels • MOU with the Institute of Chartered Shipbrokers (ICS) for training and certification of maritime professional

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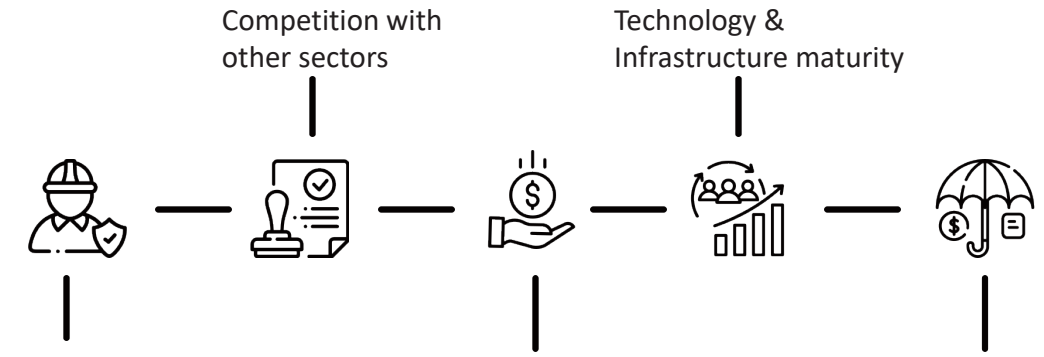
Key Challenges for Adoption as a Marine Fuel



Lack of Scale and Certainty

Key Challenges for Adoption as a Marine Fuel

Safety & Operational Readiness

1. **Ammonia is toxic and corrosive**. Requires appropriate Personal Protection Equipment (PPE) for personnel, corrosion resistant materials, specialised systems (e.g., safety, detection etc) and mitigation measures (e.g., ventilation systems, safety zones) for safe operations.
2. **Operational readiness needs to developed**. Ports need to implement real-time operational monitoring capabilities during sea trials/operations, and conduct emergency drills (e.g., fire, evacuation, leak scenarios).

Crew competency and emergency preparedness

3. **Training on fuel handling and emergency response is limited**. The global maritime workforce needs to be equipped with the relevant knowledge and skills to handle ammonia safely.

Economic, Infrastructure & Regulatory Gaps

4. **Uncertainty regarding cost competitiveness**. Robust supply chains have to be set up for low- or zero-carbon ammonia, and the cost premium will need to be addressed.
5. **Ammonia bunkering infrastructure is limited globally.** Ports need to prepare terminals, storage facilities and safety systems. Ports must also prepare for emergency response and public safety.
6. **Current IMO and national regulations are still evolving.** Greater clarity on safety standards (along with harmonisation) will be needed.

Enabling Ammonia as a Marine Fuel

Joint Industry Projects (JIP)

- Participated in hazard studies of several industry projects.

Standards Development

- Draft Technical Reference for ammonia bunkering in development.

Safety studies with Institutes of Higher Learning (IHLs) / Research Institutes (RIs)

Supply chain & Infrastructure development

Request for Proposal (RFP) to develop ammonia power generation & bunkering solutions

- MPA and the Energy Market Authority (EMA) have shortlisted 2 bidders for pre-Front End Engineering Design (pre-FEED) study. A lead developer will be selected in 2025.

Request for Information (RFI) to quote shipping and insurance cost of ammonia

- Identify ammonia demand hubs between source country and Singapore, demand aggregation to reap economies of scale

Ammonia bunkering trials in Singapore

Successful trials and partnerships have boosted confidence in ammonia as a viable marine fuel.

Conducted on the Singapore-flagged *Fortescue Green Pioneer*.
World's First Use of Ammonia as Marine Fuel in a Dual-Fuelled Ammonia-Power Vessel (Mar 2024)
Successful Propulsion and Maneuverability Trials Completed (May 2024)

Ammonia bunkering trials in Singapore – Preparatory Activities

5 and 19 Oct 2023 – HAZID & HAZOP workshops

- Conducted by MPA to identify potential risks, and develop corresponding prevention, control, and mitigation methods

24 Jan 2024 – Table Top exercise / workshop

- Conducted by MPA as a refresher prior to the operation together with relevant agencies
- Presentation on ammonia plume models*, as part of the safety, risk and environmental impact assessment.

**Ammonia Plume Model* – Developed by the Agency for Science, Technology and Research's Institute of High Performance Computing (A*STAR's IHPC), Nanyang Technological University's Maritime Energy and Sustainable Development Centre of Excellence (MESD), the Technology Centre for Offshore and Marine, Singapore (TCOMS), and the National University of Singapore's Tropical Marine Science Institute (TMSI).*

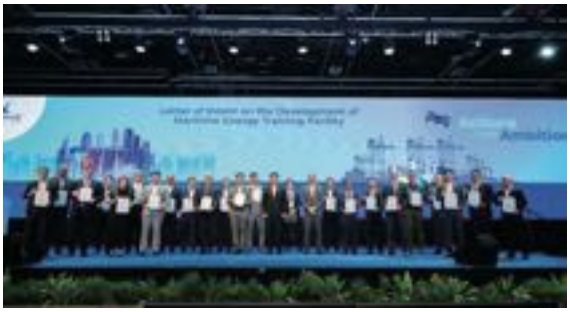
4 Nov 2023 and 30 Jan 2024 – Ship Emergency Drills onboard

- Conducted by MPA to assess the readiness and preparedness of crew onboard

2 Feb, 23 Apr, 25 Apr 2024 – Emergency Ops Center (EOC)

- Emergency Ops Center (EOC) convened for relevant key shore personnel on standby with monitoring live
- During the period of ammonia trial, the EOC was actively manned daily.

Training the Maritime Workforce in Safe Handling of Alternative Fuels - Maritime Energy Training Facility (METF)



- The METF was first launched in 2024 as part of Singapore's efforts to advance maritime decarbonisation and workforce development.
- Since then, MPA has engaged training providers, shipping companies and maritime associations to align training standards with industry needs.
- These efforts have led to the METF Digital Platform, a training management system that simplifies access to training, streamlines certification issuance and ensures alignment to international standards.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SINGAPORE
THANK YOU

2025 Our Ocean Conference

Seminar on Ammonia as Clean shipping fuel towards Shipping Decarbonization

Busan, Korea, 30 April 2025

UPA ULSAN PORT AUTHORITY

PACIFIC ENVIRONMENT