THE PLACE OF USEFUL LEARNING

University of Strathclyde Glasgow

Research Challenges and Opportunities in Shipping Industry's Pathway to Decarbonisation by 2050

Mar 2025

By

HoD - Prof. Evangelos Boulougouris

Contents

Naval Architecture, Ocean and Marine Engineering

The department of ***Naval Architecture, Ocean and Marine Engineering (NAOME)*** was formed in 2001 through the merger of the department of *Ship and Marine Technology* at the ***University of Strathclyde*** and the department of Naval Architecture and Ocean Engineering at the ***University of Glasgow***, which have been involved in teaching and research in naval architecture since 1881.

https://www.strath.ac.uk/engineering/navalarchitectureoceanmarineengineering/

Why Decarbonisation?

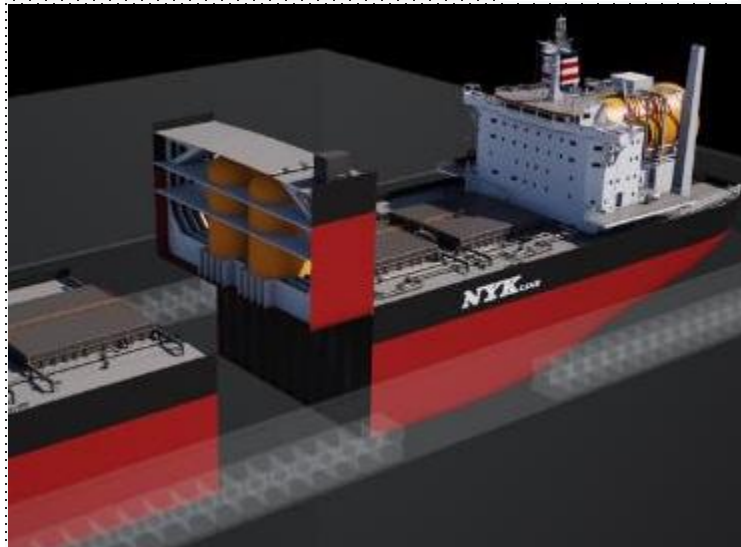
- Shipping accounts for ~3% of global CO_2 emissions
- “Fit for 55” package aims at reducing emissions by 55% by 2030
- IMO 2050 targets: Net-zero emissions, 20% reduction by 2030, 70% by 2040
- EU FuelEU Maritime and UK Net Zero Strategy - Regulatory pressure

Key Challenges in Shipping Decarbonisation

- Policy & Regulatory Uncertainty: IMO vs regional frameworks
- Technological Readiness Issues: Low TRLs for alternative fuels
- Infrastructure & Investment Barriers: Green fuel supply limitations
- Public Perception & Safety: Concerns with nuclear and hydrogen fuels
- Interactions with other disruptive developments such as digitalisation and AI
- Skill availability: Training and upskilling of existing and future workforce.

AUTOSHIP
Autonomous Shipping Initiative for European Waters

NH3 CRAFT



Shipping's Decarbonisation Solutions

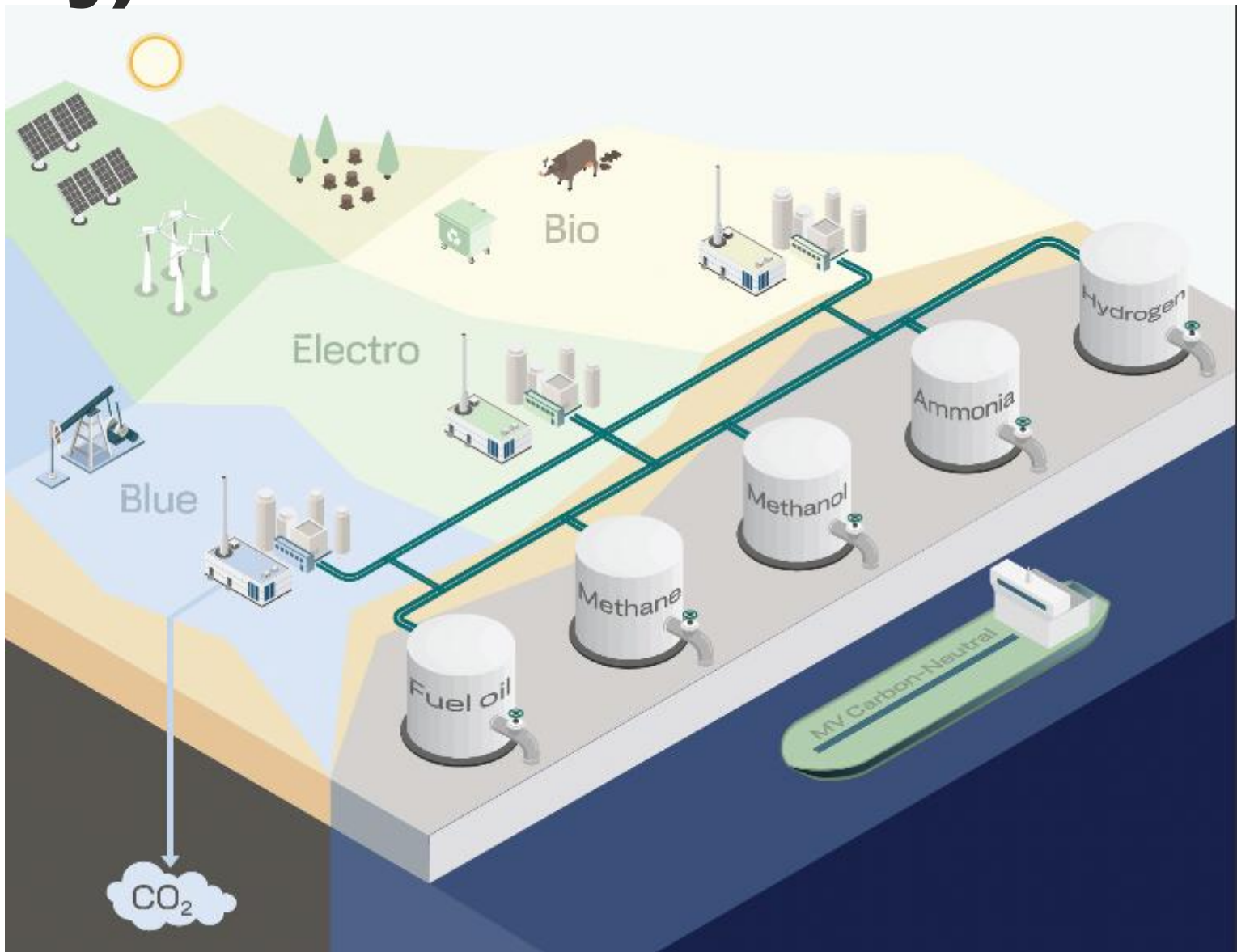
Operational Measures	• Weather Routing	• New Charter Arrangements	
	• Speed Optimisation	• Just In Time Shipping	
	• Vessel Performance Reporting	• Smart Vessel/ Improved Reliability	• Fleet Interactive Performance Optimisation
Technology Improvement	• Air Lubrication	• Improved Hull & ESD Options	• Wind/Solar
	• Hybrid	• Fuel Cells	• Electric Propulsion
	• Cold Ironing	• Carbon Capture (Shore/ship)	
Alternative Fuels and Energy Sources	• LNG		• Hydrogen
	• LPG/Ethane	• Ammonia	
	• Methanol (Regional)		• Nuclear
	• Biofuels (Regional)	• Biofuels (Global)	

2050

Shipping's Route to 2050

The future of Shipping (as perceived today)

This DNV* graph captures very well what the vision for shipping is right now.



*DNV (2022), Maritime Forecast 2050

Market & Financial Considerations

- Investment Risks for Alternative Fuel Adoption
- Green finance opportunities & carbon pricing mechanisms
- The role of shipowners and financiers in enabling the transition

Policy & Regulation Pathways

- Harmonisation of International, Regional and National Regulations (e.g. IMO, EU, UK)
- Incentives & Subsidies for Early Adopters
- The De-risking Role of Classification Societies & Standardisation Bodies

LH2 CRAFT

LH$_2$CRAFT: *Safe and Efficient Marine Transportation of Liquid Hydrogen*

SAFe CRAFT

SAFeCRAFT: Safe and Efficient Use of Sustainable Fuels in Maritime Transport Applications

#@APP-FORM-HERIAIA@#

Technology Challenges & Readiness Levels (TRLs)

- Electrification: Storage, recharging
- Alternative Fuels: Storage, bunkering, and regulatory hurdles
- Energy Efficiency Technologies: Validation, integration, and standardisation
- Onboard Carbon Capture: Space constraints, energy demand, CO_2 disposal challenges
- Autonomy & Digitalization: Cybersecurity, regulatory uncertainty, AI implementation

TRL Levels Across Key Technologies

- Biofuels: TRL 7 - Commercially available but scalability concerns
- Methanol: TRL 7 – Requires infrastructure investment
- Ammonia: TRL 6- High safety risks, limited infrastructure
- Hydrogen: TRL 5 – Major storage and transport barriers
- Nuclear: TRL 4 - Regulatory and public acceptance challenges

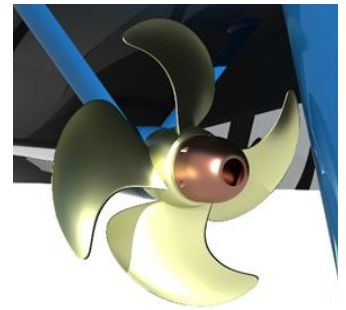
Energy Saving Devices & Operational Strategies

- Propulsion ESD: TRL 8 - Widely available
- Air Lubrication Systems: TRL 7 - Proven but limited adoption
- Wind-Assisted Propulsion: TRL 5 - Demonstrated but niche
- Advanced Hull Coatings: TRL 8 - Widely available
- AI-Based Optimization: TRL 6 - Used in fleet management but requires scaling

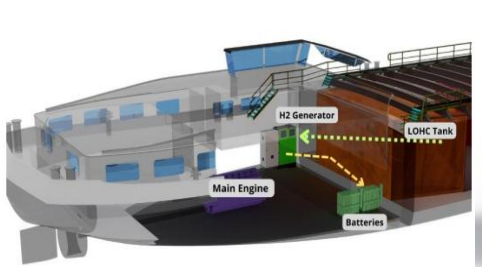
Energy Saving Devices & Operational Strategies

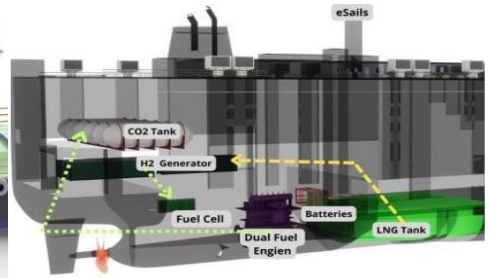
GOTERS

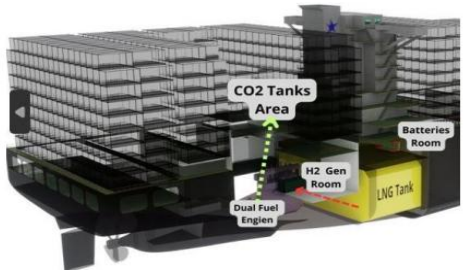
SEASTARS

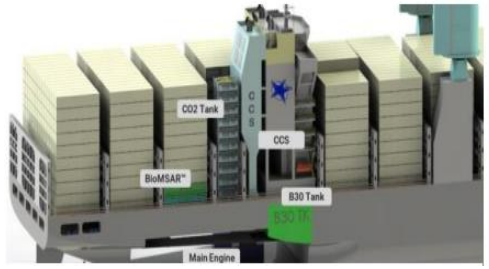


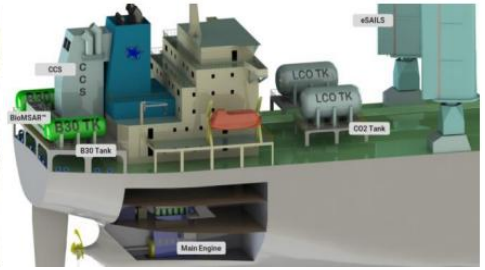
Eco Boss Cap





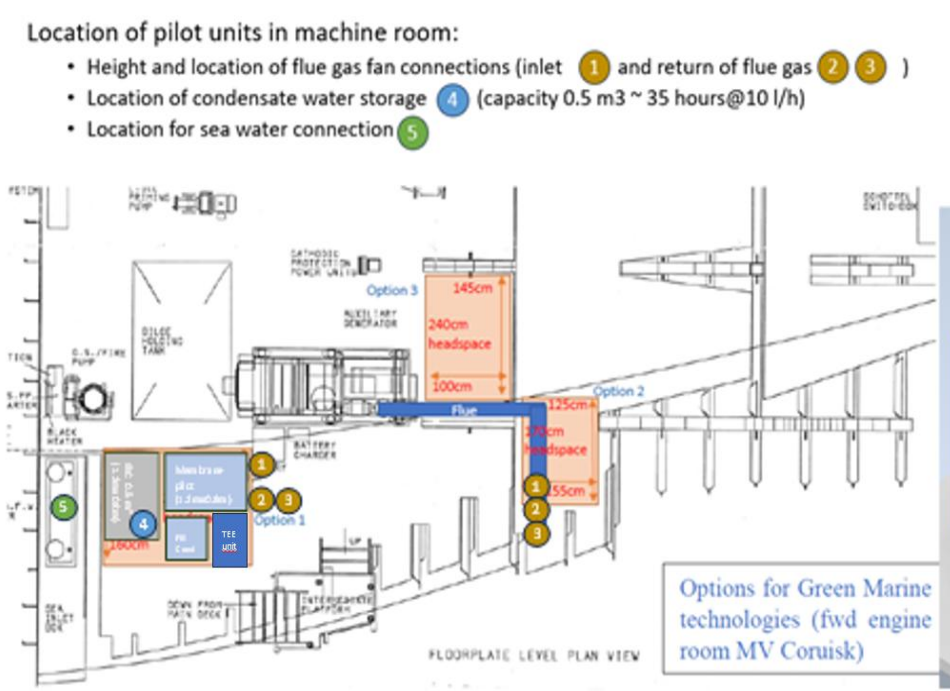


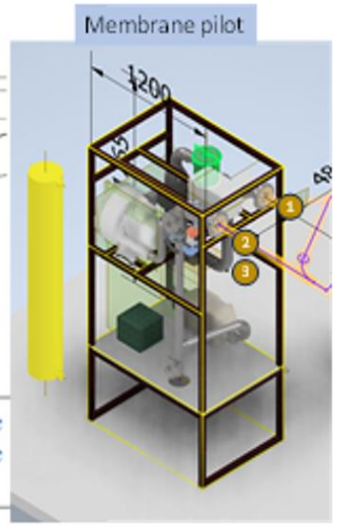




Onboard Carbon Capture & Storage

- TRL 4 - Early demonstration stage, not commercially viable
- Challenges: Ship space constraints, energy costs, CO_2 offloading needs
- Storage Methods: Cryogenic, compressed gas, chemical absorption
- Regulatory uncertainty remains a barrier to adoption





Conclusions

- Summary of Key Challenges & Opportunities
- Urgency for Immediate R&D Investment
- Collaboration Needed Between Industry, Government, and Academia
- Building a Sustainable Maritime Future Together

Discussion

University of Strathclyde Glasgow

evangelos.boulougouris@strath.ac.uk

https://www.strath.ac.uk/engineering/navalarchitectureoceanmarineengineering/