SINGAPORE INSTITUTE OF TECHNOLOGY

SMI Webinar

Future of Ship and System Design

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Singapore Institute of Technology

20th Jan 2022

SIT at a glance – University of Applied Learning

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SIT over the years

- **2022** Launched 2 new degrees (Applied AI and Digital Supply Chain)
- **2021** Launched Competency-based Workplace Learning Pathway. Intake > 3,000
- **2020** Launched 2 new degrees & 4 new joint OU degrees. Intake = 2,900
- **2019** Celebrated '5+5'. Intake = 2,718
- **2018** Launched 2 new degrees, took in 2,660 students in 43 programmes
- **2016** Intake of just over 2,500 students
- **2014** Became an Autonomous University. Launched 3 SIT degrees
- **2012** Committee on University Education Pathways Beyond 2015 (CUEP) recommended that SIT should become Singapore's new AU to meet CPR of 40%
- **2010** Took in first 500 students. 10 degree programmes with 5 OU partners
- **2009** Incorporated as an institute of higher learning (IHL)

8,226 Undergraduate students	5* Academic clusters (ENG, FCB, ICT, HSS, BCD)	261 Faculty staff
105 Postgraduate students	38# Undergraduate programmes	72 Professional officers
68 Research staff	9 Postgraduate programmes	385 Adjunct/PT academic staff

**Engineering; Food, Chemical & Biotechnology; Infocomm Technology; Health and Social Sciences; Business, Communication & Design*

#18 SIT programmes, 16 joint programmes with Overseas Universities (OU), 4 OU programmes.

SIT is also the only university offering unique programmes such as Electrical Power Engineering, Naval Architecture and Marine Engineering and Allied Health

Background on Future Ship & System Design

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Pillars of Future Ship and System Design (FSSD) R&D Programme.

Decarbonisation and Climate Change

- Transition fuels
- Alternative fuels
- IMO 2050 / Net Zero targets
- Decarbonisation measures e.g. EEDI, EEXI, CII
- Climate change and impact to environmental factors

Design for sustainability

Digitalisation

- New digital infrastructure
- Data exchange
- Cybersecurity
- Digital Twin
- New technologies: AI, Data Analytics, Machine Learning, Additive Manufacturing, etc.

Design for efficiency and security

Smart and MASS Developments

- Vessel-port interactions
- Smart and autonomous technologies
- Onshore support
- Maritime satellite communication
- Intelligent global maritime traffic management system

Design for safety and reliability

Sustainable Ship Design and Process

- Smart ship design
- Lifecycle of systems
- Maintenance and recycling
- Alternative building process e.g. modularisation of systems
- Advanced power systems

SMI-SIT Workshop

Future Ships & Systems Design Programme

Singapore Maritime Institute (SMI) and Singapore Institute of Technology (SIT) will be holding a joint workshop on Future Ships and Systems Design R&D Programme. The programme hopes to address technological, digital, environmental, and energy shifts and its impact on vessels and vessel designs.

We invite you to join us for the workshop and share your perspectives and ideas on how the R&D programme could be shaped to effectively develop solutions and capabilities for the industry.

Workshop Details

Date: **27 October 2021**

Time: **2PM-5PM**

Venue: **SIT Campus @ Dover Drive**

**In the event of heightened COVID measures, the workshop will be converted to a hybrid format.*

To register your interest for the workshop, please submit an email with **your name, designation, organisation & contact number** to rd@maritimeinstitute.sg

Registration closes on 20 October 2021.

Further details will be provided upon successful registration.

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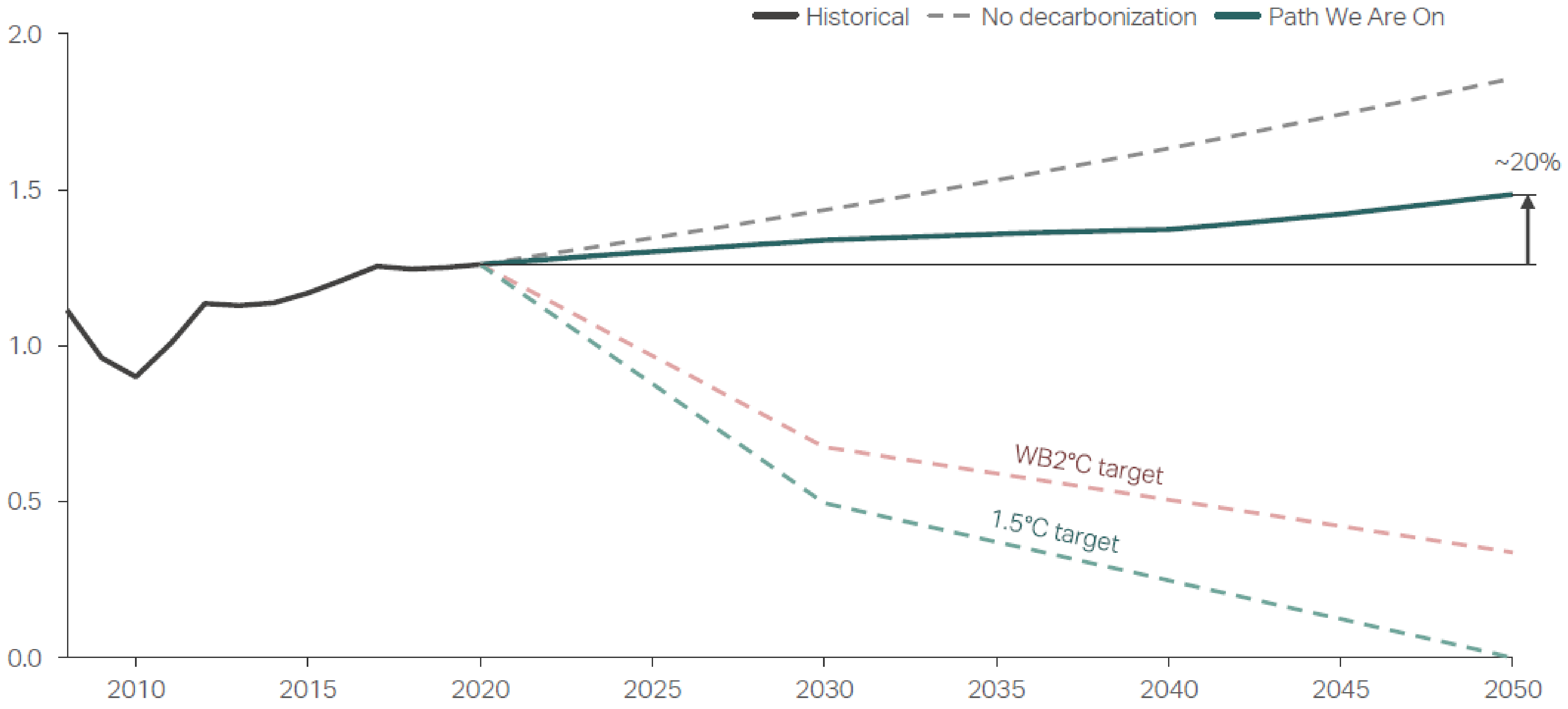
Decarbonisation and Climate Change

We are heading for an increase in maritime GHG emissions despite current industry-wide efforts

Current decarbonization efforts are outplayed by growing trade and large fuel cost differences

WTW Maritime emission pathways[1]
$GtCO_2$-eq/year



Sources: IMO, IEA, Clarksons and Techno-economic model MMM Center for Zero Carbon Shipping
1 WTW = well to wake.
2 Referencing the IPCC, 2018: Summary for Policymakers, In: Global Warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty.

Source: MMMCZCS Oct 2021 Report

Decarbonisation and Climate Change

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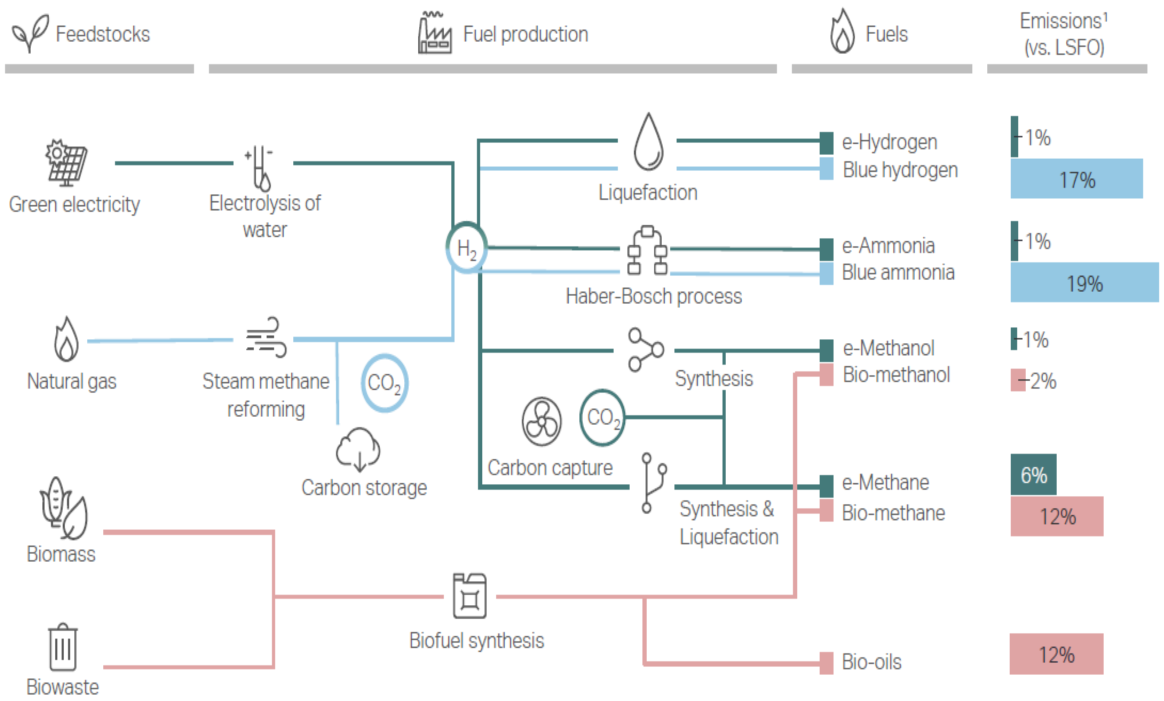
The diversity of alternative fuel options makes it difficult to agree on a common pathway…

Overview of different fuel production pathways

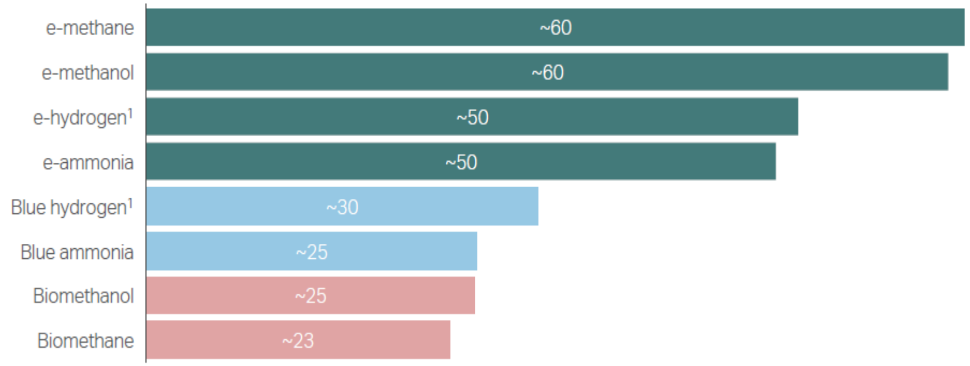


Source: MMM Center for Zero Carbon Shipping
Note: Only key processes are included; For bio-methane, methane slip emissions from the choice of engine technology and upstream production is considered based on technology readiness in 2030.
1 Relative comparisons to LSFO emissions of 96 gCO2-eq /MJ (direct emissions well-to-wake) by 2030

With low prices and already established supply chains, fossil fuels are tough competitors to beat…

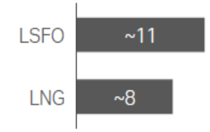
Estimated production price, 2025

USD/GJ



Estimated production price, 2025

USD/GJ

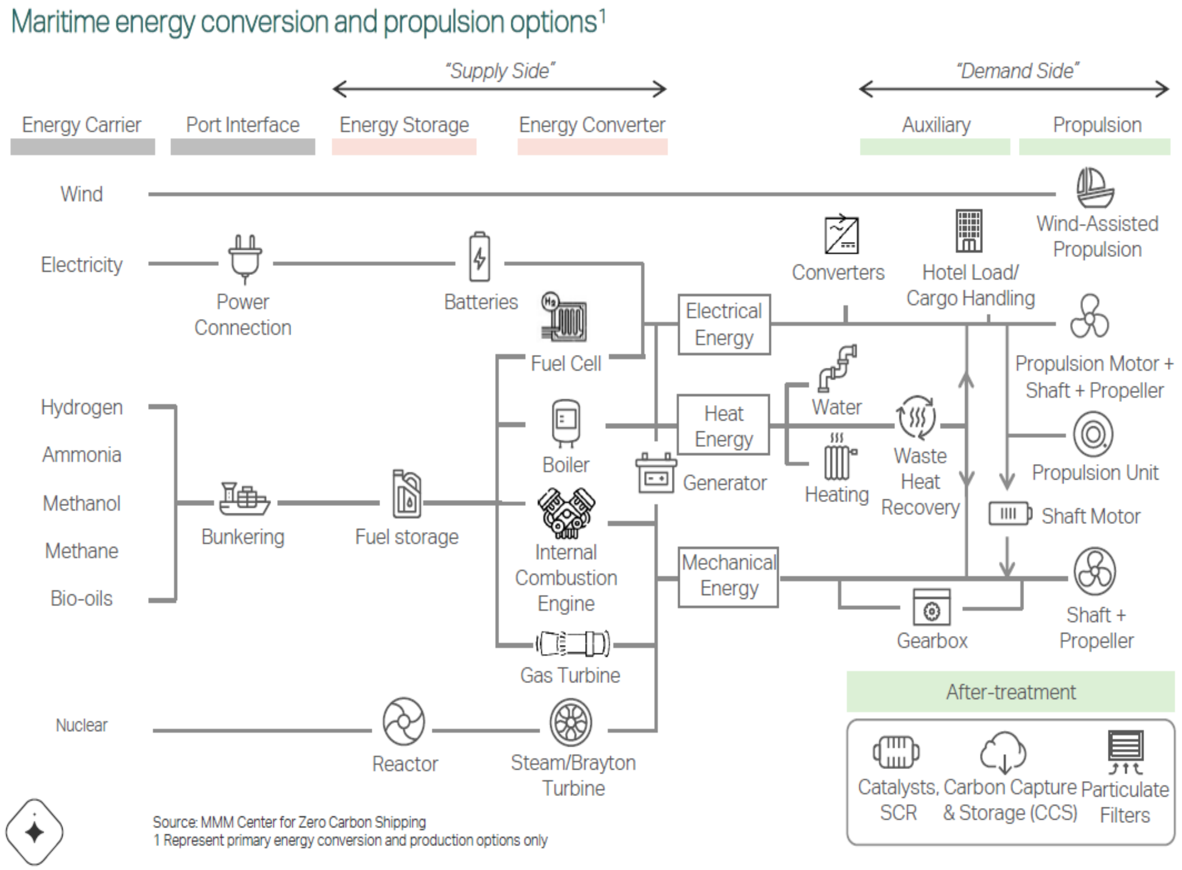


Source: Techno-Economic Model (NavigaTE) MMM Center for Zero Carbon Shipping
1 Liquefaction of hydrogen is considered; Bio-oils are only commercially available after 2025.
2 Actual fuel prices will be subject to various external factors including but not limited to supply/demand imbalances, local carbon pricing initiatives and subsidies.

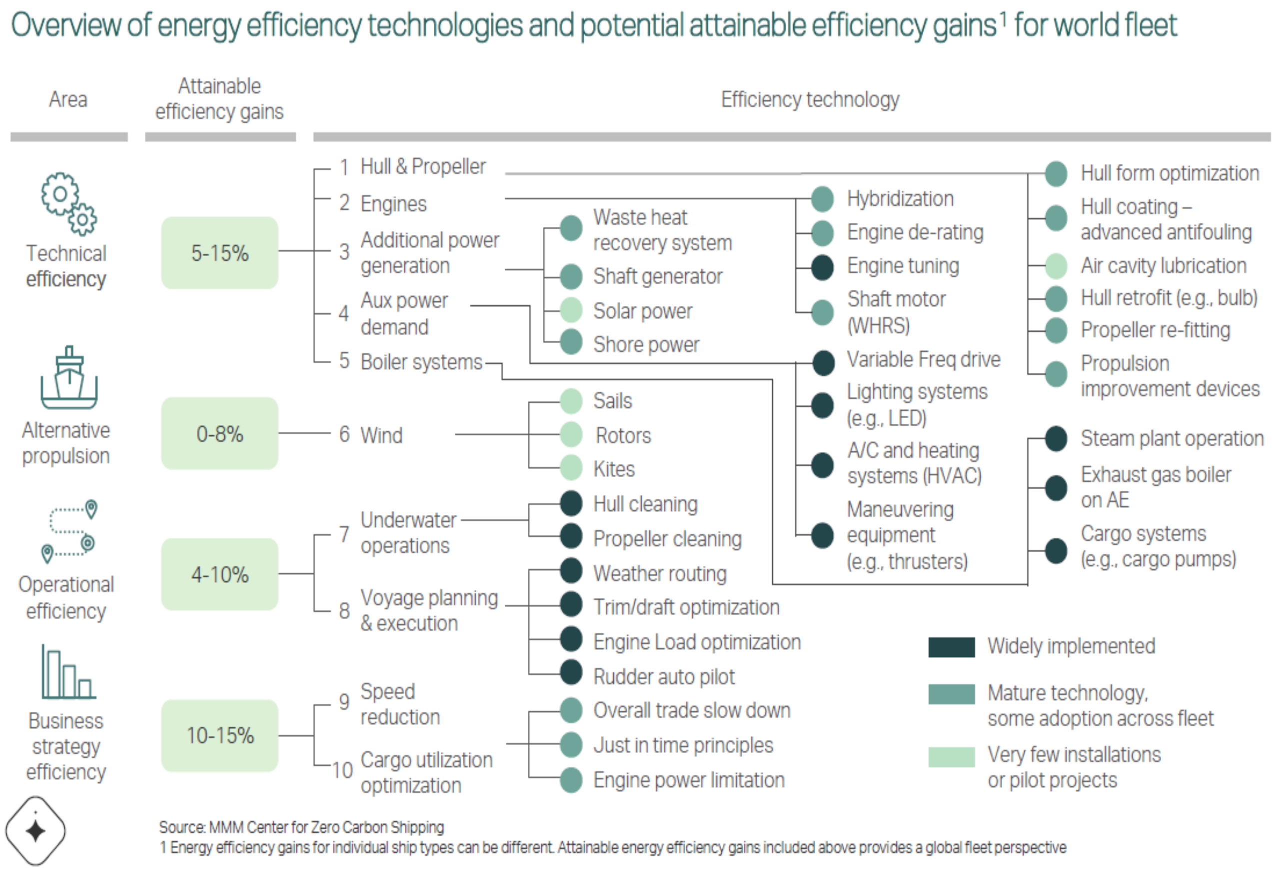
Source: MMMCZCS Oct 2021 Report

Decarbonisation and Climate Change

Moreover, onboard energy demand can be met in different ways, thus further complicating things.



Overview of energy efficiency technologies and potential attainable efficiency gains for world fleet.



Source: MMMCZCS Oct 2021 Report

Summary of outcomes from workshop (27 Oct 2021)

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Pillar	Problem statement	R&D focus area
Decarbonisation and Climate Change	Uncertainties in the use of transition and future fuels	Direct carbon capture technology; CCUS; LNG as greenest viable solution; Methanol, biodiesel, ammonia & hydrogen as future fuel; Redesign of onboard fuel storage system (space & safety); Engine technology; Bunkering infrastructure; Safety standards; Test-bedding @OEM
	Challenges in marine electrification	Hybrid or full electric; Battery technology & capacity; Energy storage system (ESS); ESS modular design & integration; Intelligent power management system; Ship performance improvement; Supplementary power from wind & solar; Charging infrastructure; Standardisation; Test-bedding @OEM
	Complexity to design carbon neutral ship	Common design platform for design optimisation and collaboration; Fundamental redesigning of ship or combination of technology solutions; Study on technology, commercial and social viability of modular nuclear power plant for ships; Test-bedding @DNV Simulation Trust Center

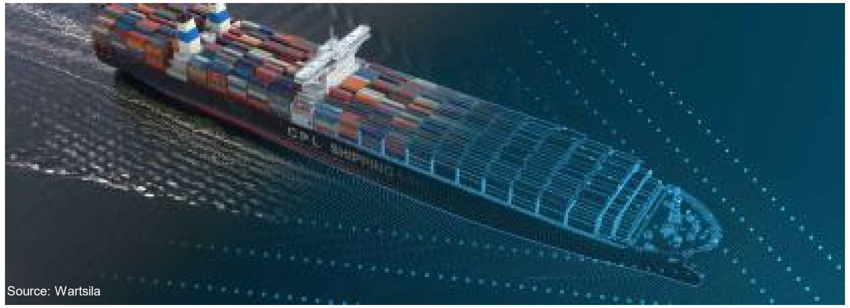
Digitalisation

What is digitalisation and what does it mean to the maritime industry?

- Enhancing performance through digital technologies – in terms of *safety, environmental protection & operational efficiencies*
- Adoption of technologies to innovate and create *sustainable* long-term solutions for decarbonization, COVID-19 related challenges, etc.
- Utilising technologies to enable automation of tasks to lessen demands on operators, increase workplace safety

Relevant digital technologies for the maritime industry

- Smart sensing, enhanced monitoring and self-learning systems
- Asset management, decision making and optimization solutions
- Automation, remote monitoring and control capabilities
- Digital twins for real-time predictions/simulations of system responses


Source: Wartsila

Source: SINTEF-TCOMS R&D Roadmap for Smart & Autonomous Sea Transport Systems

Source: TCOMS, PPT 27 Oct 2021 SMI-SIT Workshop

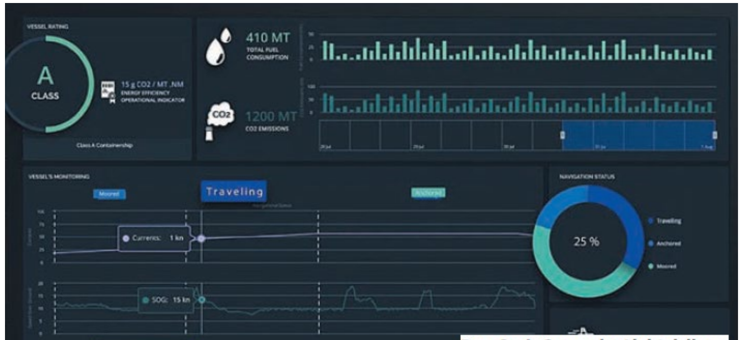
Digitalisation

Use case #1 – Silverstream and Southampton University

Goal: To develop an **advance intelligence** within the system's control and automation module to increase savings by analysing operational data taken from installed air lubrication systems.

Outcome: With the modelling and algorithms, the system is set up to adjust quantity and pressure of air provided according to conditions. By **using AI to analyse data** more quickly and automatically, Silverstream wants to identify many different scenarios, pinpoint precisely how the best performance was achieved in each, and hence respond to circumstances at sea in real time to adjust the air lubrication provision and deliver peak performance.

The Silverstream System 'bubble carpet': a layer of micro-bubbles lubricates the entire flat bottom of the hull



DeepSea's Cassandra Light delivers accurate vessel performance insights by combining noon report, AIS and weather data

Use case #2 – DeepSea Technologies

Goal: To provide vessel monitoring powered by **AI to visualize CO_2 emissions** and notify users of fuel overconsumption to help reduce environmental impact and fuel costs.

Outcome: The AI driven platform (Cassandra Light) delivers vessel performance insights using only the routine noon (daily) data provided by the vessel. It requires the placement of a data collection system onboard, with data logged every minute and transferred via satellite to the cloud. Machine learning is used to process this and spot deterioration in efficiency. Combining with AIS to see where the vessels are and augmenting that with weather data to have a good understanding of the conditions behind the fuel consumption.

Source: Marine Professional Issue 2 2021

Summary of outcomes from workshop (27 Oct 2021)

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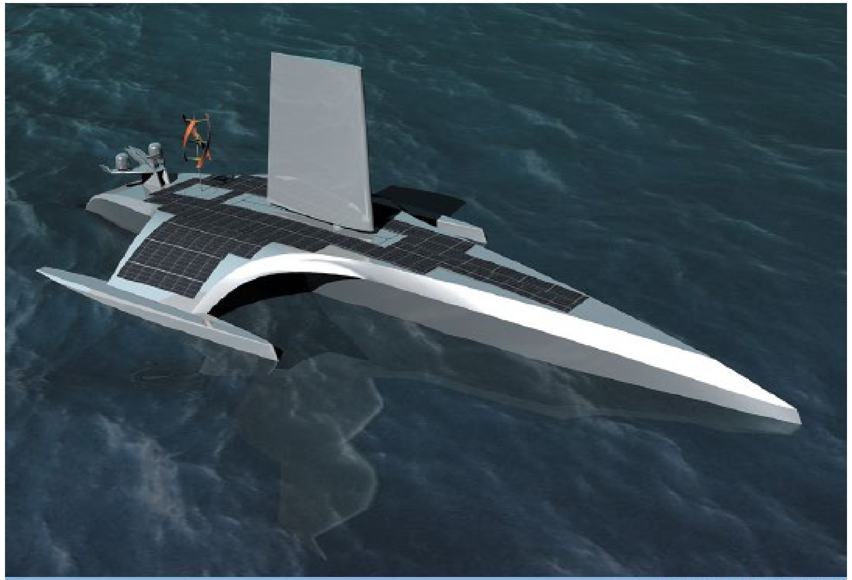
Pillar	Problem statement	R&D focus area
Digitalisation	Challenges in implementing IoT and smart ship	Cybersecurity; Impact to CAPEX & OPEX of ship; Standardisation of communication protocol and marinisation of IoT sensors; Edge computing, AI & Machine Learning; Low-cost ship-to-shore SATCOM (24-7); Shore support with digital infrastructure and expertise; Test-bedding
	Slow adoption of digital twin	Standards to harmonise cyber-physical system and approach; Adoption and validation of performance improvement (e.g. smart sensing, enhanced/remote monitoring, self-learning systems, asset management, automation) with digital twinning; Test-bedding @TCOMS
	Complexity to design smart ship	Common design platform with AI; Digital supply chain and lifecycle management; Global R&D harmonisation; Test-bedding @DNV Simulation Trust Center

Smart and MASS Developments



In a world-first trial, passenger ferry *Suomenlinna II* was wirelessly operated through Helsinki harbour. Above: The Mayflower Autonomous Ship will make its transatlantic crossing powered by a hybrid propulsion system using wind, solar, state-of-the-art batteries and a diesel generator

Smart computers have enabled a shift to fully autonomous shipping. Many ships already deploy a high degree of automation to enable safer navigation and more efficient fuel consumption.

However, it is only in the last decade that artificial intelligence, machine learning and cognitive computing technologies have developed to a point where it is now possible to remove humans from the bridge.

Automation will gain real traction among vessels that use low-maintenance fully electric propulsion systems and can be supported remotely or by ad hoc visits from a service crew.

IMO regulations need to be updated with fast-moving technology.

Network connectivity is an issue. Autonomous ships can run on 4G/5G networks close to shore than satellite-based solutions required to deliver the necessary connectivity out at sea.

Source: Marine Professional Mar/Apr 2020

Summary of outcomes from workshop (27 Oct 2021)

Pillar	Problem statement	R&D focus area
Smart and MASS Developments	Slow progress towards MASS implementation	Human-Autonomy teaming; Development of coastal communication system for MASS; Pervasive SATCOM; Proof of remote operation from onshore control tower; Standard/protocol to drive adoption from reduced manning -> remote control -> autonomous system; Study on policy and commercial viability; Test-bedding
	Concerns on safety and security	Accuracy and reliability of sensor, navigation, communication and seakeeping systems; Cybersecurity for MASS (proof of safety and reliability); Safe Mode for MASS; Integration of Digital twin & MASS; Test-bedding
	Complexity to design Smart ship and MASS	Development of auditable design approach with traceability using AI and Machine Learning; System engineering design approach; Comparison of Dynamic Positioning System and Autonomous System (system design and integration with FMEA); Test-bedding

Summary of outcomes from workshop (27 Oct 2021)

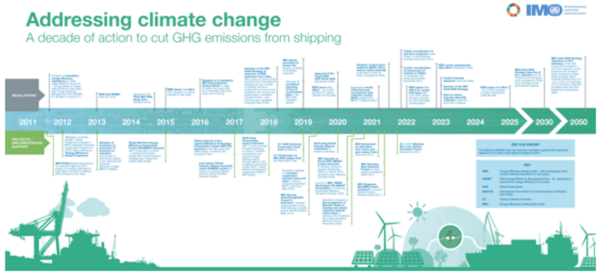
SINGAPORE INSTITUTE OF TECHNOLOGY

Pillar	Problem statement	R&D focus area
Sustainable Ship Design and Process	Limitation to drive significant improvement in energy efficiency and ship performance using current design approach	New design philosophy and concept upon comprehensive study of EEDI, EEXI, CII and Ship Energy Efficiency Management Plan; Development of holistic ship design optimization framework; Development of algorithm for design optimisation and lifecycle management; Development of digital twin to test and implement design improvement before production; Test-bedding @TCOMS and @DNV Simulation Trust Center
	Lack of design standardisation leading to sub-optimised system level design.	Development of intra-company design standardisation; Development of international design standards
	Too many different types of design tool and simulation platform	Development of common design tool and platform for simulation/optimisation and collaborative design; Test-bedding @TCOMS and @DNV Simulation Trust Center

Conclusions

Objective 1

- To enable Singapore maritime industry to navigate relevant mega trends such as decarbonisation, digitalisation, and sustainability through future ship and system design R&D.



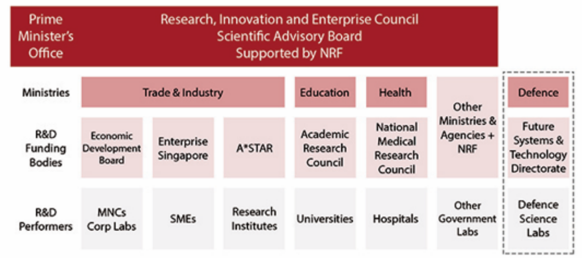
Source: https://www.imo.org/en/MediaCentre/HotTopics/Pages/Cutting-GHG-emissions.aspx

Key Results

- New design philosophy and concept
- New design standard
- New design methodology and tool
- New test bedding facility
- New policy insights

Objective 2

- To organise R&D ecosystem by projects and develop future capabilities and solutions for the maritime industry.



Source: https://www.nrf.gov.sg/about-nrf/rie-ecosystem

Key Results

- Long-term collaboration agreement between IHL, RI and industry partners
- Clustering of CoE
- New capability roadmap
- Human capital development
- IP and technology solutions
- Implementation and commercialisation of solutions
- Thoughts leadership

1. *Due to the complexity of designing future ship and system, a collaborative approach must be taken to involve key stakeholders such as industry partners, IHL, RI and government agencies.*

2. *Interested parties are invited to provide your inputs and participate in the Future Ship and System Design R&D program by contacting Assoc Prof Kenneth Low at Kenneth.Low@SingaporeTech.edu.sg*

Thank you