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Accelerating the Transition Towards Sustainable Marine Fuels

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POLICY BRIEF

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Highlights

1. An international consensus on the definition and inclusion of sustainable marine fuel options is needed.
2. Invest in enabling technology and infrastructure as well as "infrastructure diplomacy".
3. Encourage international collaboration and support capacity building.
4. Adopt a portfolio and all-inclusive approach to advanced technologies.
5. Recognise the benefits of civilian nuclear propulsion and get ready for its emergence.

Summary

The adoption of sustainable marine fuels (SMFs) is a complicated issue requiring an interdisciplinary approach to bolster synergistic developments in technology, infrastructure, policy and regulation and human resources. Against the global debate about options, standards and supply and demand dynamics, strategic "no regret policies" needs to be in place to continue industrial economy development.

What's the issue?

The maritime industry faces a critical challenge at the intersection of environmental sustainability and the energy transition. Shipping, a backbone of global trade, accounts for a significant portion of the world's greenhouse gas (GHG) emissions. According to the International Maritime Organization (IMO), maritime transport emits over one billion tonnes of CO_2 annually[1], which translates to approximately 13% of global transport emissions and around 2.5% of total global energy-related CO_2 emissions[2]. Additionally, shipping emissions contain pollutants such as sulphur oxides (SOx), nitrogen oxides (NOx) and particulate matter (PM), which have detrimental effects on air quality, public health and marine ecosystems.

A significant contributor to maritime emissions is the use of heavy fuel oils (HFOs), a cost-effective yet highly polluting fuel. The "IMO 2020"[3] mandates a significant reduction in the sulphur content of marine fuels and calls for a shift towards alternative options. However, more than 99% of today's marine fuels are still fossil based[4].

As such, there is growing recognition of the urgent need to transition towards sustainable marine fuels (SMFs) of low or zero carbon

[1] IMO. 2020. Initial IMO Strategy on Reduction of GHG Emissions from Ships. International Maritime Organisation.
[2] IEA. 2020. Energy Technology Perspectives 2020. International Energy Agency.
[3] IMO. 2019. IMO 2020 - Cleaner Shipping for Cleaner Air. International Maritime Organisation.
[4] IMO. 2024. Report of Fuel Oil Consumption Data Submitted to the IMO Ship Fuel Oil Consumption Database in GISIS (Reporting Year: 2023). International Maritime Organisation.

intensity to mitigate both environmental pollution and GHG emissions.

The IMO has set ambitious targets to address this issue. Their strategy aims to reduce GHG emissions per transport work by 40% of 2008 levels by 2030 and reach net-zero GHG emissions by or around, i.e., close to 2050[5]. Central to this strategy is the adoption of regulatory measures to phase down and eventually phase out the use of fossil-based fuels. Moreover, the IMO is developing a portfolio of legally binding mid-term measures comprising of both technical and economic elements to create a just and equitable transition to a net zero future[6].

Why is this important?

The imperative to transition towards SMFs extends beyond the maritime sector and aligns with broader decarbonisation and energy transition goals for the global energy industry. This transition holds particular significance for emerging economies in Asia, where rapid industrialisation and urbanisation drive increasing energy demand and emissions[7].

By moving towards SMFs, the maritime industry contributes to the wider decarbonisation efforts of the global energy sector. As one of the major contributors to global emissions, reducing the carbon footprint of shipping is essential for achieving international climate targets such as those outlined in the Paris Agreement[8]. SMFs offer a pathway to significantly reduce emissions from maritime transport, thereby supporting the broader goal of limiting global warming to well below two degrees Celsius.

Moreover, the transition to SMFs presents economic opportunities for developing countries in Asia. As emerging economies continue to grow, there is a growing demand for energy infrastructure and services. Investing in renewable energy technologies and sustainable fuel production can drive economic development, create jobs and enhance energy security in Asia[9]. SMF adoption will accelerate decarbonisation efforts of domestic fleets of vessels regulated by national commitments. Additionally, transitioning towards cleaner energy sources can mitigate the adverse impacts of air pollution and environmental degradation, improving public health and quality of life for millions of people.

Furthermore, the shift towards SMFs stimulates innovation and technological development not only in the maritime sector, but also across the entire energy industry. By investing in research and development (R&D) of alternative fuels and renewable energy technologies, policymakers can drive innovation and foster a culture of sustainability in the maritime industry and beyond[10]. This innovation can spill over into other sectors, accelerating the transition to a low-carbon economy and supporting sustainable development goals.

In summary, the transition towards SMFs is not only crucial for reducing emissions and pollution from the maritime sector but also

[5] Marine Environment Protection Committee (MEPC 80). 2023. 2023 IMO Strategy on Reduction of GHG emissions from Ships. International Maritime Organisation.
[6] MPEC. "Marine Environment Protection Committee (MEPC 82), 30 September – 4 October 2024." Marine Environment Protection Committee. International Maritime Organisation, October 4, 2024. https://www.imo.org/en/MediaCentre/MeetingSummaries/Pages/MEPC-82nd-session.aspx.
[7] World Bank. (2020). Global Economic Prospects.
[8] International Chamber of Shipping. 2020. *Guidance for Developing a National Maritime Transport Policy*.
[9] ADB. 2021. Asian Development Outlook (ADO) 2021: Financing a Green and Inclusive Recovery. Asian Development Bank.
[10] United Nations Environment Programme. 2021. Emissions Gap Report 2021.

aligns with wider decarbonisation and energy transition goals for the global energy industry. This transition presents economic opportunities for developing countries in Asia, stimulates innovation and contributes to the broader efforts to address climate change and achieve sustainable development.

What should the policymakers do?

1. Implement regionally appropriate regulatory frameworks and taxonomy for SMFs with reference to international best practices

Implementing regionally appropriate industry standards and taxonomy for SMFs requires a nuanced approach that considers regional differences, balances sustainability objectives and promotes inclusivity and transparency. First, to account for regional differences, there is a need to properly define SMFs towards regional industry standards instead of enforcing a single global standard. While a common technical basis such as environmental impact and life cycle GHG levels should be established, national regulatory frameworks and industry standards must be flexible enough to accommodate regional variations in fuel availability, infrastructure and other national circumstances to encourage industry participation. An SMF adoption strategy specific to the region while aligning with the broader goals of IMO and the Paris Agreement is required.

Next, there is a need to adopt a holistic approach and implement flexible and science-based governance frameworks that are transparent, enforceable and regionally appropriate to address the need for environmental protection, social responsibility and economic prosperity (balancing the people-planet-profit triple bottom line of sustainability), while also providing clarity and certainty for industry stakeholders. In turn, this can promote responsible practices, encourage innovation and drive sustainable growth in the maritime sector.

Policymakers must recognise the need to depoliticise the development of taxonomy to allow for technology, vendor and "colour" agnostic approaches and avoid the exclusion of technologies and solutions on a non-scientific basis. Taxonomy development should be based on robust scientific evidence, stakeholder consultation and objective criteria to ensure fairness and transparency. It is only possible to create a level playing field for all technologies and solutions, fostering competition and driving continuous improvement in sustainability performance if political biases and vested interests are removed from the process.

2. Invest in enabling infrastructure and “infrastructure diplomacy”

While the industries are familiar with the storage and handling of liquified natural gas (LNG) fuels, almost all SMF options would require costly new-build bunkering infrastructure that would attract speculations of perceived risks and scepticism rather than optimism. As such, the first consideration is alignment with long-term industrial economy development goals. Additionally, while there is a need to invest heavily to build new domestic infrastructure or upgrade existing ones, there is also a need to consider infrastructure development globally to ensure alignment with international efforts and industry trends to avoid duplicative efforts. Emerging economies should also

consider collaborating with international partners in global infrastructure initiatives so as to leverage resources, expertise and best practices to accelerate the development of domestic infrastructure supporting the adoption of SMFs. International collaboration can help facilitate knowledge exchange to ensure the appropriate infrastructure and supporting mechanisms that are applicable at domestic level and following global best practices.

Furthermore, policymakers should consider strategic partnerships for cross-investment in infrastructure to build green corridors to enable "SMF diplomacy". These partnerships can improve visibility on both the supply and demand sides of the market, facilitating coordinated investments and supply chain development. By establishing strategic infrastructure partnerships, policymakers can enhance regional cooperation, promote economic integration and strengthen energy security. Investing in infrastructure diplomacy can foster long-term relationships with key partners, mitigating geopolitical risks and enhancing market access for SMFs.

3. Support international collaboration in research, development and deployment in demand side and supply chain relevant technologies, and advance policy and regulatory research

Research, development and deployment (RD&D) are essential for unlocking the full potential of SMFs, promoting the adoption of the appropriate technological solutions and driving down costs over the long term. Given the global nature of technology and especially SMFs, it is necessary to foster a collaborative environment for international and national research and development initiatives to encourage industries, especially those in the value chain ecosystem, to participate in national RD&D projects. The only way to accelerate adoption of SMFs is to accelerate the deployment of demand side technologies such as methanol, ammonia and potentially hydrogen compatible engines. In addition, it is crucial to remove political biases and vested interests when investing in enabling technologies, adjusting national priorities if necessary. Advanced marine propulsion systems, such as hybrid drive, full electric and nuclear propulsion systems for civilian use should all be included in RD&D roadmaps. Investments in supply chain technology are essential to alleviate bottlenecks in SMF adoption.

Moreover, policymakers should adopt the concept of "knowledge and innovation without borders" to encourage global technology transfer and fund cross-border R&D efforts. Soft-grouping of research labs and R&D centres can facilitate knowledge exchange and international collaboration among experts, accelerating joint technology development and expanding go-to-market opportunities. Moreover, international and cross-border R&D efforts can help identify not only technological gaps but also gaps in policy and regulation, especially those related to international codes and standards, regulatory and legal frameworks, and the intersection of climate and industrial policies so as to drive innovation and research in those important fields.

4. Pay attention to capacity building and outreach programmes

Qualified experts, skilled workforce and competent regulators are critical human capital in supporting the adoption of SMFs. However, there is a general lack of crew training and educational programmes designed to accommodate the interdisciplinary nature of SMFs. While

traditional education and training can cover the technical and operational aspects of SMF industries, sustainability governance concepts should also be integrated into training programmes to educate regulators, policymakers, legislators and other stakeholders on the energy transition in the maritime space. Policymakers should adopt a holistic approach to ensure operational staff such as vessel and bunkering crew are adequately trained alongside top experts while keeping abreast of developments in artificial intelligence and IIoT (acronym for industrial internet of things), augmenting the autonomous operation of future SMF facilities.

Additionally, there is also a need to invest in public and industry outreach programmes to improve the acceptance of SMFs. These programmes need to be designed to raise awareness about the benefits of SMFs, address misconceptions, remove biases and engage local and community stakeholders in the transition towards sustainable maritime transport. In turn, these programmes can help foster international collaboration in R&D and demonstration projects that could lead to further development of innovative solutions for the maritime industry. Engaging local stakeholders in the adoption of SMFs (e.g., operators of smaller vessels) can also ensure acceptability and inclusiveness towards more sustainable fuel transition.

5. Open to innovative technologies and solutions

The competing technology pathways to decarbonise international shipping are not limited to cleaner fuel options such as ammonia, methanol, biofuel and even LNG. The options of onboard carbon capture and storage and nuclear propulsion systems are far from being dismissed. Despite varied sensitivity, contention and acceptance, onboard carbon capture and storage can lead to a decarbonisation pathway without phasing out the current fossil-based fuels and civilian nuclear propulsion would offer unparalleled mileage on a "full tank" leading to greater operational efficiency and route planning possibilities. The developments and acceptance of civilian nuclear propulsion would significantly open new industrial development opportunities for shipyards to provide servicing, maintenance and supply chain services for nuclear-propelled vessels. However, regulation and legislation must be in place to enable the safe, secure and efficient operation of civilian nuclear-propelled vessels and to allow such vessels to enter into ports of non-nuclear states.

Recent studies further suggest that full electric vessels for ocean liners are also possible with the development of offshore floating charging stations powered by offshore renewables and floating nuclear power plants[11]. The Centre for Strategic Energy and Resources is developing the concept of an offshore floating multi-utility complex[12] powered by small or micro modular reactors as a way of encouraging further R&D and of innovative technologies and solutions to enable an ecosystem for future SMF development and adoption and to advance further industrial economy development for the maritime and greater energy industries.

[11] Shuai Yang, Jun Yuan, Victor Nian, Lu Li, Hailong Li. "Economics of Marinised Offshore Charging Stations for Electrifying the Maritime Sector." *Applied Energy 322*, (2022): 119389.
[12] Nian, Victor. "An Ecosystem Approach to Maritime Decarbonisation in ASEAN." Green Denmark in Southeast Asia. Danish Trade Council, July 19, 2022. https://www.greendkinsea.com/post/an-ecosystem-approach-to-maritime-decarbonisation-in-asean.

Biography

Dr Victor Nian is a Founding Co-Chairman of the Centre for Strategic Energy and Resources. His expertise is in energy, sustainability and net-zero policy and strategies. He is one of the go-to-persons in nuclear energy and the hydrogen economy in Southeast Asia. Dr Nian holds a PhD in Mechanical Engineering and a BEng (Hons) in Electrical Engineering with a Minor in Management of Technology, all from the National University of Singapore.

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Ashish Anilan brings over 15 years of experience in developing technology-driven marine projects across Southeast Asia and the Pacific. Currently, as Assistant Director and Sustainability Lead at Bureau Veritas Marine & Offshore, he spearheads strategic initiatives for the region's sustainability and energy transition in maritime and adjoining sectors. Ashish holds a MSc in Management of Technology from the National University of Singapore and a BEng (Hons) in Mechanical Engineering from Nanyang Technological University.

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Alex Ng is Director of Orcades Marine Management Consultants and CEO of the startup OM 88. He has been working on marine renewable energy projects across Europe and Asia in the fields of wave, tidal, floating solar and, more recently, floating offshore wind. His experience spans from desktop techno-economic analysis to field work involving resource assessment and marine operations. In recent years, he has been developing floating solutions to provide cold-ironing to ships in the UK and electric charging to harbour crafts in Singapore. He holds a BEng (Hons) in Mechanical Engineering from the Nanyang Technological University.

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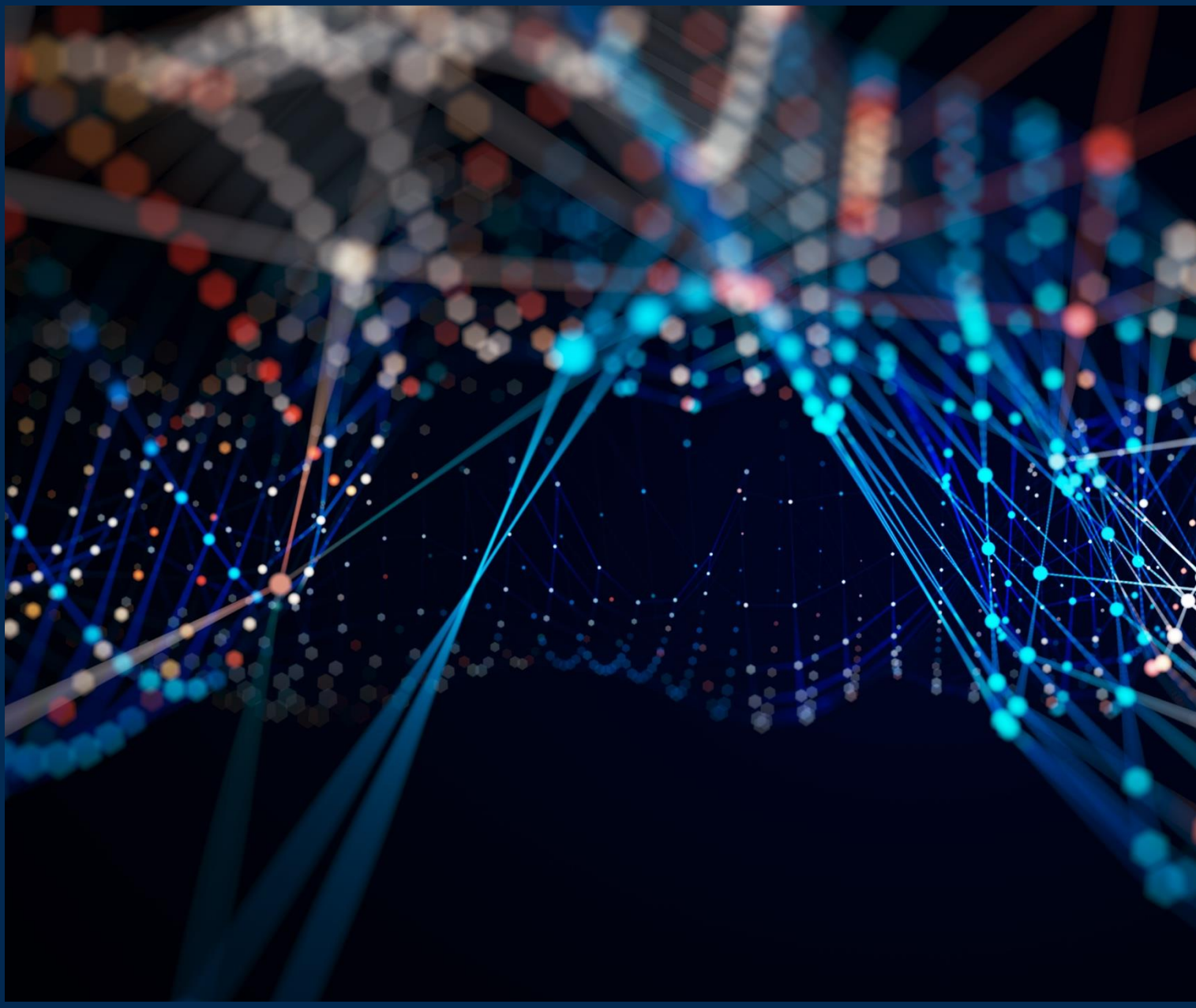

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