Background Note

Thematic Track 1: **Progress and Adoption of Alternate Engines and Future Fuels (Green Methanol, Ammonia, H2 and other Blend-fuels) for Sustainable Maritime Transport**

Thematic Track 2: **Shaping the Future-the Path towards Net-zero Future Fuels for Shipping**

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Globally, ports handle over 80% of international trade and are considered the backbone of global economic growth (UNCTAD, 2021). However, emissions from the shipping sector contribute about 3% of the global anthropogenic emissions (IMO, 2020), which is believed to be increased by a factor of 2.5 to 3.5 by 2050 in the absence of any sustainable and significant actions. The International Maritime Organization (IMO) aims 50% reduction of GHG emissions from international shipping by 2050 with 2008 as reference level (IMO, 2020). India, with its long coastline of ~7,500 km with 13 major and 200+ non-major ports, has set a target of achieving net zero emission in shipping operations by 2050[1].

Among key missions introduced by the Indian government, the Vision of Blue Economy 2047, which targets harnessing the ocean resources to full optimization, national Hydrogen Mission (2022) aimed at producing 5 million tonnes of green hydrogen per year by 2030[2], National Biofuel Policy (2018) introduced to reduce the use of fossil fuels, the Sagar Mala Project (2015) outlined 200+ port connectivity projects are mention worthy which are directly or indirectly making an impact on decarbonising maritime transport.[3]. The initiatives under hydrogen mission also envisage building or retrofitting at least two Indian ships to run on green hydrogen or a derivative fuel by 2027. Additionally, to boost the ship manufacturing in India several policies like Financial Assistance Policy on Shipbuilding (2016), Grant of Infrastructure status (2016), SOP for chartering /procurement of tugs (2020), Pradhan Mantri Matsya Sampada Yojna (2020) are some decisive steps to boost to the indigenous manufacturing and shipbuilding considerably reducing the carbon footprint by avoiding import of ships and components. These initiatives also promote the use of sustainable green/future fuel in shipping operations.

[1] https://pib.gov.in/PressReleasePage.aspx?PRID=1877185
[2] https://pib.gov.in/PressReleasePage.aspx?PRID=1877185

The country's first national centre of excellence on green port and Shipping (NCoEGPS) is established in TERI's field station in Gwal Pahari. The main objective of the proposed NCoEGPS is to provide support to MoPSW in developing and maintaining a policy and regulatory framework for a green alternative technologies road map for the shipping sector in India for its transition to carbon neutrality and CE principles. It is aspired that this centre's collaborative work with other organisations on policy research and technology development will be key in greening the shipping sector. This centre will also facilitate valuable education, applied research and technology transfer in maritime transportation at the local, regional, national and international levels.

Under this Centre activities, one of the key projects deals with the development of roadmap on green future fuel adoption in marine transport. The major objectives of the sustainable green future fuel project are:

- Comparative study for ranking of sustainable green/future fuels based on suitability in marine application (co-blending/dual fuel or mono fuel) in order to find India's best options.
- Study and prepare report on comparative technical feasibility/easiness of establishment of sustainable green/future fuel Reception, Storage, Bunkering facilities at selected ports in east and west coast of Indian ports.
- Steps to establish sustainable supply chain logistics for sustainable future fuel options Phase 1: towards 2030 (`5%) & Phase 2: beyond 2030
- Understanding the existing global standards, rules and regulation for use, storage, transport, bunkering of sustainable green/future fuel(s) for marine application and developing the standards for India
- Converting/constructing vessels as pilot project to prove the best identified sustainable green/future-fuel for Indian ships (moving from smaller inland water ships to bigger ships)
- Exploring collaborating opportunities for development and adoption of sustainable green/future fuel in maritime sector (fuel technology, engine, fuel standards, digital emission reporting templates, storage bunkering and sustainable green/future financing)

India has recently set an ambitious target to be a leading hub for green tugs including coastal vessels and ferries. A 3-phase transition is envisioned with Interim phase (50% green tugs between 2023-2030), 1st Phase (75% transition to green tugs between 2030-2035),and 2nd Phase (100 % transition to green tugs between 2035-2040). This implies that 50 % of all new tugs that would be constructed in the interim period is expected to run on sustainable green/future fuel. In order to achieve the target, accelerated innovation, setting up supply chain for green fuels, developing technology at scale, establishing mono and blend fuel standards, storage and safety protocols are extremely crucial in the time towards 2030.

The alternative fuel choices available today includes Liquefied Natural Gas (LNG), Renewable Electricity, Biodiesel, Green Diesel, and Methanol, whereas, Liquefied Petroleum Gas (LPG), Dimethyl Ether (DME), Biomethane, Synthetic fuels, Hydrogen and its derivatives (for fuel cells), Hydrogenation-Derived Renewable Diesel (HDRD) and Pyrolysis Oil derived fuels are emerging as promising future alternates. Presently diesel engines and Otto Engines are most widely used for new fuels. Diesel engines are compatible with a range of fuels like diesel, biodiesel (FAME), vegetable oil, dimethyl ether (DME), gas-to-liquid (GTL), biomass-to-liquid (BTL) like pyrolysis and hydrothermal bio-crude upgraded oil, and hydrotreated vegetable oil (HVO). etc with little

or no engine or bunkering modifications required. Otto engine in contrary works on the fuels like gasoline, ethanol, methanol, natural gas, biomethane both in compressed (CNG) and in liquid form (LNG) and hydrogen.

Marine alternative fuels are implemented in either mono-fuel or dual-fuel mode while each type has its pros and cons. In case of mono fuel, marine diesel engines are reported as more efficient than Otto engines, which is attributed to their higher compress ratio. In Dual fuel options, the ship operates on multiple combination of the fuels resulting in high CO2 savings and high variable cost savings.

It is expected that by 2030, biofuels will also play a key role, provided that sizable volumes are produced sustainably at an attractive price. Biodiesel, HVO, Green Diesel, SVO are preferred choices as drop in/blended fuel for marine diesel engines. Nevertheless, Marine fuel (LSMGO and HFO) co-blending options need to look beyond immediate oil resources-based biofuels which seems to have national and global feedstock sustainability issues. All these fuels are made from similar feedstocks, such as, tree borne oils, used cooking oil, non-edible vegetable oil, animal fats, oils, algal lipid etc. A major challenge lies in its' competitive use in SAF production (Sustainable Aviation Fuel). Green Diesel & Biodiesel are also adopted as major alternate for Road Transport especially for heavy duty vehicles.

Globally Marine sector is moving towards LNG (near and medium term though fossil based but later can be shifted to CBG), methanol (immediate) and hydrogen & green ammonia (long term) as dual fuel & retrofitting options for marine engines. Dual Fuel (new build) or retrofitting offer the possibility to remain flexible on the evolving transition pathway and offer the opportunity to tailor the vessels to meet global standard and adapt to fuel availability also offering reductions in GHG emissions as well as reduction in air pollution in line with IMO ECA regulations. However, with technological disruptions large investments in dual fuel options still could lead to high volume of stranded assets. Policy support for ramping up production of green fuel with simultaneous development / adoption of hybrid and mono fuel engines especially with green methanol and hydrogen derived fuels would be crucial to greening tugs.

Comparing the aspect of relative easiness w.r.to bunkering, storage and on-board storage, the scenario look different for large vessels for international trade against small and medium tugs operating between specific terminals where bunkering stations in fewer no of ports could be sufficient to manage the fleet operation sustainably. This also give the opportunity to make sustainable fuel supply a reality with fuel grade liquid alternate fuels being produced in localised plants. liquid fuel offers the choice/ flexibility/option to be bunkered to ship via ship-to-ship bunkering, truck to ship bunkering or land storage to ship bunkering. In reality several smaller vessels like road ferries and commuter ferries are currently bunkered by truck in some European countries. Port of Singapore & Port of Rotterdam are pioneering in establishing multi-fuel bunkering and refuelling hubs for a variety of low- and zero-carbon fuels towards 2030.

Other green fuel technology options like hydrogen and ammonia are emerging/evolving, and not yet available in sizable volume to retrofits. Hydrogen in fuel cells is propounded as an efficient and clean electricity provider for propulsion where it necessitates storing on board as a compressed gas (700 bar) or as a liquid (cryogenic, −252 °C). Also new ships with hydrogen option require large degree of redesigning. India's aspirational green hydrogen mission could accelerate construction of hydrogen infrastructure/ hubs to facilitate hydrogen uptake in marine sector.

From Indian perspective, in order to achieve long term feedstock sustainability, only looking beyond oil-based feedstock to produce diesel like alternates might not be sufficient enough to meet alternate fuel demand. It is also highly desirable to adapt green/future fuels in broader perspective over merely biofuel by expanding the biofuel feedstock horizon and embracing other abundantly available wastes like MSW, Plastic and Scrap tyres to make non-biogenic alternate fuels. In the short to medium term, diesel alike drop-in fuels, diesel electric hybrid and green methanol appear to be the viable options while in the longer-term bio crude-based drop in fuel, CCUS based synthetic fuel as low carbon option, green methanol, ammonia and eventually hydrogen derived fuels could be promising energy carriers in marine sector. Quickly piloting tug designs both with dual fuel and mono alternate fuels along with adopting/developing diligent emission monitoring protocols could generate extremely insightful data prior to large investment towards large scale green fuel adoption both in old and new fleets across sizes.

There is a great need to compare all possible green fuel options for India including (Methanol/Ethanol-Dieselblends/DME/Hydrogen/Ammonia/Bio-Diesel/Green-Diesel) and their roles in decarbonizing India's Maritime transport. The overall activities require alignment with global developments. Towards this it is of paramount importance to understand progress in fuel and engine development, policy, economics and regulations and the global perspectives.

The green fuel transition can be considered in two parts. The immediate focus would be more on assessing green/future fuel choices for coastal and inland water shipping till 2030 and beyond. As a first step while establishing a minimum 5% supply of green fuel, there would be a greater flexibility for use of sustainable future /green fuels in India's inland water and coastal shipping. Adoption of future fuel necessitates immediate action is establishing green facilities for reception, storage, bunkering at selected ports as a pilot. Subsequent to the pilot studies, the feasibility, adaptability and expansion of operations in other ports could be prepared with specific transition timelines.

This WSDS side event in TERI will bring relevant experts onboard and have greater consultation with Ministries like Ministry of Port, Shipping and Waterways, Ministry of Petroleum and Natural Gases (MoP&NG), Ministry of New and Renewable Energy (MNRE), Bureau of Indian Standards (BIS), Oil refineries, OEMs and other stakeholder institutions and developers in the domain of green fuel production, alternate engine development and domain of fuel policy and standard. The discussions in this event would provide critical inputs and insights in developing the roadmap that will guide for the path to be taken, and the policies, standards and safety and framework development in order to ensure a smooth transition towards sustainable marine fuels and engines.

With this as a background two thematic tracks are designed with the objectives to get insight on the global progress and present challenges on green/ future fuel productions, engine developments (especially the options for smaller ships), bunkering and storage of future fuels and last but not the least the evolution of fuel and blend fuel standards, safety protocols related to storage, transport, and use. The discussion on reducing the policy gaps between India and other countries and the overall scope for short- and long-term collaboration opportunities will also be critically assessed.