MARITIME TECHNOLOGIES FORUM
LEADING THE MARITIME WORLD FORWARD

FRAMEWORK FOR ASSESSING DECARBONIZATION TECHNOLOGIES AND ALTERNATIVE ENERGY CARRIERS

Maritime Technologies Forum (MTF)

ABOUT MTF

The Maritime Technologies Forum (MTF) is a forum of Flag States and Classification Societies.[1] It has been established to provide technical and regulatory expertise to benefit the maritime industry. The role of the Forum is to work together on research which it will publish to the maritime industry and draw on regulatory expertise to be able to offer unbiased advice to the shipping sector. It will seek to give guidance on the use of alternative fuels and increased levels of automation in the industry. Furthermore, it will allow for the safe testing and adoption of new technologies and it will help shape world-leading regulation.

1. INTRODUCTION

The Initial IMO GHG Strategy[2] sets a clear vision for international shipping to reduce and phase out GHG emission as soon as possible within this century. This vision is supported by ambitions for GHG emissions and carbon intensity in 2030 and 2050, stating that *"technological innovation and the global introduction of alternative fuels and/or energy sources for international shipping will be integral to achieve the overall ambition"*

The MTF recognizes that the most pressing challenge for the shipping sector is to improve its energy efficiency and to reduce carbon intensity which requires the use of alternative energy carriers and new prime mover technologies. This will also require a change in other on-board technologies and supporting infrastructure that the new technologies will require. Whilst greenhouse gas emissions reduction is the main purpose of this change, we need to ensure we consider the impact of other social, economic and environmental factors when finding and applying the solutions.

Therefore, the framework has been created in order to promote a holistic and considered assessment of technologies and energy carriers to be accepted into the maritime environment, which are suitable for long term use in the marine environment without detriment to the planet and the people living on it, in line with the premises of the United Nations Sustainable Development Goals.[3]

1.1 Purpose and scope

The purpose of the framework is to:

- Provide a shared agreement as to what criteria are important when assessing decarbonization technologies and alternative energy carriers
- Facilitate understanding and communication on such technologies and energy carriers[4]
- As a result of the assessments, identify gaps where further regulations and standards are needed to remove barriers

The framework should, in general, be applicable for all decarbonization technologies and alternative low- and zero-carbon energy carriers.

[1] https://www.maritimetechnologiesforum.com/
[2] IMO Resolution MEPC.304(72): Initial IMO Strategy on reduction of GHG emissions from ships
[3] https://sdgs.un.org/goals
[4] ISO 13600:1997 (withdrawn) defines energy carriers as "Substance or phenomenon that can be used to produce mechanical work or heat or to operate chemical or physical processes". IPCC Fourth Assessment Report: Working Group III states that "Energy carriers include electricity and heat as well as solid, liquid and gaseous fuels".

1.2 Key benefits

The key benefits of the framework are:

- It considers all areas of criteria relevant in order to achieve sustainable outcomes from the introduction of decarbonization technologies and energy carriers: technology status, sustainability, safety, security, regulations, people, engineering and economic feasibility.
- The extensive criteria in the framework ensures that important systemic aspects will be duly considered rather than omitted.
- It can be used for a singular assessment, or for comparison between multiple technologies or energy carriers.
- Assessments can be carried out in a repeatable and consistent way.
- A full system can be assessed using it, or just a sub-system, notwithstanding that not all criteria apply in all cases, particularly when using it for assessing an energy carrier versus a technology.

1.3 Current status of framework and work ahead

The framework is intended to be developed further over time, following feedback from maritime actors*. The initial promotion of the framework, included within this paper, promotes only the set of criteria, the high-level explanation of them, and an initial proposal from the Forum on the priority. MTF will consider a methodology specific to each criterion and its minimum thresholds in the future.

2. METHOD

At the time of writing, there are many assessments being carried out on decarbonization technologies and energy carriers, by different actors within the maritime industry and wider environment. A limitation of these assessments is that they do not duly consider the wider sustainability aspects, and only focus on a small set of criteria. Often there are through life aspects of the technology or energy carrier which are not considered.

The UN's Sustainable Development Goals through its 19 goals and more than 160 targets, link all the various aspects that need to be considered in a sustainability perspective, including biosphere, societal and economic factors. The SDGs, however, do not provide a framework for evaluating new technologies and energy carriers.

There is ongoing work on establishing frameworks and criteria for evaluating such new solutions. Examples are the Sustainable Shipping Initiative work on sustainability criteria for marine fuels[5], and the Global Industry Alliance to Support Low Carbon Shipping workstream on alternative low- and zero-carbon fuels[6], as well as research work.

In this framework, the MTF applies a Systems Engineering approach bringing consideration of all relevant criteria, in a through life fashion, ensuring that this spans right through from initial consideration to disposal. It encourages sustainable decarbonization, and provides an enduring framework that may be used more widely throughout the maritime industry beyond the current main focus area of GHG emision reduction.

*Members have the right to reserve themselves from positions in MTF publications that may be contrary to Members' own policies

[5] https://www.sustainableshipping.org/our-work/current-work/sustainability-criteria-for-marine-fuels/

[6] https://greenvoyage2050.imo.org/gia-workstreams/

The International Council on Systems Engineering describes Systems Engineering as:

"Systems Engineering is a transdisciplinary and integrative approach to enable the successful realization, use, and retirement of engineered systems, using systems principles and concepts, and scientific, technological, and management methods".[7]

In making an assessment there will always be trade-off between one attribute to another. The prioritisation is needed to determine which attribute is more important when using the framework to assess decarbonization technologies and energy carriers. Each criterion has initially been prioritised (higher, medium or lower) with respect to what is important from a decarbonization perspective. If the priority of an attribute is set to 'higher' it cannot be traded-off and the minimum threshold must be met; 'medium' and 'lower' priority can be traded-off if it conflicts with an attribute of a higher priority (for example economic feasibility). If the framework were to be used post-decarbonisation or on another challenge, the prioritisation may change.

3. FRAMEWORK

CRITERIA (HIGH LEVEL)	SUB CRITERIA	EXPLANATION / ADDITIONAL NOTES	PRIORITY (HIGHER, MEDIUM, LOWER)	DRAFT: MIN. THRESHOLD (ACCEPTANCE LEVEL)	DRAFT: METHODOLOGY FOR THE MEASUREMENT
SUSTAINABILITY & ENVIRONMENTAL					
Sustainability & Environmental	Greenhouse gas emission	Well to wake greenhouse gas emissions from the production, storage & distribution, use and disposal of the technology and/or energy carrier.	HIGHER		
Sustainability & Environmental	Ecological and social impact (externalities) in production scenarios	This is the ecological and social impact (externalities) arising as a result of production scenarios. There may be subsets within this such as toxicity, and resource use (land, minerals, etc), water use or pollution (air/water etc), labour aspects such as welfare, health and equality + equity (in international aspects), etc.	HIGHER		

[7] https://www.incose.org/about-systems-engineering/system-and-se-definition/systems-engineering-definition

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SUSTAINABILITY & ENVIRONMENTAL					
Sustainability & Environmental	Ecological and social impact (externalities) in storage & distribution scenarios	This is the ecological and social impact (externalities) arising as a result of storage & distribution scenarios.	HIGHER		
Sustainability & Environmental	Ecological and social impact (externalities) in bunkering scenarios	This is the ecological and social impact (externalities) arising as a result of bunkering scenarios, considering shore-to-ship and ship-to-ship bunkering.	HIGHER		
Sustainability & Environmental	Ecological and social impact (externalities) in onboard use scenarios	This is the ecological and social impact (externalities) arising as a result of onboard use scenarios.	HIGHER		
Sustainability & Environmental	Recyclability and disposal	This is the recyclability and waste aspects, within production scenario, when in service (via operation and maintenance), and also when it comes to end of life, relating to the energy carrier or technology. Includes all impacts from disposal, at end of system life.	HIGHER		
Sustainability & Environmental	Resilience to shocks and disruptions (in market, ecological, etc; not physical)	This relates to resilience within the system (including within its supply chain and value chain) in relation to shocks and disruptions which can happen in the market, ecologically, etc.	MEDIUM		

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SAFETY					
Safety	Safety during production	This considers the level of safety achieved, and achievable, during production.	HIGHER		
Safety	Safety during land distribution	This considers the level of safety achieved, and achievable, during land distribution.	HIGHER		
Safety	Safety during land storage	This considers the level of safety achieved, and achievable, during land storage.	HIGHER		
Safety	Safety during bunkering	This considers the level of safety achieved, and achievable, during bunkering, including all modes of bunkering.	HIGHER		
Safety	Safety during onboard storage	This considers the level of safety achieved, and achievable, during onboard storage (on the vessel).	HIGHER		
Safety	Safety during onboard usage	This considers the level of safety achieved, and achievable, during onboard use (on the vessel). This includes during all onboard use scenarios (underway, at anchor, in port, dry dock, etc), and includes operation and maintenance.	HIGHER		
Safety	Aggregated safety considerations	The level of safety may be affected by the environment outside the vessel itself. This considers the level of safety achieved, and achievable, when you go beyond one singular vessel, such as when you look at multiple vessels in the same location (e.g. port, anchorage, etc).	HIGHER		
Safety	Safety during disposal	This considers the level of safety achieved, and achievable, during disposal.	HIGHER		

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TECHNOLOGY STATUS					
Technology Status	Current technology readiness	This is the technology readiness level at the time of assessment.	LOWER		
Technology Status	Potential trajectory of technology readiness	This is the expected change of technology readiness level over time, in order that this contributes to the assessment by informing of when technology may be available.	MEDIUM		
SECURITY					
Security	Security during production	This considers the level of security required, and achievable, during production.	MEDIUM		
Security	Security during land storage	This considers the level of security required, and achievable, during land storage.	MEDIUM		
Security	Security during land distribution	This considers the level of security required, and achievable, during land distribution.	MEDIUM		
Security	Security during bunkering	This considers the level of security required, and achievable, during bunkering, including all modes of bunkering.	MEDIUM		
Security	Security during onboard usage	This considers the level of security required, and achievable, during onboard usage. This includes during all onboard use scenarios (underway, at anchor, in port, dry dock, etc), and includes operation and maintenance.	MEDIUM		
Security	Security during disposal	This considers the level of security required, and achievable, during disposal.	MEDIUM		

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ECONOMIC FEASIBILITY					
Economic Feasibility	Cost of storage (on land)	This relates to the cost of storage on land.	HIGHER		
Economic Feasibility	Cost of storage (onboard)	This relates to the cost of storage on onboard.	HIGHER		
Economic Feasibility	Cost of production	This relates to the cost of production.	HIGHER		
Economic Feasibility	Cost of distribution	This relates to the cost of distribution.	HIGHER		
Economic Feasibility	Technical complexity of distribution	This is how technically complex it will be, to achieve distribution, in the quantities required.	MEDIUM		
Economic Feasibility	Complexity of retrofitting	This is the complexity of applying this in retrofit scenarios.	LOWER		
Economic Feasibility	Impact on ship operation	This is the impact of the technology or energy carrier on ship operation. This will differ with different ship types and uses. Below a certain threshold it will not be viable to progress a technology / energy carrier because the negative impact will be too high.	MEDIUM		
Economic Feasibility	Availability (quantity)	This is the availability, in terms of quantity of supply. Depending on the technology or energy carrier, availability could be limited due to availability of an element within it. Cost to scale up availability would be included.	HIGHER		

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REGULATORY					
Regulatory	Complexity of resulting regulation (onboard focus)	This is complexity of the regulatory aspects relating to onboard; the implementation of it, plus potential cost of changes.	MEDIUM		
Regulatory	Regulatory compatibility between nations	This is the level of compatibility between multiple nations when it comes to regulation.	MEDIUM		
Regulatory	Regulator interfaces (internal to singular nations)	This is the look of the complexity of the landscape with regard to regulatory interfaces between where jurisdictions meet (jurisdictions internal to one nation, rather than compatibility/ complexity of regulation between nations). For example, where the ship to shore regulatory interface exists.	MEDIUM		
Regulatory	Complexity of production, storage and distribution regulations (on land)	This is complexity of the implementation of the regulations relating to production, storage and distribution. This includes consideration to the cost associated with that complexity.	MEDIUM		
PEOPLE					
People	Skill base and competency within production, distribution and storage industry	This is the level of change that would be required, regarding the skill base and competency within production, distribution and storage industry, in order to accept the new technology or energy carrier into service.	MEDIUM		
People	Certification & Training within maritime industry	This is to the level of change that would be required, regarding the certification & training for maritime industry personnel, in order to accept the new technology or energy carrier into service.	MEDIUM		
People	Social acceptance	This concerns the social acceptance of the technology or energy carrier in question. It also includes whether it is aligned with other sectors in the drive to decarbonization, or misaligned.	MEDIUM		

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ENGINEERING					
Engineering	Engineering complexity (production, installation, decommissioning)	This is the engineering complexity relating to bringing the technology or energy carrier into service.	LOWER		
Engineering	Availability	Availability is the measure of an item/system's readiness for use. It is a function of the reliability and maintainability attributes of the system/item, and the level and effectiveness of the support arrangements in place. Preventative maintenance may be considered, as part of the availability calculation.	MEDIUM		
Engineering	Reliability	Reliability relates to an item/system working to its full capability (design capability) when it's required to.	MEDIUM		
Engineering	Maintainability	Maintainability relates to the difficulty of repairing things once they have a problem. Therefore, it does not include preventative maintenance, but does incorporate the notion of corrective maintenance.	LOWER		
Engineering	Logistics / supportability	This looks at the aspects required in order to support the item, including their complexity. For example, how simple is it to get support (parts, labour, etc) when in many worldwide locations, as well as constraints around that (cost, time, complexity, etc). This is - and affects - the supply chain, across all required locations and how complex that is (what is required to achieve it). But, more relating to the support supply chain, rather than initial production of the item. It can also include aspects such as consideration to connections for data for maintenance etc, diagnostics and calibration, etc.	MEDIUM		

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ENGINEERING					
Engineering	Interoperability	This concerns the interoperability surrounding the technology or energy carrier. For example, shore power connection compatibility, fuel quality.	MEDIUM		
Engineering	Quality standards	This concerns safety aspects as a result of quality, as well as compatibility (internationally) as a result of quality, etc. This can apply for technologies and also energy carriers.	MEDIUM