MARINE ENVIRONMENT PROTECTION COMMITTEE
73rd session
Agenda item 7

MEPC 73/7/2
17 August 2018
Original: ENGLISH

REDUCTION OF GHG EMISSIONS FROM SHIPS

Implementation programme for effective uptake of alternative low-carbon/zero-carbon/fossil-free fuels

Submitted by CESA and EUROMOT

SUMMARY

Executive summary:	This submission contains proposed definitions and considerations to promote the timely introduction of alternative fuels, such as low-carbon, zero-carbon and fossil-free fuels into shipping
Strategic direction, if applicable:	3
Output:	3.2
Action to be taken:	Paragraph 27
Related documents:	MEPC 67/INF.3; MEPC 71/INF.34; ISWG-GHG 3/INF.2 and resolution MEPC.304(72)

Introduction

1 MEPC 72 adopted resolution MEPC.304(72) on *Initial IMO Strategy on reduction of GHG emissions from ships* (hereinafter the Strategy) and decided to consider follow-up actions and how to progress the matter of reduction of GHG emissions from ships on the basis, for example, . of a report from ISWG-GHG 4 which will take place from 15 to 19 October 2018.

2 The Strategy includes candidate long-term, mid-term and short-term measures which will be considered in the present submission to propose some information regarding the implementation programme for effective uptake of alternative fuels to support the future development towards decarbonization of the shipping industry.

3 Although the present submission focuses on alternative fuels, other technical solutions will support the intended implementation programme. These solutions comprise the direct use of renewable energies like wind, solar, wave energy, etc. in future ship design as well as enhanced technologies for use of energy on board including energy recovery.

4 The combination of alternative fuels, direct use of renewable energy and improved efficiency of onboard use of energy are three expected core pillars for the implementation programme.

Definitions

5 In the context of the proposed candidate measures of the Strategy, the co-sponsors would like to offer the following definitions and explanations:

6 *Energy carriers for use in the shipping industry* means all types of fuels, batteries or any other energy storing device to provide secondary energy for further conversion on board to mechanical, electrical and thermal energy.

7 *Zero-carbon fuel* means an energy carrier that does not contain any carbon, hence does not release any CO_2 when being used in internal combustion engines, gas turbines, fuel cells or any other energy converting device. Such fuels are for example hydrogen or ammonia. These fuels typically carry a CO_2-backpack from production (well to tank) which must be considered when assessing CO_2 emissions from well to propeller. In addition, electrical energy from renewable sources stored in batteries can be regarded as a zero-carbon fuel (or energy carrier). In this case, the emissions from well to propeller depend on the production pathway (well to tank) of the electrical energy.

8 *Fossil free fuel* means a synthetic fuel (energy carrier) which is produced from other non-fossil sources using renewable energy sources, including biomass to liquid fuels (BtL) or power to liquid (PtL) / power to gas (PtG) fuels. Typical feedstock for such fuels are CO_2 from biomass or extracted from atmosphere. Fuel type candidates in this respect are, for example, methanol, synthetic methane (liquefied for storage purposes) and Fischer-Tropsch diesel not excluding other types of energy carriers.

9 *Low-carbon fuel* means a fuel which uses CO_2 from industrial processes or other fossil CO_2 point sources as feedstock for a synthetic fuel with less GHG intensity.

10 *GHG intensity (CO_2-eq. emissions/MJ Fuel)* means a measure to define the total emission of greenhouse gases, in CO_2 equivalent, from production of the corresponding fuel and subsequent full conversion of the fuel's carbon content to CO_2 during combustion. The co-sponsors are of the opinion that the development of guidelines of GHG intensity of fuels is of upmost importance. A principle exercise has already been performed under the EU-funded JOULES project and corresponding information has been provided in document ISWG-GHG 3/INF.2 (CESA).

Key parameters for effective uptake of alternative fuels

11 Beside GHG intensity other environmental key parameters must be included in a life cycle assessment (LCA) exercise. In particular the use of land plays a dominant role for future decision-making. A simple example shows the potential of energy harvesting from different sources and provides a clear ranking for future considerations (see figure 1 below).

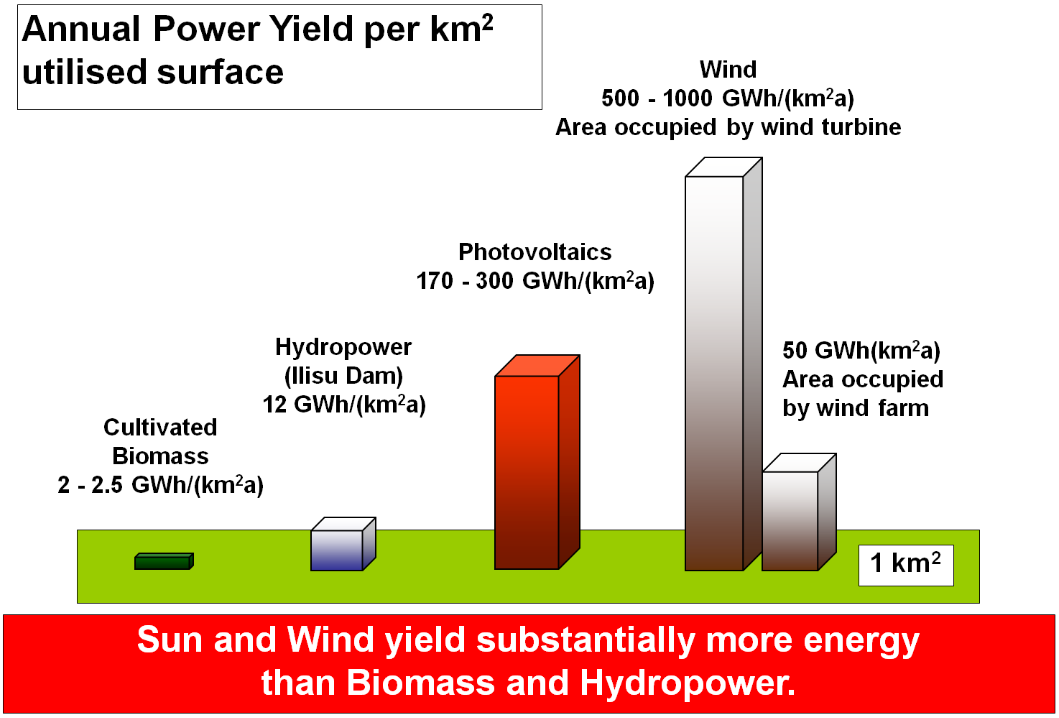

Figure 1: Annual power yield per km^2 utilized surface
Source: Bossel, *Energiewende zu Ende gedacht*, 2014 (ISBN: 9783033047730)

12 The amount of energy to produce future zero-carbon, fossil-free or low-carbon fuels will require substantial amounts of renewable energy, which should be considered in future LCA of such fuels.

13 Greenhouse gases are those gases which contribute to global warming with their characterization factors as defined by the Intergovernmental Panel on Climate Change (IPCC) in 2013. In this context, the role of methane slip should be further assessed due to the higher global warming potential of methane (1 kg of methane has the same impact equivalent to 28 kg of CO_2). The methane slip is dependent on the engine type (lean gas engine, dual fuel engine either two-stroke or four-stroke), the production pathway of liquefied natural gas (LNG), tank design (e.g. membrane tanks or type C-tank) and other effects like boil-off handling or operating profile (e.g. low load operation).

Long-term perspective

14 As a long-term measure, the provision of carbon-free and/or fossil-free fuels (energy carriers) is necessary to ensure the fulfilment of the objectives of the Strategy. The co-sponsors have reviewed document MEPC 67/INF.3 as well as document MEPC 71/INF.34 to reflect socio-economic pathways (SSPs) being in line with Representative Concentration Pathway 2.6 and Policy Assumptions (impact from today's and future IMO legislation on technology uptake and energy efficiency). For the 2050 CO_2 emission projections from international shipping, a range from approximately 1,000 million tonnes of CO_2 to roughly 1,750 million tonnes of CO_2 has been used to calculate an approximate amount of such fuels needed in the future.

15 Using the baseline emissions of 810 million tonnes in 2008 and the required 50% reduction of the total annual GHG emissions from the Strategy, the target emissions are 405 million tonnes of CO_2 in 2050 from international shipping. As an example, using the above mentioned emission projections and using diesel fuel as the predominant fuel with a fuel to carbon factor of 3.206, it is expected that fossil-free diesel fuel in a range between 185 million tonnes and 419 million tonnes will be needed in 2050. This amount will differ when other fuel types are used depending on the fuel to carbon factor (see figure 2 below).

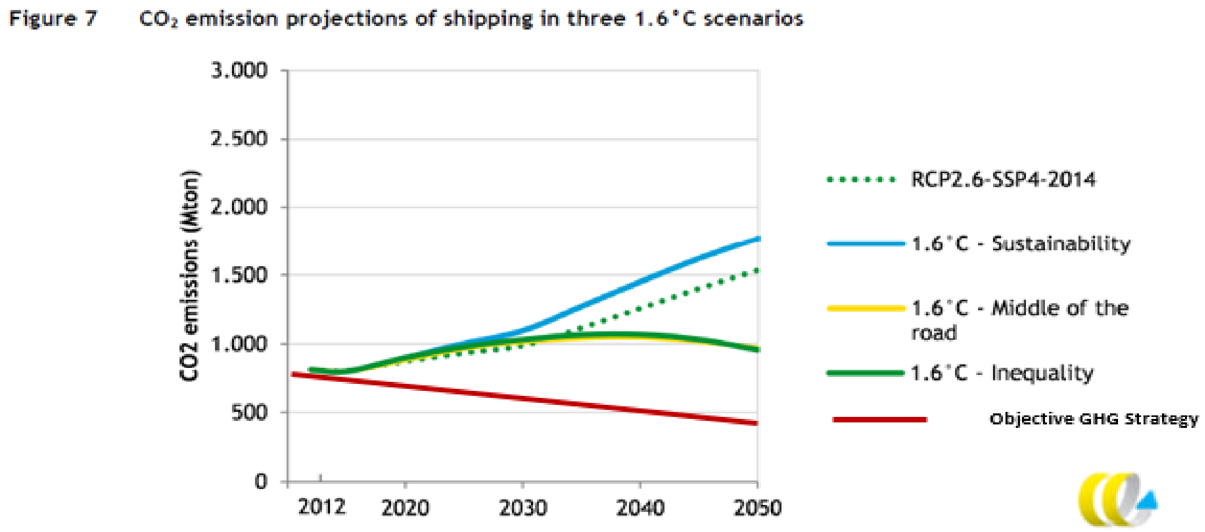

Figure 2: Modified ("Objective GHG Strategy" curve added) graph of CE Delft report as set out in document MEPC 71/INF.34

16 In order to be able to produce such an amount of fossil-free fuel, corresponding technology must be available on a large industrial scale such as electrolysis, methane synthesis and subsequent liquefaction, methanol synthesis, Fischer-Tropsch synthesis, potential fresh water distillation from sea water (the production of 1 tonne of hydrogen needs 9 tonnes of water) and carbon capture and usage (CCU). With the exception of CCU, all technologies are mature and commonly used on an industrial scale.

17 CCU technology is currently in a research and demonstration phase and needs significant development in the future to be able to play its role in the production of fossil-free fuels. In the future, CCU may be introduced in different ways in the fuel production process:

.1 CO_2 can be extracted from industrial point sources (as long as sufficient point sources are available in the future);

.2 CCU can be used in a shipping-related circular CO_2 economy for fuel production (CO_2 extracted and stored on board ships and then sent ashore for new fuel production); and

.3 CO_2 can be extracted from the atmosphere and released to the atmosphere again when used in corresponding synthetic fuels for shipping in a circular process.

18 Only if CO_2 is used in a circular economy (see paragraph 17 above), the corresponding fuels can be regarded as fossil-free fuels with zero GHG intensity. In case CO_2 from industrial point sources using fossil fuels is used, the CO_2 will finally be released into the atmosphere having been reused for fuel production. It will then be credited with respect to the GHG intensity as a so-called low-carbon fuel in the context of the Strategy.

19 In conclusion, the objective of 50% GHG reduction in 2050 compared to the 2008 level is in principle achievable from a technology point of view. However, recent research projects, e.g. JOULES (EU funded) and MethaShip (funded by the German Ministry of Economics and Energy), revealed that a significant amount of renewable energy is needed to produce these fossil-free fuels. As a general indication, around 2.2 to 3 MJ of renewable energy is needed to produce 1 MJ of final fuel (being fossil-free) depending on types of future fuels. In the context of required GHG reduction, the accelerated build-up of energy infrastructure from renewable energy is of upmost concern.

Mid-term perspective

20 In the mid-term aspect, an implementation programme for zero-carbon and/or fossil-free fuels is required. From today's perspective, the optimal combination of fuel types, infrastructure and shipboard installations cannot be determined. While electrification of short-sea shipping is an option to use renewable energy in an optimal way, liquid fuels with high energy density per tonne and cubic metre will however be required for longer distances. In addition, technical solutions on board ships will be implemented depending on the ship's type, operation profile and achievable prices for future fossil-free fuels. In the opinion of the co-sponsors, there will be no "one fits all solution" in the future, but different solutions will evolve over time.

Short-term perspective

21 The predominant action in the short-term perspective is an increased research activity to identify the best possible solutions from a societal, technological and economical point of view. Such an approach is derived from the final conference of the JOULES project as an example set out in figure 3 below.

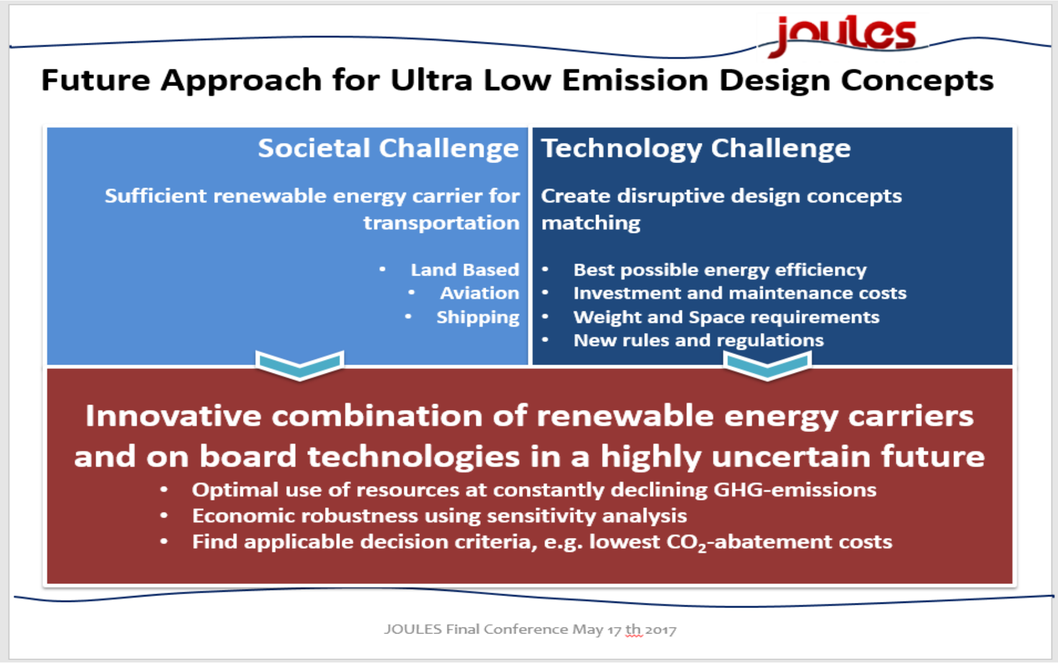

Figure 3: Future approach for ultra-low emission design concepts (example from the final conference of the JOULES project)

22 These research activities need to include stakeholders from different industrial sectors and sciences (energy, chemistry, environmental sciences, macro-economic sciences and ship technology) with an open mindset to not prioritize any solution without accepting the complexity of the issue as addressed in the present document.

23 A strategy for smooth transition from the existing conventional fuel system to fossil-free fuels is required. As a result of research activities, future fossil-free or zero-carbon fuel candidates for the shipping sector will be identified and an implementation programme needs to be initialized. The implementation programme needs to include demonstration projects of such fuel production pathways and onboard installations before roll-out on a large technical scale, which may also include adaptation of existing technology (e.g. internal combustion engines) to these new fuel types.

24 Rules and regulations have in many cases been identified to be an obstacle when introducing new technologies. The research projects must also be set up in a way that future development of rules and regulations is supported. Such an approach holds for new types of energy converters, proper representation of energy efficiency measures in the existing regulatory framework, new energy distribution concepts on board ships, etc.

25 Investigations on future economic viability must be a central aspect for these research projects but need to include all kinds of costs involved (fuel production, infrastructure, societal costs including external costs from emissions and costs of onboard technology). Cost-effective solutions with the highest CO_2 reduction potential should be identified and further promoted.

26 As a possible indicator for decision-making (beside other important issues like land use for BtL production and renewable energy power plants for PtL/PtG production) are the CO_2 abatement cost curves considered for each BtL/PtL/PtG-fuel pathway. Policy instruments may also be considered to achieve the GHG reduction objectives based on the holistic macro-economic assessment. A multi-step approach to identifying the optimum technological measures should be considered to comply with the strategic GHG reduction targets in the future at lowest possible cost and highest benefit for society.

Action requested of the Committee

27 The Committee is invited to consider the explanations regarding definitions in paragraphs 5 to 10 and the implementation programme for effective uptake of alternative fuels to support the future development towards decarbonization of the shipping industry, as provided in paragraphs 11 to 26, and take action as appropriate.

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