The IMO initial strategy for reducing Greenhouse Gas (GHG) emissions, and its follow-up actions towards 2050

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ABSTRACT
At the 62nd Meeting (2011) of the Marine Environment Protection Committee (henceforth MEPC), the IMO had adopted the proposed amendment adding to the MARPOL Annex Chapter VI, making it mandatory the EEDI (Energy Efficiency Design Index) for new ships as well as the SEEMP (Ship Energy Efficiency Management Plan) for all ships. This was eventually for reducing GHG emissions from international shipping vessels, and has been effective since the 1st of January 2013 for ships weighing 400GT.

Notably, at the 70th MEPC, the plan to develop a roadmap for the comprehensive IMO strategy on reducing GHGs from ships was approved, and as such, the plans including its short-term, mid-term and long-term measures have been arranged in order to adopt the pertinent strategy by 2023.

Following the approved roadmap, at the 72nd MEPC (April, 2018), the first stage of reducing GHG emissions from ships was selected/passed as the Initial IMO strategy for the reduction of GHGs from ships (henceforth Initial IMO GHG Strategy), and at the 73rd MEPC (October, 2018), subsequent programs following the Initial IMO GHG Strategy were arranged.

In this paper, the following issues will be introduced and discussed (1) the Initial IMO strategy for the contents of the 73rd-74th MEPC meeting regarding the follow-up actions related GHG reduction programs until 2023 to be executed (including specific matters concerning the execution of potential short-term, mid-term and long-term measures) (2) the GHG reduction strategies, GHG response policies of IMO member states and (3) finally, trends in technological developments for GHG reduction from ships.

Introduction
In 2015, at the 21st Conference of the parties (COP21) of the United Nations Framework Convention on Climate Change, representatives of 196 state parties including developing countries have agreed to keep the increase in global average temperature to well below 2°C above pre-industrial levels; and to pursue efforts to limit the increase to 1.5°C. (the Paris Agreement). This is an agreement to replace the Kyoto Protocol, which will be completed in 2020, and signals the beginning of the New Climate System (POST2020). The agreement requires countries to submit voluntary GHG reduction targets, while emphasizing voluntary efforts outside of the framework of the Climate Change Convention. Accordingly, it also called for the International Maritime Organization (IMO) to voluntarily establish international standards in the international shipping sector.

At the 62nd Meeting (July 2011) of the Marine Environment Protection Committee (henceforth MEPC), the IMO had adopted the proposed amendment adding MARPOL Annex Chapter VI making it mandatory the EEDI for new ships as well as the SEEMP for all ships. This was eventually for reducing GHG emissions from international shipping vessels, and has been effective since the 1st of January 2013 for ships weighing 400GT. Notably, MEPC 70 has approved the plan to develop a roadmap for the comprehensive IMO strategy for reduction of GHG emissions from ships, and as such, has arranged the plans including its short-term, mid-term and long-term measures in order to adopt the pertinent strategy by 2023. In accordance with the approved roadmap, IMO(MEPC72) 2018 has adopted the initial IMO strategy on reduction of GHG emissions from ships, and IMO MEPC73 2018 has arranged subsequent programs following the Initial IMO GHG Reduction Strategy.

In this key review paper, we will introduce the Initial Strategy for IMO GHG Reduction adopted by MEPC 72, and share the programs to implement by 2023 as its follow-up action (specific details such as the timing of implementation of short-term, mid-term and long-term candidate actions).

The IMO initial strategy for reducing ghgs from ships
MEPC 72 held in April 2018, has adopted an Initial Strategy for the Reduction of GHGs from international ships IMO MEPC72 2018 focusing on the followings:
The IMO Initial Strategy states the organization’s vision reaffirming the commitment to reducing GHGs from international shipping, while continuing efforts to phase them out as soon as possible over the century. In accordance with this ambition level in the Initial Strategy, it is intended to achieve the mitigation of the volume of total annual GHGs from international shipping by at least 50% by 2050, compared to 2008. The aims should be achieved by improving energy efficiency; decreasing the Carbon Intensity (CI) of new ships by stages; strengthen the Energy Performance Index (EEDI). For implementing these plans, it is necessary to have some guiding principles and a list of follow-up actions foreseeing possible measures in the short, medium and long term, with possible timetables and their impact on States. Initial IMO Strategy on Reduction of GHG Emissions from Ships was adopted as Resolution MEPC.304(72) as the first step in the GHG reduction roadmap. The core contents are described in Table 1, including the vision, levels of ambition and guiding principal. In addition, the short-, mid-, and long-term measures with proceeding schedules and impacts on states were discussed to achieve the initial strategy. In October 2018, follow-up actions were also considered and discussed at the 4 ~ 5th IMO ISWG (Intersessional Working Group)-GHG and the 73 ~ 74rd MEPC sessions.

### Follow-up actions & programs in order to achieve the IMO initial strategy for reducing ghgs

#### Follow-up actions

In October 2018, the 4th GHG Working Group (the ISWG-GHG 4th Meeting) and MEPC 73 discussed the development of a program for the follow-up actions of the IMO Initial Strategy for Reducing GHGs caused by ships and the ways to progress the issues of mitigating GHGs. The 4th ISWG-GHG Meeting established the following eight follow-up programs, planned for 2023, as a follow-up program of the Initial Strategy for the GHG reduction.

- Short-term Candidate Actions (Group A): Actions already in place and Short-term Candidate Actions currently regulated by the IMO.
- Short-term Candidate Actions (Group B): Actions that are not in place and Short-term Candidate Actions that require data analysis
- Short-term Candidate Actions (Group C): Actions that do not require data analysis
- Activities to deal with Medium-, Long-term Candidate Actions and identified barriers
- Impacts on States
- The 4th IMO GHG Study
- Capacity building, technical support, R & D
- Additional actions to develop the Final Strategy

The follow-up actions and the timeline for achieving the IMO Initial Strategy are shown in Figure 1. In 2023, based on the information collected by the Data Collection System (DCS), which will commence in 2019 with short, medium and long term candidate actions (MARPOL Annex VI, Regulation 22A) and the 4th IMO GHG Study, a revised IMO GHG Strategy will be in place (IMO MEPC73 2018).

The 4th ISWG-GHG Meeting and MEPC 73 discussed matters including the improvement and the reinforcement of the EEDI and the SEEMP, the reduction of ship speed and the optimization of ship routes, market-based measures and alternative fuel use. These are candidate measures implementing the “Initial Strategy” that progress the issue of GHG emissions from ships. In conjunction with the results of the 4th ISWG-GHG meeting, MEPC73 approved “the 4th IMO GHG Study” Plan. The 4th IMO GHG Study will estimate international shipping GHG emissions from 2012 to 2018, and the study will predict future GHG caused by international shipping from 2018 to 2050. The 4th IMO GHG Study aims to establish a steering committee, starting with the 2019 expert workshop, and to review and approve the final report at MEPC 76 in 2020 by getting to this study in October of the same year.

#### Approach methods for GHG reduction & time frame

In April to May 2019, the 5th GHG Working Group (the ISWG-GHG 5th Meeting) and MEPC 74 discussed the 14 approach methods for GHG reduction & time frame. The 5th ISWG-GHG meeting established the following 14 approach methods and time frame for implementing the short term measures in 2023, as shown in Table 2.

| Table 1. Initial IMO strategy on reduction of GHG emissions from ships (IMO(MEPC72) 2018). |
|---|
| **Vision** |
| “IMO remains committed to reducing GHG emissions from international shipping and, as a matter of urgency, aims to phase them out as soon as possible in this century.” |
| **Level of ambition** |
| (1) Carbon intensity of the ship to decline through implementation of further phases of the EEDI for new ships, |
| (2) Carbon intensity of international shipping to decline, |
| (3) GHG emissions from international shipping to peak and decline. |
| **Guiding principal** |
| (1) The need to be cognizant of the principles enshrined in instruments already developed, |
| (2) The requirement for all ships to give full and complete effect, regardless of flag, to implementing mandatory measures to ensure the effective implementation of this strategy, |
| (3) The need to consider the impacts of measures on states, including developing countries, and in particular, on the least-developed countries and small island developing states as noted by MEPC 68 and their specific emerging needs, as recognized in the IMO’s Strategic Plan, |
| (4) The need for evidence-based decision-making balanced with the precautionary approach as set out in resolution MEPC67(37). |
The participants of ISWG-GHG 5 and MEPC 74 further noted that any approved amendment to MARPOL Annex VI would require at least 22 months to enter into force. The Group noted the illustration of steps and possible time frames for the development of an amendment to MARPOL Annex VI (IMO(MARPOL), Annex VI, Regulation 22A) expected to enter into force on 1 January 2023 at the latest, as set out in Table 3 and Table 4 below.

Finally, the ISWG-GHG 5 and MEPC 74 is instructed, taking into account the Initial IMO Strategy on reduction of GHG emissions from ships, its programme of follow-up actions up to 2023, the Procedure for assessing the impacts on States of candidate measures, documents submitted to ISWG-GHG 6 (2019, November) and relevant documents submitted to ISWG-GHG 5 and MEPC 74, to:

1. Further consider concrete proposals to improve the operational energy efficiency of existing ships, with a view to developing draft amendments to chapter 4 of MARPOL Annex VI and associated guidelines, as appropriate;
2. Further consider concrete proposals to reduce methane slip and emissions of Volatile Organic Compounds (VOCs);
3. Consider a draft MEPC resolution urging Member States to develop and update a voluntary National Action Plan (NAP) with a view to contributing to reducing GHG emissions from international shipping, and develop associated guidelines, as appropriate;
4. Further consider concrete proposals to encourage the uptake of alternative low-carbon and zero-carbon fuels, including the development of lifecycle GHG/carbon intensity guidelines for all relevant types of fuels and incentive schemes, as appropriate;
5. Consider the development of further actions on capacity-building, technical cooperation, research and development, including support for assessment of impacts and support for implementation of measures;
6. Consider other concrete proposals for candidate measure (IMO(MEPC74) 2019a)

| Approach numbers | Candidate measures |
|------------------|--------------------|
| Approach No. 1   | Improve the energy efficiency of existing ships building on the EEDI framework |
| Approach No. 2   | Further develop the EEDI framework for new ships |
| Approach No. 3   | Improve the energy efficiency of existing ships building on the SEEMP framework |
| Approach No. 4   | Identify appropriate operational energy efficiency indicators |
| Approach No. 5   | Develop a speed optimization and speed reduction mechanism |
| Approach No. 6   | Develop regulatory measures to reduce methane slip |
| Approach No. 7   | Develop regulatory measures to reduce emissions of Volatile Organic Compounds (VOCs) |
| Approach No. 8   | Encourage the development of National Action Plans (NAPs) |
| Approach No. 9   | Encourage port developments and activities to facilitate reduction of GHG emissions from shipping |
| Approach No. 10  | Initiate and support research and development activities |
| Approach No. 11  | Encourage incentive schemes for first movers |
| Approach No. 12  | Develop lifecycle GHG/carbon intensity guidelines for all types of fuels |
| Approach No. 13  | Implementation programme for the effective uptake of alternative low-carbon and zero-carbon fuels |
| Approach No. 14  | New/innovative emission reduction mechanism |

The participants of ISWG-GHG 5 and MEPC 74 further noted that any approved amendment to MARPOL Annex VI would require at a minimum 22 months to enter into force. The Group noted the illustration of steps and possible time frames for the development of an amendment to MARPOL Annex VI (IMO(MARPOL), Annex VI, Regulation 22A) expected to enter into force on 1 January 2023 at the latest, as set out in Table 3 and Table 4 below.

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5. Consider the development of further actions on capacity-building, technical cooperation, research and development, including support for assessment of impacts and support for implementation of measures;
6. Consider other concrete proposals for candidate measure (IMO(MEPC74) 2019a)
The above items will be discussed in ISWG-GHG 6 meeting in November 2019.

De-carbonization of international shipping – innovative technology and alternative fuel

In response to the Paris Agreement in 2015, the IMO adopted an Initial Strategy for reducing GHGs caused by ships in April 2018. As shown in Figure 2, this Initial Strategy is to reduce the total annual GHG emissions by 50% by 2050 compared to 2008, and aims to decrease the CI by 40% by 2030, and by 70% by 2050 to decarbonize as soon as possible within this century. In order to establish a joint response strategy for the IMO regulation of GHGs, a variety of programs with the industry involved have been developed and carried out along with various research activities in between member states.

Strategy to the IMO regulation of GHGs

Countries leading the IMO GHG Reduction Strategy, such as European countries, are predicting the amount of CO2 emitted from the international shipping sector, examining whether the GHG reduction targets proposed by the IMO are possible to reach in the existing technology, and preparing countermeasures. In response to the IMO GHG Reduction Strategy, the EU has decided to reduce the volume of GHGs from ships by less than 80% by 2025 compared to 1990, targeting the Decarbonization. As an interim target to achieve this, it is stated to reduce 40% by 2030 and 60% by 2040. Notably, in the EU shipping sector, the system of monitoring, reporting and verifying about ships in operation (EU MRV) has been operated since 2018 (DNV-GL, 2019). This is the basis for the EU Regional Emission Trading System (ETS), which will be implemented in the region if there is no appropriate action for the GHG reduction strategy in the IMO (DNV-GL, 2019).

Figure 3 shows the scenario that can be decarbonized by 2050, categorizing the measures for achieving the IMO Initial Strategy into three; improving the ship’s energy efficiency, optimizing the speed and operation of the ship, and alternative fuels. According to the Response Strategy (anticipated) for the IMO GHG Reduction Strategy, the improvement of the ship’s energy efficiency should steadily rise, but from an operational point of view, it should reach its
peak in 2035 and then should keep that level. Besides, it can be seen that the GHG Reduction Strategy by fuel should be dominant afterwards. Consequently, research on alternative fuels is urgent.

**Potential technologies and considerations for responding to the IMO GHG regulation**

As another study to achieve the goal of the IMO Initial Strategy, Bouman et al. (2017) reviewed about 150 research results published so far and presented comprehensive contents. By comparing the results of the possibilities for various means for reducing CO2 emissions from ships, they show the differences and set up a significant interval, as shown in Figure 4. According to this figure, five technologies (linear improvement, dynamometer/propulsion system, alternative fuel, renewable energy and ship operation) were classified as a meaningful means to reduce GHGs of ships. The range of possible cost-effective CO2 emission reductions for technical and operational measures, excluding alternative fuels, is 20-30%, and increases to 50-60% with more expensive innovative technologies. Therefore, in order to achieve the objectives of the IMO Initial Strategy, only one measure is insufficient and each measure should be well combined, as shown in Figure 5. Providing these policies and regulations for achieving the mitigation of GHGs are well prepared, combination of the existing technologies is expected to reduce up to 75% by 2050 (Bouman et al., 2017).

**Conclusions**

As the initial IMO GHG strategy was established and the follow-up schedule was agreed, it is inevitable for the domestic shipping and shipbuilding industry to undergo some changes such as strengthen regulations (EEDI/SEEMP), introduction of Market-Based Measures (MBM), and using alternative fuel vessel.

Moreover, as EEDI Phase 4 comes into force in 2030 (which means 40% efficiency enhancement compared
Figure 4. (a) CO2 emission reduction potential from individual measures, classified in 5 main categories of measures (Bouman et al., 2017). (b) IMO regulation and ship technology trend (Joung).

Figure 5. IMO regulation and ship technology trend [Joung, 2019]
to the ships in 2008), international shipping sector should be focused on and research on the next-generation eco-friendly fuel propulsion ships such as the hydrogen fuel cell, ammonia, bio-fuels etc.

Finally, member states of IMO has to establish a national strategy (or National Action Plan, NAP) and to prepare short-, mid-, long-term measures and systematic approach to implement the IMO GHG reduction strategy to the relevant sectors.

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