Typical Question and Answer

Questions about Draft Lifecycle GHG Guidelines for marine fuel

Question	Answer
It was very good to learn more about the intention behind the paper ISWG-GHG 11/2/3. We are a bit confused about what information will be passed on to the IMO - the FLL will include WtT emissions, but will these also be reported to the IMO or will they only be part of the BDN? How are we sure that the WtW emission numbers are information that fuel choice is based on?	The LCA Guidelines are being developed as "stand-alone" guidelines which do not have any direct linkage to existing mandatory instruments, and the Guidelines are thus of non-mandatory nature. We understand that reporting scheme for FLL will be for future consideration. Please note that the proposal on the updated draft LCA Guidelines (ISWG-GHG 11/2/3) includes the following sentence in square brackets: 8.2 The FLL provides the necessary information….(omitted). [The FLL [could]/[should] be documented in the Bunker Delivery Note and reported through the IMO Data Collection System].
Giving a value of 0 to a fossil carbon source is not consistent with LCA methodologies (ISO 14040). Even if this is done conditionally, one can imagine that this practice will be impossible to trace. How would it be demonstrated that the fossil carbon is accounted elsewhere and might this be different from country to country? Doesn't this depict fuel based of fossil sources very advantageously even though they are not green fuels?	The main purpose of applying S_F as zero only under specific conditions is to avoid double counting between the national inventory of one country and the IMO Inventory for international maritime transport, in accordance with the IPCC Guidelines (not ISO 14040). If the CO_2 is captured from industrial sources, such as blast furnaces, and such captured CO_2 is NOT geologically sequestered, the IPCC Guidelines for National GHG Inventory clearly requires the captured amount to be accounted as the emission of the industrial sources of the country where the CO_2 is emitted and captured. This means that, once accounted in the national inventory, the captured CO_2 can be utilized as fuel with TtW emission being regarded as zero (S_F=0). Proper certification and reporting process will be necessary. Please note the relevant part in our proposal on the LCA Guidelines (ISWG-GHG11/2/3). 8.14 Captured carbon from land-based sources (and accounted in national inventories): IPCC guidelines state that any captured CO_2 for later uses should not be deducted in the sector where it is captured, unless it is accounted for elsewhere in national GHG inventories, while emissions associated with the CO_2 capture should be reported under the sector (e.g., stationary combustion or industrial activities). This means that regardless of whether the CO_2 was captured directly from the atmosphere, from biogas, from reforming fossil methane, or any other process, if the captured CO_2 is to be accounted in national GHG inventories of any UNFCCC member countries, it should be reported by the IMO's GHG inventory for international shipping as carbon neutral (S_F = 0).
As to fuel with CO_2 capture from industry, it is a matter how to allocate "negative CO_2 at captured site" and "CO_2 emission at sea". Please let us have your opinion whether it is an issue of IMO only or mutual issue between IMO and Paris Agreement.	
Could you elaborate on what the binary Sf factor/Cf in the FLL is intended for? Isn't it sufficient with solid WtT and TtW values plus sustainability criteria/certification? Thanks!	

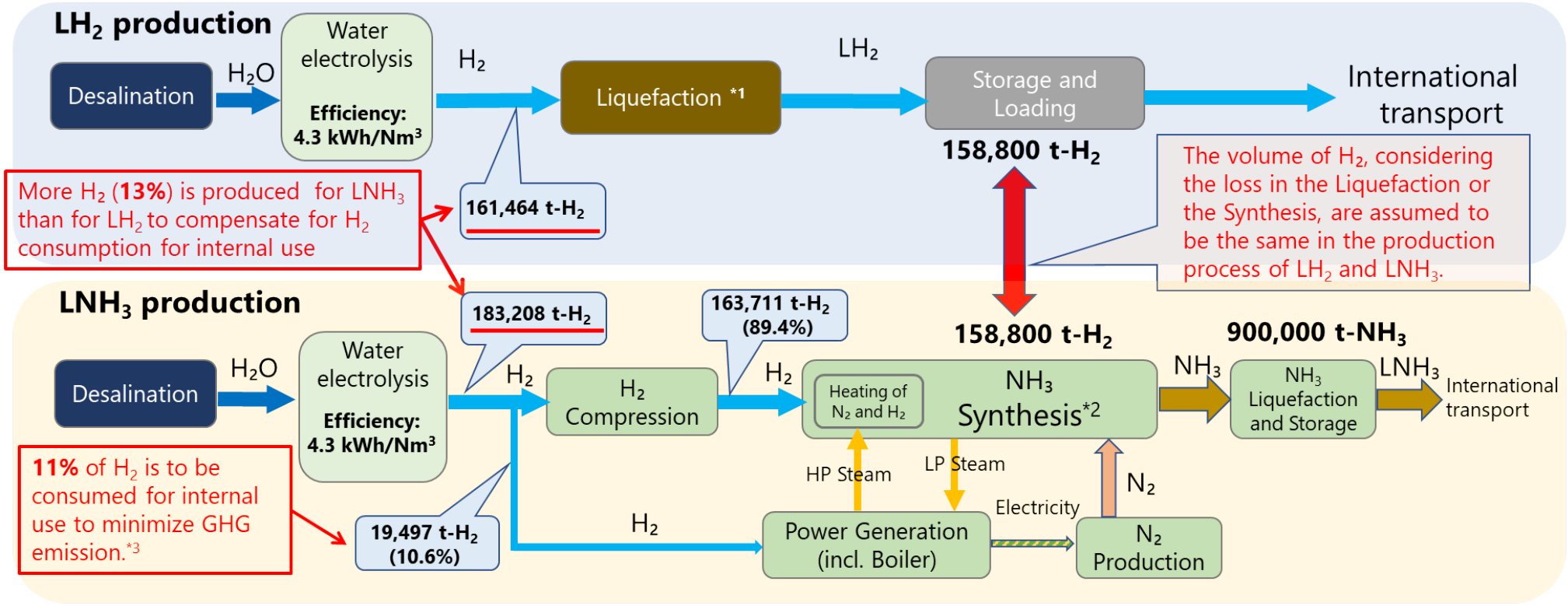
Questions about JTTRI's presentation

Question	Answer
On Slide 19 on JTTRI's presentation, Brown Coal Extraction shows emission of methane and CO_2, as indirect emissions. CO_2, I understand is captured and handled through CCS (90-95% efficiency assumed) but how is the emission on methane reflected using the proposed methodology? Fuel users needs to be aware of these fugitive emissions when purchasing fuel.	In our calculation, Methane emitted during the extraction process is not from the exhaust gas by the use of Fuel Oil. This methane is fugitive emission from brown coal itself. Depending on the geographical location (underground or open ground) and methods of extraction, methane will vapour to atmospheric air. As it is difficult to capture such fugitive emissions, we applied Carbon Capture only to process gas, but not for fugitive methane.
Question about P.27 case 3. Could you please show us reasons why energy for water electrolysis of ammonia is much larger than that of LH_2. It seems to me that the electrolysis energies should be the same for LH_2 and NH_3.	Firstly, please note that both of Case 3 of LH_2 and Case 3 of LNH_3 show the WtT calculations under hypothetical scenarios, for the purpose of estimating how the emission would increase from Base Cases (Case 1 and 2), if a partial support of Power Grid were applied to the Base Cases in which only renewable energy is used. We do not foresee that any projects would be realized under the conditions of Case 3. Therefore, if one wishes to evaluate the two fuel types (LH_2 and LNH_3), comparison should be made between Case 1, or between Case 2, of the two fuel types. In Cases 1 and 2, GHG emissions of both LH_2 and LNH_3 are nearly zero, as stated in the presentation. Therefore, comparing the calculation results of Case 3 of the two fuels would not make much sense, and not suit our intended purpose of the studies. Having said that, let us explain why our calculation shows a difference in the emission per calorific value of the final product (g/MJ), even though we assumed in our calculation the same efficiency for the electrolysis for the two fuels. Cases 1 and 2 of LNH_3 assumes the optimized plant design to minimize WtT emissions. In this plant concept, about 10% of the H_2 produced by electrolysis is supposed to be consumed for the power generation necessary for N_2 production as well as for the heating to meet the reaction conditions of Haber–Bosch process. GHG emissions from these processes would be zero, however, with the consumption of H_2 in the mid of the process, additional H_2 must be produced to keep the same volume of the final product (LNH_3); otherwise, the volume of the final product (LNH_3) will decrease. For your reference, the H_2 flow in the process of producing LH_2 and LNH_3 in our estimation is attached (Please refer to the chart of H_2 Flow in P4).

	In our calculation, the same plant concept as mentioned above for Cases 1 and 2 was applied to Case 3 where the partial use of electricity from Power Grid leads to the indirect emission. The above loss of the H_2 (consumed in the production process) means the additional volume of H_2 to be produced by electrolysis, and this leads to the "on appearance" increases of emissions when counted per unit calorific value (MJ) of the final product. If we assume that the electricity from Power Grid is to be used, we could come up with a variety of alternative plant designs; the electricity from Power Grid could be directly used instead of consuming "precious" H_2 produced by electrolysis, and fossil fuels could be used for fired heating. Such consideration of plant design suggests that Case 3 does not probably represent the optimized system. There are other assumptions on future technological improvements which considerably affect the calculated results of the emissions. For example, the efficiency of the liquefaction process of H_2 is set at (6.17 kWh/H_2-kg), about twice as high as of the currently achieved value. The electricity consumption of NH_3 synthesis process is based on the assumption that the efficiency will improve by 15% from the present value. We should bear in mind the high sensitivity of the calculation results by setting these future improvement factors when trying to evaluating the sustainability of different fuels in detail.

Comparison of H_2 flow between LH_2 and LNH_3 production

Annual Production volume of LH_2: 158,800 [t]
Annual Production volume of LNH_3: 900,000 [t]



*1 Liquefaction loss: 1.65% of H_2 cannot be liquefied because of the system limitation.
*2 Synthesis Loss: 3% of Hydrogen cannot be synthesized because of the limitation of chemical equilibrium.
*3 In Case 3, this internal consumption is assumed to be same as in Case 1. In other words, we assumed that 11 % of H_2 produced using the Grid Power is consumed for internal power generation. With this assumption, Case 3 may not form an optimized plant concept.

any analysis for WtW for eMethanol? (did not see any in Shinichiro-san's ppt)	As far as we are aware, there is no project in Japan to produce carbon neutral methanol as shipping fuel, while there is a small-scaled factory in operation to produce carbon-neutral methanol by directly synthesizing methanol using CO and H_2 generated from biomass. We did not select methanol for our study as we have not found any quantitative assessments by now.
While we address LCA for new (alternative) fuel today, is there any LCA for the current Marine Fuel (HFO, MDO etc.) for benchmarking purpose?	Our presentation quoted some of existing studies on the LCA of LNG and we suggested the existence of large variation of WtT emission depending on various factors such as country/region of production, transport distance, methods of extraction (conventional/unconventional). In our presentation we emphasized that the efforts by project stakeholders to apply the latest technologies and to optimize the production and supply chain could make a lot of difference in reducing the WtT emissions. We believe that the above points would also apply to the WtT emissions of traditional marine fuels such as HFO/MGO, although we have not focused on searching available LCA studies on these fuels. It should be noted that there may be difficulties in conducting LCA specific to the petroleum products including traditional marine fuels. A variety of petroleum products (naphtha, gasoline, gas oil, LSFO, HSFO, etc.) are manufactured in oil refinery from crude oil, and the emission from the common process of manufacturing these different petroleum products could not be properly allocated to each product. For example, it would be difficult to distinguish the energies used for producing the gasoline and LSFO.
It is good to know that various zero-emission fuel options are being considered. 1/ Have you analyzed the price scenarios for zero-emission fuels? 2/ LNG is now commonly traded, but in the beginning, we had to develop supply chain, say gas fields, liquefication, port for shipping, transport it by tanker, and vaporization at the same time. What is your thoughts on hydrogen? Will maritime sector take the lead in setting up the supply chain? Or do you assume there is no need for maritime sector to worry about the supply chain because there is a large demand for hydrogen and ammonia elsewhere?	1. In our study, we did not include the price forecast of Zero-Carbon fuels. 2. The establishment of a supply chain for zero-emission fuels will be an important initiative to achieve the 2050 target. Generally, as explained in Slide 3 of our presentation, it would be desirable that fuel producers/suppliers and fuel users (shipping industries) cooperate and work together. However, it is up to business decision of each company in maritime industries whether it takes “wait and see” strategy, or it steps into the participation and/or investment in upstream process of supplying alternative fuels although it is not considered as traditional business domain for shipping companies.

Will Australian Hydrogen GO scheme be included in the estimation of WtT emission? If so, how?	We have not considered Australian Hydrogen GO scheme in this study. Incorporation of this scheme into the calculation and certification of the WtT emissions would be left for future consideration. 3.
Please would the panelists advise: 1) As regards the emissions accounting, has the work carried out considered potential emissions abatement technologies - possibly not yet developed - which may reduce environmental footprint from what each fuel currently results in, and will this be factored into the factors being developed for specific fuels. 2) has the need for the use of pilot fuels either as necessary to enable efficient combustion or as additional fuel to supplement boil off been factored into future fuel factors being proposed for development at the IMO, as well as the presented study on environmental footprint of fuels. 2) To what extent have incidental environmental factors been considered e.g., Wind turbines have a considerable environmental footprint for their development and maintenance, so energy they produce is not in fact carbon neutral. has this been considered?	1. We estimated the GHG emissions of each fuel considering the technologies to be realized and the efficiencies to be achieved by 2030. (See slide12) 2. In our estimation, the use of pilot fuel in transportation and the shortage of BOG used as fuels (thus the inevitable use of fossil fuels during voyages) have been considered (See slide 43). We understand that such technical consideration to estimate the emission onboard has not been yet discussed in detail in the process of developing the TtW sections of the draft LCA Guidelines. 3. The construction, maintenance and decommissioning of the facilities including wind farms is not included in the scope of our estimation. (See slide 12)

Other Questions

Question	Answer
Many of your proposals depend on successful Carbon Capture projects. A recent USA report (https://iopscience.iop.org/article/10.1088/1748-9326/abd19e/meta) claims that over 80% of such projects fail to reach their targets. What is your opinion on this issue?	We recognize that some of CCS projects have been unable to reach their intended capture rates. One of the reasons for such underperformance would be the impurity in the exhaust gas. In the plant concept that we assumed in our calculation, the exhaust gas would be pretreated before CO_2 capture; not only heavy metals but also Sulphur and moisture should be totally removed. Combined with the application of improved solvent and adsorbers under development in Japan, we assumed that 95% recovery rate would be achievable by 2030. It should be also noted that there is uncertainty in the sequestration. Some countries impose strict verification systems for the area of storage in order to secure that injected CO_2 stably remain underground. The selection of proper terrain for sequestration is the prerequisite. In view of the above technological and geological constraints, it may be premature to say that CCS would be a perfect solution for WtT emission reduction at present. Despite that, we considered that on-going technological development and concrete project plans could be reasonably taken into account in the LCA of the fuels.
Can the panelists please comment on what the implications on LCA would be if using nuclear power to produce the future marine fuel?	We recognize the potential of nuclear power to produce future marine fuels. For example, the hydrogen production by Nuclear Power may include the following option: .1 water electrolysis by using the electricity generated in conventional nuclear power stations, or .2 direct H_2 production through thermochemical cycle. New type of nuclear reactor will generate extremely high temperature (>900 Celsius degrees). Under such high temperature, with the use of iodine and sulphur for intermediate reaction, water can be directly decomposed into hydrogen and oxygen. This technology is still at the preliminary R&D stage. Despite such potential, in Japan, the prospect for the use of nuclear power is not favorable one: the operation of nuclear power plants has been suspended after the earthquakes and tsunamis in 2011 with stringent safety re-assessment being required,

	and the process of resuming the operation has been staggering. In these circumstances, we did not include the use of nuclear power in probable scenarios in our studies. Generally, the potential for the utilization of nuclear power would depend on the public acceptance and other factors, including the energy mix, in each country. We note that fuels produced by utilizing the nuclear power are not included in the draft LCA Guidelines under consideration at the moment. We understand that the inclusion of such fuels in the scope of LCA Guidelines is not precluded.
In case of our target is to be carbon zero emission, what will be maximum percentage ammonia fuel can be included and if it is not 100%, does it mean CCS will be mandatory.	We understood that the question intended to clarify the minimum amount of fossil fuel used onboard for pilot injection in the ammonia-fueled ships. National Maritime Research Institute in Japan, NMRI, recently reported that the maximum ratio of ammonia to be burned in ICE (Internal Combustion Engine), expressed in calorific value, was only 80%; this means that the ICE would have to use the fossil fuel by 20%. However, taking into account the on-going R&D project to realize Ammonia Fueled Ammonia Gas Carrier by 2026, where the target is set at 95% rate of ammonia in ICE, we assumed in our study, as shown in Slide 44, that the ratio of ammonia fuel in ICE could reach more than 95% by 2030 (the pilot fuel ratio of 2-stroke diesel engines would be 5%). Regarding onboard CCS to capture the CO_2 from pilot fuel, it would be technically difficult to capture such a small concentration of CO_2 (app 0.4% in dry base) from the Ammonia burned exhaust gas with 5% pilot injection. Therefore, we consider that possible measures to nullify the residual emission by 5% use of fossil fuel as pilot injection would be to use carbon-neutral diesel fuel or to utilize the carbon offset. We do not foresee the situation where the onboard CCS will be regarded as the only possible solution and be made mandatory.