Roadmap to Zero GHG Emission toward 2050

Shinichi Hanayama
Research Institute, ClassNK
June, 22\textsuperscript{nd}, 2019
@ICCT Technical Workshop on Zero Emission Vessel Technology
1. Overlook at short-term measures
2. Back cast from the GHG reduction target by IMO
3. Technology Gaps
4. Issues to be taken into account
5. Conclusions
Overlook at short-term measures

Several mitigations measures have been discussed during the recent MEPC and its ISWG-GHG to reach the minimum reduction target of Carbon Intensity at 2030.

ClassNK considers that the main intentions of the proposals are;

• Enhance EEDI, establishing Phase IV
• Accelerate slow steaming (including power limits of Main Engines)
• Expand regulatory frameworks to existing ships

ClassNK considers that IMO may reach to the 2030 targets of Carbon Intensity by adopting a mandatory framework by 2023.
CONTENTS

1. Overlook at short-term measures
2. Back cast from the GHG reduction target by IMO
3. Technology Gaps
4. Issues to be taken into account
5. Conclusions
Back cast from the GHG reduction target by IMO

Even though IMO will achieve the 2030 target, it is clear that there are limitations either to expand the energy saving technologies or to improve operational conditions. More efforts will be needed to reach over the 2050 reduction target (minimum 50% reduction from 2008 level), it is critical to change/transit our propulsion energy from the conventional residual fuel to low/zero carbon fuels in advance to 2050.

ClassNK identified “Innovation Gaps” and radical actions that make these energy transitions feasible and realistic.

ClassNK considers that back cast approach will be useful to make a road map toward 2050 for International Maritime Transport sector.
ClassNK considers that back cast approach will be useful to make a road map toward 2050. The similar approach has been applied for the other sectors on-land and NDCs under UNFCCC.

Step 1
Estimates GHG emissions in 2050 under BAU scenarios.

Step 2
Identify the minimum required total GHG reduction in 2050.

Step 3
Allocate the required GHG reduction to ship-type and ship-size categories, and identify possible uses of the low/zero carbon fuels in each category (including changing the propulsion systems).

Step 4
Identify “innovation gaps”, and assess actions to be taken
CONTENTS

1. Overlook at short-term measures
2. Back cast from the GHG reduction target by IMO
3. Technology Gaps
4. Issues to be taken into account
5. Conclusions
New demands for international transport toward 2050. The demand of some cargo, such as Coal, Crude Oil, Conventional Oil products and Iron Ore, could be declined in near future, because the Paris Agreement will significantly affect both on the global energy demands and industrial process (decline of fossil energies and resources is assumed in the 1.5 Degrees Special Report by IPCC).

However, new demands for international maritime transport would be expected such as:

- Hydrogen (Liquid or together with its carriers)
- Carbon Dioxide (captured)
- Freshwater (to mitigate the growth of crops under climate changes)
- Biofuel

These new demands may produce new ship types (LNG/CO2 carriers).
Issues to be taken into account

ClassNK noted some candidates of the low/zero carbon fuels; Electricity, Biofuel, Hydrogen, Ammonia and some Electricity to Gas.

It is crucial whether a sufficient amount of these low/zero carbon fuels can be provided to our sector after satisfying the demand on-land. There are several reports that future supply potentials of these alternative fuels are larger than our total demands. However, we should note that the supply potentials currently estimated are for on-land sectors. Also, it should be noted that new infrastructure will be required for some candidates (e.g. hydrogen and ammonia).
Issues to be taken into account

A smooth transition of our propulsion energy from fossil fuel to low/zero carbon fuel

Use of LNG as fuel will be one of the major solutions to attain phase IV of EEDI, together with lower NOx, SOx and PM (BC) emissions.

Toward 2030, more LNG will be used in our sector, as infrastructures for refuelling will be build up in major ports.

In addition, ClassNK identifies fewer innovation gaps for the use of LNG as propulsion energy.

If liquid synthesis methane, which is identified as carbon neutral, will be sufficiently provided as fuel, then we may utilize both the infrastructures and existing ships which will be originally built as use of LNG. Such a smooth transition should be considered as one of the options.
Issues to be taken into account

Is it feasible to use Liquid Synthesis Methane as Fuel?

Methane can be produced from Carbon Dioxide and Hydrogen by Sabatier reaction (Exothermic) as follows:

\[ \text{CO}_2 + 4\text{H}_2 \rightarrow \text{CH}_4 + 2\text{H}_2\text{O} \]

Methane as Hydrogen carrier

<table>
<thead>
<tr>
<th>Carrier</th>
<th>Energy loss at conversion</th>
<th>Energy per 1 liter (LHV)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Methylcyclohexane</td>
<td>137 kJ/mol of H2</td>
<td>5.7 MJ/L</td>
</tr>
<tr>
<td>Liquid Hydrogen</td>
<td>80 kJ/mol of H2</td>
<td>8.4 MJ/L</td>
</tr>
<tr>
<td>Liquid Methane</td>
<td>50 kJ/mol of H2</td>
<td>19.5 MJ/L</td>
</tr>
</tbody>
</table>

Large scaled methanation plant can be expected using a modern catalyst (© 2016 Hitachi Zosen.)
Issues to be taken into account

Is it possible to identify Liquid Synthesis Methane as carbon neutral?

Recently, Hydrogen can be produced by electrolysis using lower cost renewable electricity (e.g. by fuel cell at the Middle East and wind farms in Northern Europe). However, we need Carbon Dioxide, which can be classified as Carbon Neutral.

According to the similar approaches on land, CO2 captured from on-land sources, Bio Energy and CCS (BECCS) and DAC (Direct Air Capture of CO2 from ambient air) could be used as source of Methanation. Capturing CO2 onboard may be one of the potential sources.

Regardless, a new rule by UNFCCC will be needed for clarification whether such Synthesis Methane could be classified as ‘carbon neutral’.
1. Overlook at short-term measures
2. Back cast from the GHG reduction target by IMO
3. Technology Gaps
4. Issues to be taken into account
5. Conclusions
Conclusions

• There is **clear limitation** either to expand the energy saving technologies and/or to improve operational conditions, **after achieving the 2030 target of Carbon Intensity**.

• Therefore, ClassNK considers that a roadmap developed by using back cast approach will be essential to achieve the GHG reduction targets toward 2050.

• We will contribute to this sectors by our road map together with Innovation gaps.

• It may be important to consider **a smooth transition** of our propulsion energy from fossil fuel to low/zero carbon fuel, such as use of LNG to use of synthesized methane from neutral carbon.
Thank you very much for your attention.

ClassNK Research Institute (mail to s-hanayama@classnk.or.jp)