



## Work Group #4: Sustainable Marine Fuels

### Deliverable 3.1 Report Review Template

1. Report title	<b>Safety considerations for the use of zero-carbon fuels and technologies</b>
2. Publication date	January 2019
3. Author	Lloyd's Register and UMAS  Lloyd's Register is a marine classification society and private entity. UMAS is a consultancy and set up as a partnership between the University College London (UCL) Energy Institute and MATRANS Ltd. and thus a private/public entity.
4. Client (organization and type of organization, specifying private/commercial/public; research institute/interest group etc.)	n/a
5. Context of study (e.g. project in the context of which report is published or titles of other reports if part of a series)	The report is part of the 'Low carbon pathway 2050 series' published by Lloyds Register (and UMAS), consisting of: 1.A) Zero-Emission Vessels: Transition Pathways. as published 2019, with the following two directly related reports B) Safety considerations for the use of zero-carbon fuels and technologies. C) Fuel production cost estimates and assumptions. 2. Zero Emission Vessels 2030. How do we get there? as published 2017 3. Low carbon pathways 2050 as published 2016.
6. Length (pages)	16
7. Link (or where to get if not available online)	<a href="https://sustainableworldports.org/wp-content/uploads/Lloyds-Register_2019_Safety-for-the-use-of-ZE-fuels-and-tech-report.pdf">https://sustainableworldports.org/wp-content/uploads/Lloyds-Register_2019_Safety-for-the-use-of-ZE-fuels-and-tech-report.pdf</a>

8. Sector coverage	Maritime shipping
9. Main aim of the study	This paper gives an overview of specific safety risks associated with zero-carbon maritime shipping fuels.
10. Methodology	The methodology of this report is unclear. Also, no references are included to support the statements.
<p>11. Topic(s) and indication of the level of detail</p> <p>For example:</p> <ul style="list-style-type: none"> <li>• System Description - <i>A description of the full marine energy system.</i></li> <li>• System Components - <i>A description of all the components.</i></li> <li>• Infrastructure requirements for new fuels</li> <li>• Applicability - <i>which of the new fuels are expected to replace existing fuels?</i></li> </ul>	<p>The following topics are discussed without much detail:</p> <ul style="list-style-type: none"> <li>• Fuel characteristics – <i>a description of the fuel characteristics</i></li> <li>• Safety – <i>a description of safety considerations per fuel type</i></li> <li>• Storage – <i>a description of how the fuels are stored</i></li> </ul>
12. What are the main conclusions from the report?	The current risk management landscape in the shipping sector is designed to meet the demands of conventional fuels. New fuels need to be introduced in the shipping sector, but different safety concerns apply to each fuel. Therefore it has to be ensured that safety standards are maintained or enhanced where possible.
<p>13. What fuel/energy type(s) are discussed in the report and in what level of detail?</p> <p>For example:</p> <ul style="list-style-type: none"> <li>• Fuel description e.g. type, energy density, specific energy density, flash point, boiling point, fire point, flammability limits, hazards</li> </ul>	<p>The following fuel/energy types are discussed in the report:</p> <ul style="list-style-type: none"> <li>• Ammonia</li> <li>• Biofuels</li> <li>• Methanol</li> <li>• Hydrogen</li> <li>• Batteries</li> <li>• Fuel cells</li> </ul>

	<p>For each of these, the following characteristics are discussed when applicable:</p> <ul style="list-style-type: none"> <li>• general safety risks</li> <li>• physical state when stored/combusted (liquid/gas)</li> <li>• buoyancy</li> <li>• water solubility</li> <li>• flammability</li> <li>• toxicity</li> <li>• explosiveness</li> <li>• energy density</li> <li>• detectability (visibility, odour)</li> <li>• flashpoint</li> <li>• boiling point</li> <li>• evaporation point</li> </ul> <p>Some details are given per fuel type for each of the following stages:</p> <ul style="list-style-type: none"> <li>• bunkering</li> <li>• vessel storage</li> <li>• processing</li> <li>• propulsion</li> </ul>
<p>14. What environmental aspects does the report consider? E.g. Air quality emissions, climate change emissions (GHG + BC), other (for example terrestrial or underwater noise, water quality, emergency releases, fugitive emissions, odour, water resources, mining)</p>	<p>Toxicity and odour are considered in the description of the fuel characteristics.</p>



<p>15. Does the report consider exhaust emissions only, or life-cycle, or both (or some other range of emissions)?</p>	<p>The report does not give specific information about emissions.</p>
<p>16. If determined in the report, what are the emission rates/factors by pollutant? NO<sub>x</sub>, SO<sub>x</sub>, PM<sub>10</sub>, PM<sub>2.5</sub>, ultra fine PM, VOC, NH<sub>3</sub>, GHGs, Black carbon, and any others e.g. that may be unique to the fuel/energy.</p>	<p>Emission factors are not determined in the report.</p>
<p>17. Does the report discuss barriers and opportunities for ships to use the fuel(s)/energy? Does the report identify the maturity level of the fuel on a regional or global scale with respect to use by vessels?</p>	<p>The report discusses safety barriers of the different fuel types for ships.  The report does not identify the maturity level of the fuel with respect to ships.</p>
<p>18. Does the report discuss barriers and opportunities for ports to provide the fuel(s)/energy? Does the report identify the maturity level of the fuel on a regional or global scale with respect to provision by ports?</p>	<p>The report does not consider ports specifically.</p>
<p>19. Does the report include capital and operating cost estimates for the ship and/or land-side?</p>	<p>This is not specified in the report.</p>
<p>20. When are the fuel(s)/energy expected to be at a demonstration stage vs. commercialization? For example:</p> <ul style="list-style-type: none"> <li>• Technology Readiness Level of the system - <i>Estimated maturity of the system technology</i></li> </ul>	<p>On board safety readiness is discussed to some extent for each fuel, but no scale is defined.</p>



<ul style="list-style-type: none"> <li>• On Board Safety Readiness Level of the system - <i>Estimated maturity of the risk mitigations on board (on a scale of 1-9)</i></li> <li>• External Safety Readiness Level of the system - <i>Estimated maturity of the risk mitigations for bunker operations (on a scale of 1-9)</i></li> </ul>	
<p>21. Are the fuels suitable for short and/or long (trans-oceanic) voyages?</p>	<p>This is not specified in the report.</p>
<p>22. Does the report identify/discuss potential issues around community acceptance for this fuel, or potential social/community impacts associated with the system?</p>	<p>This is not specified in the report.</p>