



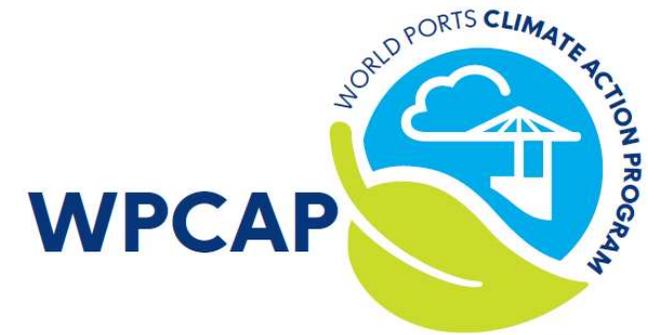
## Work Group #4: Sustainable Marine Fuels

### Deliverable 3.1 Report Review Template

1. Report title	<b>Fuel production cost estimates and assumptions</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)	44
7. Link (or where to get if not available online)	<a href="https://sustainableworldports.org/wp-content/uploads/Lloyds-Register_2019_Fuel-production-cost-estimates-and-assumptions-report.pdf">https://sustainableworldports.org/wp-content/uploads/Lloyds-Register_2019_Fuel-production-cost-estimates-and-assumptions-report.pdf</a>

8. Sector coverage	Maritime shipping
9. Main aim of the study	Aim of the report is to present production cost estimates and emission estimates for different alternative bunker fuels.
10. Methodology	A comparison of emissions and costs of different fuels is made based on existing literature and assumptions.
<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 covered in detail in the report:</p> <ul style="list-style-type: none"> <li>• fuel production – <i>an elaborate discussion of the production processes</i></li> <li>• transportation – <i>description of the fuel transportation</i></li> <li>• bunkering – <i>the bunkering process for each fuel</i></li> <li>• vessel storage – <i>how the fuel is stored in the vessel</i></li> <li>• production cost estimates – <i>detailed tables with cost estimates per stage</i></li> <li>• emissions – <i>emissions due to fuel production</i></li> <li>• energy production potential – <i>a figure with the renewable energy production capacity per region</i></li> </ul>
12. What are the main conclusions from the report?	The report does not state explicit conclusions, since it can be considered an Annex to the above mentioned report.
<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 mentioned in the report:</p> <ul style="list-style-type: none"> <li>• Electricity</li> <li>• Diesel (biodiesel, e-diesel)</li> <li>• Methanol (e-methanol, bio-methanol)</li> <li>• Ammonia (e-NH<sub>3</sub>, NG-NH<sub>3</sub>)</li> <li>• Hydrogen (e-H<sub>2</sub>, NG-H<sub>2</sub>)</li> <li>• Fossil fuels (LNG, LSHFO, MDO, HFO)</li> </ul> <p>For each of these fuels the following specifics are stated:</p>

	<ul style="list-style-type: none"> <li>• production processes</li> <li>• transportation</li> <li>• bunkering</li> <li>• vessel storage</li> <li>• production potential</li> <li>• production costs</li> <li>• emissions</li> </ul>
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)	The report considers both greenhouse gas and air pollutant emissions.
15. Does the report consider exhaust emissions only, or life-cycle, or both (or some other range of emissions)?	The report presents life-cycle emissions of CO <sub>2</sub> , CH <sub>4</sub> , N <sub>2</sub> O, NO <sub>x</sub> , SO <sub>x</sub> and PM (see Executive Summary, Figure 9 – Figure 14)
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.	The report presents life-cycle emissions of CO <sub>2</sub> , CH <sub>4</sub> , N <sub>2</sub> O, NO <sub>x</sub> , SO <sub>x</sub> and PM (see Executive Summary, Figure 9 – Figure 14). In addition, Tables 5, 9, 13 and 17 present the according emission factors for the production of hydrogen, ammonia, methanol and diesel respectively.
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>The report does not explicitly discuss barriers and opportunities for ships to use the fuels/energy.</p> <p>The report does not explicitly identify the maturity level of the fuels/energy 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 discusses the barriers and opportunities for ports to provide the fuel with respect to the regional production capacity of low-carbon fuels. The geographic location of the port is of importance for the prices of renewable fuel production in the region.</p> <p>The report does not explicitly identify the maturity level of the fuels/energy with respect to ports.</p>
<p>19. Does the report include capital and operating cost estimates for the ship and/or land-side?</p>	<p>The report gives capital and operational expenditures for the production of the different fuels (Tables 3, 4, 7, 8, 11, 12, 15,16) as well as product cost estimates (Tables 6, 10, 14, 18).</p>
<p>20. When are the fuel(s)/energy expected to be at a demonstration stage vs. commercialization?</p> <p>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> <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>This is not explicitly specified in the report.</p>
<p>21. Are the fuels suitable for short and/or long (trans-oceanic) voyages?</p>	<p>The only information about the suitability of fuels for short/long voyages is about electricity production: two distinct energy storage facilities are considered, one for short voyages and one for long voyages.</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>