



Work Group #4: Sustainable Marine Fuels

Deliverable 3.1 Report Review Template

1. Report title	Low carbon pathways 2050
2. Publication date	2016
3. Author	Lloyd's Register Lloyd's Register is a marine classification society
4. Client (organization and type of organization, specifying private/commercial/public; research institute/interest group etc.)	UK Engineering and Physical Sciences Research Council (EPSRC)
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 study is part of the Shipping in Changing Climates (SCC) research project funded by the UK EPSRC. 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)	13



7. Link (or where to get if not available online)	https://sustainableworldports.org/wp-content/uploads/Lloyds-Register_2016_Low-carbon-pathways-2050-report.pdf
8. Sector coverage	Maritime shipping
9. Main aim of the study	Aim of the study is to give alternative CO ₂ emission pathways that maritime shipping could follow if it had a carbon budget of 33 Gt in the period 2011-2050 to meet the Paris agreement goals.
10. Methodology	A numerical model (GloTraM) was used to simulate future scenarios for the shipping industry. The input parameters of the model are based on scientific literature as well as scenario-specific assumptions.
11. Topic(s) and indication of the level of detail For example: <ul style="list-style-type: none"> • System Description - <i>A description of the full marine energy system.</i> • System Components - <i>A description of all the components.</i> • Infrastructure requirements for new fuels • Applicability - <i>which of the new fuels are expected to replace existing fuels?</i> 	The following topics are discussed: <ul style="list-style-type: none"> • Transport demand – <i>the future transport demand are estimated until 2050</i> • CO₂ budget – <i>CO₂ budgets for the shipping sector are estimated</i> • Pathway scenario's – <i>three pathways for reducing carbon footprint are presented in detail</i>
12. What are the main conclusions from the report?	Staying within the required carbon budget to meet the Paris agreement goals will be a significant challenge for the maritime shipping sector, therefore decarbonisation should start immediately to minimize the disruption. The future fuel mix largely depends on policy choices and technical developments. The sooner the shipping industry sets a high-level emission reduction target, the easier the process of change will be.
13. What fuel/energy type(s) are discussed in the report and in what level of detail? For example:	The fuel types which are mentioned are: <ul style="list-style-type: none"> • Hydrogen • LNG • Biofuels • MDO

<ul style="list-style-type: none"> Fuel description e.g. type, energy density, specific energy density, flash point, boiling point, fire point, flammability limits, hazards 	<ul style="list-style-type: none"> MGO HFO LSHFO <p>No specifics are stated about these fuel types.</p>
<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>The report considers greenhouse gas emissions.</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 considers exhaust CO₂ emissions only.</p>
<p>16. If determined in the report, what are the emission rates/factors by pollutant? NO_x, SO_x, PM₁₀, PM_{2.5}, ultra fine PM, VOC, NH₃, GHGs, Black carbon, and any others e.g. that may be unique to the fuel/energy.</p>	<p>Emission rates/factors are not given 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 barriers and opportunities for ships are not explicitly discussed in the report.</p> <p>The maturity level is not explicitly discussed, but assumptions about maturity do translate into the scenario choices (which can be found in Table 1).</p>
<p>18. Does the report discuss barriers and opportunities for ports to provide the fuel(s)/energy? Does the report identify the</p>	<p>No barriers or opportunities for ports are explicitly discussed in the report.</p> <p>The maturity level of the fuel is not discussed explicitly either on a global or regional scale.</p>



<p>maturity level of the fuel on a regional or global scale with respect to provision by ports?</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"> • Technology Readiness Level of the system - <i>Estimated maturity of the system technology</i> • On Board Safety Readiness Level of the system - <i>Estimated maturity of the risk mitigations on board (on a scale of 1-9)</i> • External Safety Readiness Level of the system - <i>Estimated maturity of the risk mitigations for bunker operations (on a scale of 1-9)</i> 	<p>The study graphically illustrates (Fig. 4) the development of the fuel mix of maritime shipping between 2010 and 2050 for each of the three pathways.</p>
<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>