



Work Group #4: Sustainable Marine Fuels

Deliverable 3.1 Report Review Template

1. Report title	DNV GL Handbook for Maritime and Offshore Battery Systems
2. Publication date	2016-12-19
3. Author	DNV GL DNV GL is a marine classification society
4. Client (organization and type of organization, specifying private/commercial/public; research institute/interest group etc.)	The Handbook was developed based on a joint project between DNV GL, ZEM and Grenland Energy, supported by ENOVA
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)	n/a
6. Length (pages)	69
7. Link (or where to get if not available online)	https://sustainableworldports.org/wp-content/uploads/DNV-GL_2016-Handbook-maritime-offshore-battery-systems-report.pdf
8. Sector coverage	Maritime shipping (findings are also valid for mobile offshore units)
9. Main aim of the study	The aim of the handbook is to help ship owners, designers, yards, system- and battery vendors and third parties in the process of feasibility study, outline specification, design, procurement, fabrication, installation, operation and maintenance with a safe and efficient introduction of large (> 50 kWh) Lithium-ion based battery systems.

10. Methodology	Expert expertise.
<p>11. Topic(s) and indication of the level of detail</p> <p>For example:</p> <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> 	<p>The report fully focusses on maritime battery systems. Within this scope the following topics are considered in much detail:</p> <ul style="list-style-type: none"> • Maritime battery systems – <i>a general description of the different configurations of marine battery systems</i> • Safety considerations – <i>safety considerations related to maritime battery systems</i> • Battery and system design and procurement – <i>discussion of important aspects of battery design</i> • Implementation – <i>Feasibility studies, outline specifications, standards, rules and regulations</i> • Battery fabrication and testing – <i>how are maritime batteries fabricated and tested</i> • installation and commissioning – <i>description of the installation and commissioning process</i> • Operation and maintenance – <i>discussion of operation and maintenance of maritime battery systems</i>
12. What are the main conclusions from the report?	<p>The handbook does not explicitly draw conclusions, since the main aim is to provide detailed information about maritime battery systems.</p> <p>Implicit conclusions are: The risks posed by battery systems are manageable and it is feasible to ensure a safe battery system, but the risks and challenges need to be identified and appropriately taken into account.</p>
<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"> • Fuel description e.g. type, energy density, specific energy density, flash point, boiling point, fire point, flammability limits, hazards 	<p>The report fully focusses on batteries, therefore the energy type considered is electricity.</p> <p>At least the following specifics are stated about batteries:</p> <ul style="list-style-type: none"> • Battery chemistries • degradation mechanisms • system configurations • system topologies • implementation phase • design and procurement • safety

	<ul style="list-style-type: none"> • fabrication and testing • installation and commissioning • operation and maintenance
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>The handbook only briefly mentions the environmental benefits of emission reduction (both climate and air quality) due to batteries as an alternative maritime fuel source.</p> <p>The specific environmental risks due to the chemicals within the battery are extensively discussed.</p>
15. Does the report consider exhaust emissions only, or life-cycle, or both (or some other range of emissions)?	n/a
16. If determined in the report, what are the emission rates/factors by pollutant? NO _x , SO _x , PM ₁₀ , PM _{2.5} , ultra fine PM, VOC, NH ₃ , GHGs, Black carbon, and any others e.g. that may be unique to the fuel/energy.	This is not considered in the handbook.
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>Aim of the handbook is to facilitate the management of potential issues/safety risks associated with the use large Lithium-ion based battery systems by ships.</p> <p>The handbook mentions the following opportunity for batteries as an energy source for ships:</p> <ul style="list-style-type: none"> - hybrid electric systems allow for an optimization of the engine load, thus improving fuel efficiency - batteries are capable of providing standby power for redundancy with zero fuel consumption penalties
18. Does the report discuss barriers and opportunities for ports to provide the fuel(s)/energy? Does the report identify the	The handbook does not consider barriers and opportunities for ports.



<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>The handbook does not include capital and operating cost estimates.</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>This is not explicitly discussed in the handbook.</p>
<p>21. Are the fuels suitable for short and/or long (trans-oceanic) voyages?</p>	<p>Both fully electric and hybrid electric propulsion are considered, with the former being suitable for short voyages only.</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 explicitly discussed in the handbook.</p>