WP4 - Multi-level management systems development

D4.6: ESS life extension predictive and diagnostic approaches - Public Summary:

The ambition of the NEMOSHIP project is to develop, test and demonstrate innovative technologies, methodologies, and guidelines to better optimise large electric battery power technology within hybrid and fully electrically powered ships.

The project will act as a key enabler of the new co-programmed European Partnership Zero Emission Waterborne Transport (ZEWT) roadmap to better reach International Maritime Organization (IMO) objectives regarding the reduction of Greenhouse Gas (GHG) emissions from waterborne transport by 2030 and 2050. The NEMOSHIP project is developing advanced digital tools to improve the performance, safety, and lifetime of large battery systems used in hybrid and fully electric ships. As maritime transport moves toward low- and zero-emission solutions, battery systems are becoming a key technology, but their long-term reliability and optimal operation remain major challenges. This deliverable presents new predictive and diagnostic approaches designed to extend the lifetime of onboard energy storage systems and associated power electronics.

The report introduces an enhanced Battery Health Management (BHM) system that transforms raw operational data from ships into clear, actionable insights for crews and operators. By continuously analysing temperature, charge and discharge currents, state of charge, and ageing indicators, the BHM estimates battery health, remaining useful life, and compliance with warranty conditions. New features include an automated advice engine that flags harmful operating practices and an anomaly detection engine that identifies battery cells behaving differently from the rest, enabling early intervention before failures occur. All results are presented through an intuitive cloud-based dashboard that supports decision-making at system, subsystems (array, pack and module level), and at cell level.

In addition, the deliverable presents a physics-based methodology to assess the lifetime of power electronic converters that interface batteries with the ship's electrical grid. Using real vessel mission profiles, detailed electro-thermal models and established failure mechanisms are combined to evaluate how operating conditions influence component ageing. Rather than focusing on absolute lifetime values, the approach identifies the dominant stress factors and degradation mechanisms, supporting improved design, operation, and predictive maintenance strategies.

Overall, the results demonstrate how data-driven diagnostics and predictive models can significantly enhance the reliability, safety, and cost-effectiveness of battery-powered ships. These developments directly support the NEMOSHIP objective of accelerating maritime electrification and contributing to substantial reductions in greenhouse gas emissions in line with European and international climate targets.

Co-funded by the European Union

The NEMOSHIP project has received funding from the European Union's Horizon Europe Research and Innovation programme under grant agreement No 101096324. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or or the European Climate, Infrastructure and Environment Executive Agency. Neither the European Union nor the granting authority can be held responsible for them.

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