WP4 - Multi-level management systems development

D4.3: Energy optimisation approaches for hybrid vessels - version 1- 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. To help achieve this ambition, NEMOSHIP will develop a 1 MWh modular and standardised battery energy storage solution (BESS) that is able to exploit heterogeneous storage units and a cloud-based digital platform to enable data-driven, optimised and safe exploitation. The project will demonstrate the maturity of these innovations at TRL 7 for hybrid ships as well as their adaptability towards fully electric ships.

This report relates to Task 4.2 of the NEMOSHIP project, which aims to develop an energy management system for hybrid vessels equipped with batteries in order to optimise their use.

This document presents the first version of the management algorithms developed. It supports one of the project ambitions: converging to an optimal use of BESS coupled with other power sources, in order to minimise vessel emissions while maximising BESS lifetime.

The general principle of the present optimization algorithm, integrated into the NEMOSHIP digital platform, is as follows:

- The algorithm ensures, via Mixed Integer Linear Programming (MILP) optimization, that the power requirements are always met over the horizon, while respecting all constraints and minimizing the selected objective (costs, emissions or a trade-off of both)

- Under crew and systems operational constraints, and an estimation of the power requirements over a given time horizon

- With mathematical modelling of the power system architecture and its components (thermal engines, diesel generators, electrical motors and generators, BESS) and fuels

- As a result, all optimal power set-points of the systems, found by the optimizer over the horizon, are recommended to the crew via a tablet

The advantage of such an approach is that it provides the crew with a lot of flexibility and uses optimal set-points, depending on sailing modes, through various objectives over different timescales and planning horizons.

However, this algorithm is designed to provide operational guidance at time intervals of at least 15 minutes and does not intend to replace onboard systems controllers nor orchestrate their behaviour.

The Task 4.2 algorithms are developed in two steps with the version 1 being the objective of the present deliverable. Version 2 will be provided at a later stage of the project and will include further improvements discussed at the end of this deliverable.

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