Battery System Concepts for Fully Electric Vessels

Introduction

Dear SEABAT Community,

As we embark upon the final leg of our journey, it's with great enthusiasm that I welcome you to the fourth edition of the SEABAT Project Newsletter. Over the past three years, our collaborative efforts have propelled us forward in our mission to develop a modular full electric maritime hybrid battery concept to substantially reduce the costs of large waterborne battery systems for over 1MWh.

Entering the fourth year marks a significant milestone for the SEABAT project; the virtual integration, validation and certification of the chosen concept. This phase will validate the developed battery system concept. This includes proving reliability and effectiveness of the chosen concept, to validate that the developed battery system topology works as intended in a realistic environment and to verify fault-tolerance and fault ride-through capabilities of the developed system topology and control system, considering both electric and electromechanical faults.

In this edition, we reflect on the progress we've made thus far, highlighting key results achieved in 2023 and specifically the introduction to the cost model calculation, including online demonstration tool. Further, a listing of the peer reviewed publications, including the open access to these publications, is given.

As we set our sights on the final year, we will present the major events organised by the project, like the third academic workshop and the final event mid November 2024 in Antwerp, Belgium.

Thanks to the unwavering dedication and tireless efforts of the consortium, we will make this final year of the SEABAT project one to remember.

Jeroen Stuyts, Project Coordinator, SEABAT Project

Battery Sizing Tool

Hybrid Battery Energy Storage Systems or HBESS for short combine different battery cell technologies with complementary features in a single battery system. This approach enables HBESS to strike an optimal balance between energy content, maximum power output, and battery lifetime leading to significant reductions in total cost and weight of the battery system. The benefits derived from HBESS play a pivotal role in advancing the electrification of highly demanding sectors like construction, agriculture, maritime and aviation.
The aim of this webtool is to demonstrate how battery hybridization can work for a multitude of applications, and emphasize the possible cost and weight savings which can be made. All results displayed are calculated using non-linear optimization, resulting in the lowest cost possible for the battery system. The influence of different parameters like nominal voltage and minimum lifetime on the sizing of the HBESS can be observed by adjusting sliders on the first page. A comparison between traditional monotype battery system and the cost-optimal hybrid battery system is displayed on the second page.

If you want to know more, please visit our website.

Cluster EUWT-SE

EU Waterborne Transport – Synergies Ecosystem

In November 2023, three EU funded projects, FLEXSHIP, HYPOBATT and SEABAT came together and started a collaboration with the aim of identifying common areas of interest, explore ways to adopt best practices and to enhance their project results for the benefit of waterborne transport.
Being the initiative open to other parallel/similar EU funded projects, since the beginning of 2024 EUWT-SE has welcomed other three projects, AENEAS, NEMOSHIP and DT4GS, as new participants in this compelling initiative which will further boost the results of all the involved projects.

Read more about this on the SEABAT website.

Click here for more linked projects!

Events held in 2023

WATTSup 2024 conference

SEABAT GA06

SEABAT -2nd Academy

SEABAT GA05

General results 2023

WP4: Component development

This work package will focus on the design and develop the components for a modular and flexible hybrid battery system towards low cost.

- D4.1: Design, development and implementation of advanced strategies for battery temperature regulation
  Deliverable 4.1 provides an in-depth analysis of the advanced strategies used for battery temperature regulation, from the module level to the HESS level. The deliverable outlines the functional and safety requirements necessary for selecting thermal components and designing the overall battery thermal management system, based on international marine application standards.

- D4.2: BMS design, development approach and validation
  Deliverable 4.2 provides an in-depth analysis of the development and validation of the BMS for the modules integrated into the HESS level. Moreover, the deliverable outlines the state functions integrated into the BMS.

- D4.3: System interface between energy storage and power storage and its control
  This deliverable summarizes the DCDC converter design and validation. Additionally, other important HW elements like the String inductance, String and HESS master controllers design is detailed.

- D4.4: EMC analysis of the system and definition of the safety requirements
  The scope of task 4.3 is to analyse the battery system security at component level. For that, the safety requirements of the battery system have been defined based on the analysis of the existing regulations. Moreover, the need for Safety Integrity Level (SIL) in the Battery Management System (BMS) and its implementation has been evaluated as well as Electromagnetic Compatibility (EMC) studies.

- D4.5: Design and development of the casing
  The SEABAT module design is based on a platform design which implements identical components and systems shared by both applications (high-power and high-energy). This approach comes from the automotive sector and leads to reduced costs for systems. Some components are adapted to fulfil the needs of the naval application. For the SEABAT modules Lithium-ion cells, safety layers, terminal busbars, flexible PCBs (Printed circuit board) and their carrying structure and some cables are different for the high-power (HP) and the high-energy application (HE). All other components are identical. The different dimensions of both cell types and their fixation are covered by a centre alignment and in addition compensated by different positions of the cell side fixation. The side fixation itself is the same part for both module types.

WP5: Battery module and pack assembly & manufacturing and integration

This work package aims to integrate the full hybrid battery energy storage system.

Specific system architecture and integration tools will be used to correctly understand, identify and risk mitigate the relevant interfaces between the battery cells, battery housing, converter, communication, energy interfaces, physical interfaces and fluid related interfaces. When the design of the manufacturing assembly process is tackled, focusing on putting such a large battery pack together in an efficient and cost-effective manner, the final step will be the verification tests.

- D5.1: Boundary Diagram, Interface Analysis and requirements
  Boundary diagrams are commonly used in automotive to show interactions between various systems and components. Similar methodology is used to develop and analyze the interface between the various components of the Hybrid Energy Storage System (HESS) to ensure all of them could work together seamlessly.

- D5.2: Process Flow Diagram and list of process steps
  This report explains the advancements on the SEABAT project with respect to battery modules and HESS (Hybrid Energy Storage System) manufacturing. This work package comprised of realization and functional tests of the design.

- D5.3: PFMEA and Control Plan
  This deliverable outlines the de-risking methodology, PFMEA development steps, and Control Plan definition, all aligned with industry standards.

WP6: Virtual integration, validation and certification

This work package will validate the developed battery system concept.

A roadmap for final type approval / certification of the developed system will be a specific outcome of this work package.

- D6.1: Report of the Integration and validation test program
  This document provides a comprehensive overview of the P-HIL setup, which includes virtual integration, fault tolerance, and fault ride-through testing. The document also describes the necessary modifications to the control system and discusses the limitations of the test setup.

- D6.2: The P-HIL test setup description
  This document provides a comprehensive overview of the P-HIL setup, which includes virtual integration, fault tolerance, and fault ride-through testing. The document also describes the necessary modifications to the control system and discusses the limitations of the test setup.

Upcoming events in 2024

3rd SEABAT Academic workshop

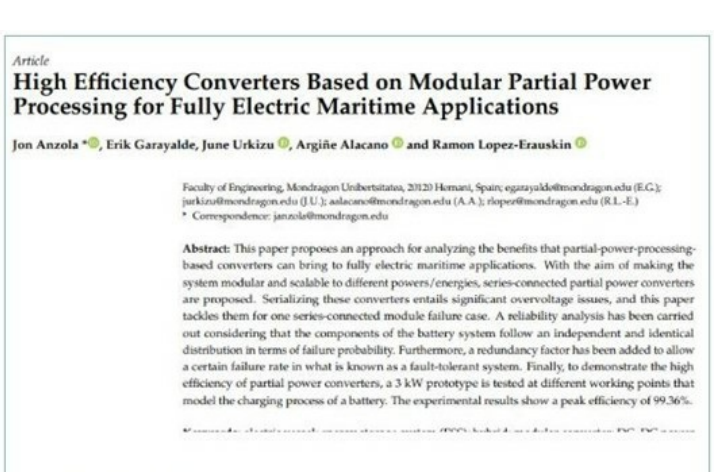
Upcoming on the 14th of June 2024, the third SEBAT academic workshop, to be held in Darmstadt in Germany at Frauenhofer.

Topics addressed are:

1. Session 1 on the component development and the innovations
2. Session 2 on the overall system integration on hardware level
3. Session 3 on the overall system integration on software level

If you are interested, register on the newsletter, and you will receive an invitation soon.

Publications


Article
High Efficiency Converters Based on Modular Partial Power Processing for Fully Electric Maritime Applications
Jon Anzola, Erik Garayalde, June Urkizu, Argiñe Alacano and Ramon Lopez-Erauskin

High Efficiency Converters based on Modular partial Power Processing for Fully Electric Maritime Applications

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Article
Design and Evaluation Framework for Modular Hybrid Battery Energy Storage Systems in Full-Electric Marine Applications
Zhenmin Tao, Rene Barrera-Cardenas, Mohsen Akbarzadeh, Olve Mo, Jasper De Smet and Jeroen Stuyts

Design and Evaluation Framework for Modular Hybrid Battery Energy Storage Systems in Full-Electric Marine Applications

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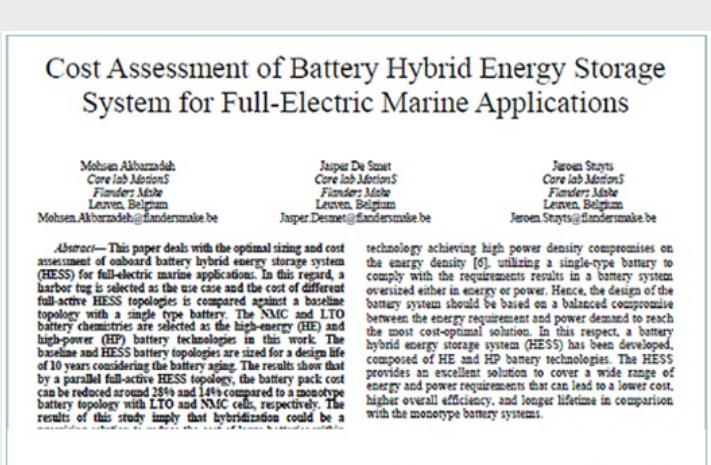
Cost Assessment of Battery Hybrid Energy Storage System for Full-Electric Marine Applications

Cost Assessment of Battery Hybrid Energy Storage_for Full-Electric Marine Applications

Published: June 2022 Authors: Mohsen

Read more →

Outlook final year (2024)

The final year is the start of the demonstration, testing and validation campaign.

Upcoming technical topics:

- Completion of the hardware: production of 24 modules (12 high energy & 12 high power) should be completed in April. Currently, we are over halfway through.
- Systems validation tests are scheduled at CEA in France, let's find out if our prototype really works! Validation tests of a single module at IKERLAN in Spain are promising.
- Validation will feed back information such that the confidence in all our models and simulations will increase. This will enable the consortium to come to final conclusions on prospected cost savings, energy savings, material savings, emission savings etc.

Please note the following upcoming events and workshops in your agenda:

- Third academic workshop: June 14th, 2024, in Darmstadt, Germany.
- Seventh General Assembly Meeting: June 27th-28th, 2024, in Trondheim, Norway.
- Final event: November 12th-13th, 2024 in Antwerp, Belgium.

We expect that three publications will appear.

SEABAT Partners

FLANDERS MAKE, DAMEN, FINCANTIERI Si, RINA, Fundación Soermar, VARD a Fincantieri company, ABEE, IMECAR, UNIRESEARCH, cea, Fraunhofer, ikerlan, Mondragon Unibertsitatea, SINTEF, POLITECNICO DI TORINO

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