EUROPEAN COMMISSION
HORIZON 2020 PROGRAMME - TOPIC H2020-LC-BAT-2020

Solutions for large batteries for waterborne transport

GRANT AGREEMENT No. 963560

D3.1 – Evaluation and selection of architectural concept

Report details

Deliverable No.	SEABAT D3.1	
Deliverable Title	Evaluation and selection of architectural concept	
Deliverable Date	23/12/2021	
Dissemination level	Confidential – member only (CO)	CO
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Document History

Version	Date	Author	Remarks
V0.1	06/12/2021	Mohsen Akbarzadeh Rene Barrera-Cardenas Jon Anzola Garcia	First draft for review
V0.2	20/12/2021	Mohsen Akbarzadeh Rene Barrera-Cardenas Jon Anzola Garcia Erik Garayalde Perez June Urkizu Arocena Deniz Süzen	Second draft for review
V1.0	23/12/2021	Mohsen Akbarzadeh Jasper De Smet Rene Barrera-Cardenas Olve Mo Jon Anzola Garcia Erik Garayalde Perez June Urkizu Arocena Deniz Süzen	Final version

Project Abstract

The goal of the SEABAT project is to develop a full-electric maritime hybrid battery concept that is based on:

- Modularly combining high-energy batteries and high-power batteries,
- novel converter concepts and
- production technology solutions derived from the automotive sector.

The modular approach will reduce component costs (battery cells, converters) so that unique ship designs can profit from economies of scale by using standardized low-cost components. The concept will be suitable for ships requiring up to 1 MWh of storage or more.

Public summary

The main goal of the SEABAT project is to develop a cost-effective hybrid energy storage system (HESS) architecture for large marine applications that is scalable to at least 1 MWh and validated at a level of 300 kWh. For this purpose, a suitable system architecture is required for a mix of high-energy and high-power batteries that allows a balanced compromise between ship energy and power requirements. In this regard, a novel electrical storage concept is needed to be flexible, scalable, energy-efficient, and cost-effective to optimally control the power flow between the high-energy and high-power batteries.

Within this deliverable, three HESS topologies with novel converter concepts, as defined in the SEABAT proposal, are explained, evaluated, and compared towards a baseline state of practice mono-type battery topology. The HESS topologies that are investigated in this work are based on the following concepts:

a) Topology 1: Converter integrated into the battery modules

b) Topology 2: Switching between individual cells

c) Topology 3: Partial power converter integrated into the battery modules

The evaluation and comparison of the HESS topologies is made via a generic optimization and modeling process. The inputs of the optimization are high-energy and high-power battery cell specifications, and the operational requirements of different vessels as the use case for the design process of the HESS defined in deliverable D2.1. The output of the optimization is the optimal size of each topology per application for 10 years operational lifetime of the vessel. The investigated topologies are then compared against the baseline to the key performance indicators (KPIs) defined in deliverable D2.2. The used KPIs are: total battery system cost; total battery mass; total battery volume; battery system losses and the required amount of components for each topology.

It is up to the reader to perform his own analysis based on this document since this document only provides insights on how the final topology within SEABAT will look. The documents does not make a final conclusion on which topology to be used within SEABAT. This is a common project decision, and planned on the GA in February 2022. However, a few general observations are discussed here.

Topology 1 scores on average on all points better than the baseline battery pack. It has the most advanced models for the different systems. However, it uses the same approach and input requirements as the other topologies.

Topology 2 scores on average higher on volume, weight and amount of components when comparing to the baseline. Assigning a switching device to multiple cells is a possible solution to improve the size and cost of this topology.

Topology 3 scores on average equal to the battery pack volume. While an improvement on the other KPIs is feasible. One major improvement for this topology would be related to the DC/DC cost model, the heat sink is at the moment oversized and it would be favorable for the cost when a more optimized cooling size, and thus cost, is used.

13 Acknowledgements and disclaimer

The author(s) would like to thank the partners in the project for their valuable comments on previous drafts and for performing the review.

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1	FM	FLANDERS MAKE
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This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 963560. The information and views set out in this publication does not necessarily reflect the official opinion of the European Commission. Neither the European Union institutions and bodies nor any person acting on their behalf, may be held responsible for the use which may be made of the information contained therein.