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

Solutions for large batteries for waterborne transport

GRANT AGREEMENT No. 963560

D6.2 – P-HIL test setup description

Report details

Deliverable No.	SEABAT D6.2	
Deliverable Title	P-HIL test setup description	
Deliverable Date	2023-09-01	
Dissemination level	Confidential – member only (CO)	CO
Author	Tor Inge Reigstad (SINTEF) Julen Paniagua Amillano (MGEP) Amaia Lopez de Heredia (IKERLAN) Mikel Rivas (IKERLAN) Nicolas Hascoët (CEA) Olve Mo (SINTEF)	2023-08-31
WP leader	Olve Mo (SINTEF)	2023-09-01
Reviewers	Peter Rampen (DAMEN) Guenael Le Solliec (CEA)	2023-08-31 2023-08-31
Coordinator	Jeroen Stuyts (FM)	2023-09-29

Document History

Version	Date	Author	Remarks
V1.0	2023-09-01	Tor Inge Reigstad (SINTEF)	First version
V2.0 FINAL	2023-09-29	Cor van der Zweep (UNR)	Prepared for submission

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 primary objective of WP 6 is to verify that the HESS (Hybrid Energy Storage System) meets the requirements outlined in WP2 and the specifications from WP3. The validation process for the HESS involves two steps: a power-hardware-in-the-loop (P-HIL) virtual integration and validation test, and a performance test of the entire battery system.

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.

The P-HIL setup consists of two physical battery modules and is developed in Task 6.2. While some components of the test setup are physical, most of the components are simulated by a real-time simulator and controlled voltage sources. The setup will be utilized for testing the hardware and software of the master controller, string controller, and module controller, including the DCDC controller and BMS system. The tests to be conducted in Task 6.3 include the integration of the controllers, control functionality, and fault handling of the control systems, virtual integration with the vessel power system, and virtual upscaling of the battery system.

Contents

List of figures

List of tables

Abbreviations

AI	Analog Input
BMS	Battery Management system
DI	Digital input
EMT	Electromagnetic Transient
ESS	Energy Storage System
HE	High-energy
HESS	Hybrid Energy Storage System
HIL	Hardware-In-the-Loop
HP	High-power
LTO	Lithium-Titanate Battery
NMC	Nickel Manganese Cobalt
NTC	Negative Temperature Coefficient
P-HIL	Power-Hardware-in-the-Loop
PMS	Power Management System
PWM	Pulse Width Modulation
RMS	Root Mean Square
SOC	State of Charge
SOF	State of Function
SOH	State of Health
TVS	Transient-Voltage-Suppression

7 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.

Project partners:

#	Partner	Partner Full Name
1	FM	FLANDERS MAKE
2	DAMEN	SCHEEPSWERF DAMEN GORINCHEM BV
3	FCSI	FINCANTIERI SI SPA
4	RINA	RINA SERVICES SPA
5	SOERMAR	FUNDACION CENTRO TECNOLOGICO SOERMAR
6	VARD	VARD ELECTRO AS
7	ABEE	AVESTA BATTERY & ENERGY ENGINEERING
8	IMECAR	IMECAR ELEKTRONIK SANAYI VE TICARET LIMITED SIRKETI
9	UNR	UNIRESEARCH BV
10	CEA	COMMISSARIAT A L'ENERGIE ATOMIQUE ET AUX ENERGIES ALTERNATIVES
11	Fraunhofer	FRAUNHOFER GESELLSCHAFT ZUR FOERDERUNG DER ANGEWANDTEN FORSCHUNG E.V.
12	IKERLAN	IKERLAN S. COOP
13	MGEP	MONDRAGON GOI ESKOLA POLITEKNIKOA JOSE MARIA ARIZMENDIARRIETA S COOP
14	SINTEF	SINTEF ENERGI AS
15	POLITO	POLITECNICO DI TORINO

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.