NEMOSHIP

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GA No. 101096324

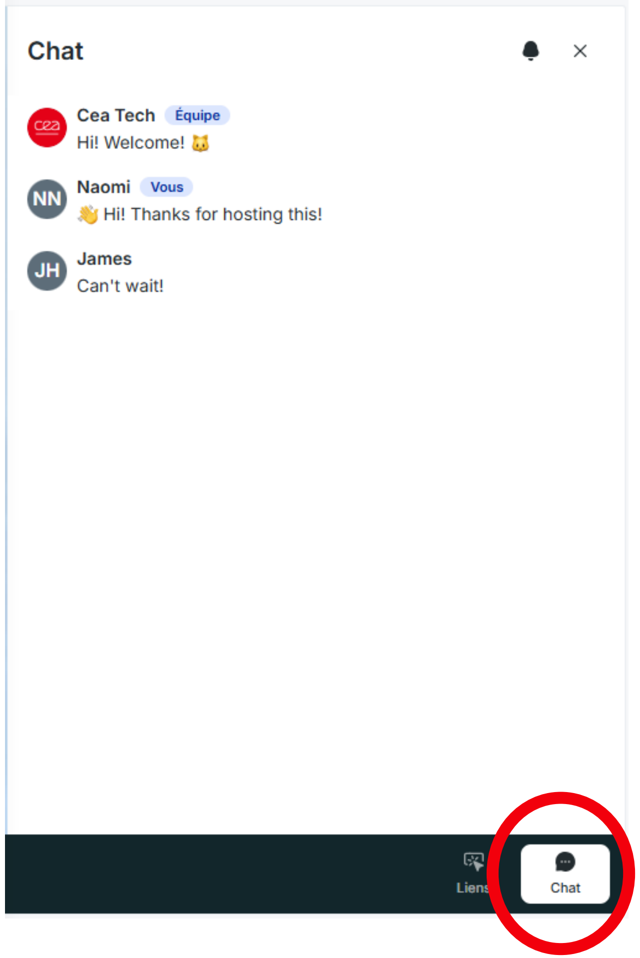
DECARBONISATION OF MARITIME TRANSPORT WITH LARGE BATTERY SYSTEMS
WEBINAR #1

November 18th 2025

HOUSEKEEPING

NEMOSHIP

- Your microphones will be muted during the event
- We will have 2 Q&A sessions
- You can ask your questions in the chat box at anytime during the event (see bottom right of the screen). If possible indicate to which speaker you wish to address the question.
- Slides will be shared on our website: https://nemoship.eu/results/



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AGENDA

NEMOSHIP

14:00 – 14:05 Welcome - *CEA, Solène Goy*

14:05 – 14:20 NEMOSHIP Overview *- CEA, Solène Goy*

14:20 – 14:40 NEMOSHIP BESS design *– Corvus, Tommy Sletten*

14:40 – 14:45 Q&A

14:45 – 15:10 Experiences from NEMOSHIP 1.1 MWh heterogeneous BESS installation – *Solstad, Kjetil Vatland Olsen and Equinor, Wei He*

15:10 – 15:40 NEMOSHIP BESS control with BPMS – *CEA, Guénaël Le Solliec / VUB, Saeed Kazemian / Elkon, Mert Can Celik*

15:40 – 15:50 Q&A

15:50 – 16:00 Closing - *CEA, Solène Goy*

BESS: Battery Energy Storage System

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NEMOSHIP

NEMOSHIP OVERVIEW

Solène Goy, CEA

PROJECT DATA

NEMOSHIP

NEMOSHIP	
Title	New modular electrical architecture & digital platform to optimise large battery systems on ships
Call ID	HORIZON-CL5-2022-D5-01-01 - Exploiting electrical energy storage systems and better optimising large battery electric power within fully battery electric and hybrid ships (ZEWT Partnership)
Type	Innovation Action
Lead	CEA
Duration	4 years - 01/01/2023 to 31/12/2026
Total cost	11.3 M Euros
EU contribution	7.9 M Euros

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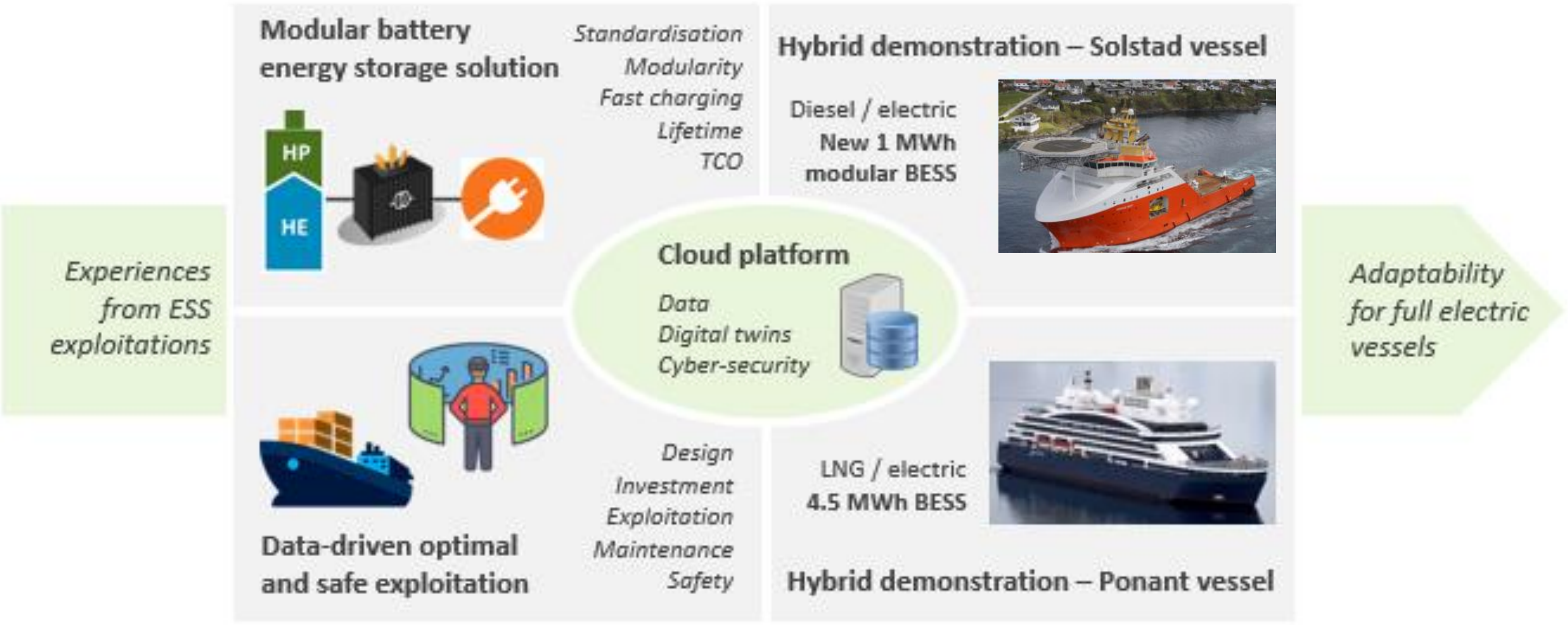
PROJECT EXPECTED OUTCOMES

NEMOSHIP



2 main innovative solutions:

- A modular and standardised 1.1 MWh battery energy storage solution enabling to exploit different types of batteries (HE and HP)
- A cloud-based digital platform enabling a data-driven optimal and safe exploitation

HE: High-Energy
Optimized for sustained energy delivery, suitable for longer voyages and continuous operation.

HP: High-Power
Designed for rapid discharge and charge cycles, ideal for dynamic marine applications.

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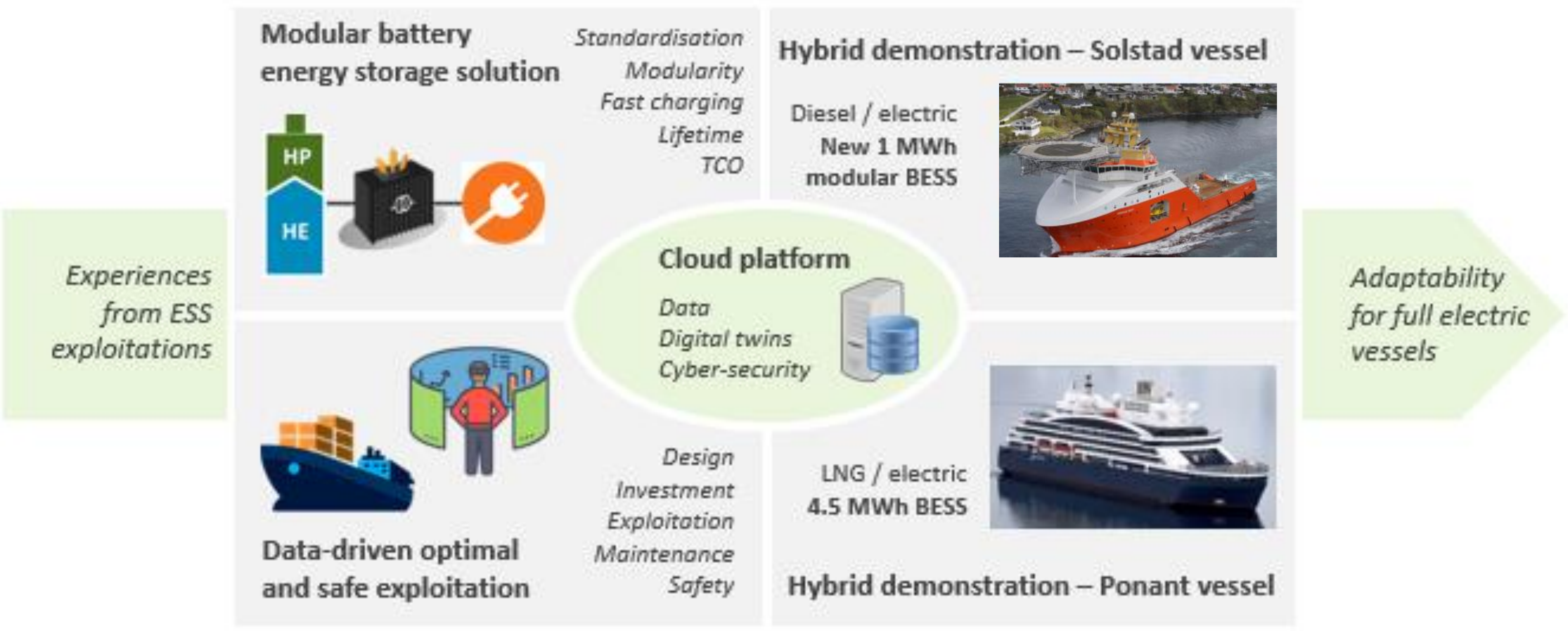
PROJECT EXPECTED OUTCOMES

NEMOSHIP



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- A modular and standardised 1.1 MWh battery energy storage solution enabling to exploit different types of batteries (HE and HP)
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→ Demonstrate their maturity for hybrid ships at TRL 7 and their adaptability for full-electric ships

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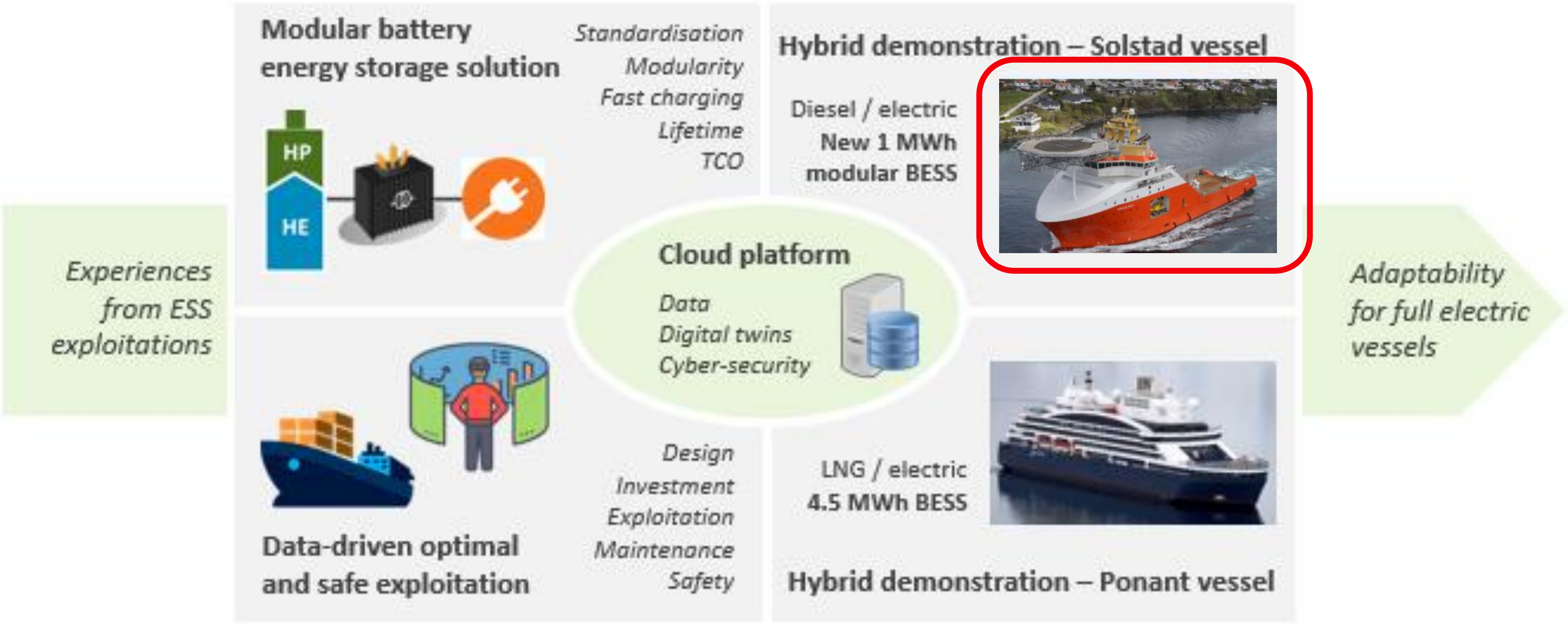
PROJECT EXPECTED OUTCOMES

NEMOSHIP



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→ Demonstrate their maturity for hybrid ships at TRL 7 and their adaptability for full-electric ships

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CONSORTIUM

NEMOSHIP

Consortium:

- 6 countries
- 11 complementary partners

Covering the entire value chain:

- 3 Research Technology Organization (CEA, VUB, Cidetec)
- 1 SME (SDI)
- 7 private large groups (Siemens, Corvus, Elkon, Solstad, Equinor, Ponant, In Extenso)

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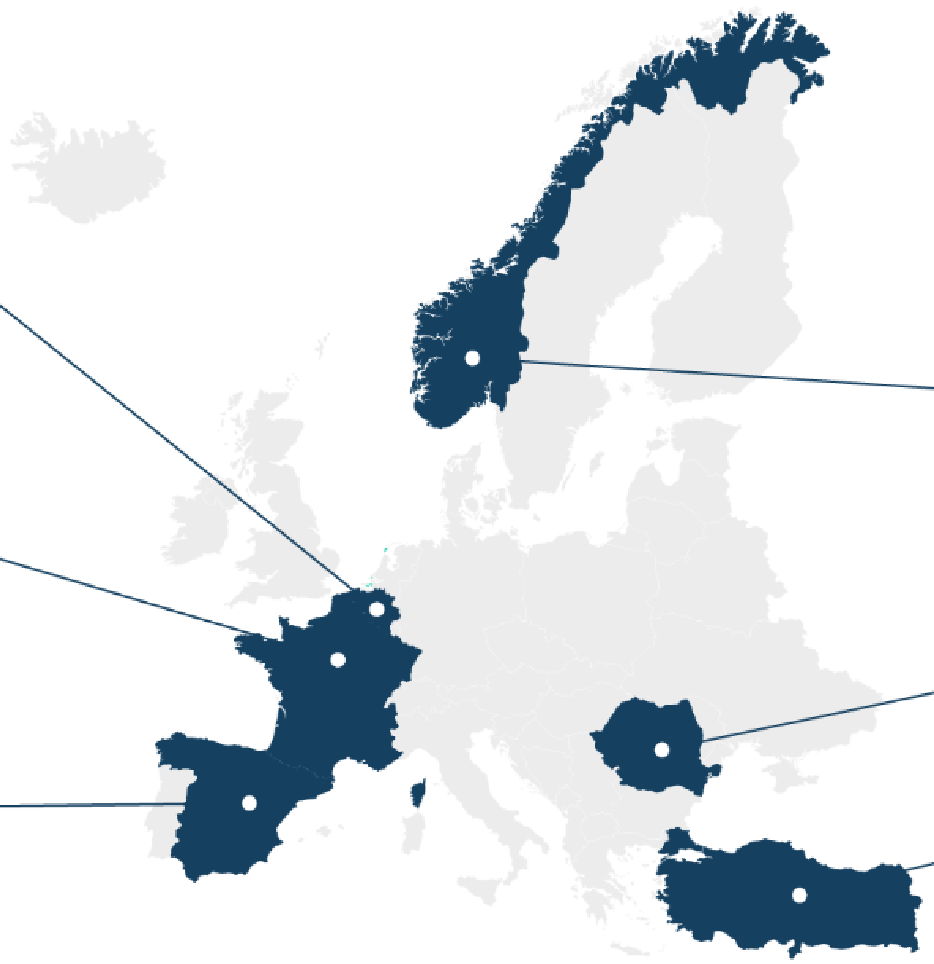
CONSORTIUM

NEMOSHIP



Belgium

VUB VRIJE UNIVERSITEIT BRUSSEL

France

cea

In Extenso INNOVATION CROISSANCE

PONANT

SDI

Spain

cidetec energy storage

Norway

SOLSTAD OFFSHORE

Corvus Energy

equinor

Romania

SIEMENS

Turkey

elkon

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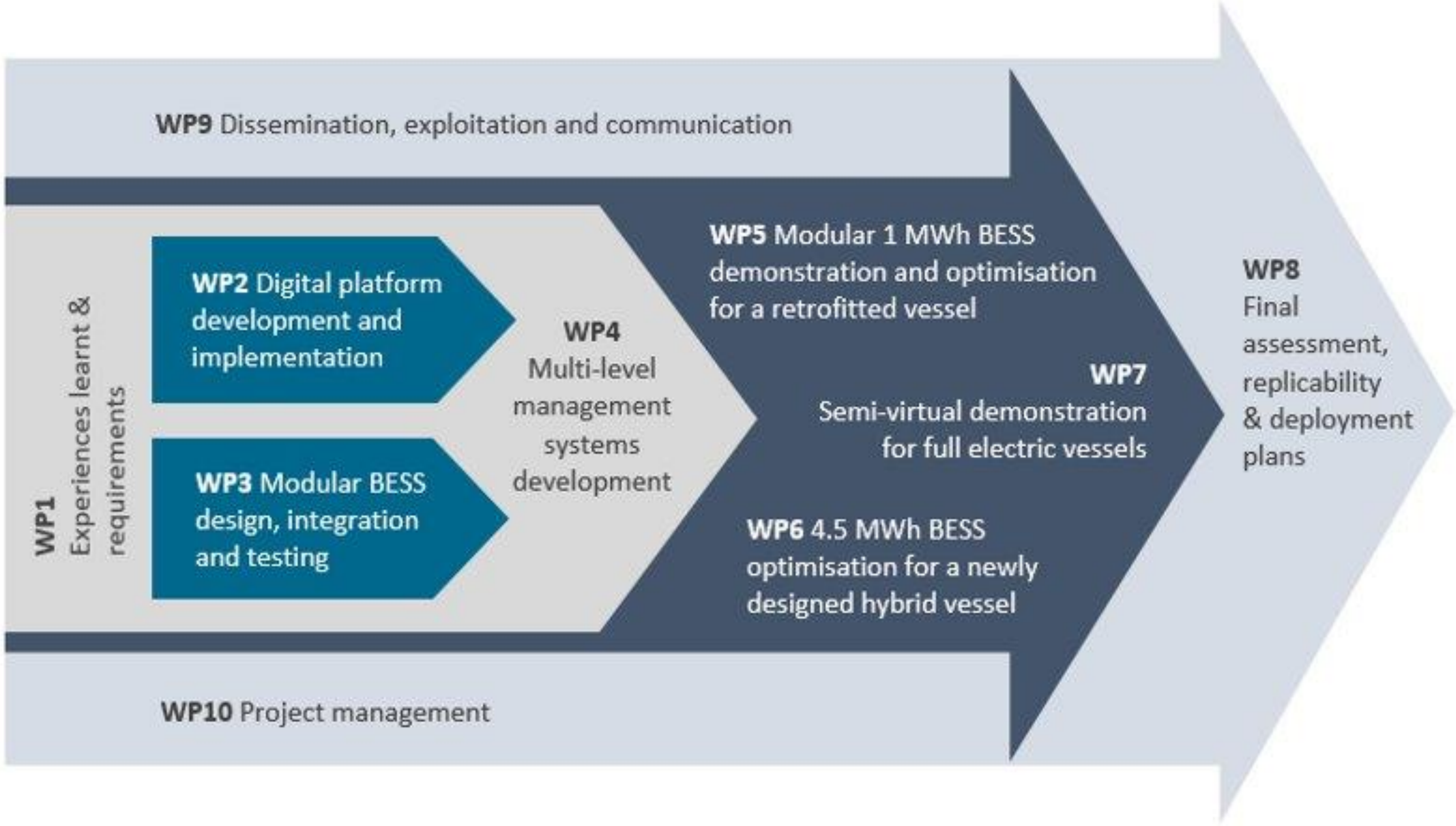
WORK PLAN



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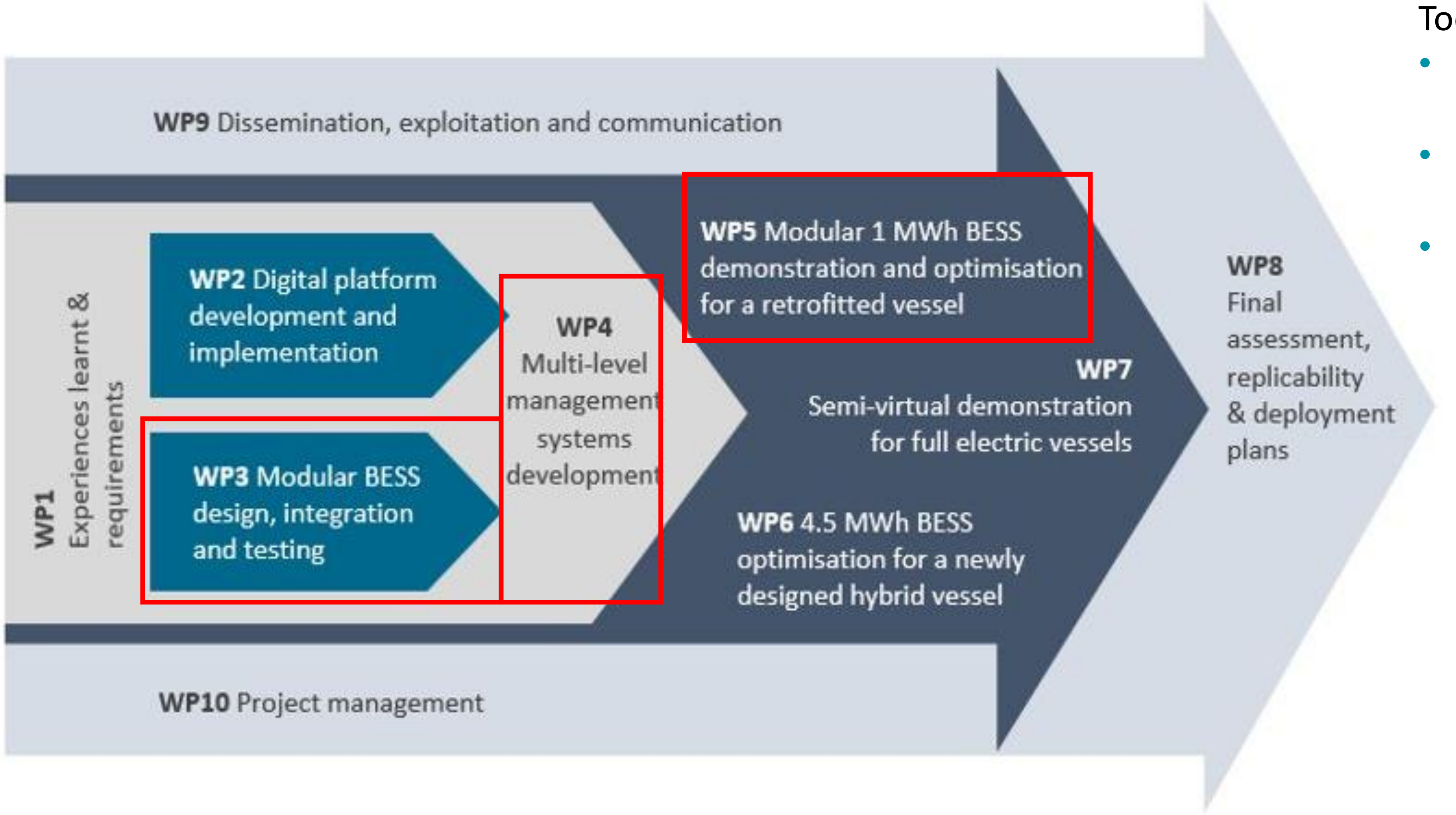
WORK PLAN

NEMOSHIP



Today:

- WP3 (BESS design, integration and testing)
- WP4 (control algorithm development)
- WP5 (BESS demonstration and optimisation)

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RESULTS ACHIEVED SO FAR

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- **Review** of past R&I projects (see D1.2 here) / **Analysis of data** and **lessons learnt** from existing battery systems – See D1.1
- Definition of **requirements**/specifications for the **digital platform** and for the **battery system** (e.g. D2.1 here)
- Sizing of the battery system (including High Energy/High Power battery share) (see paper here)
- Control algorithms for the heterogeneous BESS (**BPMS**)
- **BESS installation** on Normand Drott
- Development of the **digital platform** + predictive and optimal **energy management algorithms**

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DISSEMINATION

NEMOSHIP

- NEMOSHIP is a member of the EUWT-Synergies Ecosystem (with FLEXSHIP, HYPOBATT, SEABAT, AENEAS, DT4GS, BlueBARGE)
- 1st NEMOSHIP journal paper published – here
- 7 other conference papers presented in 2024 and 2025 - here
- Get the latest updates on our:
  - Follow us on our Linkedin page
  - Website: https://nemoship.eu/ - Keep an eye on our website for new deliverables !
  - Registrer for our newsletter on our website

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NEMOSHIP BESS DESIGN

Tommy Sletten, Corvus

ESS TECHNOLOGY EVOLUTION

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Advancement over time

Corvus AT 6500

2016

÷50% Footprint

÷50% Volume

÷30% Weight

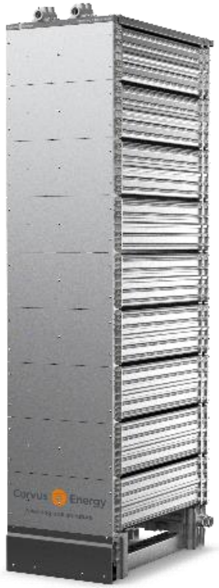
Corvus Orca

2025

÷50% Footprint

÷50% Volume

÷30% Weight



Corvus Blue Whale

Sustainable shipping

Corvus Energy

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BATTERY TYPES

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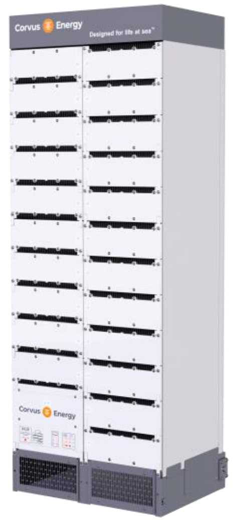
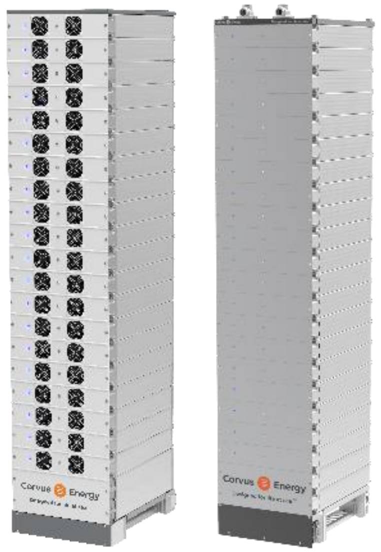


Orca Energy

- NMC Chemistry
- Pouch Style Cell
- Air Cooled
- Racked Design

Blue Whale
NxtGen

- LFP Chemistry
- Prismatic Cell
- Liquid Cooled
- Rackless Design



Dolphin Energy
NxtGen

- NCA Chemistry
- Cylindrical Cell
- Air or Liquid Cooled
- Rackless Design

Dolphin Power
NxtGen

- NCA Chemistry
- Cylindrical Cell
- Liquid Cooled
- Rackless Design

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NEW DESIGN

Modular Design Approach: Supports quality and cost efficiency

Modularized design, where cell-agnostic components can be applied across product lines offers many benefits.

Modular design supports improved:

- Product quality
- Performance reliability
- Cost efficiency
- Production timelines

Blue Whale ESS

Dolphin Energy NxtGen ESS

Corvus Energy

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NEMOSHIP BESS DESIGN CRITERIA

- Two different battery systems
- ~1MWh total size
- Working in parallel
- Able to supply 2300kW max power
- 1100V
- Both systems same lifetime

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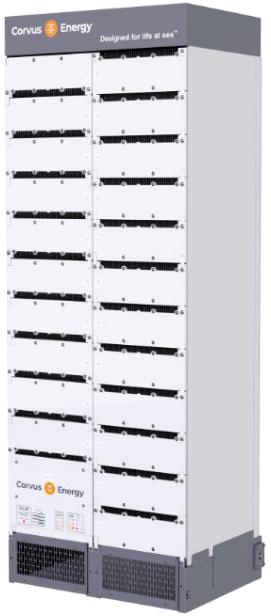
NEMOSHIP BESS SELECTION



Orca Energy

- NMC Chemistry
- Pouch Style Cells
- Air Cooled
- Racked Design

Dolphin Energy

- NCA Chemistry
- Cylindrical Cells
- Air Cooled
- Racked less Design

Total System Energy (+-2%)	745	kWh
Design Life	10	Years
Maximum Voltage	1,100	VDC
Minimum Voltage	800	VDC
Total Dry Mass (+-15kg/pack, incl rack)	9,768	Kg

Total BESS : 1.1 MWh

Total System Energy (+-2%)	361,2	kWh
Design Life	10	Years
Maximum Operational Voltage	1100	VDC
Minimum Operational Voltage	713	VDC
Total Dry Mass (+-3%)	2187	Kg

Corvus Energy
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CONNECTION TO SHIP SYSTEM

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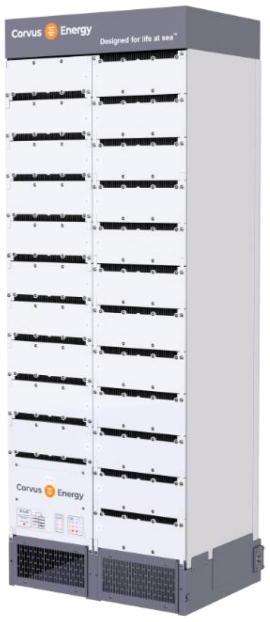
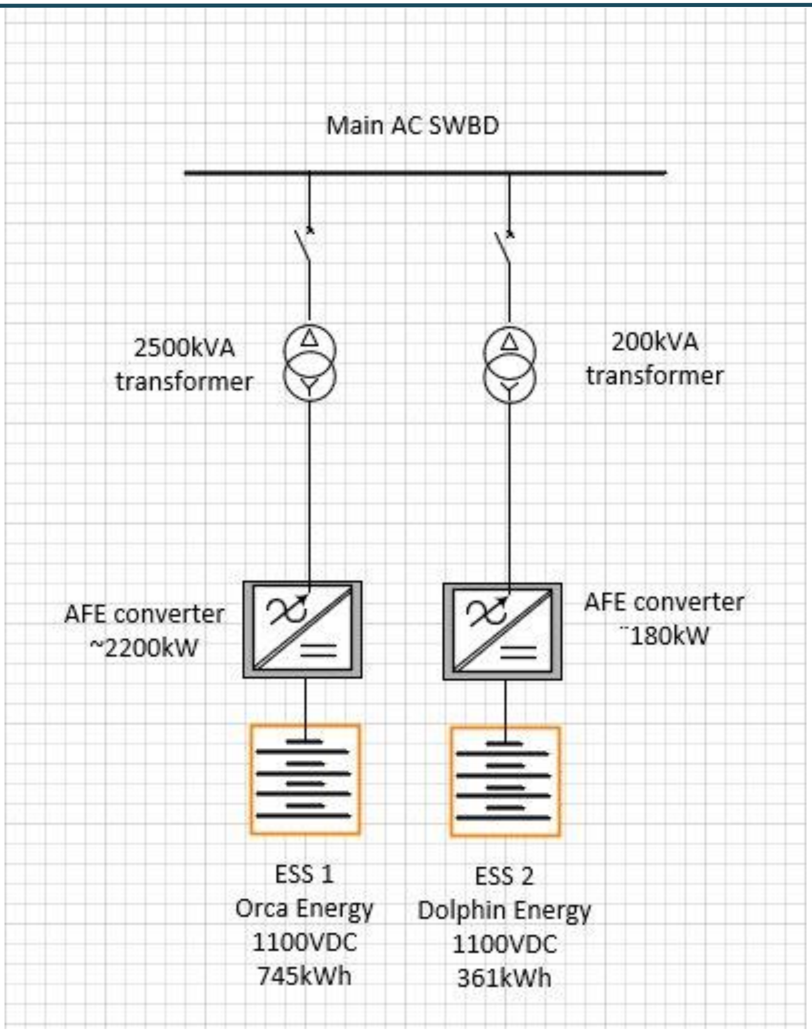
Orca Energy
- Max 3C





Dolphin Energy Nxt Gen
- Max 0.5C

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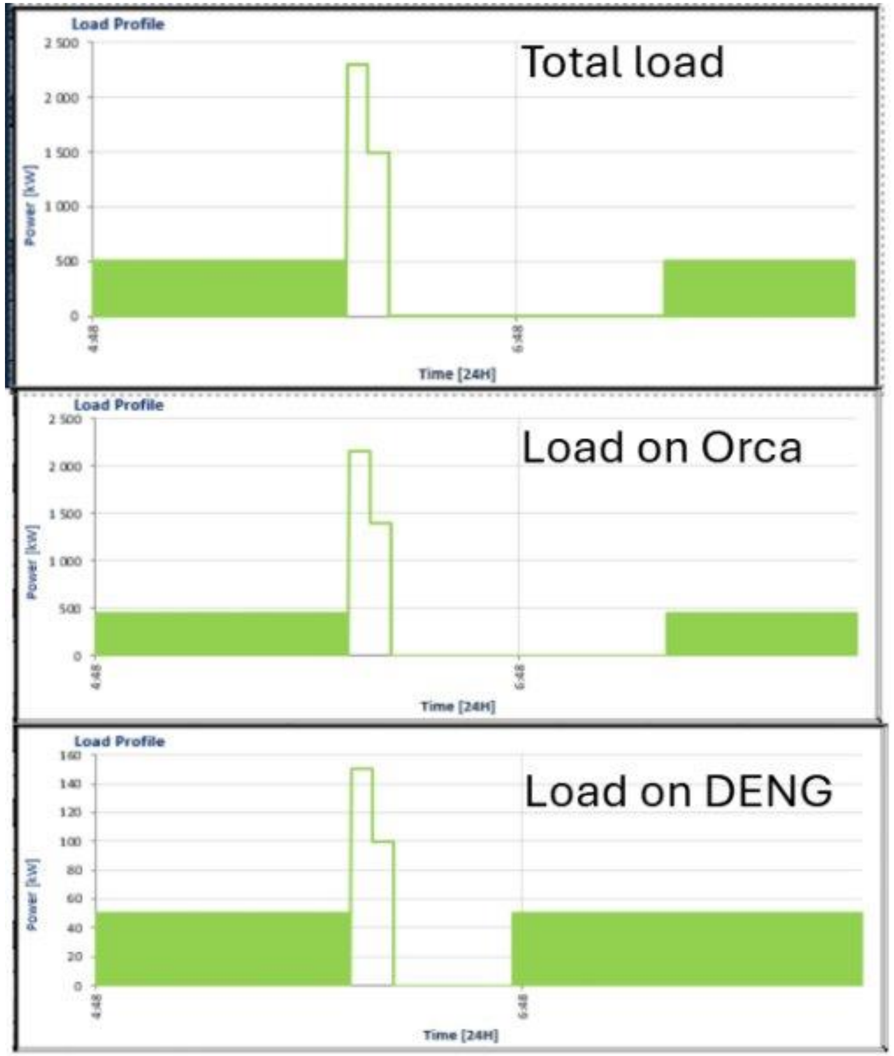
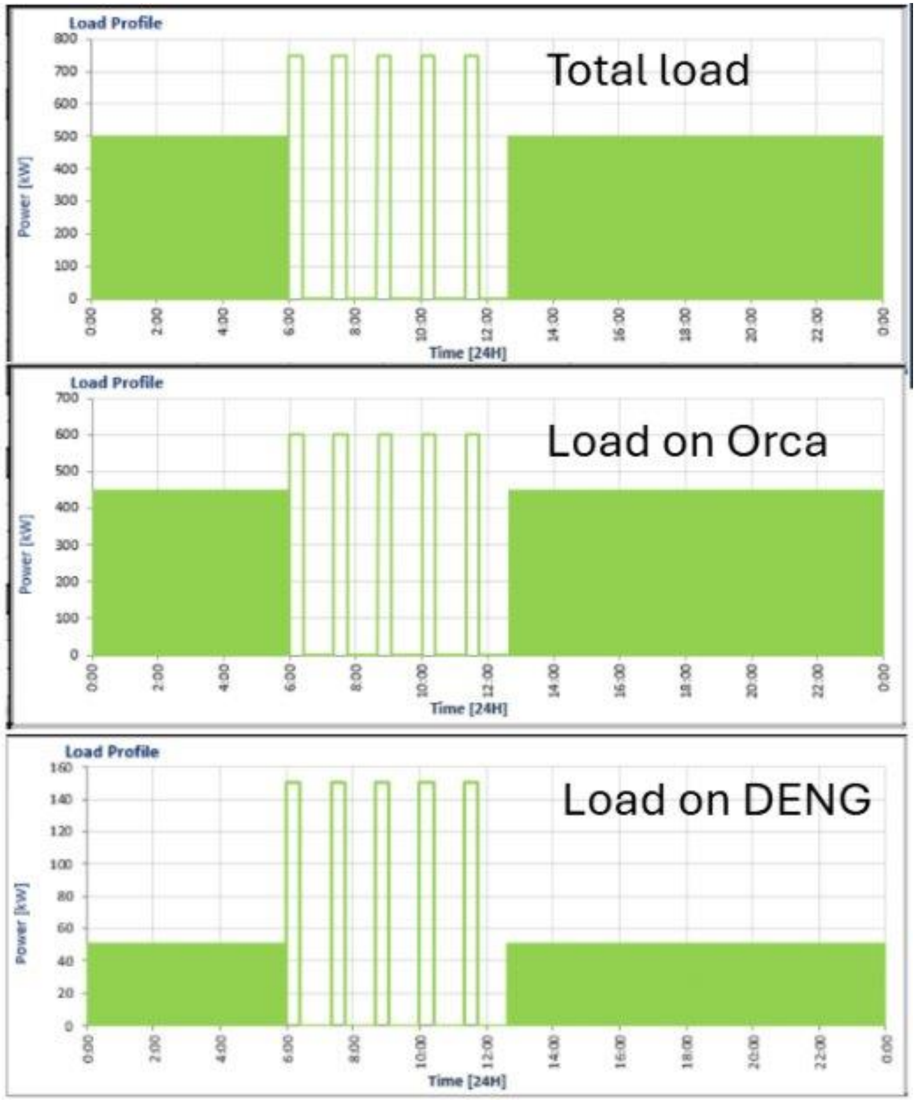
PARALLEL OPERATIONS - POWER



Peak shaving With a spinning reserver

Peak Shaving in combination with load levelling cycles



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PARALLEL OPERATIONS – DOD/AGING

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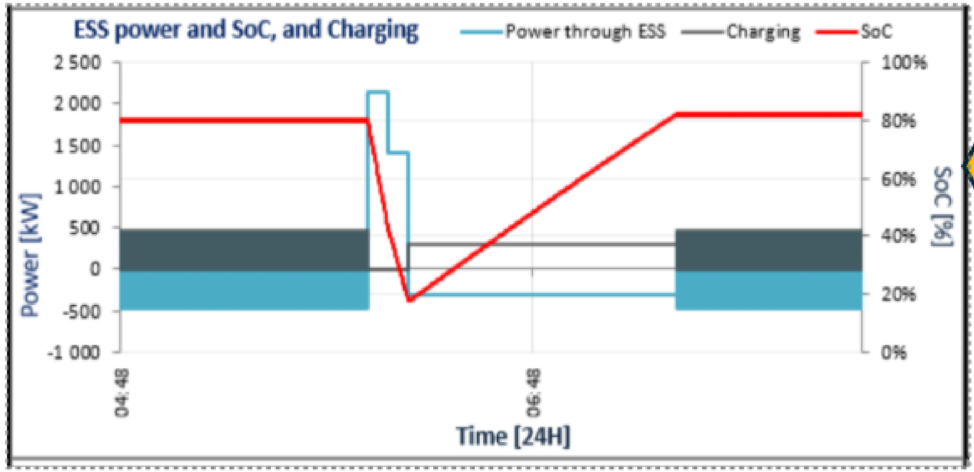
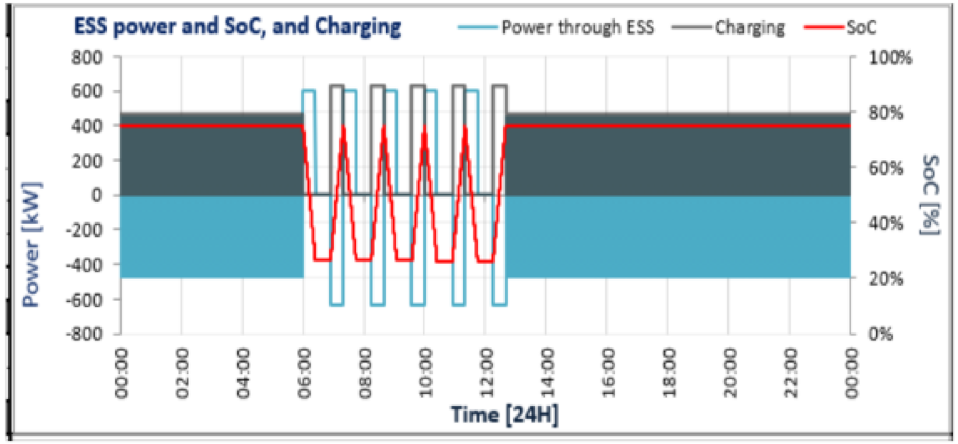
DoD vs SoC Orca

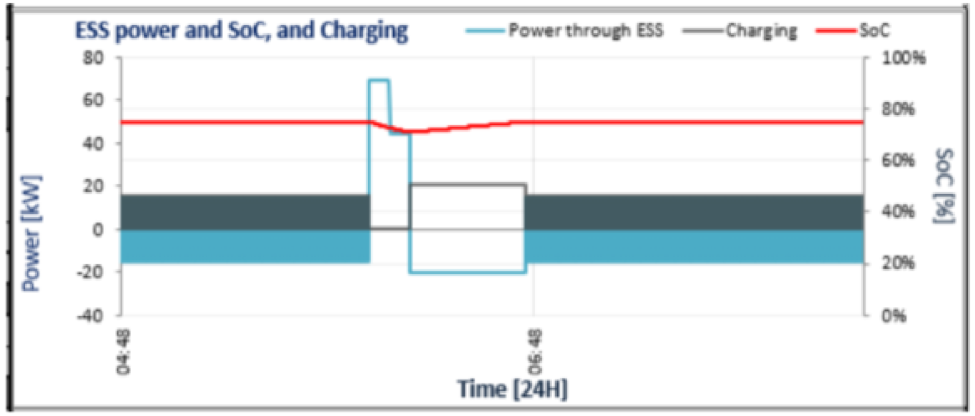


Peak shaving With a spinning reserver

DoD vs SoC Orca



SoC vs DoD DENG



Peak Shaving in combination with load levelling cycles

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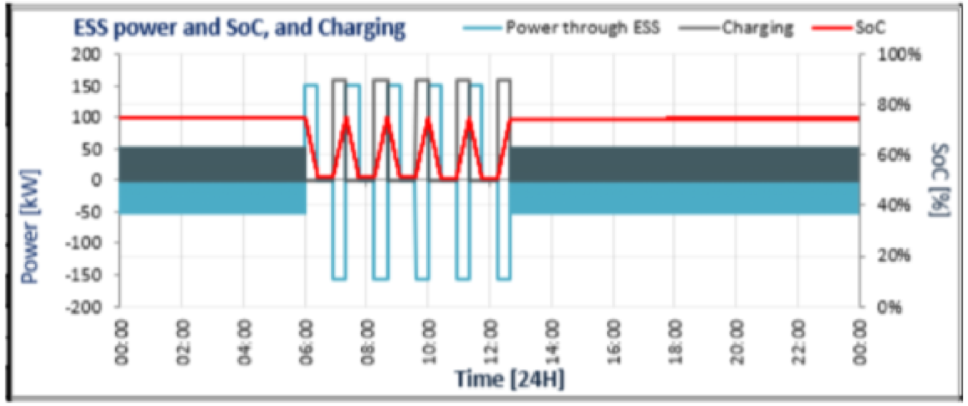

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Q&A

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EXPERIENCES FROM NEMOSHIP 1.1 MWH HETEROGENEOUS BESS INSTALLATION

Kjetil Vatland Olsen, Solstad
Wei He, Equinor

NEMOSHIP

EXPERIENCES FROM NEMOSHIP 1.1 MWH HETEROGENEOUS BESS INSTALLATION

Wei He, Equinor

KEY FACTS OF THE 1.1 MWH BESS INSTALLATION

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The total preparation and execution period was 14 months: May 2024 to July 2025.

BESS installation/testing/commissioning period at the shipyard: end of April to early July 2025

All NEMOSHOP partners contributed to the 1 MWh BESS installation plans via various tasks under NEMOSHIP.

- The three NEMOSHIP partners Corvus, Elkon, and Solstad, have direct interfaces to the 1 MWh BESS installations.
- Solstad had four major contractors: Wärtsilä, Vard, GMC Yard, and DNV:
  - Wärtsilä: System integrator
  - Vard: Ship designer for the hybrid battery room and the equipment layout
  - GMC Yard AS Stavanger: Providing all standard docking services and assisting with specialized services, and supporting sea trial completion
  - DNV: The required approvals, certifications and Failure Mode and Effects Analysis (FMEA)

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SHIPYARD FOR THE 1.1 MWH BESS COMMISSIONING AND SEA TRIALS

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- The arrangements with the shipyard in Stavanger were crucial for the new 1 MWh BESS installation, testing and commissioning

	Dimensions	Facilities	Services
	Measures: 140 x 22.5 m Azimuth pit: 6 x 6 x 2.4 m	Freshwater, compressed air Power: • 400 V 50 Hz 250 A • 690 V 60 Hz 200 A • 440 V 60 Hz 380 A Ballast water, slope, cranes: 3 shipyard cranes of 90 tonnes	Standard docking services and assistance with specialized services based on customer requests.

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NEMOSHIP

EXPERIENCES FROM NEMOSHIP 1.1 MWH HETEROGENEOUS BESS INSTALLATION

Kjetil Vatland Olsen, Solstad

NORMAND DROTT

Normand Drott characteristics	
Owner Group	Solstad Maritime
Built	2010
Type	Anchor Handling Tug Supply
Flag	NOR
LOA	95m
Classification Society	DNV GL
Dynamic Positioning	DP 2 from Kongsberg
Accommodation	70 Persons
Bollard Pull	339mt
Deck Dimensions	760,2m² (36,2m x 21m)
Deadweight	5000mt

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PLACEMENT OF BATTERY SYSTEM

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- Vard study
- Conversion of fuel oil tank to battery hybrid room

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CONVERSION

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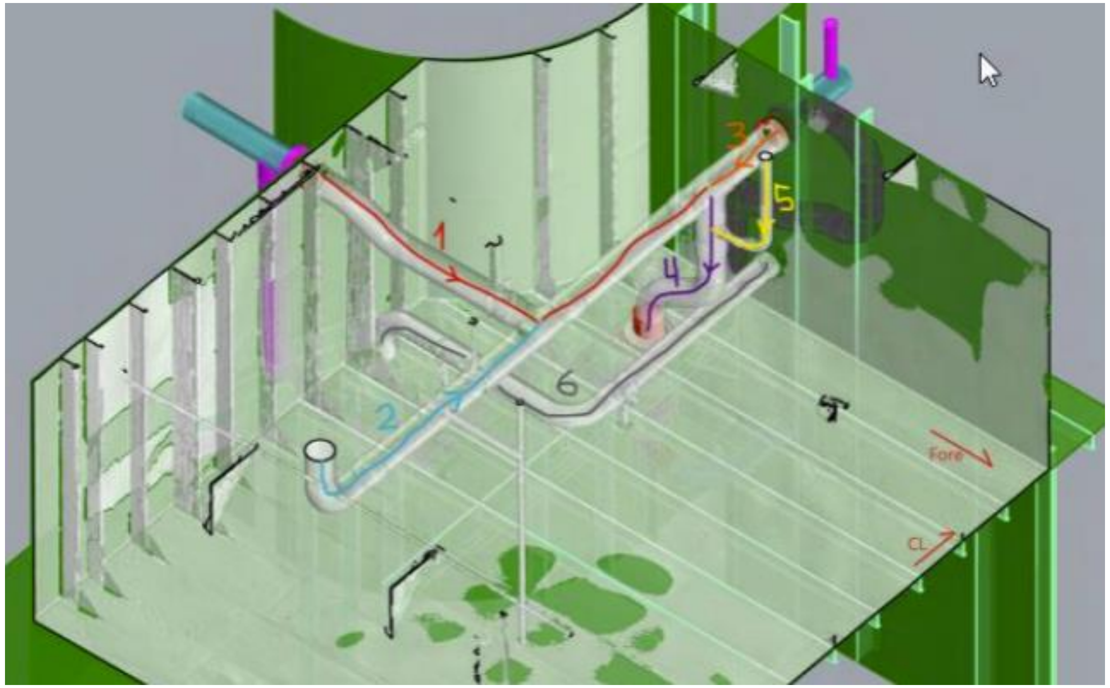
- Infrastructure of tank
- Rerouting of pipes
- Sizing of battery container and skid with power conversion and control equipment



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EXECUTION

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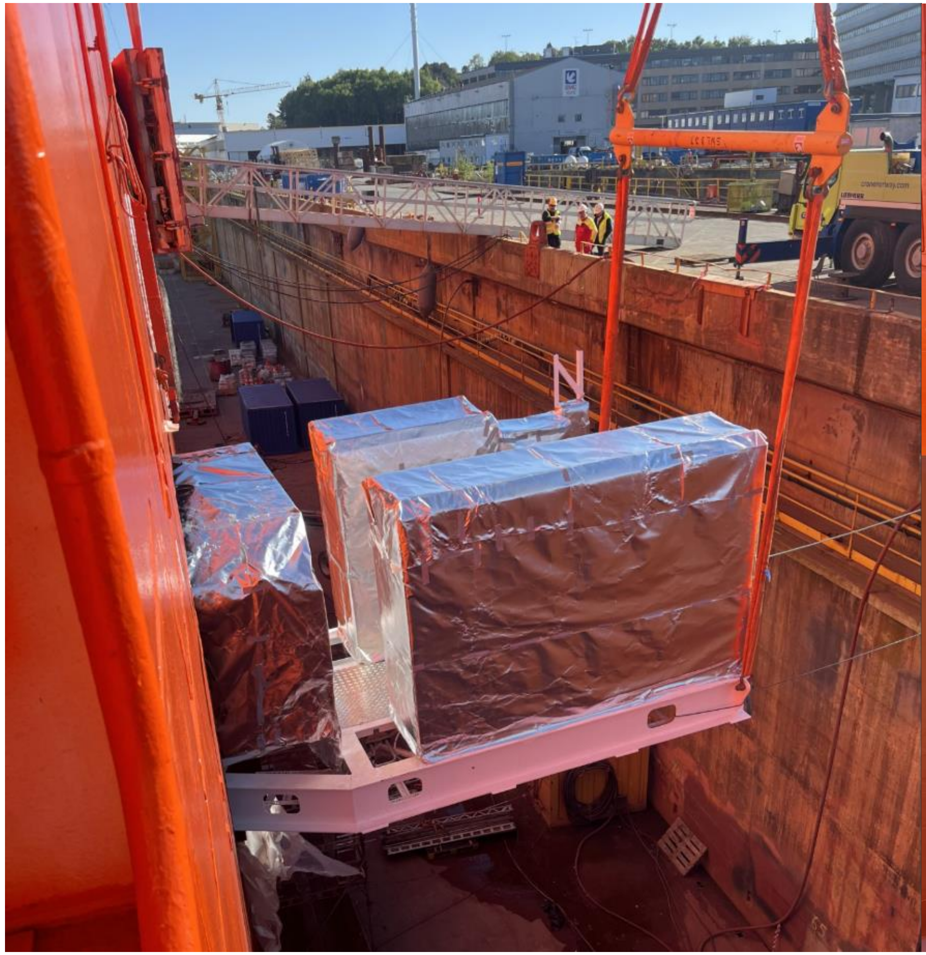
- Power consumer skid and battery container lifted onboard into the converted battery hybrid room
- Power consumer lifted onboard and then moved into right position further back.
- Battery container lifted in and moved straight into position.



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CRITICAL ASPECTS INCLUDING DELIVERY TIME FOR EQUIPMENT

NEMOSHIP

- Critical aspects:
  - Safety (e.g., DNV approvals)
  - Cost increases
  - Risks to delay the installation schedule
- Delivery time for equipment:
  - Drives and transformers long delivery time.
  - On order May 2024 to reach installation May 2025

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SUMMARY

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- Drydocking period and installation time end of April to beginning of July
- Battery functional tests. Alongside prior to sea trails
- Dynamic position (DP) failure model and effects analysis
- DNV battery power notation. Long approval and documentation process

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NEMOSHIP

NEMOSHIP BESS CONTROL WITH BPMS

Guénaël Le Solliec, CEA
Saeed Kazemian, VUB
Mert Can Celik, Elkon

NEMOSHIP

BPMS OVERVIEW

Guénaël Le Solliec, CEA

ELECTRICAL AND CONTROL ARCHITECTURE

NEMOSHIP

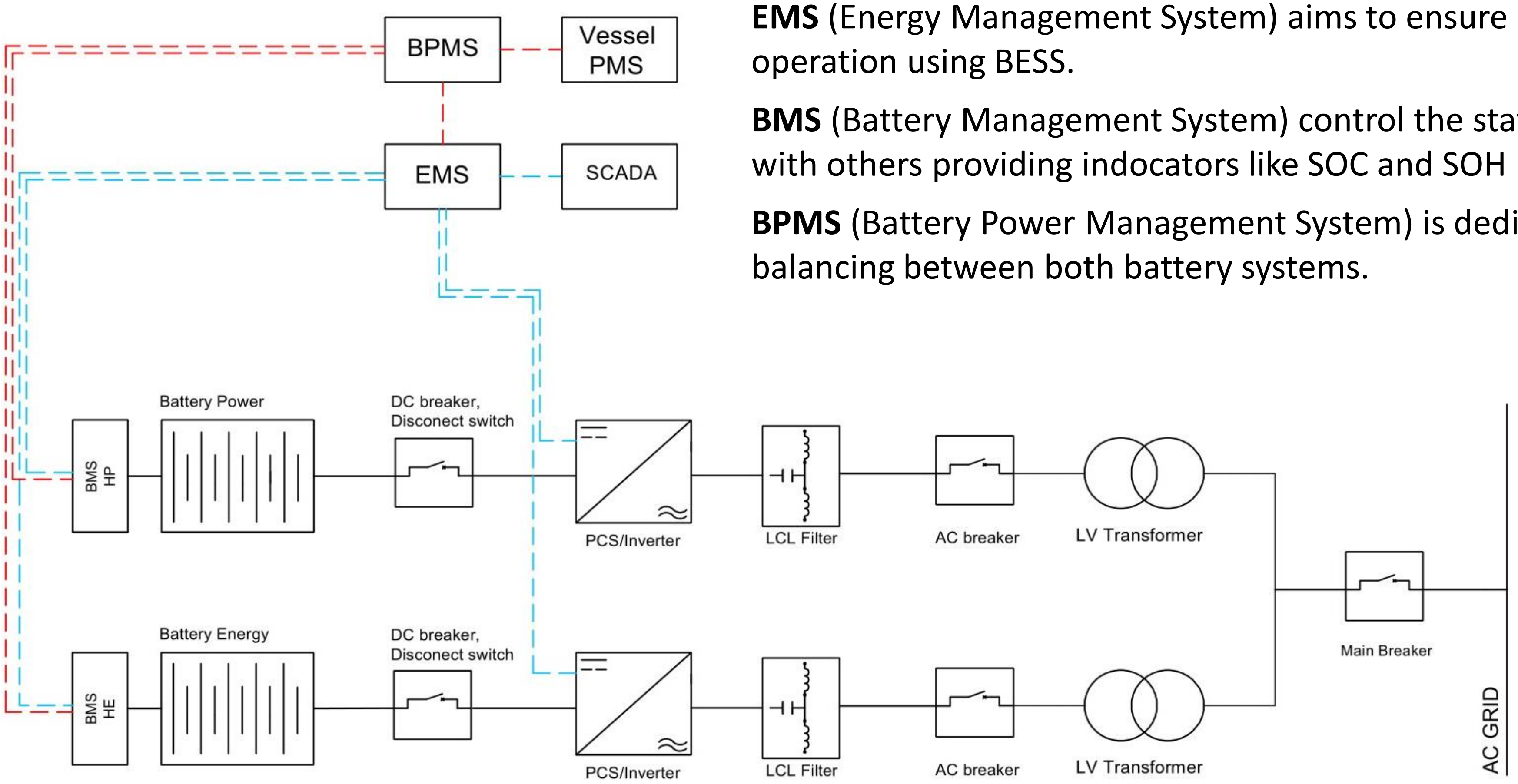
The electrical architecture integrates several key systems :

PMS (Power Management System) controls all power sources including Diesel generators

EMS (Energy Management System) aims to ensure energy efficient and reliable operation using BESS.

BMS (Battery Management System) control the states of the batteries and interact with others providing indocators like SOC and SOH

BPMS (Battery Power Management System) is dedicated to energy and power balancing between both battery systems.



RQ: For certification reason, BPMS is not intrusive. It provides setpoint that are finally applied by EMS.

SOC: State of Charge
SOH: State of Health

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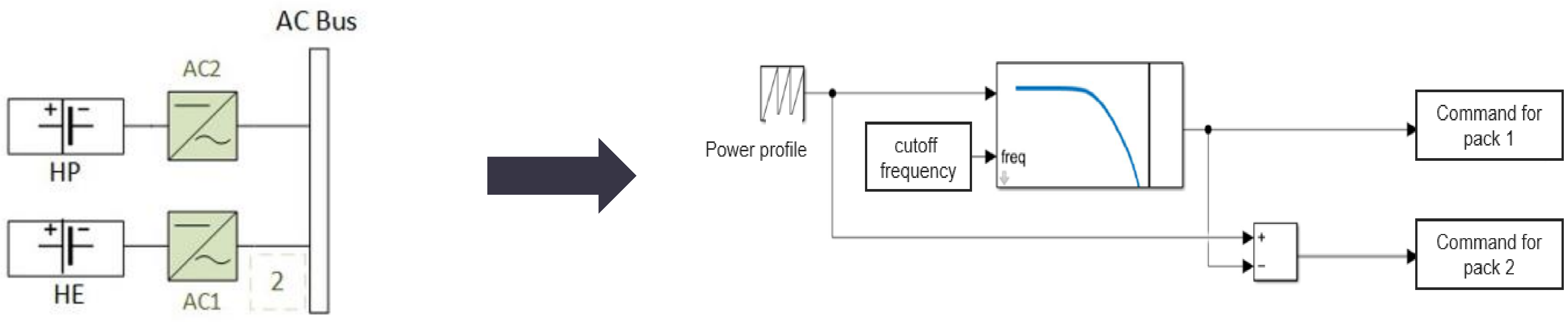
BPMS MAIN FUNCTION : POWER SPLIT



- PMS and EMS define power to be provide by overall BESS on AC bus.
- BPMS strategy split this power request in two power setpoints for HE and HP ESS **based on a exponential filter.**
- This kind of filter is basically set with a parameter named Tau, changing the frequency value of the filter.

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BPMS V1 : PRELIMINARY DEVELOPMENT AND TUNING IN SIMULATION

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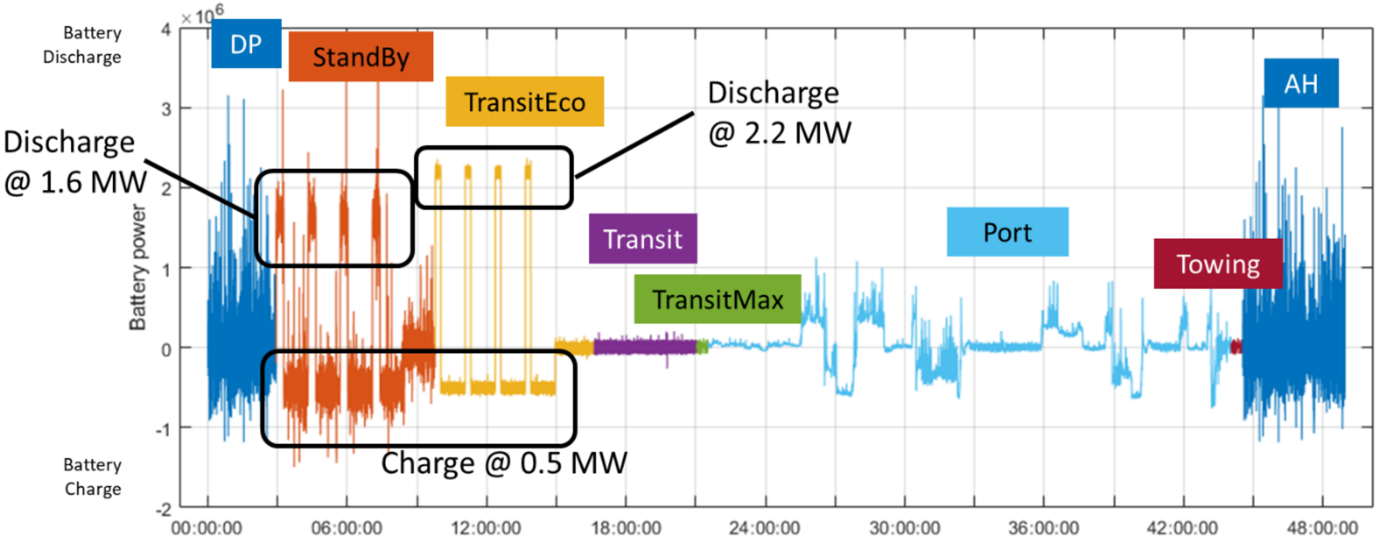

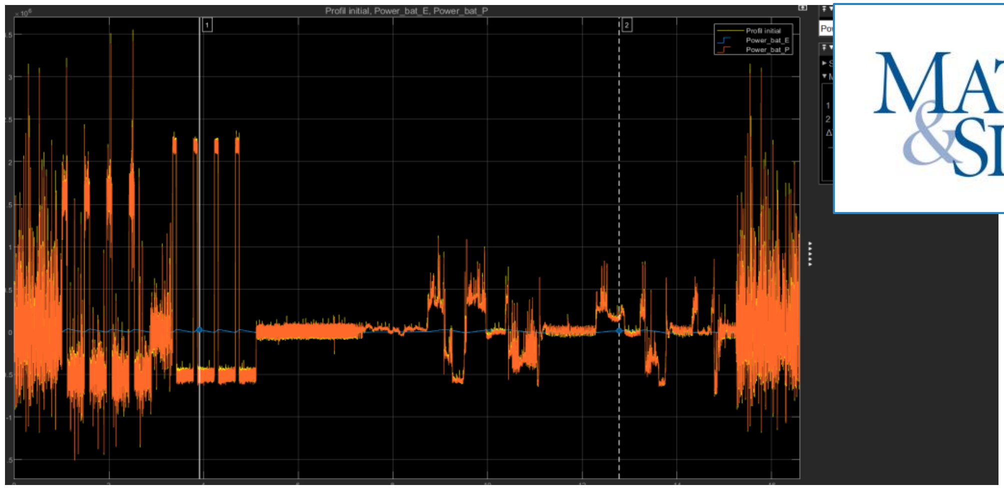

- Definition of a generic power profile taking into account all power variations met during vessel operations
- “Open-loop” power switch using only filtering without taking in account BESS states

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BPMS V2 : ALGORITHM IMPROVEMENT USING REAL-TIME HARDWARE IN THE LOOP (HIL) TESTING

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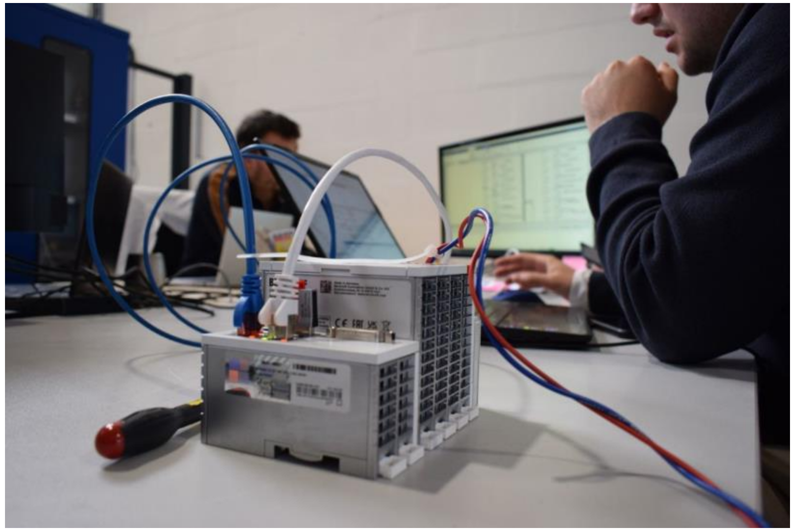
Goal : Improve the robustness of the algorithm and limit battery aging

- **Filter behavior:** Change filter by a critically damped second-order filter. This helps better suppress high-frequency components and **allows tuning gain and time constant** for greater flexibility in adjusting the power distribution**.**
- **Anti interpack current function:** Power sign changes are not instantly followed in the HE battery power setpoint due to the inertia of the filtering. This phenomenon leads to losses in the converters and accelerated battery aging without providing any useful service **-> Filter reset and slope.**
- **Anti-drift SOC function:** Control loop based on the average SOC value of the HP battery to compensate HE SOC battery from drifting
- **SOC limitation:** Implemented SOC limit for the HP battery



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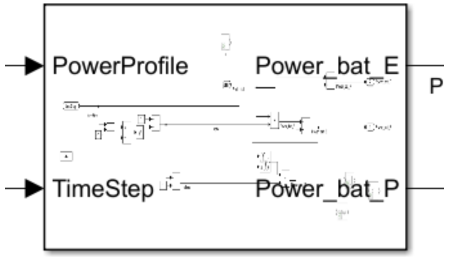
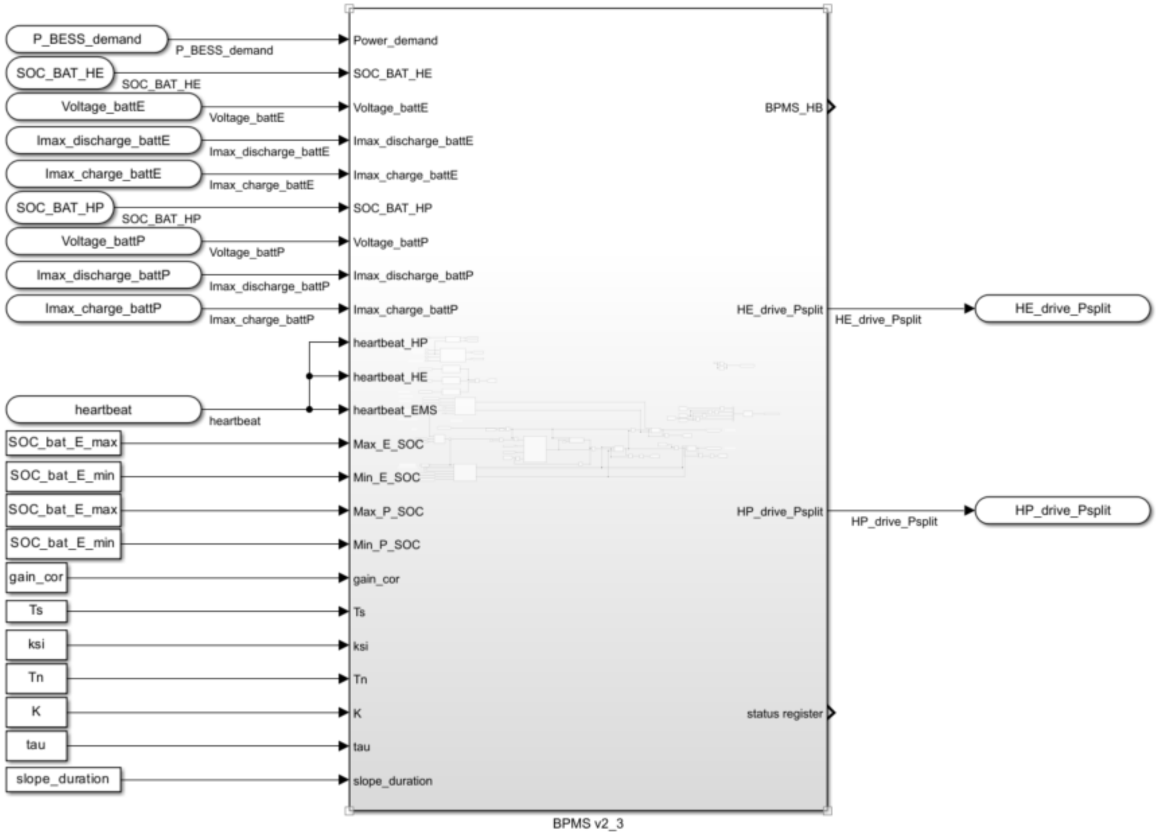
BPMS INPUTS/OUTPUTS



V1



V2

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HIL VALIDATION RESULTS

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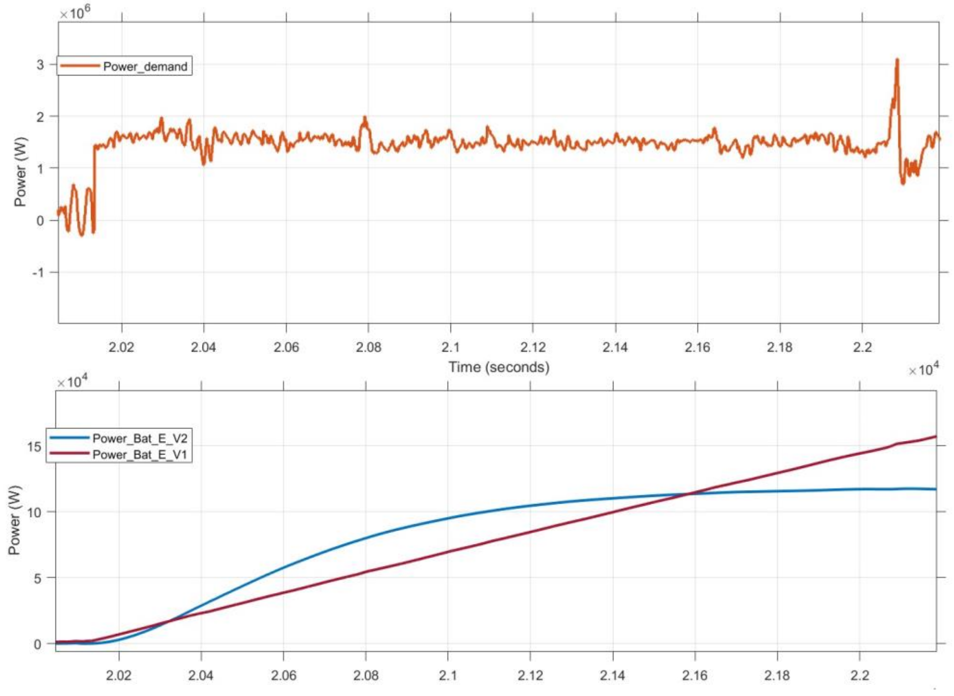
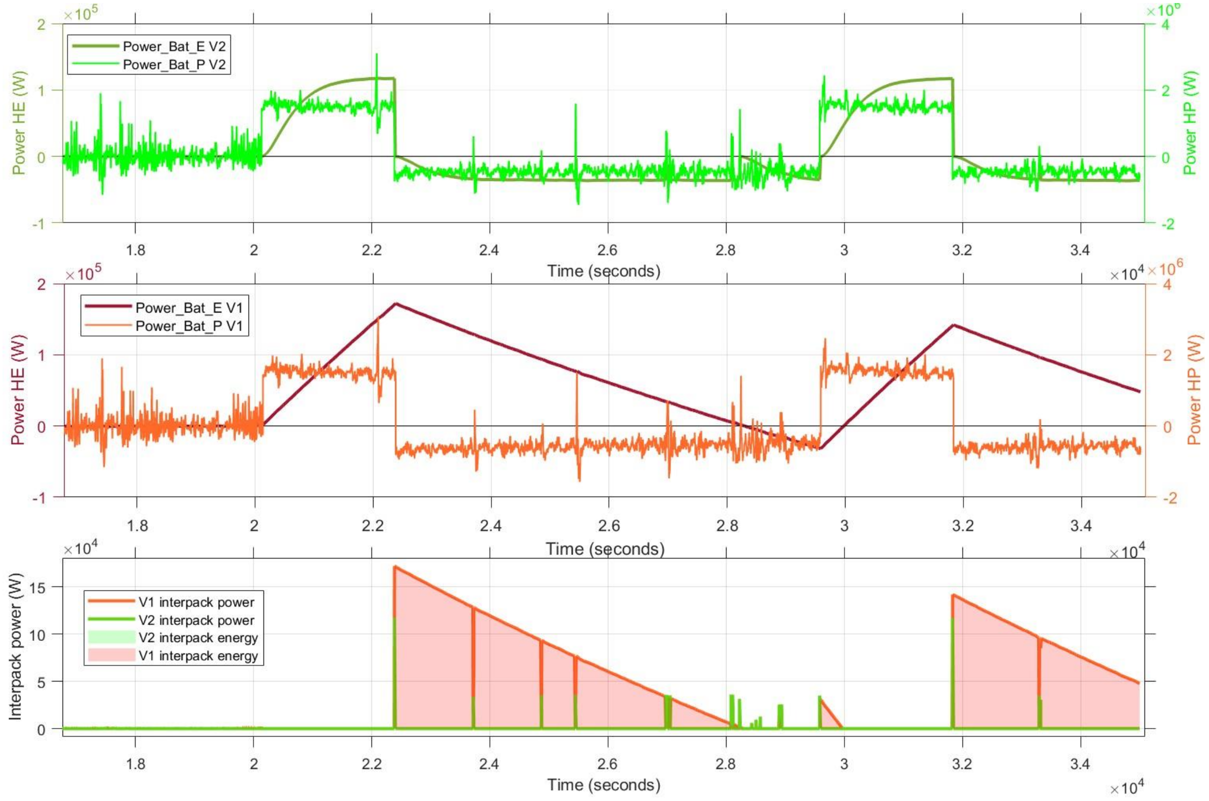
Filter behavior: HE battery contributes its share of power during constant charge or discharge phases while rejecting high-frequency disturbances, which are handled by the HP battery



Anti interpack current function: a filter reset is triggered upon a sign change. To prevent abrupt transitions and frequent unintended resets, a smooth slope decrease is applied to the HE battery's power setpoint



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HIL VALIDATION RESULTS

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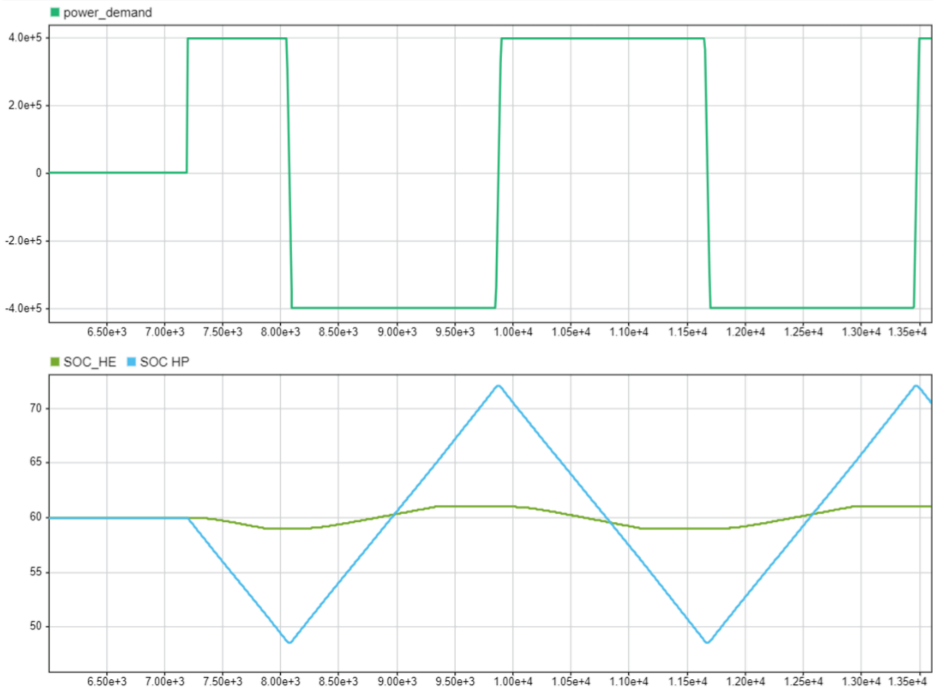
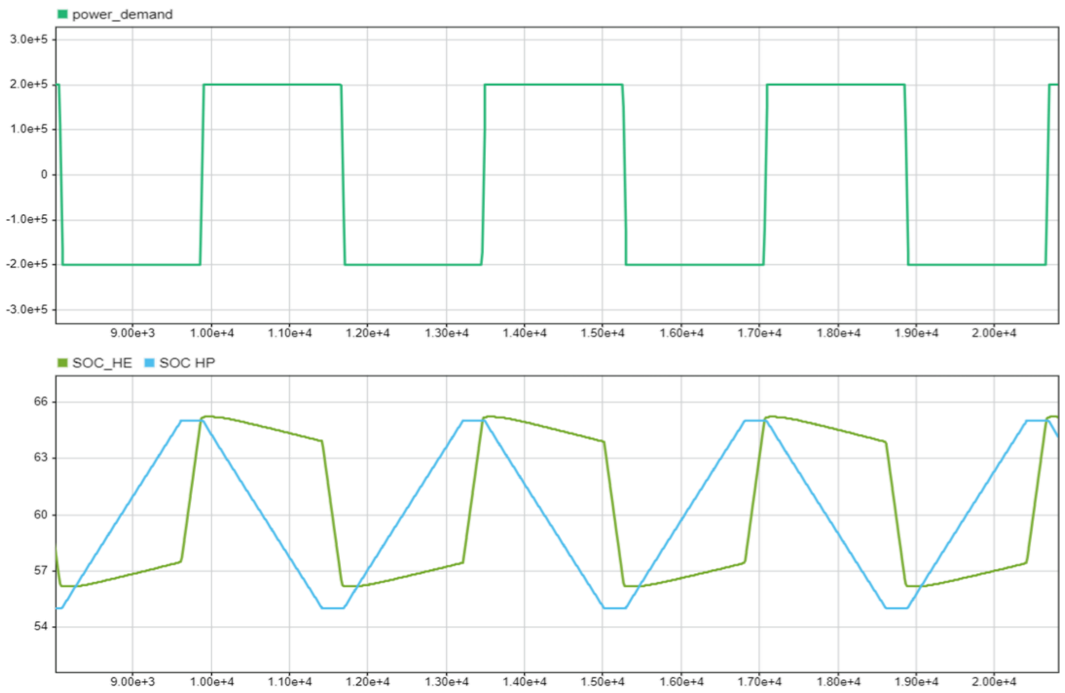
SOC limitation functions have been implemented on both HE and HP batteries. By restricting the SOC variation range, substantial gains in battery lifetime can be achieved. However, this limitation reduces battery availability, and a compromise must be found to best meet these criteria.



State-of-charge (SOC) limitation on the HE battery



SOC limitation on the HP battery, there is a transfer of charge to the HE battery

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NEMOSHIP

IMPACT OF BPMS VERSIONS ON BESS LIFETIME

Saeed Kazemian, VUB

OPTIMIZING MARITIME BATTERY LIFETIME

BPMS

The NEMOSHIP tool evaluates two energy management strategies: V1 and V2, with various parameter sets

High Power (HP) Batteries

Designed for rapid discharge and charge cycles, ideal for dynamic maritime applications

High Energy (HE) Batteries

Optimized for sustained energy delivery, suitable for longer voyages and continuous operations

EOL

The end-of-life (EoL) is defined as 80% usable capacity, based on a weekly repeated 2-day power profile.

What impacts lifetime?

- Higher DoD per cycle accelerates degradation.
- Fast charging and high power demand increase internal stress.
- Frequent full cycles shorten lifespan.
- Smart power allocation and peak-shaving reduce stress on cells.

VUB EPOWERS EFFICIENT POWER ELECTRONICS, POWERTRAIN & ENERGY SOLUTIONS RESEARCH GROUP

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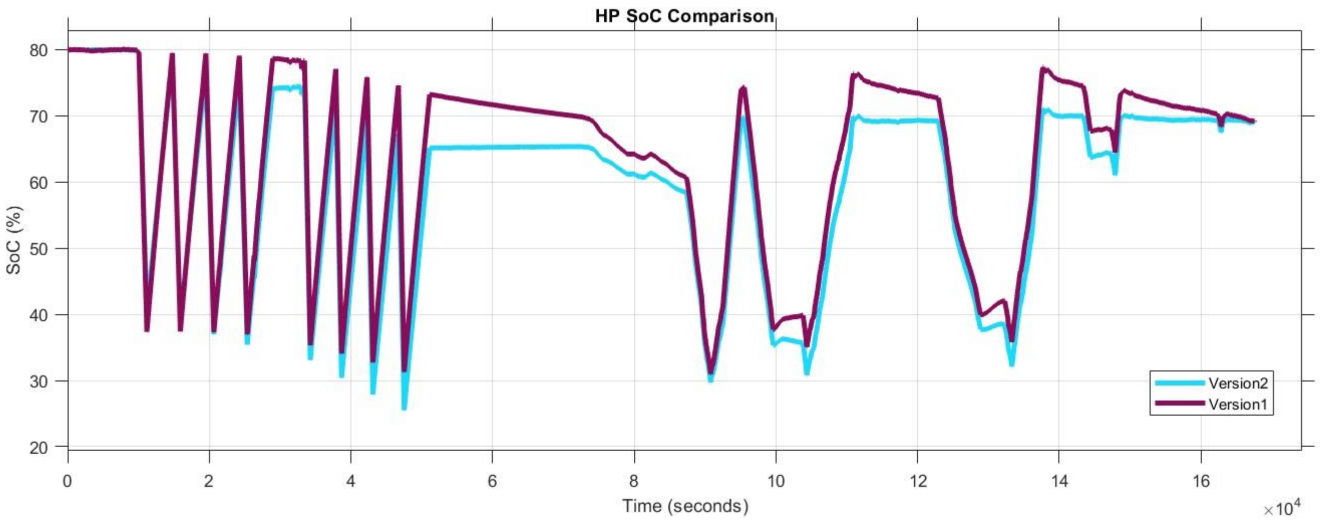
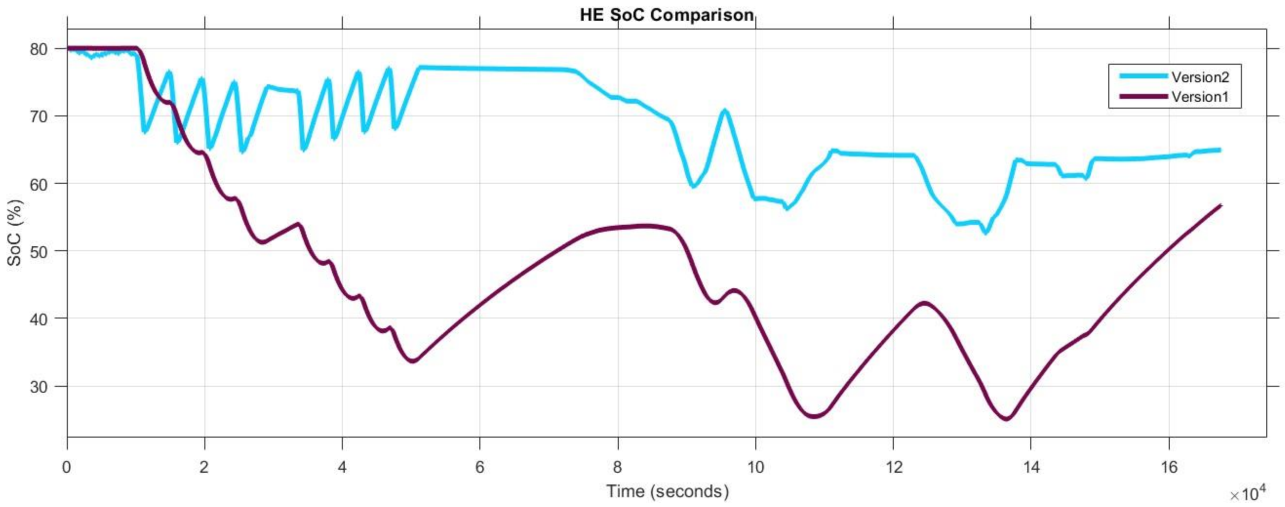
SOC ANALYSIS THROUGH BPMS VERSIONS

NEMOSHIP

- V2 keeps HP battery in a slightly narrower and more stable SoC range.
- V2 HE battery shows more frequent but shallower cycles, avoiding the deep SoC swings.
- This overall reduction in SoC stress and avoidance of deep cycling leads to the lower degradation rate observed for V2.





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BATTERY LIFETIME ANALYSIS THROUGH BPMS VERSIONS

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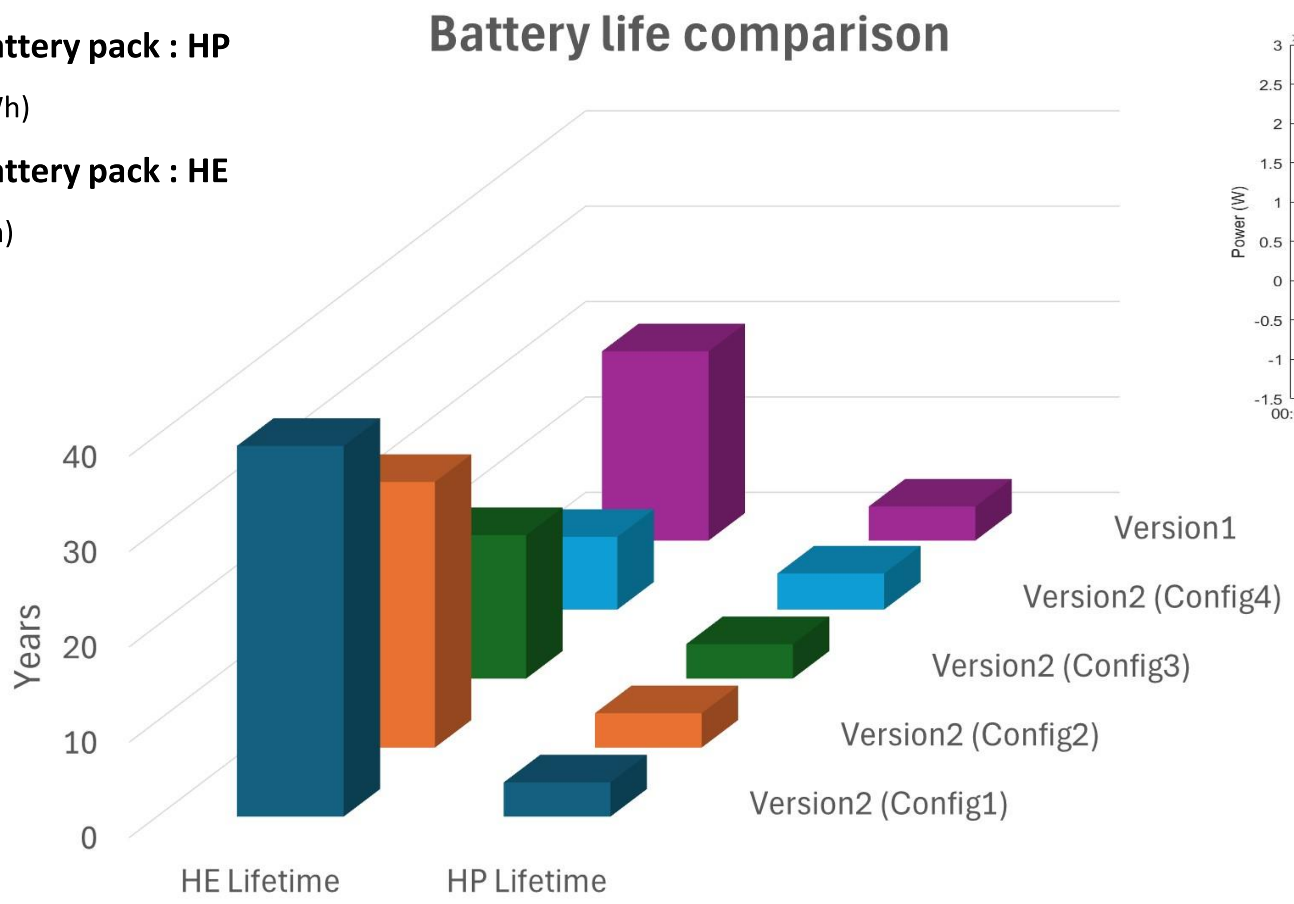
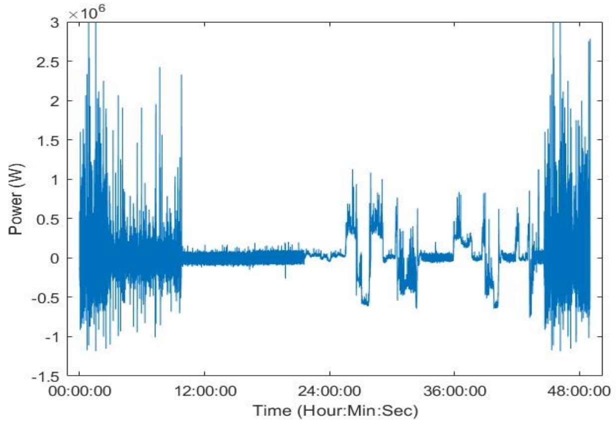
- **80% of total battery pack : HP**

(147 modules, 823 kWh)

- **20% of total battery pack : HE**

(22 modules, 180 kWh)

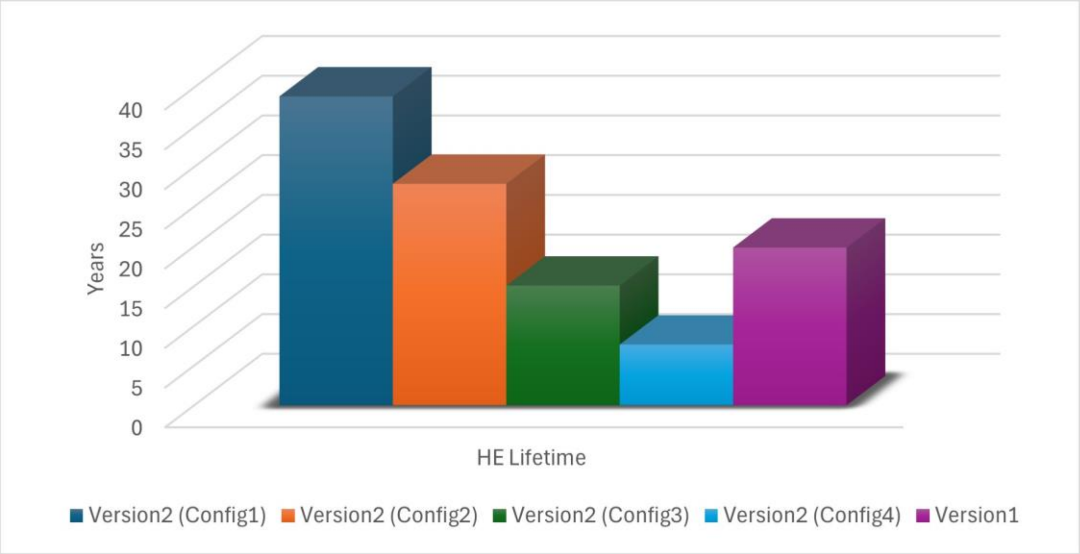




- **Power profile** that the analyses are based on

BATTERY LIFETIME ANALYSIS THROUGH BPMS VERSIONS

NEMOSHIP

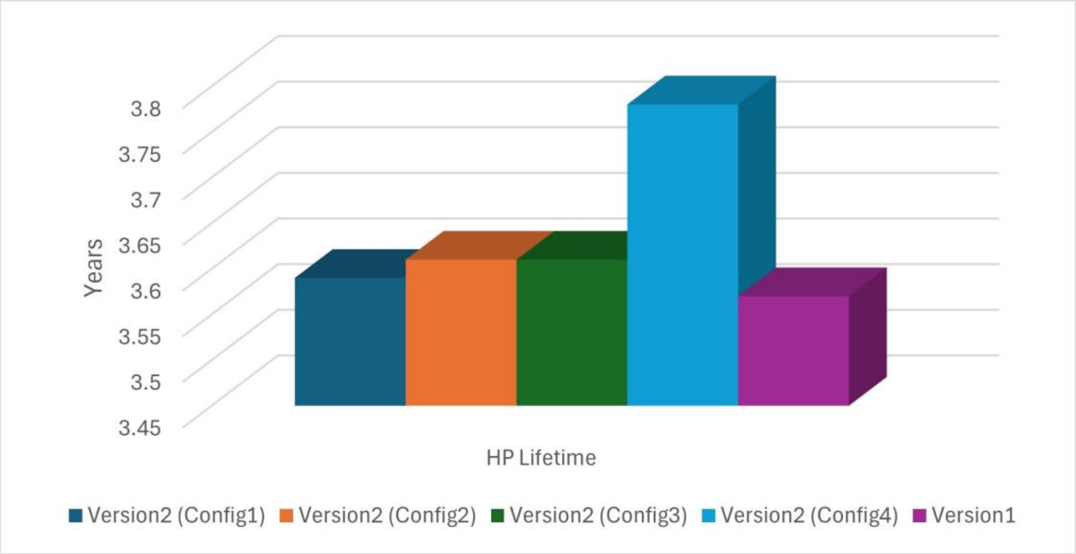


High Energy Battery estimated lifetime

- Around 50% improvement (best case in V2 compared to V1)

- Around 7% improvement (best case in V2 compared to V1)

High Power Battery estimated lifetime



- Parameters in BPMS-V2-Config4 offer best trade-off between durability and performance.
- Both battery types benefit from context-specific parameter tuning.

OPTIMIZING MARINE BATTERY LIFE / CONCLUSION OF THE BPMS STUDY

NEMOSHIP

- The lifetime assessment is primarily designed to offer a consistent and robust basis for **comparing different BPMS versions**, parameter selections, and energy-sharing strategies, rather than focusing on absolute lifetime predictions.
- Results highlight how **SoC management, cycle depth, and power allocation** strongly influence battery wear in marine profiles.
- V2 also enables synchronized HP/HE replacement cycles (e.g., 2× HP per 1× HE), simplifying maintenance planning.
- Insights support **design choices**, **parameter tuning**, and **future EMS development** toward durability-focused strategies.

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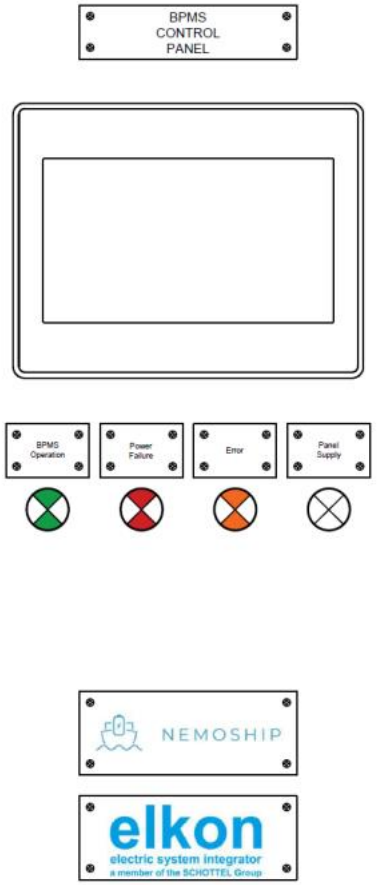
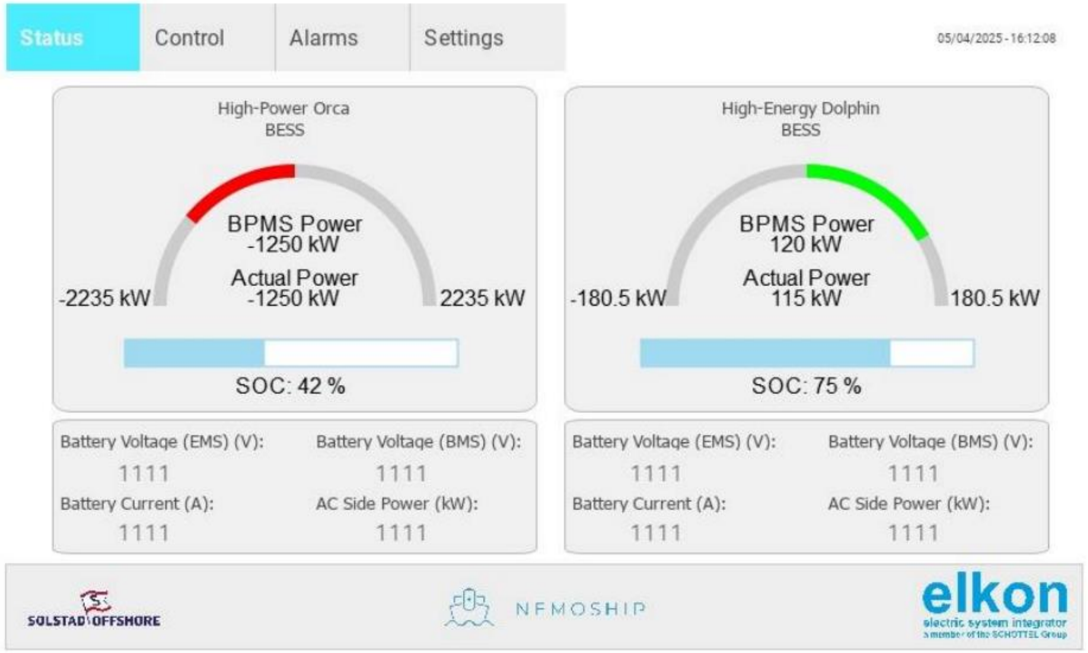
BPMS INTEGRATION AND DEPLOYMENT

Mert Can Celik, Elkon

BPMS PANEL & INTERFACE





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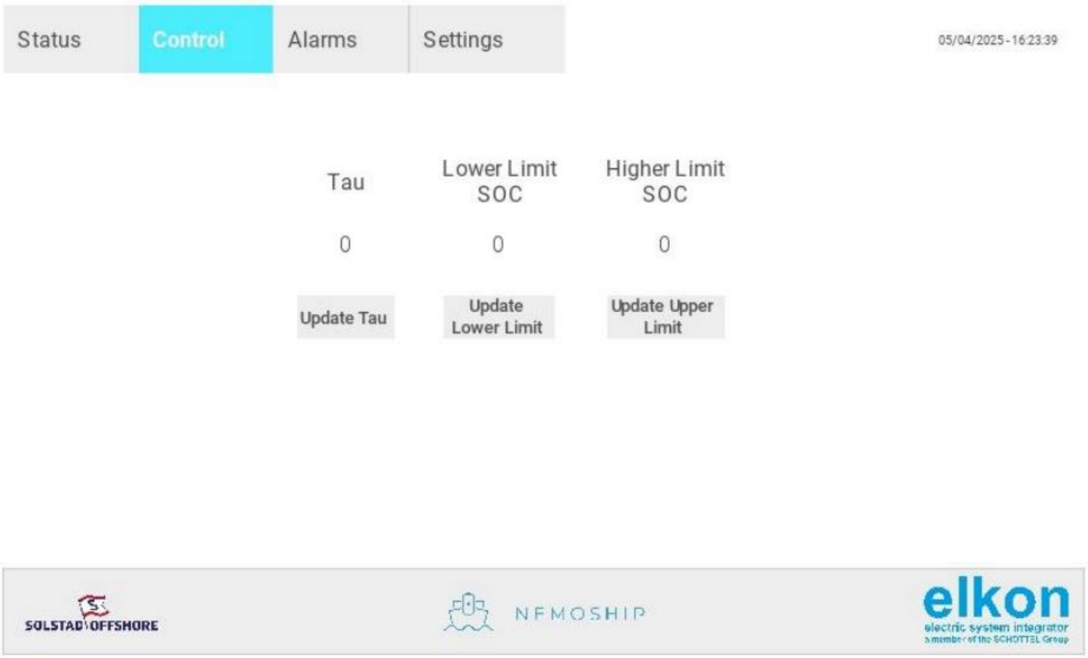
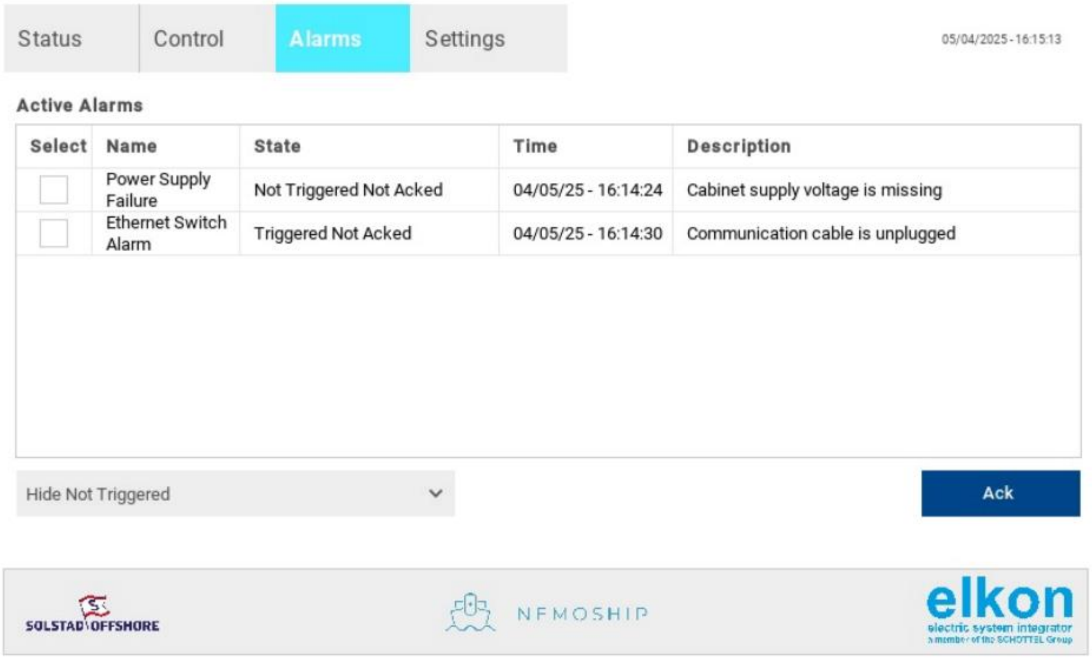
BPMS PANEL & INTERFACE





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COMMUNICATION SYSTEM

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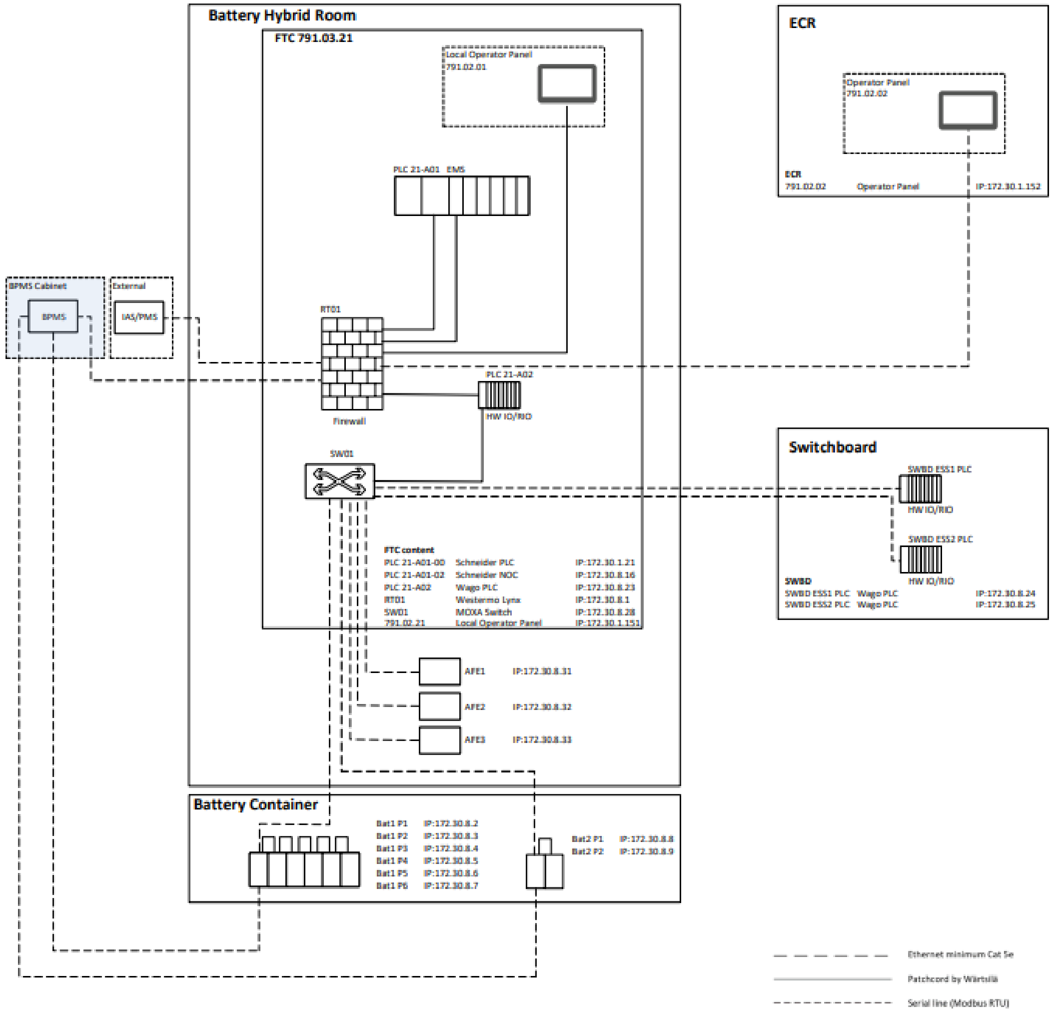

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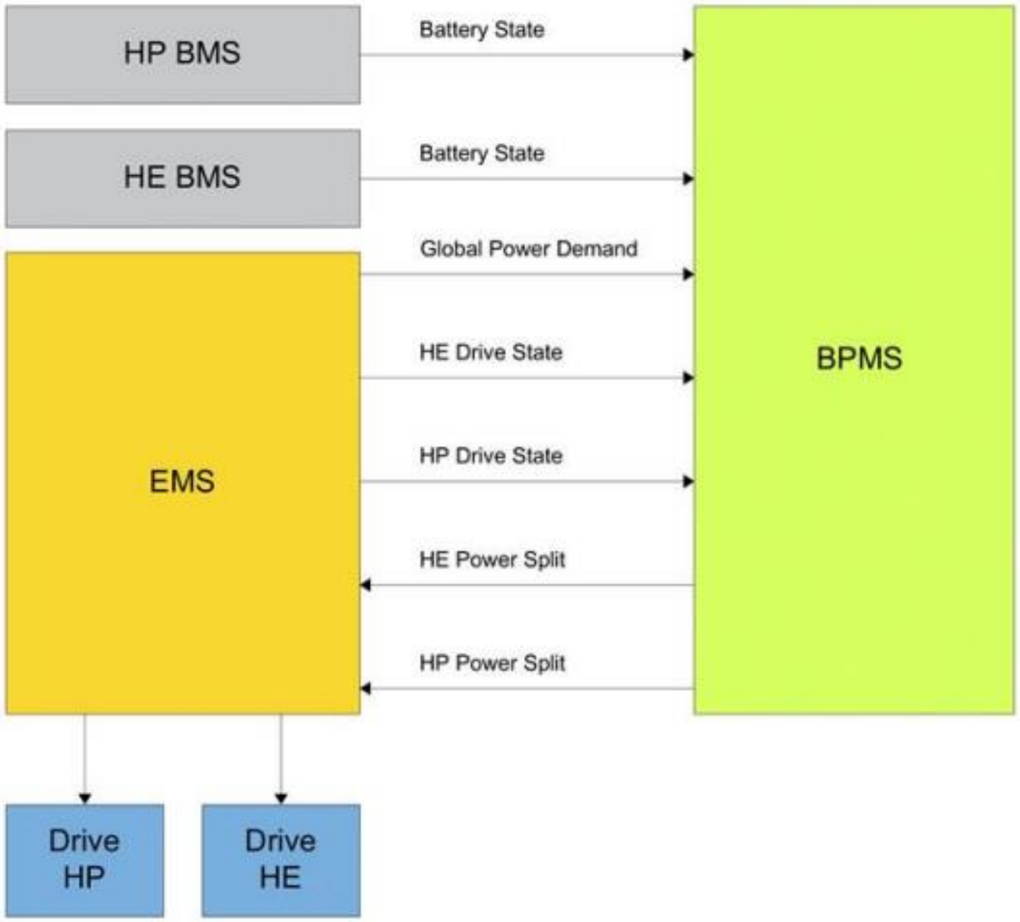
DATA DEFINITION



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MODBUS COMMUNICATION TABLE

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Variable name	Access	Type	Address (could be change)	Register length	Unit	description
BPMS_HB	RW - Holding register	Uint 16	40001	1		BPMS heartbeat signal to check communication status
HE_drive_Psplit	RW - Holding register	Int16	40002	1	kW/10	HE drive power split
HP_drive_Psplit	RW - Holding register	Int16	40003	1	kW/10	HP drive power split
EMS_HB	R - input register	Uint16	30001	1		EMS heartbeat signal to check communication status
P_BESS_Demand	R – input register	Int16	30002	1	kW/10	Global power demand = total BESS power (HE and HP) - how much the batteries should deliver
VDC_HE_drive	R - input register	Int16	30003	1	V/10	DC voltage of the HE drive
IDC_HE_drive	R - input register	Int16	30004	1	A/10	DC Current of the HE drive
PDC_HE_drive	R - input register	Int16	30005	1	kW/10	DC side Power of the HE drive
PAC_HE_drive	R - input register	Int16	30006	1	kW/10	AC side Power of the HE drive
Status_HE_drive	R - input register	Uint 16	30007	1		Status (available, fault, running…) -TBD
VDC_HP_drive	R - input register	Float	30008	1	V/10	DC voltage of the HE drive
IDC_HP_drive	R - input register	Float	30009	1	A/10	DC Current of the HE drive
PDC_HP_drive	R - input register	Float	30010	1	kW/10	DC side Power of the HE drive
PAC_HP_drive	R - input register	Float	30011	1	kW/10	AC side Power of the HE drive
Status_HP_drive	R - input register	Uint 16	30012	1		Status (available, fault, running…) -TBD

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ACTIVITIES RELATED TO BPMS

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Results achieved so far:

- BPMS panel production completed
- BPMS FAT completed
- BPMS successfully shipped to Solstad

Next steps:

- BPMS panel mechanical and electrical installation on Solstad vessel
- BPMS panel HAT/SAT & commissioning

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Q&A

CLOSING

CLOSING

NEMOSHIP

Thanks for your participation !

To keep in touch with us:

- Email: contact@nemoship.eu
- Linkedin: NEMOSHIP
- Website: https://nemoship.eu/

Save the date:

Next NEMOSHIP event will be held on **Thursday January 29th morning** – In person in Grenoble France and remotely via Livestorm.

Registration link will soon be available on our Linkedin and website !

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GA No. 101096324

Thank you for your attention

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