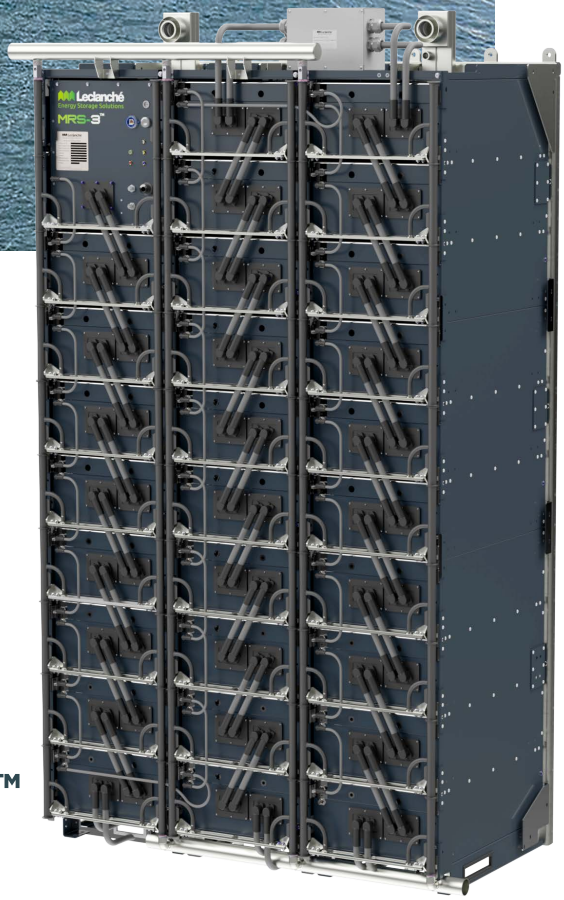
Leclanché
Energy Storage Solutions

E-MARINE SOLUTIONS

Navius MRS-3

Marine Battery System



High performance, European-made lithium-ion battery system for marine applications.

MRS-3™

e-MOBILITY

Class Leading Safety

Exceeds class requirements for fire safety

Exceptional Cycle Life

7,000 cycles at 80 % DoD*

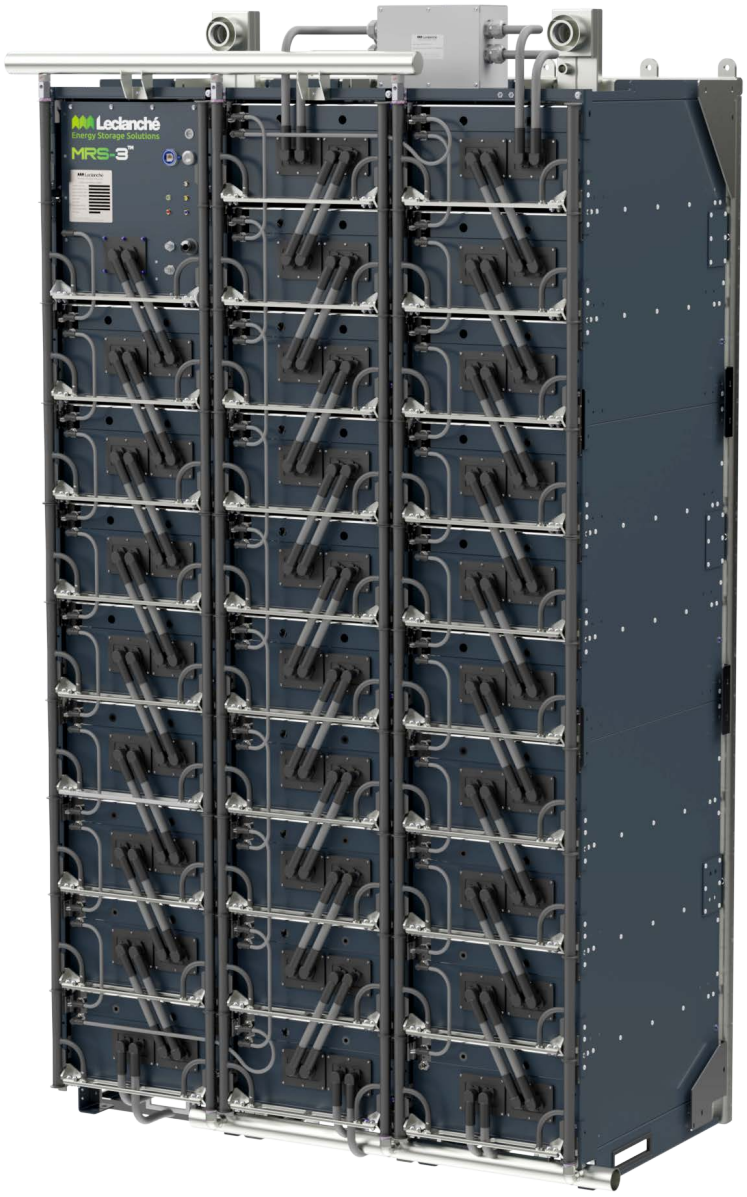
European Made

Cells and system made in Europe

Greenest Cell

35 % lower carbon footprint

*With 65 Ah G/NMC cell.



The **Overview**

The Navius MRS-3, from Leclanché, is a new generation of marine battery system specifically designed for the supply of on-board energy storage in marine applications.

It comprises the latest generation Leclanché M3 Energy battery modules fitted with our proprietary high energy lithium-ion cells, a Functionally Safe Battery Management system and is assembled into a scalable and modular rack system. This new design enables the Navius MRS-3 to be configured to fit efficiently into the available space on nearly any vessel.

It is an evolution of the successful and well proven Leclanché MRS-2 system which is powering vessels around the world, with over 80 MWh already installed.

The Navius MRS-3 battery system utilises liquid-cooling for more efficient thermal management, a longer system lifetime and high performance in a compact footprint.

At the heart of the new Navius MRS-3 battery system are unique Leclanché high cycle-life lithium-ion cells which are designed and developed by our world class electrochemistry experts and produced at our automated facility in Germany.

Features and Specifications

- Battery string voltage up to 1200 VDC
- Up to 4.6C peak discharge current (720 A continuous) per string
- Up to 2.8C peak charge current (480 A continuous) per string
- Integrated Leclanché Functionally Safe BMS battery management system
- High energy Leclanché 65Ah G/NMC or 72Ah G/NMCA cells
- Scalable string configuration for multi-MWh system sizes
- Optional multi-string controller (MSC) to support parallel battery strings
- Liquid-cooled for optimum system temperature control, cell cycle life & energy density
- Thermal propagation protection using an integrated active safety system
- European manufactured cells, modules and racks for enhanced supply chain reliability, reduced environmental footprint and best in class quality.

Operation Modes

Spinning Reserve

Switching off redundant generators allows the MRS to handle the emergency power load. It also enhances operational safety by preventing power outages.

Enhanced Dynamic Performance

The MRS smoothens the sudden changes in load demand on the generators.

Peak Shaving

Removing load peaks helps generators to operate at a steady and optimal power level.

Strategic Loading

Allows switching, as appropriate, from diesel to electrical power for propulsion, manoeuvring, cargo handling, hotel load provision at port, etc.

Zero Emission Operation

The Leclanché MRS powers fully-electric vessels with no emissions, no fuel consumption and quiet operation.

Photo: Cadeler A/S F-class, jack-up vessel

Cells

Leclanché holds over 160 patents in lithium-ion cell development and manufacture. At the core of the MRS-3 are G/NMC or G/NMCA cells with an unmatched combination of energy density and cycle life. Our focus on high cycle life improves overall environmental footprint while providing significant cost of ownership benefits. The cells are manufactured by Leclanché at our advanced production facility in Germany.

Modules

The Leclanché M3 Energy modules have 13 % more energy than those fitted to our previous generation, MRS-2, battery system. Each cell in the module is temperature monitored. The modules are assembled on a new state-of-the-art automated assembly line in Switzerland.

Battery Management System (BMS)

The Navius MRS-3 is equipped with a state-of-the-art Functionally Safe BMS that offers the ultimate in safety and reliability. Both the BMS master and module slave units are designed in line with Functional Safety standards.

A secure, remote battery-data monitoring system is available, which enables continuous monitoring of the battery condition through a user-friendly, cloud based, IoT platform.

Certification

The Navius MRS-3 has received Type Approvals from DNV, BV and LR, confirming compliance with the most stringent rules, regulations and safety standards in the industry. Additional class approvals are in progress.

Warranty and Service

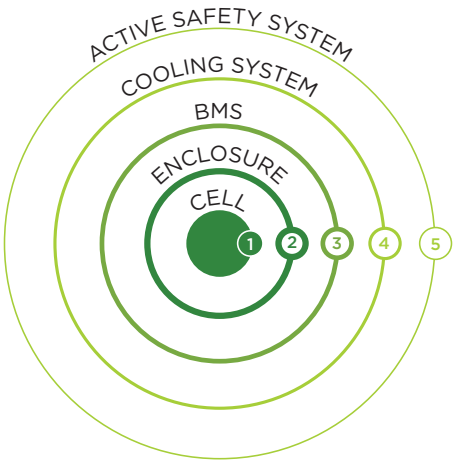
A comprehensive service offering is available to support our customers over the battery system's life. This includes reactive, preventive and predictive services as well as the option of spare parts packages.

Navius MRS-3 battery systems are provided with a 2-year warranty period. Performance warranty periods of up to 10 years are available, subject to the inclusion of a Leclanché support and maintenance contract.

Photo: courtesy of Guillaume Plisson

Safety

The safety of marine battery systems is of paramount importance. At Leclanché, safety is engineered into our solutions at all levels from individual cells to the complete battery system.



1 Cells

Laminated ceramic separators provide protection against internal short circuits and the reduced electrolyte design minimises the potential volume of flammable materials.

2 Modules and Enclosure

The module is fitted with a functionally safe slave unit which measures cell voltages, cell temperatures and runs diagnostics such as open wire detection and self-checks. The IP-rated module enclosure provides protection against mechanical and electrical incidents. Water and contaminants are kept out while in the event of a thermal runaway; noxious gases or flames are kept in and routed out via a sealed exhaust system.

3 Battery Management System (BMS) & Control Unit

A Functionally Safe BMS comprising of master and slave units integrated inside every module ensures the highest levels of safety. Cell surface temperature detection on each cell enables superior reactiveness. Reliable operation is guaranteed in hostile EMC environments. A high voltage breakdown solution provides additional safety.

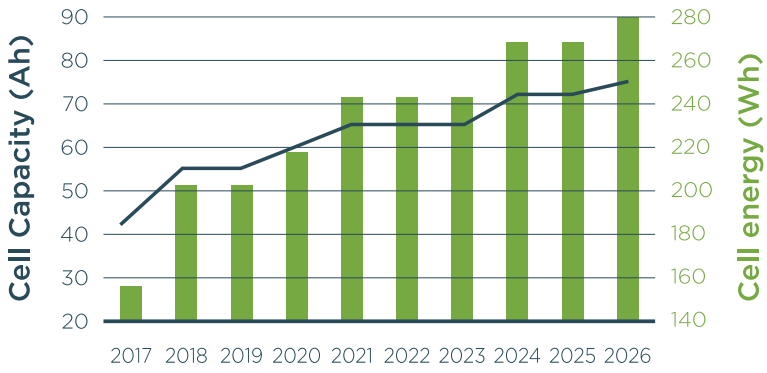
4 Liquid Cooling

The modules are liquid-cooled with dedicated cooling plates. All cooling plate and pipe connections are external to the module enclosure, preventing the risk of leaks within the module that could compromise isolation integrity.

5 Battery Active Safety System

Each module enclosure contains an automated system that prevents thermal propagation.

CELL CAPACITY ROADMAP



Technology

At Leclanché, we pride ourselves on being in control of the entire marine battery system development process, from cell design and manufacturing to complete solutions which incorporate our own dedicated battery management systems.

Our experienced electrochemistry team strives to continually develop cutting-edge, high-performance G/NMC, G/NMCA and high power LTO lithium-ion cells, which deliver class-leading cycle life.

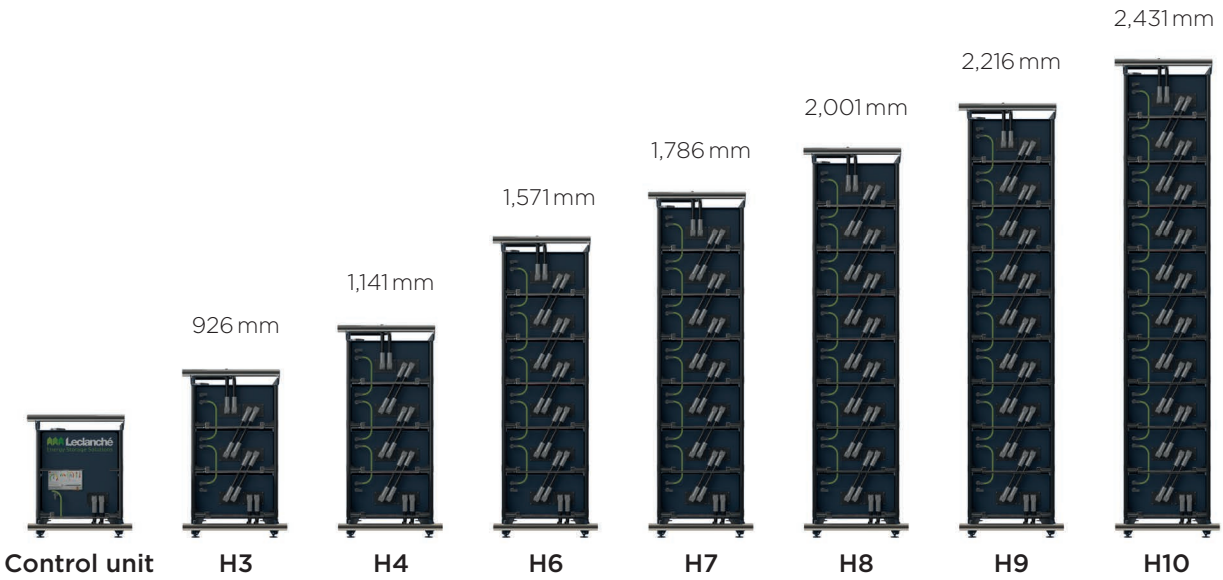
Our product roadmap delivers relentless cell performance improvements to provide the best cost of ownership options for our customers.

System Configurations

The Navius MRS-3 battery racks are available in 7 different heights, ranging from 926 mm to 2,431 mm (including the exhaust duct), which enables them to fit perfectly into nearly all battery room sizes, whatever the vessel type.

The lowest “H3” variant contains up to 3 modules and the tallest “H10” variant up to 10 modules.

A number of racks are combined into a string – each containing a dedicated Battery Management System. Strings are then combined in parallel to create a complete system providing the required energy of the vessel application. Strings with differing heights can be combined into a system if required.



System Specifications

Rack Heights	H3: 926 mm, H4: 1,141 mm, H6: 1,571 mm, H7: 1,786 mm, H8: 2,001 mm, H9: 2,216 mm, H10: 2,431 mm
Rack Width & Depth	W 435 mm, D 710 mm

	MRS-3 / 65	MRS-3 / 72
Cell Type	G/NMC, 65 Ah	G/NMCA, 72 Ah
Single Module Energy / Nominal Voltage	8.7 kWh/33.5 V to 67.1 V	9.6 kWh/33.5 V to 67.1 V
Single String Max. Voltage	1200 V	1200 V
Max. Gravimetric Density – String[1]	99 Wh/kg	110 Wh/kg
Max. Volumetric Density – String[1]	108 Wh/litre	120 Wh/litre
Max. Energy Density footprint – String	263 kWh/m²	291 kWh/m²
Typical system usage :	Power applications	Energy applications
Clearances required per string :	Above: 100mm, Front: 750mm, Each side: 70mm	

[1] Excluding Battery Active Safety System skid, where fitted

Performance Specifications

	MRS-3 / 65	MRS-3 / 72
C-Rate – Peak, 20s (Discharge / Charge)	4.6 C[1] / 2.8 C	TBC
C-Rate – Continuous (Discharge / Charge)	2.7 C / 1.8 C	2.4 C / 1.5 C
Cycle Life (80% DoD, 1C/1C, no pause)	7,000 cycles	6,000 cycles

Example System 1

	MRS-3 / 65	MRS-3 / 72
System Configuration	4 strings[2] each comprising of 3 x H10 racks with 1 x Control Unit[3]	
Energy	975 kWh	1,080 kWh
Voltage (Min / Nom / Max)	756 / 937 / 1096 V	756 / 920 / 1058 V
Dimensions & Weight (Depth x Width x Height / Mass)	710 X 5,220 x 2,431 mm / 9,840 kg	
Energy Density	99 Wh/kg/108 Wh/litre	110 Wh/kg/120 Wh/litre

Example System 2

	MRS-3 / 65	MRS-3 / 72
Rack Types	4 strings[2] each comprising of 3 x H7 racks with 1 x Control Unit[3]	
Energy	662 kWh	733 kWh
Voltage	513 / 636 / 744 V	513 / 624 / 718 V
Dimensions & Weight (Depth x Width x Height / Mass)	710 X 25,220 x 1,786 mm / 6,895 kg	
Energy Density	96 Wh/kg/100 Wh/litre	106 Wh/kg/111 Wh/litre

Safety Specifications

Thermal Runaway Anti-Propagation	Battery Active Safety System
Disconnect Circuit	String level with HV breakdown
Short Circuit Protection	Fuses at battery string level.
Emergency Stop Circuit	In line with class requirements
Ground Fault Detection	Integrated in each battery string
Disconnect Switchgear Rating	400 A / 800 A (continuous)

General Specifications

Communication Protocol	CAN or Modbus
Class Compliance	DNV[4], BV[4], LR[4], RINA, ABS
Ingress Protection	IP44
Cooling	Liquid-Cooled

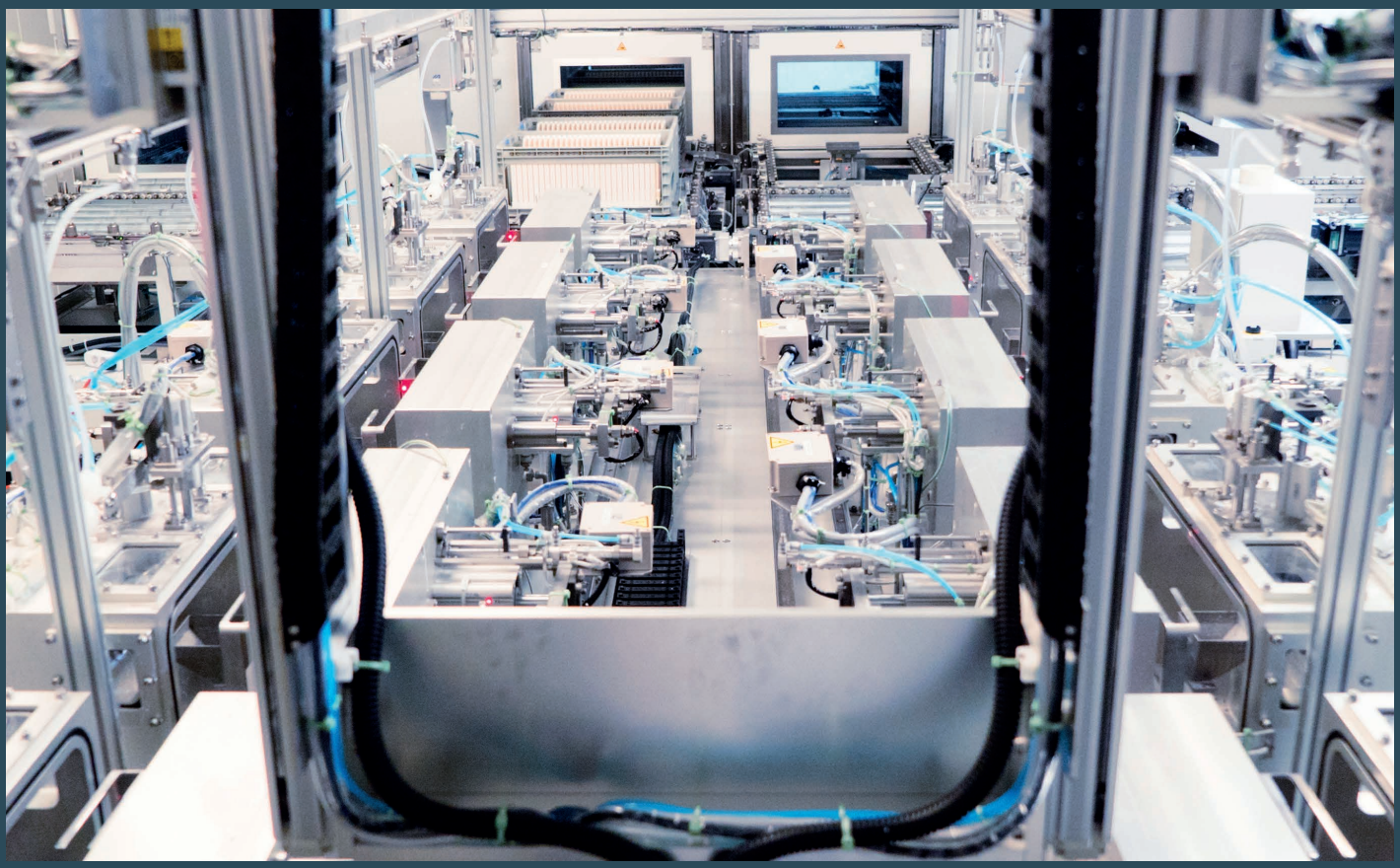
[1] Assuming 18s2p M3 modules.
[2] A string comprises of a number of sets of battery racks. Strings are combined in parallel to create the complete battery system.
[3] When a Control Unit (consisting of BMS and Switching) is fitted to a rack, it takes the space of 2 modules.
[4] Type Approved for MRS-3 / 65.

Leclanché Manufacturing Sites

An environmentally conscious manufacturing company:

- Cell manufacturing facility fully powered by renewable energy
- Conventional cell manufacturing involves the use of harmful solvents. Leclanché manufactures all cell electrodes using patented water-based binder technology
- Automated cell production at our state-of-the-art facility in Germany

Production and engineering facilities fully accredited by the leading international quality standards organizations including ISO 9001, 14001 and 45001



Leclanché Cell Production Line

Leclanché E-Mobility SA
(Headquarters)

Avenue des Découvertes 14 C
1400 Yverdon-les-Bains
Switzerland

Leclanché GmbH

Industriestrasse 1
77731 Willstätt
Germany

Leclanché
North America, Inc.

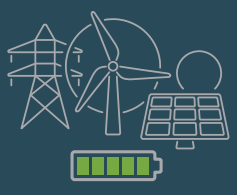
2685 Enterprise Dr
Anderson, IN 46013
USA

Leclanché
Norway

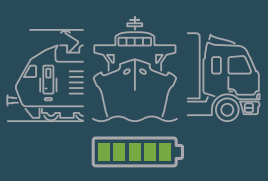
Karenslyst alle 53
0279 Oslo
Norway

www.leclanche.com
info@leclanche.com

WE ARE ENABLING THE ENERGY TRANSITION



STATIONARY SOLUTIONS



e-MOBILITY

SPECIALTY BATTERY SYSTEMS

MRS EN-EUR B20255_1