



# Green Battery



# Electric Energy Storage

## Features

The Mega-Guard Electric Energy Storage (EES) is an advanced system for electric energy storage for marine environment. Sailing and silent running on stored electric energy becomes a reality with Mega-Guard EES.

The Mega-Guard EES consists of the following main components:

- ▶ GreenBattery
- ▶ GreenBattery BMS
- ▶ Battery Rack

Energy storage systems in between 40kWh and 12MWh can be built with Mega-Guard EES.

Two versions are available:

GreenBattery-Energy	optimized for low volume and weight
GreenBattery-Power	optimized for fast charging and discharging

## GreenBattery

GreenBattery makes use of the extremely safe LiFePO<sub>4</sub> (or LFP) chemistry. Safety can be compared with traditional lead acid batteries and are much safer than Li-ion NMC technology which is used by other marine battery manufacturers. In addition, life time and temperature range of LiFePO<sub>4</sub> are much better when compared with Li-ion NMC batteries. GreenBattery has relatively low weight and small volume per stored kWh. In fact, GreenBattery is one of the lightest batteries available for marine energy storage and occupying minimum floor space.

Each GreenBattery has a capacity of 10kWh and a nominal DC bus voltage of 96VDC. GreenBattery can be cooled either by liquid or by forced air (GreenBattery-Energy only). GreenBattery is totally enclosed and includes a built-in slave battery monitoring system which communicates with the GreenBattery BMS. GreenBattery fulfils the latest class requirements and includes a pressure based safety release which should be vented to the outside environment. Up to 10 GreenBatteries can be wired in a string and the GreenBattery BMS monitors and controls the string. Up to 120 strings can be wired in parallel.



Specification	GreenBattery-Energy	GreenBattery-Power
Stored energy	10kWh	8,6kWh
Recommended SOC window	10% - 90%	10% - 90%
Maximum SOC window	5% - 95%	5% - 95%
Usable energy at recomm. SOC	8kW	6,8kW
Technology	LFP / LiFePO <sub>4</sub>	LFP / LiFePO <sub>4</sub>
Nominal voltage	96VDC	96VDC
BMS with cell balancing	✓	✓
Electric connections	+ and - with HVIL BMS in / out	+ and - with HVIL BMS in / out
Max charge rate	1C (=105A) @22°C	3C (=270A) @22°C
Max discharge rate	1C (=105A) @22°C	3C (=270A) @22°C
Max discharge rate 5 minutes	2C @ 10~35°C	
Cycle life @22 °C	Cycle Times 0,5C (CHA/DCH)	Cycle Times 1C (CHA/DCH)
80% capacity retention		
Depth of discharge 90%	2000	5000
Depth of discharge 80%	5000	6200
Depth of discharge 50%	20000	24000
Depth of discharge 20%	75000	80000
Depth of discharge 10%	120000	130000
Depth of discharge 5%	150000	180000
Ambient temp. charging	0 ~ 45°C	0 ~ 45°C
Ambient temp. discharging	-20 ~ 45°C	-20 ~ 45°C
Storage temperature 1 year	0 ~ 35°C	0 ~ 35°C
Heat generation	< 0.22kW	< 0.45kW
Cooling by liquid	Water/glycol mixture Liquid flow: 2l/min (5°C rise @1C) Inlet temp: 15 ~35°	Water/glycol mixture Liquid flow: 4l/min (5°C rise @3C) Inlet temp: 15 ~35°
Cooling by air	Forced air with fans	x
Exhaust	✓	✓
Dimensions with forced air cooling	453x140x685mm	x
Dimensions with liquid cooling	453x160x685mm	453x160x685mm
Weight with forced air cooling	79kg	x
Weight with liquid cooling	85kg	85kg
Protection	IP66	IP66
Housing material	Anodised Aluminum	Anodised Aluminum
Thermal runaway propagation	Test 1 passed	Test 1 passed
According class	LRS, DNV-GL, ABS, CCS	LRS, DNV-GL, ABS, CCS



## GreenBattery BMS

The GreenBattery BMS monitors and controls a string of GreenBatteries. All external connections (DC bus, Ethernet, cooling and venting) of a string are made on the GreenBattery BMS. A 5,7" touchscreen Operator Panel with built-in controller is mounted in the front of GreenBattery BMS. The state of charge (SOC), voltages and temperatures of a string can be read on the touchscreen Operator Panel. The controller takes care of cell balancing, cooling control and safety functions. In addition, the controller is equipped with quad Ethernet ports for communication to external Mega-Guard High Power Inverters for battery charging and to a Mega-Guard Energy Management System. The GreenBattery BMS contains as well a DC bus contactor with pre-charge.

A temperature controller is built inside GreenBattery BMS for external valve (liquid cooled) or for external fan (air cooled) control. A liquid cooled EES does not heat up the battery room. An air cooled EES should be equipped with additional air conditioning capacity to take away the heat of each GreenBattery-Energy (0,22kW). The recommended ambient temperature of battery room and liquid cooling fluid (in case of liquid cooling) is 22°C in order to reach highest life cycle of the ESS.

## Battery Rack

GreenBatteries and the GreenBattery BMS are placed in a specific designed Battery Rack. The Battery Rack contains cooling channels (air or liquid) and makes it possible to exchange a GreenBattery by sliding out and in. Battery Racks are supplied in two different mechanical lay-outs: a vertical one for space saving and a horizontal one which is applied when not enough room height is available.

Battery Racks need to be installed in a battery room in accordance with class regulations.

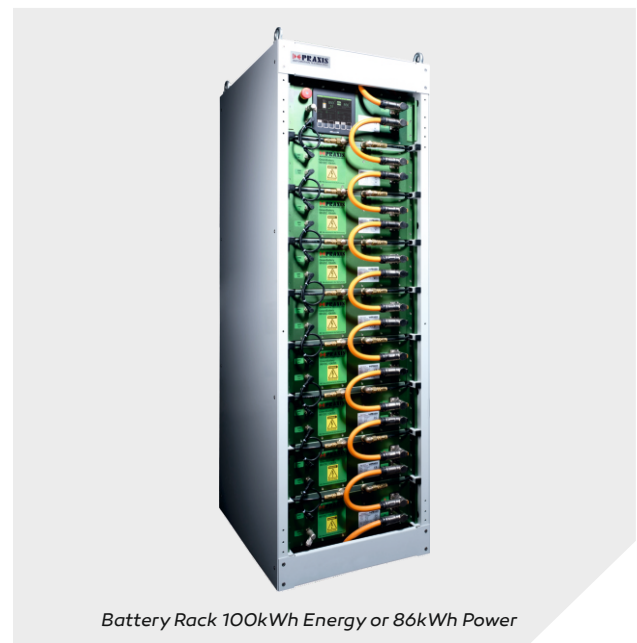
The following Battery Racks are available:



*GreenBattery liquid cooled*



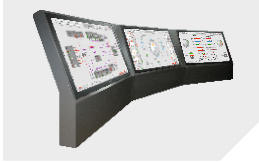
*GreenBattery BMS operator panel*



*Battery Rack 100kWh Energy or 86kWh Power*

GreenBattery Energy capacity	GreenBattery Power capacity	Rack size vertical W x H x D	Rack size horizontal W x H x D	Air cooled Weight	Liquid cooled Weight	Number of GreenBattery	Nominal DC bus voltage
40kWh	34,4kWh	520x1020x760mm	n/a	430kg	454kg	4	384VDC
60kWh	51,6kWh	520x1350x760mm	1035x860x760	615kg	651kg	6	576VDC
80kWh	68,8kWh	520x1670x760mm	1035x1020x760	800kg	848kg	8	768VDC
100kWh	86kWh	520x1995x760mm	1035x1350x760	985kg	1045kg	10	960VDC

Vessel  
Management System



Power  
Management System



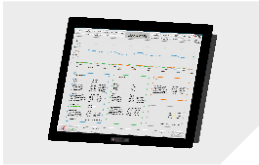
Fire  
Alarm System



CCTV  
Video Distribution



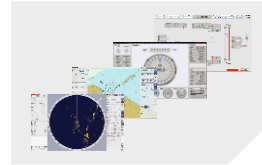
Ship  
Performance Monitor



Fleet  
Management System



Integrated  
Navigation System



Heading  
Control System



Propulsion  
Control System



Dynamic  
Positioning System



BNWAS  
Watch Alarm System



Navigation  
Light Control



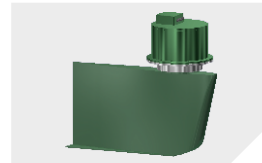
Wiper  
Control System



Energy  
Management System



Electric Fin  
Stabilizer



Electric  
Steerable POD



GreenInverter



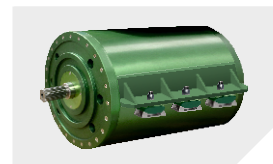
GreenGenerator



GreenBattery



GreenMotor



*Ship automation,  
navigation and  
electric propulsion*