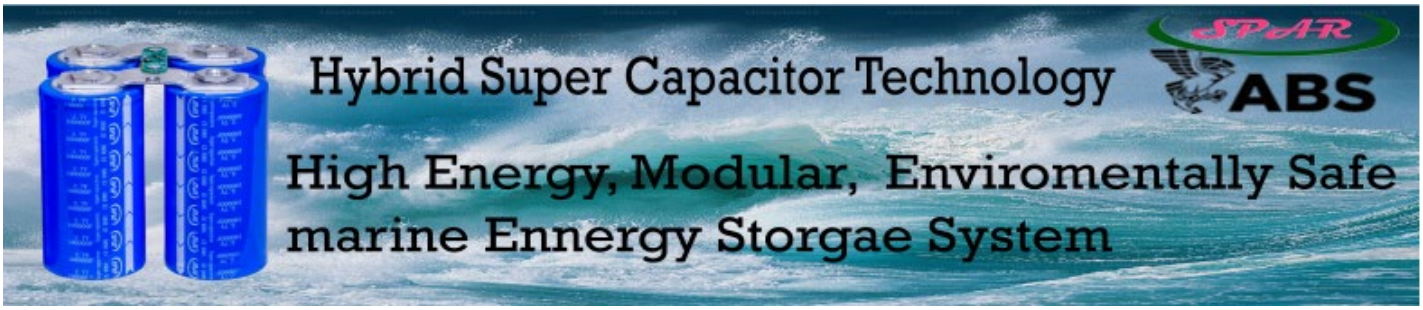
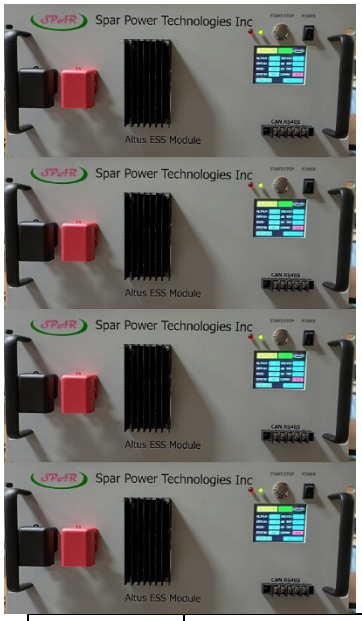


Hybrid super-capacitor technology Marine Energy Storage System Altus®-500



Altus®-500 Energy Storage System utilises state the art super-capacitor technology to provides 250,000 life cycles that will last though out the life of the product.

Spar power is pleased to offer safe and environmentally friendly hybrid super-capacitor-based energy storage system (SCESS). This system benefits from super-capacitor's inheritance property of storing energy like a battery, additionally it offers environmentally friendly features which batteries do not offer; hence it is very useful to replace batteries in the energy storage systems (BESS). Being a capacitor, it is charged much faster than the battery and survives through 250,000 operations without compromising efficiency and capacity over its entire life. The following table shows the comparative benefits of Super capacitor-based energy storage system (SCESS) and battery-based energy storage system (BESS).

Item	Feature	Super Capacitor Technology	Batteries (NiCad/Lithium Ion/Acid)
1	Life	Up to 20+ Years (250,000 cycles)	3 to 8 years (500 to 5,000 cycles)
2	Efficiency	99% (Efficiency remains same over lifetime)	70% to 95% (Efficiency degrades over life time)
3	Useable capacity	100% Capacity Remains over lifetime	50% to 80% capacity degrades over life time
4	Charging rate	Up-to 6C Very fast	Normally 0 .1C to 1 C
5	Temperature range	-40 to 65 deg. C	-10 to 30 deg. C
6	Thermal runaway	No Risk	Medium to high
7	Storage Limitation	No maintenance	Periodic charging is Required
8	Short Circuit Protection	Intrinsically safe	Information not available
9	Disposal costs	Reasonable	Significant
10	Environmental impact of disposal	None	Significant
11	Routine	None	Significant

	maintenance		

Applications:

The Altus-500 ESS is modular ad can be configured in any configuration for DC bus voltage and Energy storage capacity. System is suitable for both hybrid electric all electric vessels include:

- Ferries
- High-speed Fast Ferries
- Crew transfer vessels
- Harbour Tugs
- Offshore vessels
- Offshore Wind Construction and Support Vessels

Features:

- Suitable for rapid charging and discharging at 6C
- Low weight
- Modular Installation
- Hot swipe able modules
- 19-inch standard rack configuration
- Scalable for the vessel requirements
- Designed for Voltages up to 1500 VDC
- Enhanced EMI immunity design for maritime environments
- Modular Battery Management System (MBMS) with following protection functions:

	Colour touch screen
	Passive Cell Balancing
	Under/Over cell voltage protection
	Under/Overage String voltage protection
	Over Current protection
	Short circuit protection
	Under/Over temperature protection