



PBES CellSwap™

Battery Re-Coring Technology



Reduce, Re-Use and Recycle Result: A smaller, lighter battery system

PBES brings value in the marine battery market to a new level. PBES CellSwap™ is a retrofit process to rebuild the inside of a battery onboard a vessel. CellSwap™ represents common sense thinking in marine battery design – and is a first in the marine market.

PBES CellSwap™ is simple; with PBES's innovative battery design, the lithium-ion cells in the core of

the battery can be replaced when nearing end of life. Other items, such as cabling, electronics, cooling, racking and structural components can be reused. With PBES CellSwap™ there is no need for costly re-commissioning and reintegration. The rebuilding is possible without disruption while the vessel is in service.

CellSwap™ Advantages:

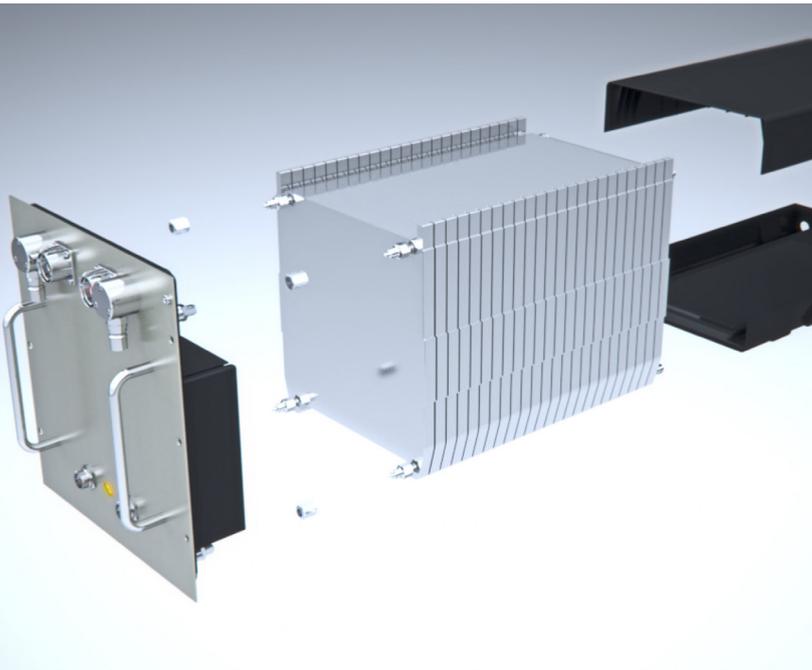
- Provides a more efficient and cost effective solution
- Reduces battery system size and weight
- Capital investment is reduced
- Reduces operational and installation cost
- Reduces installation time and effort



The 5 Year System with CellSwap™

Battery solutions are typically designed and sized to last 10 years. PBES battery solutions using CellSwap™ can now be sized as 5-year systems, and at the end of those five years the modules are “re-cored” and upgraded with new lithium-ion cells. This creates a faster financial payback on a system that has a smaller size, lower weight, and reduced capital cost of hardware and installation.

PBES's proprietary CellCool™ cooling system is the key technology that enables PBES to offer a 5-year battery. With liquid cooling of each cell, it is possible to achieve maximum battery performance without compromising safety or damaging the battery.



CellSwap™ Process

The process is simple and safe, as the cell stack easily separates from the electrical controls. The new cell stack is pre-assembled in the PBES factory in Norway and shipped to the vessel for installation by certified technicians. The front of each module containing the electronics is detached and the core is replaced with the new stack.

The entire process may be completed while the vessel is in use or while the vessel is stopped for maintenance and requires no interruption in scheduled service.

Avoids System Over Sizing for Cell Aging

Lithium-ion batteries may lose up to 2% of capacity per year. Many battery companies compensate for this loss by over sizing the system; in effect forcing the customer to purchase extra capacity. PBES CellSwap™ ensures an optimized system size while protecting the customer's investment and battery life.

No Changes in Shipboard Integration & Power Management

- A new battery system requires re-integration where costs are difficult to assess and control
- Eliminates issues with legacy/obsolete components and software

System Recycling

Traditional battery systems require the entire system to be replaced at end of life. The ability to swap out just the cells means that almost no components are thrown away or recycled, greatly reducing waste and costs.