# "MHPB" Module: Driving Innovation in Future of Battery Solutions

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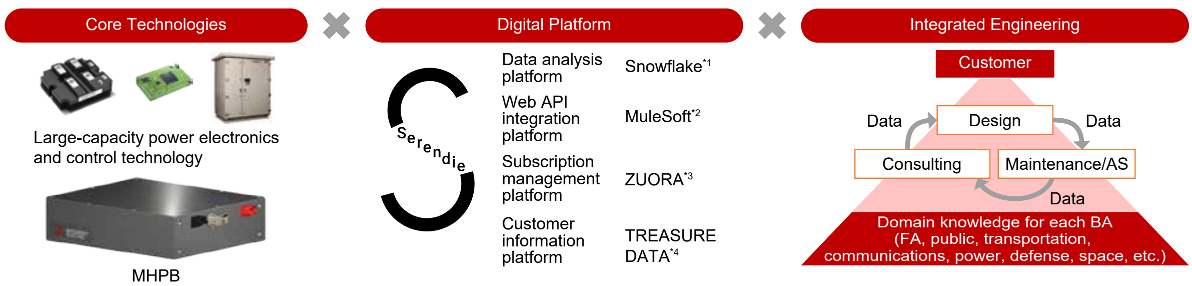
**Abstract**

To achieve a decarbonized society, advances in energy storage technology are becoming important for promoting the use of renewable energy and electrification. Batteries, which are key to electrification, have different characteristics such as output, capacity and service life depending on the product, and are used selectively according to the application. New battery-related technologies such as fast charging and wireless charging are also advancing, which is expanding their potential. An example of this is in the railway industry, where battery installation on railway vehicles is progressing for non-electrified sections and emergency operations, however issues remain such as the need for many batteries to secure output and capacity, and the need for a considerable charging time. Mitsubishi Electric Corporation has newly developed the next-generation battery module Mitsubishi High Power Battery (MHPB) which excels in high power density, long service life and increased capacity, and will contribute to promoting decarbonization through energy solutions.

## 1. Introduction

This paper outlines advances in our energy storage technology and the development of energy solutions as a means of addressing social issues, and presents the potential of the newly developed next-generation battery module. Our company provides battery and energy solutions that help resolve the energy challenges of our customers and potential needs/seeds by integrating battery-centered core technologies and integrated engineering that supports the entire lifecycle through our proprietary digital platform "Serendie" (Fig. 1).




API: Application Programming Interface, AS: After Service, BA: Business Area

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**Fig. 1 Battery and energy solutions provided by our company**

## 2. Battery and Energy Solutions

As shown in Fig. 1, we are providing battery and energy solutions by integrating battery-centered core technologies and integrated engineering that supports the entire lifecycle through our proprietary digital platform Serendie.

This chapter outlines the core technologies, digital platform, and integrated engineering that comprises this solution.

### 2.1 Core technologies

Figure 2 outlines our core technologies. High-efficiency power electronics technology cultivated in the railway business reduces power consumption and enables efficient use of energy. By combining energy management solutions (EMS), cybersecurity technologies, and state of charge (SoC)/state of health (SoH) estimation technologies developed by our company, we are establishing core technologies that boost the value of solutions. As an external collaboration technology, in May 2024 we also concluded a business alliance with Musashi Energy Solutions Co., Ltd. regarding the next-generation battery module and battery management system (BMS). Musashi Energy Solutions Co., Ltd. covers the design, development, and manufacturing of next-generation battery cells, and our company is responsible for the design, development, and manufacturing of the next-generation battery module and BMS. The next-generation battery module is outlined in Chapter 3.

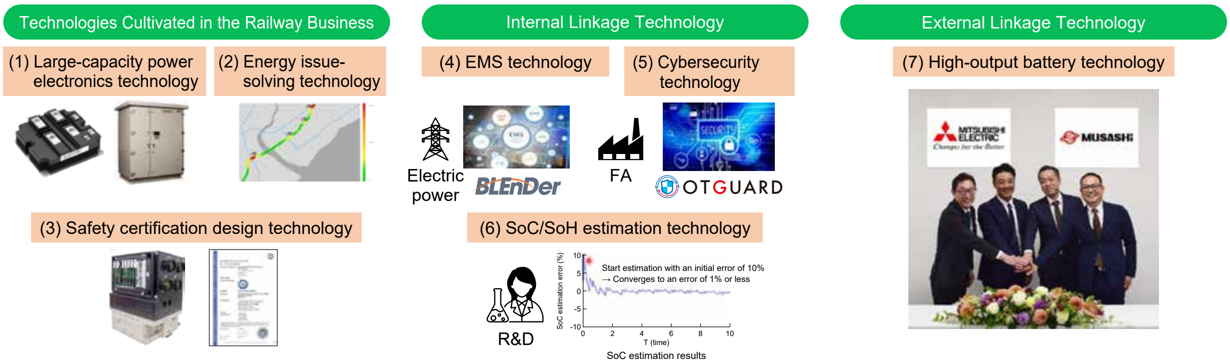


**Fig. 2 Our core technologies**

### 2.2 Digital platform

We built our proprietary digital platform Serendie to create new value from data. Serendie is a platform that allows diverse human resources to demonstrate technical capabilities and creativity and provide new services and solutions.

In railway energy solutions, the digital platform Serendie collects operational data on the charge/discharge status of onboard MHPB, and through large-scale data analysis, proposes optimal charge/discharge patterns and battery installation capacities appropriate to each railway line. Determining when to replace expensive batteries is also important for railway operators. By analyzing operational data from onboard batteries, SoH can be estimated with a high level of accuracy, enabling more precise evaluation of battery degradation.

### 2.3 Integrated engineering

Based on our technologies in each field, we are providing total support for product/system implementation, operation, maintenance, after-sales service, and system upgrades, and by leveraging data from each lifecycle phase, we are achieving integrated engineering that contributes to sustained customer value enhancement. Optimal design of the overall system is required from the perspective of integrated engineering. An example is when applying the MHPB module to railway vehicles—energy optimization of the entire railway system is achieved by linking the operation management system and implementing operation management in accordance with the battery status.

## 3. Features of the Next-generation Battery Module MHPB

Figure 3 outlines the features of the next-generation battery module MHPB. Given that MHPB is installed in railway vehicles, it is designed to ensure safety, durability and reliability, taking into consideration severe operating environments such as vibrations and outdoor temperature changes, in addition to meeting the required standards.

MHPB also offers three characteristics: high power density, long service life, and operability at high temperatures. In terms of high power density, compared with general lithium-ion rechargeable batteries, MHPB has up to about six times the power density as shown on the right side of Fig. 3, and because high-power rapid charge/discharge is possible, contributes to smaller and lighter battery systems. And given that the maximum service life is as long as 16 years, the number of battery replacements can be reduced, enabling a lower life cycle cost (LCC). Furthermore, MHPB can operate in high- and low-temperature environments, enabling stable operation in the range from −40°C to 70°C.

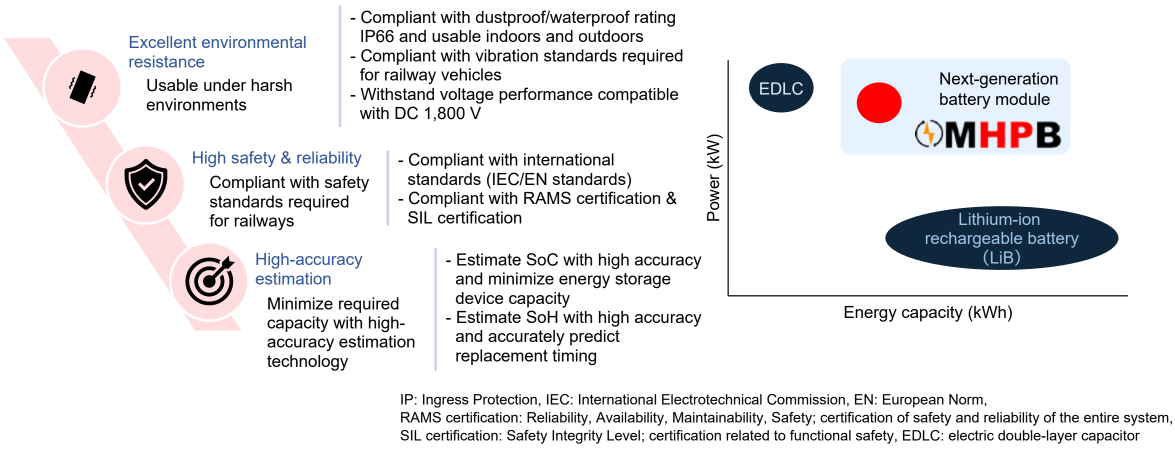


**Fig. 3 Characteristics of the next-generation battery module MHPB**

With these features, it excels at absorbing/outputting high power for about 30 seconds to 1 minute, making it an optimal module for applications such as slimming equipment through power peak cutting and energy savings by absorbing regenerative electric power.

## 4. Application Examples of the Next-generation Battery Module MHPB

Leveraging the characteristics of the next-generation battery module MHPB outlined in Chapter 3, here are details of three application cases: application to catenary-free trams, use for power peak cutting, and eliminating power wiring for warehouse stacker cranes.

### 4.1 Battery introduction for railway vehicles: catenary-free trams

Mounting batteries on railway vehicles and supplying power from the battery during powering and charging the battery with regenerative electric power during braking helps to achieve catenary-free operation that eliminates overhead lines supplying power. Figure 4 shows an overview of the catenary-free system. Catenary-free systems offer benefits such as eliminating overhead lines, providing a pleasing urban landscape, and reducing maintenance work.

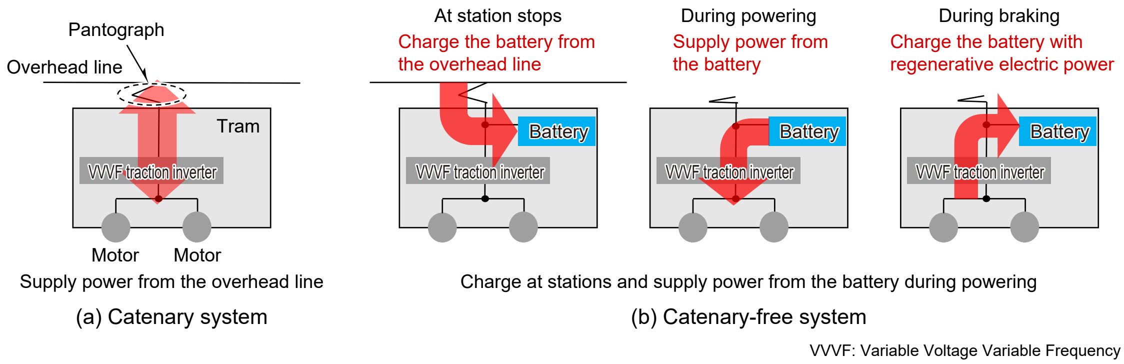


**Fig. 4 Catenary-free system**

Catenary-free trams are an application where MHPB's three characteristics—high power density, long service life, and operability at high temperatures—can be leveraged. Figure 5 shows our solution for battery introduction in catenary-free trams. Note that this solution is available not only for catenary-free trams but also to hybrid systems that combine hydrogen fuel cells, etc. with MHPB modules.

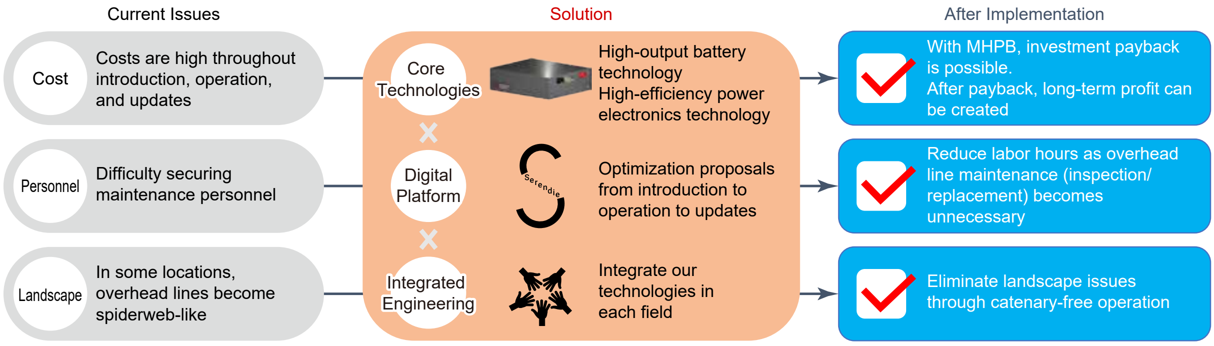


**Fig. 5 Our solution for introducing batteries in catenary-free trams**

### 4.2 Introducing batteries for power peak cutting applications

A peak-cut control method has been developed available where a battery is applied to a conventional power system. In general, during high load, the battery is discharged and power is supplied to the load from both the conventional power source and the battery, thereby reducing the peak load on the power source. This control has various applications such as reducing factory power capacity, and railway applications are outlined here. Figure 6 shows the railway peak-cut system.

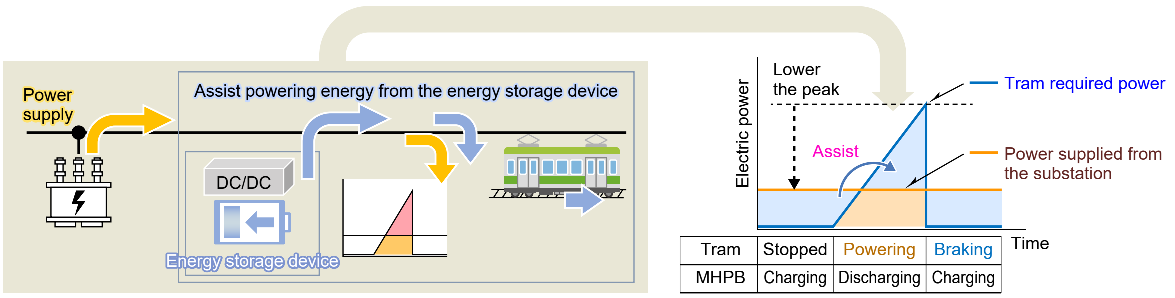


**Fig. 6 Railway peak-cut system**

In peak cutting, the onboard battery is first charged from the overhead line while stopped. After that, when the power required by the train increases during powering, discharging from the battery to assist makes it possible to reduce the maximum power supplied from the substation. During braking, regenerative electric power is also used to charge the battery in preparation for subsequent powering. Figure 7 shows our solution for battery introduction for peak cutting applications.

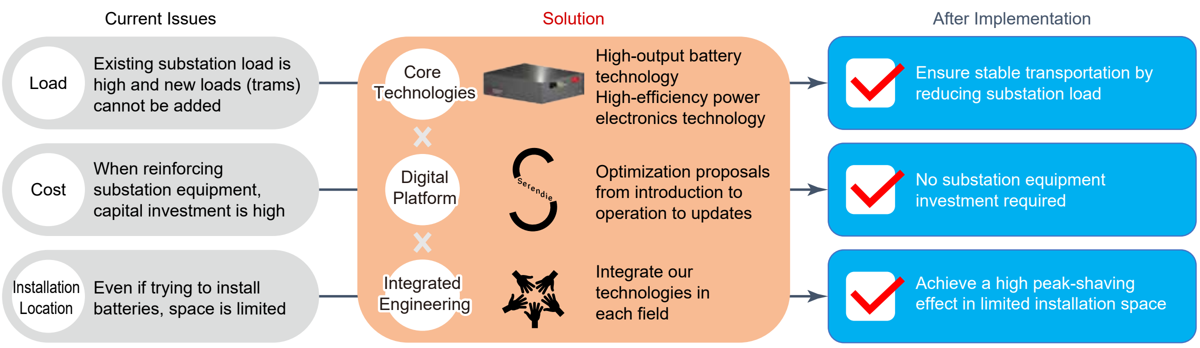


**Fig. 7 Our solution for battery introduction for peak cutting applications**

### 4.3 Battery introduction for stacker cranes

This section outlines application examples other than railway use. Stacker cranes operate while moving up/down and left/right to load and unload items in logistics warehouses and similar facilities. Currently, many systems use trolley lines, but by newly introducing batteries, removal of trolley lines becomes possible. By recovering the kinetic energy into the battery while descending, improved energy efficiency can be expected. Figure 8 shows an overview of the battery system for stacker cranes, and Fig. 9 shows our solution.

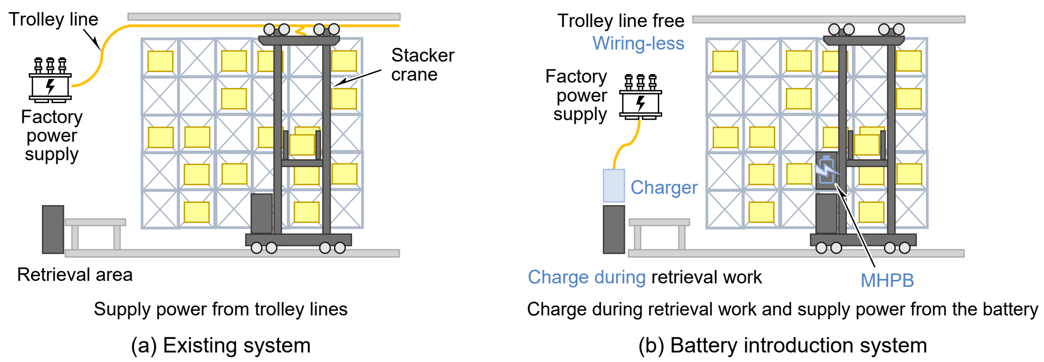


**Fig. 8 Battery system for stacker cranes**

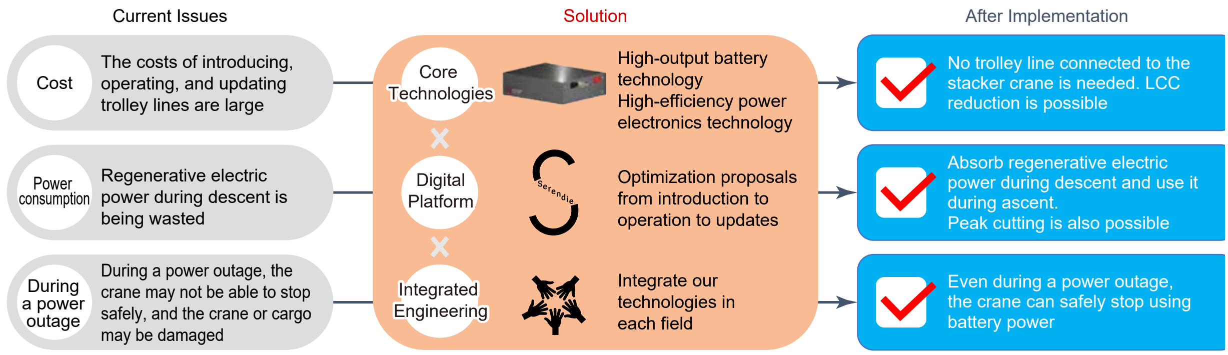


**Fig. 9 Our solution for battery introduction for stacker crane applications**

### 5. Conclusion

We outlined the development of battery and energy solutions using the newly developed MHPB by our company, to address social issues such as decarbonization and energy problems. As a result, the spread and expanded use of electric mobility will accelerate even in the transportation sector, and results such as effective energy utilization and $CO_2$ reduction can be expected.

With relentless technological innovation and limitless creativity, we will continue to promote initiatives toward solving social issues and aim to achieve a sustainable energy society.