

Lithium-ion Battery System for Smart Grid

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1 Abstract

The smart grid has been proposed as an initiative that can be optimized by fusion with IT technology, to control both supply- and demand-side power flow, the response to wide-area power outages due to the decline in power-distribution facilities and power shortages, or system instability after expanding the amount of renewable energy generated and introduced in the USA.

The battery-system roles in the smart grid include load leveling as represented by the peak cut or peak shift, power-system stabilization as an adjustment force and response in emergencies, etc. This report focuses on the contribution of lithium-ion battery system to load leveling alongside renewable energy, stabilization of the supply/ demand, and ensuring lifeline energy in the event of power failure.

2 Key Features

- One of the Japan's largest capacity lithium ion battery systems
- Contribution to electric power interchange, demand-supply variation control and securing lifeline in the event of power outages.

3 Development Background

Storage batteries for smart-grid operation can be installed together with generators, inside facilities for power system or inside users' facilities as shown in Figure 1. The role of storage batteries in joint installation with generators is to mitigate output fluctuations from renewable energy power generation. The expected role of storage batteries installed inside facilities for power systems is the ability to adjust frequency and provide surplus electricity as a countermeasure. The role of storage batteries installed on the demand side is to prevent demand from exceeding contracted power via peak shaving and peak shifting, and secure a lifeline in the event of power outages¹⁾.

In this report, we report on the Lithium-ion battery system delivered to Kashiwa-No-Ha Smart City as a case example of storage batteries installed on the demand side²⁾. In Kashiwa-No-Ha Smart City, AEMS (Area Energy Management System) was introduced to operate, monitor and control energy citywide as a core electrical energy control facility to interchange electrical power between town areas. The expected roles played by the electrical energy-storage system include helping reduce electricity charges, boost the low-carbon society, stabilize the demand-supply energy balance by mitigating output fluctuations from renewable energy photovoltaic generators and securing the minimum electrical power required to sustain the lifeline in the event of a large-scale power outage. Adopting a lithium-ion battery is an effective way of conserving installation space in urban areas by exploiting its compactness and light weight.

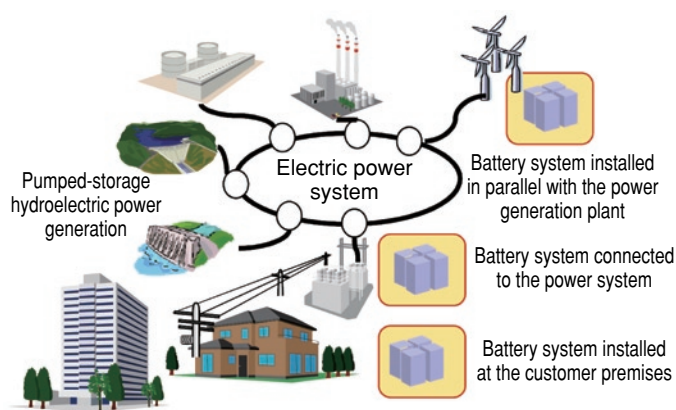


Figure 1 Smart-grid battery system

4 Technical Content

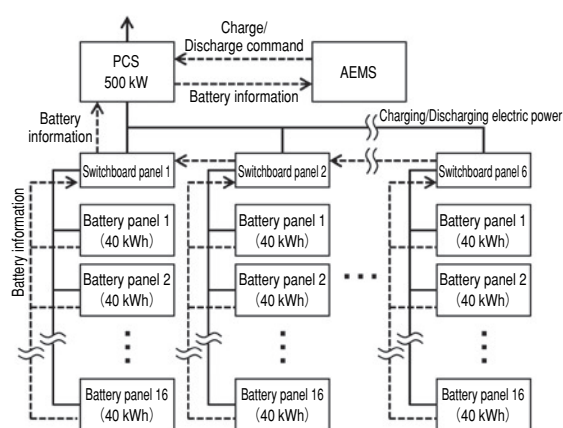


Figure 2 Block diagram of the lithium-ion battery system

A block diagram of the lithium-ion battery system delivered to Kashiwa-No-Ha Smart City is shown in Figure 2, while the exterior appearance is shown in Figure 3 and the specification in Table 1. This battery system is capable of storing 3.8 MWh and adopts a layered structure comprising a battery (cell), battery pack, battery panel and switchboard panel. Each switchboard panel acts as an interface with a 500 kW power-conditioning system (PCS), which converts input/output power from a battery system as a DC power source, into AC power. The exterior appearance of the stationary lithium-ion battery pack CH75-6 is shown in Figure 4 and its specification in Table 2.

Each battery pack includes a battery assembly housing six cells and a cell controller monitoring the voltage of all cells. Although individual cell voltages may vary after repeated charge and discharge cycles, the cell controller includes a function to detect and adjust the varied voltage automatically to the same level. The cell controller also monitors the temperature of the battery pack.

Twenty-four units of CH75-6 battery packs packed in serial arrangement are mounted in a battery panel. Also, a battery management unit (BMU), which monitors the battery pack status by communicating with the cell controller located in each battery pack, is mounted in the battery panel. The BMU is connected to an master BMU installed inside the switchboard panel and is capable of detecting various problems and malfunctions and adjusting the voltage variance between battery packs as well as transmitting monitored information collected from cell controllers to the master BMU.

Six sets of battery panel blocks - with sixteen battery panels per set - are installed in parallel to comprise the entire system. Meanwhile, the PCS and master BMU communicate with each other and all monitored battery status information is sent to AMES. The master BMU can also operate in degraded operation mode by disconnecting the battery panel in the event of trouble if any one battery panel breaks down, and avoid lowering availability factor.

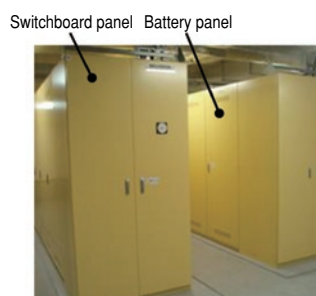


Figure 3 Installed lithium-ion battery system



Figure 4 Lithium-ion "CH75-6" battery pack for stationary use

Table 1 Specification of the lithium-ion battery system

Item	Specification
Input/Output power	500 kW
Battery capacity	3.8 MWh

Table 2 Specification of the lithium-ion battery pack

Item	Specification
Type	CH75-6
Nominal voltage	22.2 V
Nominal capacity	75 Ah
External dimension	228 (width) × 475 (depth) × 151 (height) mm
Mass	Approx. 23 kg

5 Future Business Development

- Developing high output power density lithium-ion batteries in applications to suppress frequency variation by applying next-generation long service life lithium-ion batteries
- Developing high-capacity and energy density lithium-ion battery systems for distribution networks connected to or on-site electrical energy-storage system

[References]

- 1) Atushi Nishioka, et al.: "Hitachi's Smart Grid Technologies for Smart Cities", Hitachi Review 61, No. 3, pp.134-140(2012)
- 2) News Release by Hitachi Chemical Co., Ltd.: One of the Largest

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