# SANYO's SMART ENERGY SYSTEM CONSISTS OF 1.5 MWh Li-ion BATTERY AND 1 MW PV SOLAR SYSTEM

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SANYO has developed a Smart Energy System (SES), which can generate, store, and consume green energy effectively and efficiently. At the SANYO Kasai Plant in Hyogo prefecture in Japan, we installed a 1MW PV solar system, a 1.5MWh Li-ion battery system, energy management systems that efficiently control equipment and a Smart Energy System, which combines and coordinates all of these systems to maximize energy efficiency. The key component of the Smart Energy System is the Li-ion battery system using three hundred thousand Li-ion cells typically found in laptop computers. The newly developed battery management system can control numerous cells as if they are just one single battery. We realize carbon zero-emissions in the on-site administration building and are able to reduce 15% peak demand of the whole factory by using our Smart Energy System.

**Keywords**: battery management system, Lithium ion battery, solar

## 1. Introduction

Renewable energy such as photovoltaic and wind turbine generation is expected to play an important role for future energy solutions. Additionally, electrical energy storage is needed to stabilize the electricity grid fluctuation caused by the intermittent weather conditions as they relate to renewable energy sources. In order to become a leading company in the energy and environment business, the Panasonic/SANYO Group is promoting the development of new products and technologies. The aim is to help solve environmental and energy problems on a global scale with the company's outstanding technological capabilities. In late 2010, SANYO set up a huge technology demonstration site in Kasai, using its own products such as photovoltaic panels, Li-ion batteries and newly developed energy management systems.

## 2. Smart Energy System in Kasai Green Energy Park

In the Kasai Green Energy Park (Kasai GEP), we installed a 1MW Mega Solar System, a 1.5MWh Lithium-ion Mega Battery System, an energy management system that efficiently controls each piece of equipment, and a smart energy system which combines and coordinates all of the systems using an SES controller, as shown in Fig.1.

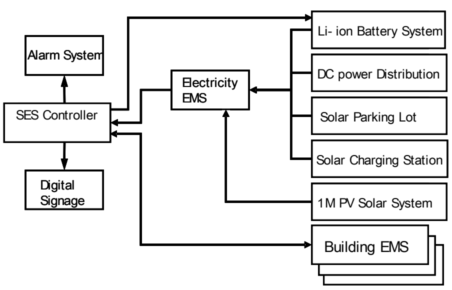


Fig.1. Construction of Smart Energy System

By using all of these systems to maximize energy efficiency, we are able to reduce approximately 2,480 tons of $CO_2$ emissions every year without sacrificing any convenience. The core component of the Smart Energy System is the SES controller. It monitors the conditions for electricity generation and storage with photovoltaic modules and storage batteries, while keeping track of the amount of electricity used by devices and equipment in real time. Through integrated control of technologies for energy generation, energy storage and energy saving, the SES can use power efficiently without waste.

## 3. Construction of the Li-ion battery system

The 1.5 MWh Li-ion battery system consists of a 1.3MWh large-scale battery storage system using 240,000 pieces of 18650 standard cells and a DC distribution system from photovoltaic modules with 200kWh Li-ion batteries. A new battery management system has been developed, which deals with a large quantity of data such as voltage, current and temperature for each cell instantaneously through advanced network technologies and then balances and controls each cell at the same time. This battery management system can control numerous cells as if they are just one single battery.

Fig.2. Photo of Li-ion Battery System in the Energy Storage Building

Fig.2 shows 1.3MWh Li-ion battery system in the energy storage building. Economical late-night electricity is mainly used to charge batteries. In order to ensure stable operation of the whole battery system, the Li-ion battery system consists of multiple elemental units which have 5 series-4 parallel of Li-ion boxes. So, a battery management unit controls 20 boxes. Each box has 312 pieces of 18650 cells. One series string consists of 5 units that have 160kWh and is connected to 1 Power conversion system (PCS), as shown in Fig.3. The battery management unit (BMU) accurately detects the conditions for the Li-ion batteries based on the electric voltage, electric current and temperature, and maximizes the performance of this large-scale storage battery as a whole.

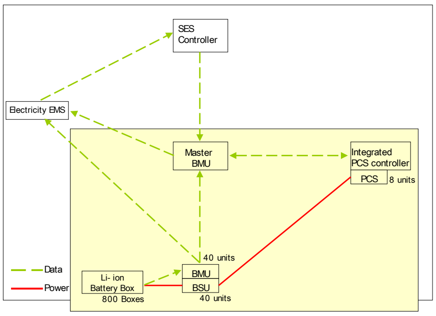


Fig.3. Configuration of the Li-ion Battery System

## 4. Efficiency of the Li-ion battery system

Energy efficiency is critical when using a battery system. In order to evaluate the actual efficiency of the Li-ion battery system, the comparison of electricity between input and output was measured.

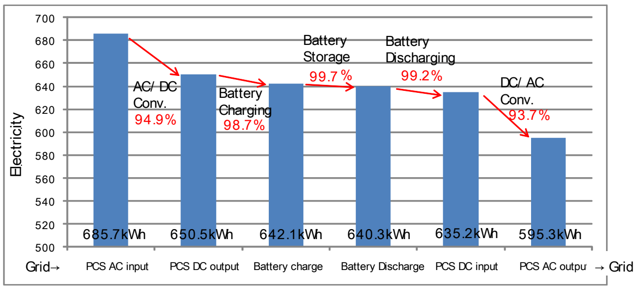


Fig.4. Transition of Electricity through Energy Devices

Fig.4 shows transition of electricity through each device at the condition of SOC25%→SOC75%→ SOC25%. Actual efficiency of the Li-ion battery system is about 98%, however the efficiency of a PCS is about 94%, the total efficiency after PCS is about 87%. It is still much higher than that of NAS battery and Lead Acid battery. [1]

## 5. DC Power Distribution through Li-ion battery system from PV solar

Green buildings can take advantage of DC power distribution with PV generation (Fig.5).


Fig.5. PV solar deployed vertically on the side surface of building

DC power from PV solar can be directly used in DC devices such as LED lightning and laptops. Then, surplus DC power is stored in energy storage and provided to DC devices from storage at night. If PV solar generates more electricity, DC power is converted into AC power and consumed by AC devices. In the administration building, unconverted DC power from photovoltaic modules is the main source of electricity for charging batteries and direct consumption.

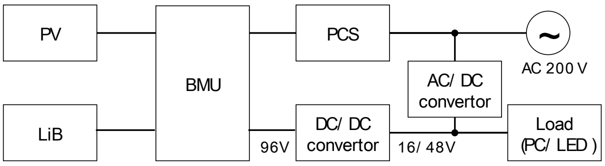


Fig.6. System Configuration for DC Power Distribution

Fig.6 shows the system configuration. A direct charging method from PV solar to Li-ion battery has been developed. Approximately 100% of the electric power consumed in the administration building can be offset by the electric power generated by all of the photovoltaic systems in the Kasai GEP and by the power consumption reduction effect of the administration building EMS.

## 6. Peak shaving by Li-ion battery system

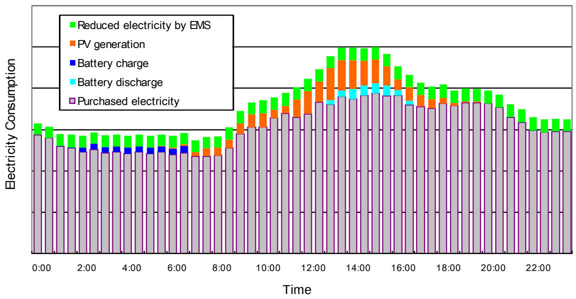


Fig.7. Peak Shaving by Smart Energy System

Fig.7 shows the total energy consumption data of the factory. The green part means the amount of energy saving by EMS, and the grey part is the electricity purchased from the grid. Smart Energy System can reduce demand charge by peak shaving. During daytime, PV solar generation, the orange part, saves the electricity purchased from the grid. However, PV solar could not provide enough electricity for peak shaving any more around 4pm, since our factory had the peak time around the sunset time. So, SES controller decided to let the battery system discharge electricity to keep the peak load shaving. Then, the battery was charged using lower costing electricity from the grid during the night. The Smart Energy System reduced peak demand by over 15%. Our factory has a different peak time according to its production planning. Lots of operational patterns have been devised trying when and how long the batteries have to charge and discharge. Kasai GEP is the ideal site to develop this kind of battery control technologies.

## 7. Conclusion

The Smart Energy System is proven to be useful for reducing carbon emissions and reducing peak demand without any inconvenience for employees or factory operation.

Fig.8. Digital Signage for Smart Energy System

By making the energy usage conditions and facility information visible, the operations staff can identify inefficiencies and inconsistencies in factory and office energy use, and take actions to improve the environmental performance of the site. Furthermore, the staff can get a real sense of the site's energy consumption visually through the large-screen displays installed around the site (Fig.8), which will raise employees' environmental awareness at the Kasai GEP. indirectly leading to the reduction of $CO_2$ emissions.

## 8. References

[1]. Research Institute on Building Cost, *http://www.ribc.or.jp/research/pdf/report/report21.pdf* No.68, pp70-73, 2010

## 9. Acknowledgements

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