A Compact Energy Storage System for the "Storage and Smart Use of Electricity"

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Abstract

NEC has commercialized a 7.8 kWh model of a household/corporate-oriented compact energy storage system incorporating a lithium ion battery with a 15-year warranty. Moreover, due to its integrated construction it features a short installation work period. According to an analysis of the usage data of previous models, the present model is given a storage capacity of 7.8 kWh, which is optimum for home use. It has a rated output of 3.0 kW under normal operation. It stores the low-priced power during nighttime or surplus power of photovoltaic generation, and then it uses them in daytime. Such features allow users to achieve further power and cost savings and to enjoy comfortable everyday life. The system is also capable of running various home appliances in the case of a power outage.

Keywords

lithium ion battery, energy storage system, photovoltaic power generation, cloud computing, monitoring and support

1. Introduction

The explosive dissemination of renewable energy such as photovoltaic power is expected to expand the use of energy storage power systems for the benefit of society. NEC provides energy storage systems that can meet the demands of electric power companies, fabrication plants, buildings and households etc. Our products are based on the achievements of our lithium ion battery development over many years, as well as on high quality, reliability, safety and innovative car-mount mass-production technology.

It was NEC that commercialized household/corporate-oriented compact energy storage systems by leading the Japanese industry in the summer of 2011. In November 2014, we announced a third-generation model with a capacity of 7.8 kWh. In this paper, we introduce the product outline, basic configuration and operational modes of the new compact energy storage system.

2. Product Outline

Photo shows the appearance of the compact energy storage system and the **Table** gives its specifications. What the compact energy storage system does is to "store electricity and use it smartly". For example, it can store low-priced nighttime power in order to reduce the electricity charges. Moreover, it can also contribute to dealing with the peak local power demand and serve as emergency backup power in the case of a power outage.

Photo Compact energy storage system (7.8 kWh model).

Table Specifications of 7.8 kWh energy storage system.

Product name	Compact energy storage system
Model	ESS-003007C1
Storage capacity	7.8kWh (*1)
Output systems	2 lines (general load, essential load)
Rated voltage	General load: Single-phase 3-wire, 100 V/200 V. Essential load: Single-phase 2-wire, 100 V
Rated output	General load: 3.0 kW (*2). Essential load: 1.5 kW
Battery type	Lithium ion battery
Installation location	Outdoors
Operating temperature	-10 to +40 ºC
Storage temperature	-20 to +40ºC
Waterproofing	IPX5 equivalent
Dimensions	980 mm (W) x 300 mm (D) x 1,150 mm (H)
Weight	Approx. 150 kg

*1: Total of the rated capacities of individual cells. The actually available electricity is 6.62 kWh (excluding the PCS efficiency), which varies depending on the environment and method of operation.
*2: To prevent reverse power flow to the grid, a fixed amount of power is purchased during discharge.
Note: This product can be linked with an ECHONET Lite compatible HEMS (IG0001STC/CM).

The following subsections describe features of the compact energy storage system.

(1) Secure remote support

NEC collects and manages energy usage data such as the power consumption status and photovoltaic power generation situation via the Internet. This means that we can monitor the energy storage system status permanently for 24 hours a day and for 365 days a year.

Even if the pattern of household power consumption or the electricity charge system changes in the future, it will be dealt with by modifying or updating software via the network. This allows users to always use the system conveniently and in a comfortable environment.

(2) Automatic power usage control in linkage with the power company grid

NEC's energy storage system is linked permanently to the power grid. It stores nighttime power in a smart way and controls the power usage automatically.

(3) Combination with HEMS for efficient energy usage

When the system is combined with NEC's cloud-based HEMS (Home Energy Management System), optimum power supply for the entire household can be achieved by "visualizing" the power consumption and providing the electricity charges within the house. This feature contributes to more efficient energy usage.

(4) Linkage with photovoltaic power generation systems

The compact energy storage system controls automatically whether the surplus power of the photovoltaic generation is to be "sold" or "stored". Combination with a photovoltaic power generation system makes it possible to operate the storage system in the most efficient manner, and to match the lifestyle of each user.

Furthermore, when the power obtained by photovoltaic generation is excessive, the power supply from the storage system to the house is interrupted automatically. This allows the user to sell the surplus power always at the highest limit price, without being regarded as "double power generation" for which the power purchase price would be lower.

The storage system can be linked with the photovoltaic power generation systems of various manufacturers.

(5) Large capacity (7.8 kWh)

The storage capacity may be as high as 7.8 kWh, and the rated output accepts equipment up to 3.0 kW in normal use and 1.5 kW during a power outage. This means that, in a house, the system can run various appliances including ones with high power consumption, such as a refrigerator (120 W) and LCD TV (110 W), for about 18 hours*.

(6) Safety

In order to "store and use electricity" repeatedly, the compact energy storage system is required to have high safety and reliability features. At NEC, we develop compact energy storage systems with the "safety first" concept so that they can be used securely and safely in the home.

(7) Long-term warranty (15 years)

NEC's compact energy storage systems are warranted for a safe period of 15 years. The fan-less structure is adopted in consideration of the water- and dust-proofing requirements. Optimum thermal design is provided so that maintenance tasks such as filter replacement are unnecessary.

(8) Lithium-ion battery

At NEC, we have been developing and marketing the lithium-ion battery for use in notebook PCs, cellphones and digital cameras as well as for power-assisted bicycles. Our products are highly evaluated so that our battery technology is currently being adopted in electric and hybrid vehicles that impose high safety requirements. The compact energy storage system is also a result of these technologies.

(9) Easy installation, environmental friendliness

A slim body with a depth of 30 cm allows the sys-

* An approximate value, which is variable depending on various conditions.

tem to be installed in a wide range of locations. The liquid protection performance equivalent to IPX5 enables safe outdoor installation. The system also features excellent quietness with a noise level below 40 dB thanks to its fan-less structure.

3. Basic Configuration

The energy storage system is composed of energy storage packs that stores electricity, a power conditioning system (PCS) that converts battery power from DC to AC, and a system controller that enables linking with the photovoltaic power generation system, etc. (**Fig. 1**). The following subsections give a description of each of these components.

(1) Laminated lithium-ion battery featuring outstanding durability, safety, service life and energy density

NEC has adopted a laminated design for the lithium-ion battery. The basic unit of a battery is the cell. Individual cells are designed based on our expertise acquired in the field of car-mount battery cells and feature high impact and shock resistance, advanced safety features and long life. Modules are collections of cells that are designed to feature high density and high thermal safety. Even in a case where heat is generated, it is absorbed by the cabinet of each module. The battery pack is composed of an optimum number of modules and it is controlled by the battery management unit (BMU). The BMU performs the voltage balance and high voltage controls in order to secure the safety of the pack as well as of the individual cells.

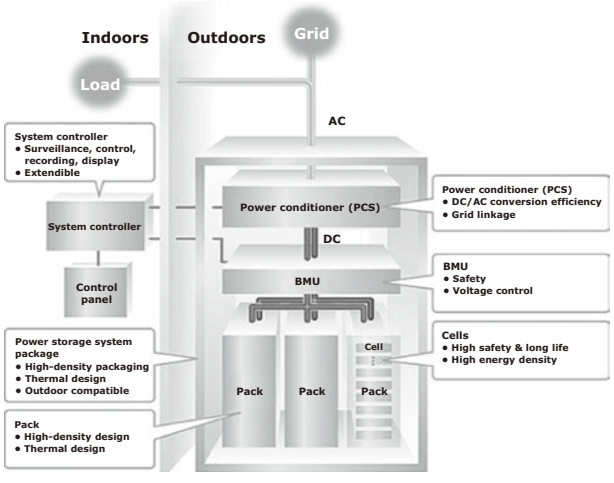
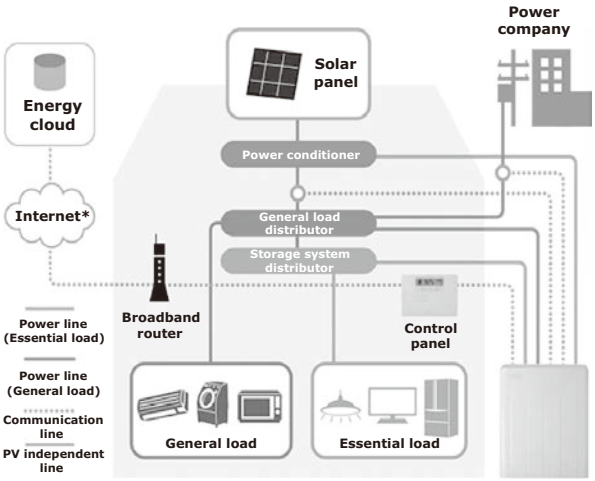


Fig. 1 Energy storage system configuration.



* A permanent Internet connection is required for provision of the monitoring and support service.

Fig. 2 Power distribution from the energy storage system.

(2) PCS for efficient conversion of various energy sources

The functions of the PCS are for the conversion of the DC power of the battery to AC power and for the adjustment of AC voltage and frequency to match the home appliances to the linked power grid. In addition, it also enables linking with a distributed power source such as a photovoltaic power generator and it has the capability of converting various energy sources efficiently.

(3) Energy management technology of the system controller

With NEC's energy storage system, the system controller controls the operation of the individual cells and modules, linkage between the storage system and the grid power and it also integrates their data. The system controller provides an energy management system making use of ICT, such as for minute energy management via control software and it also stabilizes external connections (**Fig. 2**). It is linked with HEMS in order to enable visualization of the energy storage status in the home and it is also capable of providing a variety of services, including remote mode switching and smart power conservation.

4. Operation Modes

The "Normal operation mode" is used to store the low-priced nighttime power in the compact energy storage system and to use it during the day. Power stored in the compact energy storage system is used according to daytime power demand (**Fig. 3**, top).

The "peak-cut operation mode" reduces the peak

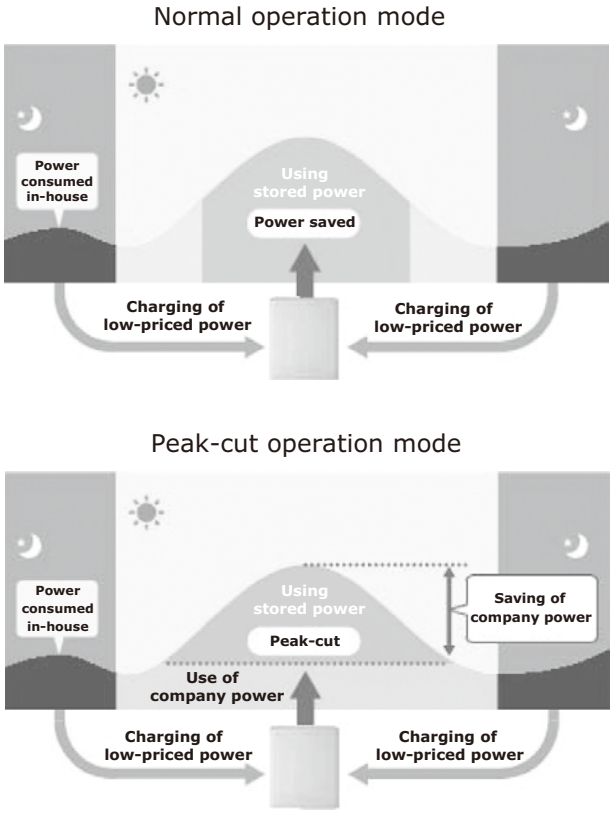


Fig. 3 Normal operation mode (top) and peak-cut operation mode (bottom).

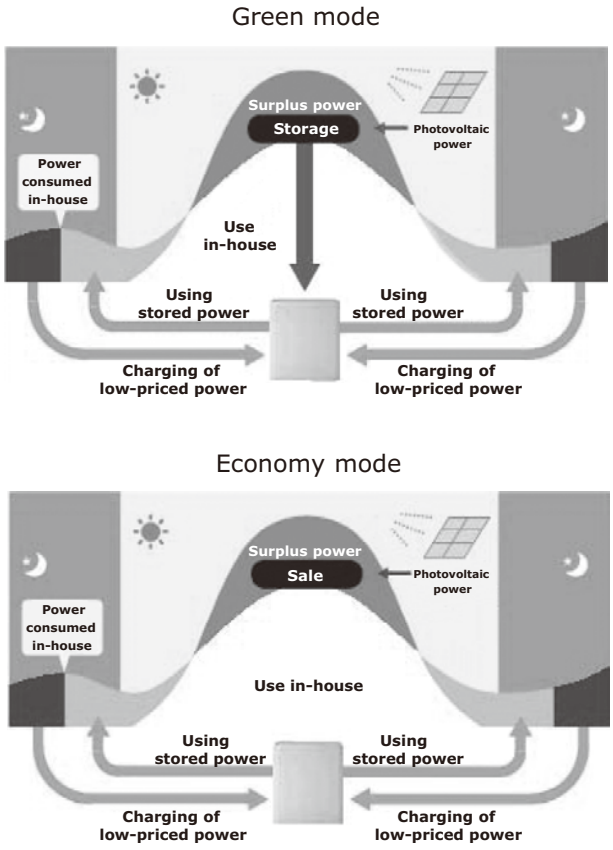


Fig. 4 Green mode (top) and economy mode (bottom).

power consumption amount. This mode uses the stored power when the consumed power exceeds a preset value. When the stored power runs out or the upper limit is exceeded, electricity from the power company is used to compensate for the shortfall (Fig. 3, bottom).

Two operational modes are available for combination with a photovoltaic power generation system. These are the "green mode" and the "economy mode" (**Fig. 4**). The "green mode" aims at self-sufficiency as far as possible. It prioritizes storage of surplus power in the energy storage system and transfers it to power sale whenever the system is fully charged. The "economy mode" aims at power sale as far as possible. It is based on self-consumption of the power generated by the photovoltaic generator but also performs auto control positively, aiming at selling the surplus power.

Other additional operation modes are the "manual operation mode" and "power outage operation mode". The "manual operation mode" is used when the user needs to charge the batteries in order to prepare for a disaster, e.g., in advance. Pressing a button on the control panel starts charging the system regardless of the current operation mode. When power outage is detected, the "power outage operation mode" is initiated automatically to discharge the stored power. The operation mode in use before the power outage resumes automatically when the outage is released.

5. Conclusion

NEC makes the compact energy storage system available via housing manufacturers, construction material trade companies and partner enterprises, such as by the ONE Energy Corporation that provides energy storage system rental service. NEC intends to continue to contribute to the implementation of a comfortable, safe and secure lifestyle by offering efficient energy usage via the compact energy storage system described above.

* ECHONET Lite is a registered trademark of ECHONET Consortium.

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