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# Storage Battery Systems for Smart Community

## 1. INTRODUCTION

Since the Great East Japan Earthquake happened in 2011, questions are raised about nuclear power which account for 30% of Japanese total electricity, and currently most of the nuclear power stations are suspending operation. Due to the suspension, power supply is tight and electric power charges are raised. On the other hand, Feed-in Tariff Law for renewable energy was started July, 2012, and migration from nuclear power to renewable energy will possibly be accelerated. In this situation, electricity consumption and electric power charge reduction activity is implemented, by peak cut and/or peak shift using PV(Photovoltaic) and storage battery.

Furukawa Electric Company (FEC) received an order of “Consignment of verification research service for promoting the introduction of smart energy system” from New Energy and Global Warming Countermeasures / Electricity Storage System Promotion Division, Environment and Agriculture Bureau, Kanagawa Prefecture. FEC is proceeding with the verification test which is characterized by an effective peak-cut with even a small battery capacity by using stationary Lithium-ion storage battery (LiB) or Electric vehicle (EV) as a storage battery.

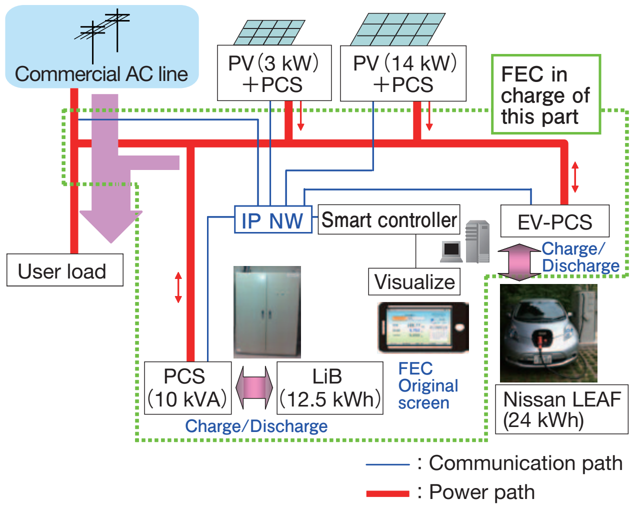


**Figure 1 System configuration.**

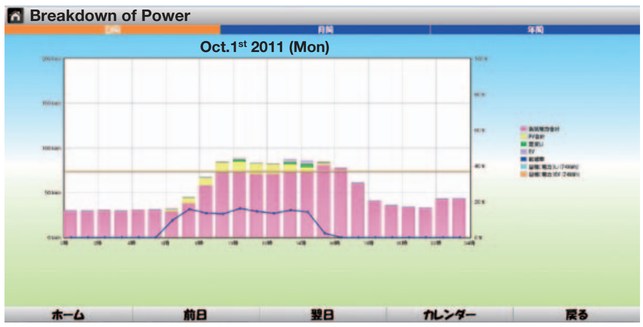


**Figure 2 Daily power consumption charts.**

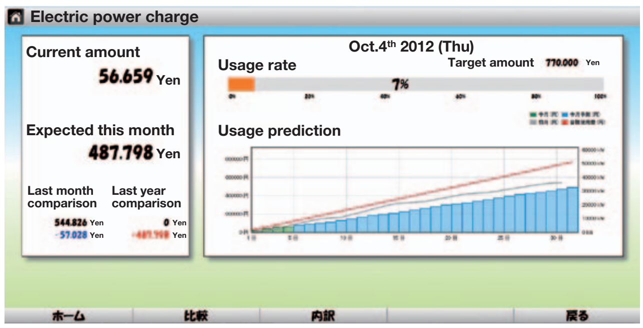


**Figure 3 Monthly cumulative power consumption charts.**

## 2. SYSTEM CONFIGURATION

The system configuration is shown in Figure 1. The system consists of PV panel (PV: 17 kW), LiB (12.5 kWh) + Power Conditioning System (PCS) (10 kW [10 kVA]), EV (Nissan LEAF: 24 kWh) + PCS (10 kW [10 kVA]), Energy management system (EMS) and Visualization user interface. FEC is in charge of all the components except for the PV panel.

## 3. BASIC ACTION

The basic action of the system is to control the battery (LiB + EV) discharging in order not to exceed the preset criterion amount of grid power by monitoring both PV power and grid power purchasing from an electric power company. A daily Power consumption chart (a chart showing consumed power in a day, PV power and discharge from LiB and EV) is shown in Figure 2, and a monthly cumulative power consumption chart in comparison with targeted power consumption as shown in Figure 3 can be displayed. These actions encourage user’s sense of reduced power consumption and help a planed use of power.

## 4. FEATURES

### 4.1 LiB + PCS

This LiB has approximately 4000 times of cycle life at 80% depth of discharge and can be used for more than 10 years with a daily repetitive discharge and charge.

### 4.2 EV + PCS

The biggest feature of this system is the grid connection for the first time in the industry (Figure 4). Grid connection means to discharge from the battery without shutting power receiving from the outside such as an electric power company. Deliberations for grid connection and approval of the electric power company are required. As this is the first time in the industry, a lot of attention is paid from others.

**Figure 4 Electric Vehicle and a power conditioning system.**

### 4.3 EMS

The main role of the system is to give discharge commands towards two batteries, to avoid exceeding the preset criterion amount of grid power. By monitoring both PV power and grid power amount, discharging power amount is defined. As several hours of discharging from the battery are required against peak power of 160 kW, various constrains are given in the control algorithm for an effective utilization of the small amount of stored power. Detailed explanation of the control algorithm is not made in here; this system can correspond to various daily load curves.

### 4.4 Visualization

As described previously, power consumption in a day and cumulative power consumption in a month are displayed in charts, and receiving power amount from the grid can be controlled. The daily power consumption charts show not only power consumption but also generated power and discharged power amounts, and if power consumption tends to exceed preset power consumption criterion in spite of charging and discharging, an alarm function is recommended to be installed to the system. Furthermore, remaining battery capacity of LiB and EV are indicated, and consumers can judge if high-loaded equipments can be used in time zones of high power consuming.

## 5. VERIFICATION TEST RESULTS AND TASKS

The verification test started on August 1$^{st}$, 2012 and will continue until the end of March in this year. Due to the hotter summer than usual, in some days, the maximum power consumption was higher than in the previous summer by more than 30 kW. Therefore, the system was not able to follow the demands in such a condition. Battery capacity was designed based on the actual result in the previous year. This was influenced by the higher than expected power consumption of the year 2012. In one case, the battery became empty during the peak period, and in another case, the battery was completely discharged before noon, due to the hot summer. Furthermore, the building in Kanagawa Industrial Technology Center had a lot of meeting rooms. And a daily power consumption chart types were differed depends on the usage of the meeting rooms. Then, in some cases at the beginning of the verification test, the system could not follow properly.

We found that the more detailed control and the power consumption prediction are necessary for recovery. Then, we clarified the necessary control for EMS based on the data in August, and improved. With these actions the system followed well to peak cut/shift. We confirm our fulfillment of the initial purpose. From now, data collection and system operation confirmation in Winter season will be conducted.

## 6. CONCLUSION

Major feature of this verification test is not only achievement of peak cut/shift by controlling multiple batteries but also grid connection of EV-PCS. Merits of EV usage are followings. When there are multiple EVs, ①Even if the battery capacity is lost, it can be replaced instantly, ② Effective utilization in the event of a disaster is possible by making the battery movable. From here on, we believe the following improvements are important. One is cost reduction to make this smart energy system possible to be used widely. The other is to make this system available to make a choice from the various controls, because the EMS control may vary slightly depending on the facility to be introduced.

For more information please contact:
Broadband Products Division
Telecommunications Company
TEL: +81-463-24-8446 FAX: +81-463-24-8491