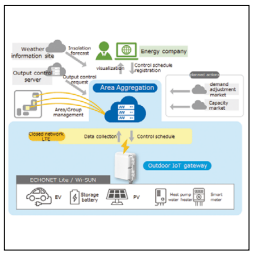

Area Aggregation System SPSS-H (Home) Technology

Hiroki YAMAMOTO*, Masahiro UCHIDA, and Nobuo KOMATSU

With the spread of solar power generation as a renewable energy source and the deregulation of electricity, attention has been focused on the realization of energy management utilizing IoT, such as local production and local consumption of energy and the development of storage batteries and EV-based power storage. To solve problems in the energy field using IoT technology, Nissin Systems Co., Ltd. primarily provides gateway devices, software, and services using cloud systems to develop business for general consumers. This paper introduces the technical contents of the area aggregation cloud system built in the island-and-islets-type Smart Community Actual Positive Business in Miyakojima, Okinawa.

Keywords: decarbonization, PPA, area aggregation, HEMS gateway, island-and-islets-type smart community verification project

1. Introduction

The Sixth Strategic Energy Plan released by the Japanese government in July 2018 aims to spread the use of photovoltaic power generation systems, storage batteries, and EV chargers, even among general consumers, in order to reduce CO_2 emissions and secure stable power supply by using renewable energy as the main power supply. Demand and supply control using renewable energy has become more important than before.

In 2010, Nissin Systems Co., Ltd. started to develop products in conformity with ECHONET Lite, OpenADR, and the Home Energy Management System (HEMS), which are international communication standards in the energy field, to realize smart cities.

Against this backdrop, Nissin Systems has participated in the island-and-islets-type smart community verification project (Fig. 1), which aims to increase the energy self-sufficiency rate to 48.9% by 2050, in accordance with the Declaration of Eco Island Miyakojima 2.0 announced by the City of Miyakojima, Okinawa Prefecture, in 2018.

The company has been developing a cloud system and HEMS gateway as the Smart Power Supply Systems*1-Home (SPSS-H).

This paper introduces the SPSS-H, which was built in the island-and-islets-type smart community verification project.

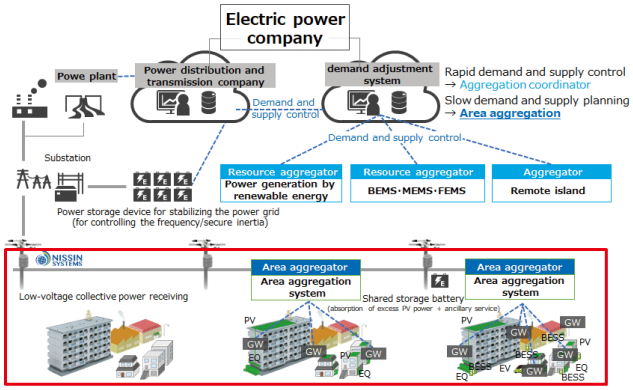

Fig. 1. Image of the island-and-islets-type smart community verification project

2. Island-and-islets-type Smart Community Verification Project

This project aims to ensure efficient use of renewable energy and reduce the energy supply cost. More specifically, it aims to introduce an energy management system using IoT technology, achieve area-based group control of power consumption, and produce economic advantages, thereby building the system into a sustainable society system.

A project has been underway since FY2018 as a third-party ownership model to promote widespread use (see Fig. 2).

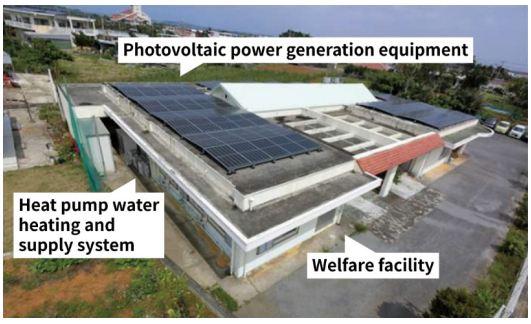

Fig. 2. Status of the project to promote widespread use

3. SPSS-H

The use of photovoltaic power generation systems, storage batteries, and EV chargers by general consumers is

expected to spread further due to the declining prices of photovoltaic power generation systems and storage batteries, in particular. However, the output of photovoltaic power generation is significantly affected by the meteorological environment, such as weather. If photovoltaic power generation is introduced on a large scale and its share increases on the power grid, it will become difficult to maintain power grid stability.

As one of the solutions, Nissin Systems proposed a system capable of ensuring the power grid stability by using the SPSS-H. In the SPSS-H, a zone subject to monitoring is divided into multiple management classifications (hereinafter referred to as "areas"). Multiple customers within an area are clustered, and the photovoltaic power generation amount is predicted for each customer in respective areas. Based on the results, the load control for charging storage batteries and EVs and boiling water in energy-efficient water heating and supply systems is optimized, making it possible to level the load of overall demand and supply.

Thus, the SPSS-H is useful for local governments and new power companies, which have been working to promote carbon neutrality and decarbonization and enhance resilience, and for power purchase agreement (PPA) operators, which hope to introduce photovoltaic power generation on a large scale.

3-1 System configuration

The SPSS-H consists of a cloud system used to manage different areas together and a HEMS gateway installed for multiple customers within an area. It has the following functions (Fig. 3).

① Visualization of energy resources for each customer
② Prediction of the photovoltaic power generation amount
③ Storage battery control
④ Control of energy-efficient water heating and supply systems
⑤ EV charger control
⑥ Device failure notification function

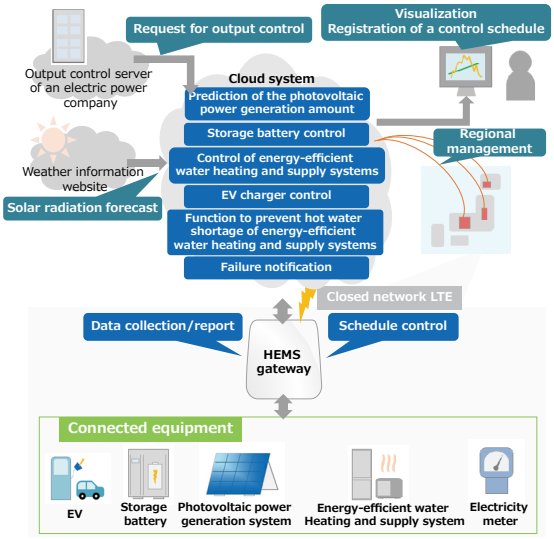

Fig. 3. Configuration of the SPSS-H system

3-2 Elemental technologies

(1) HEMS gateway

Nissin Systems' HEMS gateway, shown in Fig. 4, is an edge computer that meets the IP 66 waterproof and dustproof requirements to enable outdoor installation, maintenance-free operation, prevention of misoperation by residents, and stable communication with energy resources. The HEMS gateway is equipped with the following communication interfaces.

Standard features: LTE-supported communication device, wired LAN port, RS485

Supported communication devices (optional): Wi-Fi, Wi-SUN

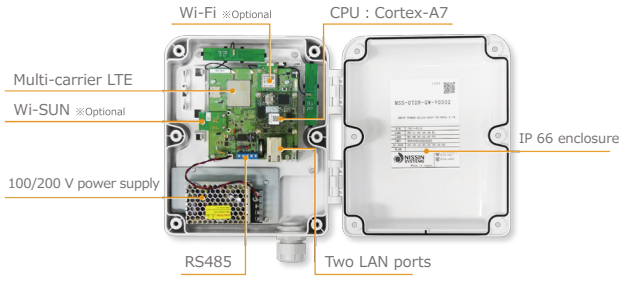

Fig. 4. HEMS gateway

Table 1. Specifications of the HEMS gateway

Item	Specifications
CPU	ARM Cortex-A7 (528 MHz)
RAM	512 Mbyte
ROM	eMMC 3.8 GB
Mobile communication	3G/LTE (EC25-J manufactured by Quectel)
Interface	LAN × 2, RS-485 × 1, USB2.0 (Host) × 1
Option (detachable)	Wi-Fi (IEEE802.11 b/g/n) Wi-SUN B route
External storage	microSD Card Slot × 1
RTC	Monthly difference ±45 sec
Switch	1
LED	3 (for user) + 1 (for power supply only)
Power supply	100/200 VAC terminal block type (L/N/FG terminal) *Excl. power cable
Outdoor durability	IP 66 dustproof and waterproof −20 to 50°C, 20 to 85% RH
Design life	10 years (mean air temperature: 35°C)
External size	200 × 240 × 99 mm (excl. protrusions)
Weight	Approx. 1 kg
Communication between resources	ECHONET Lite, Modbus

(2) Cloud system

The cloud system is equipped with functions to enable remote monitoring, control, and failure notification for energy resources installed at customer sites via the HEMS gateway.

The details of the main functions are described below.

(a) Visualization

Visualization refers to a function to enable real-time confirmation of the status of energy resources based on

trend graphs and messages and prediction of the photovoltaic power generation amount.

(b) Prediction of the photovoltaic power generation amount

Prediction of the photovoltaic power generation amount refers to a function to predict the photovoltaic power generation amount for each area based on the solar radiation forecast information for the following day obtained from a weather information website (see Fig. 5).

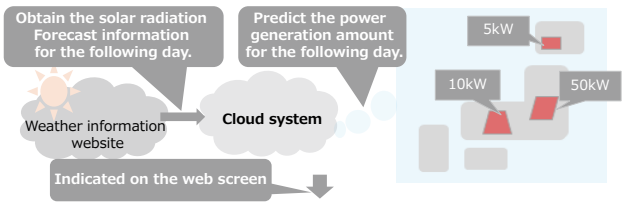

Fig. 5. Prediction of the photovoltaic power generation amount

(c) Storage battery control

Storage battery control refers to a function to create a charging schedule and perform charging control during time slots in which excess electric power is predicted to increase based on prediction of the photovoltaic power generation amount for each area (Fig. 6). It also refers to a function for an electric power company to control the output.

It becomes possible to secure the remaining storage battery charge in preparation for a disaster by setting the upper and lower limits for the state of charge (SOC: remaining battery charge).

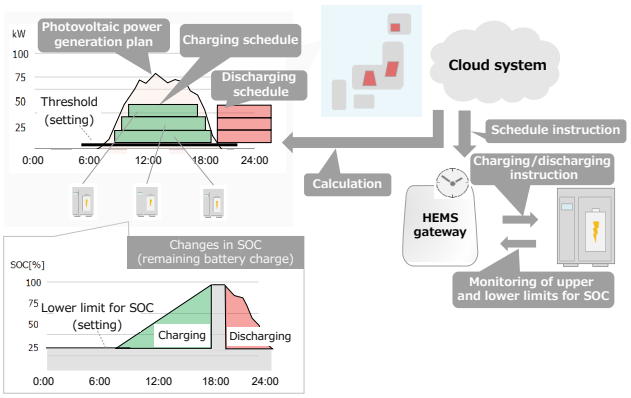

Fig. 6. Storage battery control

(d) Control of energy-efficient water heating and supply systems

Control of energy-efficient water heating and supply systems refers to a function to create a water boiling control schedule for energy-efficient water heating and supply systems and perform water boiling control during time slots in which excess electric power is predicted to increase based on prediction of the photovoltaic power generation amount for each area, as shown in Fig. 7.

It also monitors the volume of hot water remaining in energy-efficient water heating and supply systems in a one-minute cycle and automatically boils a certain volume of water when the volume of remaining hot water falls below the designated level to prevent hot water shortage.

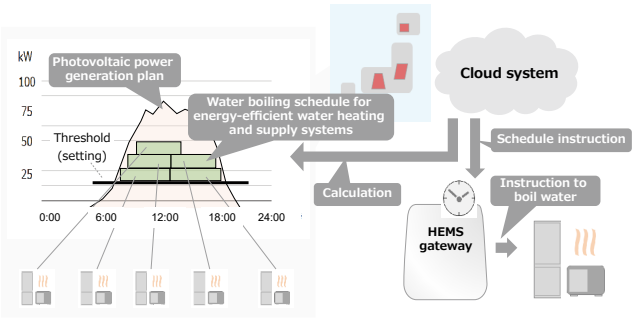

Fig. 7. Control of energy-efficient water heating and supply systems

(e) EV charger control

EV charger control refers to a function to control EV chargers during time slots in which excess electric power is predicted to increase based on prediction of the photovoltaic power generation amount (Fig. 8).

It can also reduce the charging power consumption to avoid exceedance of the upper limit set for the contract demand.

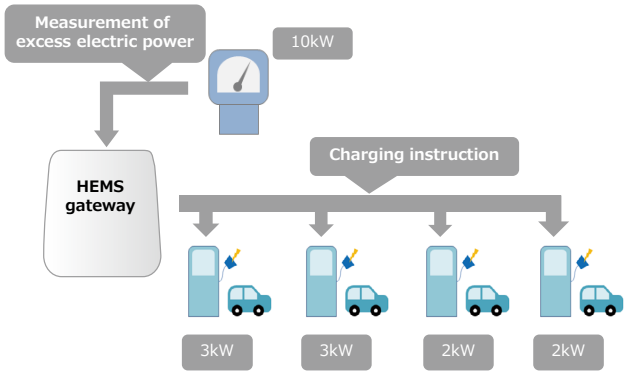

Fig. 8. EV charger control

(f) Failure detection

Failure notification refers to a function to monitor the failure status of energy resources in real time and give notification to smartphones via LINE WORKS when a failure is detected. Real-time monitoring of the failure status of devices helps improve the energy supply services and maintainability (see Fig. 9).

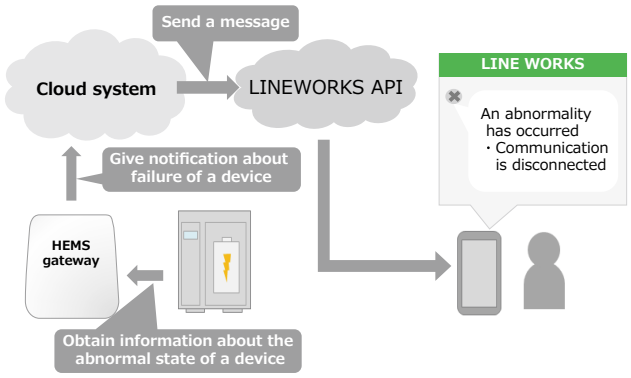

Fig. 9. Failure detection

4. Conclusion

This paper introduced technological elements related to the SPSS-H. Nissin Systems remains committed to focus on the development of energy and IoT technologies, which have been refined through many years of operations, to cope with changes in the electric power energy business.

With drastic measures for decarbonization and climate change underway, the SPSS-H can offer value in various aspects when introducing renewable energy on a large scale as the main power supply in a region. Nissin Systems will contribute to attaining SDGs by offering the SPSS-H services and promoting energy businesses with a view to achieving integration with regional microgrids (SPSS-Island).

Technical Term

∗1 Smart Power Supply Systems (SPSS): A solution developed by Nissin Electric Co., Ltd. that achieves both energy conservation and stable supply of electric power by combining various distributed power supplies.

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Source of reference

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