Technology that Evolves in Line with Market Changes

Naohiko Shiokawa Hiroshi Hirata Takeshi Hama Hiroyuki Hanaoka Shinichiro Yamagishi

1. Introduction

For industrial products, the emergence of new markets and changes in existing markets have the effect of changing how products are used and what they are used for. Such changes lead to new demands from manufacturers for additional functions or enhanced performance. These are opportunities for manufacturers to evolve the technologies used in their products.

Uninterruptible power supplies (UPS) and power conditioners made by Power Systems Division are no exceptions and we are constantly taking on new challenges to address the ever-changing market for these products.

UPS devices were conventionally adopted by data centers and communication services. However, a new market has emerged in the industrial market, resulting in UPS being adopted in manufacturing facilities. Moreover, new products are appearing which utilize storage devices or secondary batteries as a substitute for the conventional lead-acid battery, which has been used for many years.

Meanwhile, the feed-in tariff introduced in 2012 has transformed the renewable energy market in Japan. The total installed capacity of renewable energy has increased significantly, but users now place emphasis on the cost-benefit ratio over the 20-year period that the feed-in tariff is valid for. Since this scheme was introduced, it has been amended every year and is creating radical changes in the market. In addition, the capacity of power distribution equipment could not keep up with the increasing installation of renewable energy, therefore new regulations limiting power generation depending on the circumstances were introduced.

We at Power Systems Division must constantly monitor market changes such as these and evolve our technologies.

This document introduces recent changes in the UPS market and renewable energy market and the related initiatives engaged in by Power Systems Division.

2. UPS Market Example

2.1 UPS market changes

2.1.1 Changes in the operating environment

Figure 1 shows the usage examples of outdoor devices.

Until recently, main applications for small-capacity UPSs were as backup for servers and ICT devices or for embedding in industrial devices. However, due to the recent spread of mobile devices and lessons learned from natural disasters, UPS devices are now increasingly being used as backup for outdoor equipment such as mobile phone communications base stations, parking meters, outdoor surveillance cameras, traffic lights, and emergency equipment.

A new demand has emerged for medium-to-large capacity UPS in the industrial market, where UPS devices are being adopted in manufacturing facilities. In particular, the UPS usage is expected to further accelerate due to IT developments at manufacturing sites and advancements in automation and robotics.

2.1.2 Changes in power failure compensation time

Social infrastructure equipment such as traffic lights and equipments used at the time of disaster such as wireless systems for disaster are required to have longer power failure compensation time due to lessons learned from previous natural disasters. However, a large amount of energy is used by the backup devices of manufacturing facilities; therefore, to cut costs, in some cases only instantaneous voltage drops and instantaneous power failures are subject to compensation.

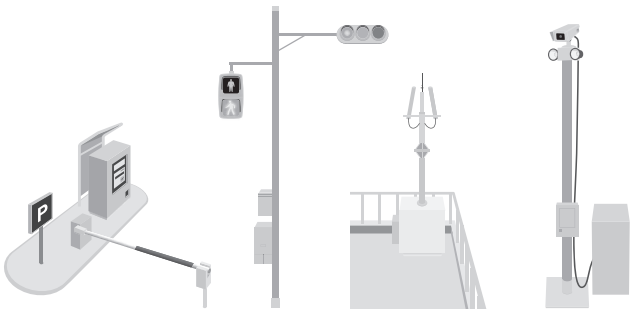

Fig. 1: Examples of UPS used in outdoor devices

2.2 Technological issues responding to changes in the UPS market

2.2.1 Adapting to tough operating environments

UPS equipped in equipments used during disasters, in cellular base stations, with traffic lights, and so on are installed outdoors and must be suitable for use in a wide-range of temperatures. Moreover, since regular inspections and replacement cannot be easily carried out, UPS for outdoor use must be maintenance-free.

Even when used in factories UPS are often installed in poor environments compared with ICT buildings, where they have conventionally been located. For this reason, countermeasures against dust and moisture, in addition to temperature and humidity, must be taken into consideration.

2.2.2 Adapting to new storage devices

UPS which are used outdoors have limited installation space, therefore must be compact as well as provide prolonged backup. Conventional lead-acid batteries have a short backup time relative to their volume and mass, so a large installation space is necessary to achieve prolonged backup. Moreover, lead-acid batteries must be replaced due to their short service life. Lithium-ion rechargeable batteries (LiB), which feature superior energy density and service life, solve these issues. With LiB, in order to satisfactorily draw out battery capacity and ensure safety, more precise management of the voltage and current being discharged and charged is needed compared with lead-acid batteries. As such, discharging and charging must be appropriately managed through communication with a battery management system (BMS) that monitors the status of LiBs.

Electric double-layer capacitors (EDLC) are sometimes used as UPS in manufacturing facilities to provide backup for short periods. The voltage characteristics when an EDLC is discharging or charging differ to those of lead-acid batteries, and there is a need to review charging/discharging voltage control.

2.3 Technical responses to solve the issue

For small capacity UPS, SANYO DENKI has established a technology which enables outdoor installation through the combination of an LiB and a converter with high conversion efficiency. Compared to using conventional lead-acid batteries, LiB offer the benefits of prolonged backup in smaller installation space and less maintenance work due to not requiring replacement of batteries. This technology is also suited to outdoor use.

UPS can be used in a wider temperature range than conventional products through innovative implementation of internal components, enhanced cooling performance, and combination with LiB, which offer high temperature resistance. These technological developments make it possible to design a UPS suitable for outdoor use in a wide range of temperatures.

If UPS are used as power sources manufacturing facilities to cut peak power or effectively utilize regenerative electric power, the “C23A” series (an instantaneous voltage drop compensator that uses EDLC) is a suitable product. The “C23A” was developed based on the “E23A” series UPS, and effectively utilizes the features of EDLC whereby a large current can be charged/discharged.

3. Renewable Energy Market Example

3.1 Changes in the renewable energy market

3.1.1 Introduction of the feed-in tariff

A factor which requires special mention that has impacted the renewable energy market in recent years is the feed-in tariff scheme introduced in 2012.

Previously, the approach of installing PV power generation systems to reduce electricity costs proved unsatisfactory as it was difficult to recover costs within ten years. Consequently, PV power generation systems did not become that popular, and were only adopted by users in regions where good sunlight conditions and comparatively longer operating times could be expected, or by environmentally-conscious users who wanted to reduce their usage of fossil fuels as much as possible.

In response, Japan introduced the feed-in tariff system which had already largely contributed to the popularization of PV power generation systems in Europe. This led to widespread installation of PV power as not only a means of contributing to the global environment, but also as a source of income.

3.1.2 Saturation of power transmission/ distribution capacity

Of the various kinds of renewable energy, the introduction of the feed-in tariff was most effective in regards to PV power generation systems. However, it was not possible to sustain the supply and demand balance conventionally controlled by power utilities, and concerns arose regarding the inability to assure a stable power supply. In response, the Agency for Natural Resources and Energy issued partial amendment of the ordinance. This made it mandatory for companies to install output control systems on power generation equipment that utilized renewable energies.

3.1.3 Applications of peak-cut and emergency power source

With the purchase price falling year by year, there is an increasing amount of attention from electricity retailers towards systems with storage batteries to serve as emergency power sources during disasters or for peak-cut purposes.

3.2 Technical issues in the renewable energy market

3.2.1 Maximization of power generation capacity

Improvement of power generation efficiency has always been demanded in order to maximize power generation capacity. However, with the introduction of the feed-in tariff scheme, it is now demanded more than ever as higher power generation efficiency directly translates to higher earnings. Moreover, the most important point when considering PV power generation as a long-term source of income is the continuation of power generation; therefore, PV inverters are required to have higher reliability.

3.2.2 Output limitations

Output limitations are imposed by power utilities to restrict connections to electrical utility grid such as PV power generation equipment. Output limitations had always applied to PV power generation equipment with a capacity of 500 kW or above, but the amendment to legislation brought about the below changes.

1. Output control previously only applicable to PV power generation equipment with capacities of 500 kW or above was expanded to cover capacities of less than 500 kW.
2. Period of time for output control with no compensation was changed from 30 days a year to 360 hours a year.
3. Made installation of remote output control systems mandatory in order to perform output control.

SANYO DENKI products must conform to these requirements too.

3.2.3 System equipped with a storage battery

When performing isolated operation using a PV inverter with a storage battery as an emergency power source during disasters, sometimes SANYO DENKI's conventional power conditioner could not effectively use power generated by PV panels. This is because the structure is one in which the storage battery is connected to the PV power input, meaning that the PV power input voltage is affected by the storage battery. Therefore, even if the power generated by the PV panels can be charged into the storage battery, MPPT (maximum power point tracking) control is ineffective.

3.3 Technical responses to solve the issue

3.3.1 (1) Multi-circuits of MPPT control in the "P61B" series

Figure 2 shows a method to increase efficiency using multiple PV panels.

There is an increasing number of cases where PV panels are installed on a large-scale compared to previous cases, in order to increase power generation. If PV panels are installed on a house roof facing not only south, but also east and west, the amount of power generation will differ between panels depending on which direction they face. Since conventional MPPT control identifies the best point of efficiency for a group of PV panels, connecting panels with different power generation amounts to one PV inverter would not improve efficiency. Previously, in order to solve this issue, it was necessary to install a PV inverter for each string, which amounted to higher costs.

Figure 3 is an external view of the "P61B", while Figure 4 is the "P61B" circuit block diagram. Figure 5 shows an example of using multiple PV panels with the "P61B".

SANYO DENKI's "P61B" PV inverter has two boost converter circuits and MPPT control can be performed on each of these independently. This makes it possible to maximize the power generation efficiency of two strings of PV panels with only one PV inverter.

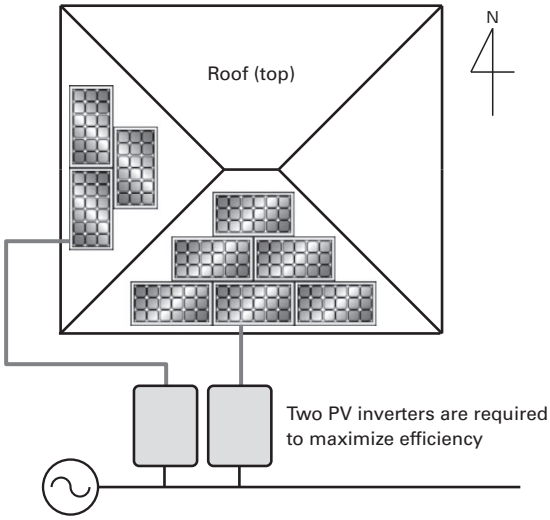

Fig. 2: A method to increase efficiency with multiple PV panels

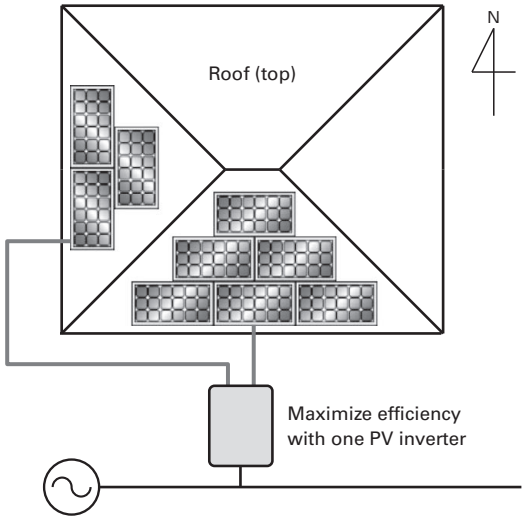

Fig. 5: An example of using multiple PV panels with the "P61B"

Fig. 3: External view of the "P61B"

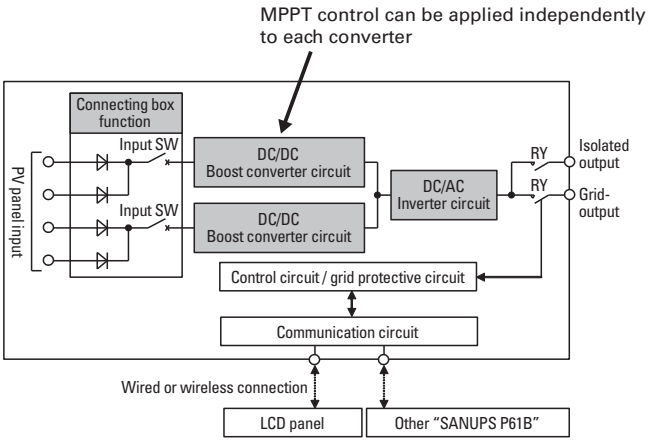

Fig. 4: "P61B" circuit block diagram

3.3.1 (2) Increase the reliability in the "P61B" series

The "P61B" series adopts a sealed structure, achieving a IP65 protection rating from dust and water ingress. This means that rain, dust, insects, animals, and so forth cannot penetrate the "P61B" so stable operation can be expected even outdoors.

Moreover, the standard warranty period of one year can now be extended to ten years with the newly introduced long-term warranty extension service.

3.3.2 Addition of an output control function on the "SANUPS PV Monitor E Model"

Since the introduction of the feed-in tariff, the number of electricity retailers has grown, creating increased demand for system maintenance and monitoring. In response, SANYO DENKI developed the "SANUPS PV Monitor E Model", a device for monitoring PV power generation systems, in December 2013. Then, to answer demands for output limitation, we added an output control function. Figure 6 is an external view of the "SANUPS PV Monitor E Model" with output control.

Fig. 6: External view
of the "SANUPS PV Monitor E model"
with output control function

As an output control unit, the "SANUPS PV Monitor E Model" with output control function is capable of being connected to up to 27 units of our PV inverters. Figure 7 shows the configuration of an output control system using this product. Two configurations are available. In one system configuration, the output control schedule is updated from time to time using an Internet connection (an output control system based on rewriting of the output control schedule). In the other system configuration, the electricity retailer themselves updates the output control schedule periodically, even when there is no Internet connection (an output control system based on a fixed schedule).

3.3.3 "SANUPS P73K" grid-connected, isolated, charging operation type

The "SANUPS P73K" grid-connected, isolated, charging operation type has been added to SANYO DENKI's lineup of PV inverters with storage batteries. With the "SANUPS P73K", a storage battery can be connected to the newly-developed charging unit on which bidirectional control (charging/discharging) is possible to ensure PV power input voltage is unaffected by storage battery voltage. By taking this approach, it has become possible to perform MPPT control even during isolated operation and efficiently utilize the power generated by PV panels.

4. Conclusion

This document has introduced the activities of the Power Systems Division in response to changes in the power source market. We will continue to swiftly and accurately assess market changes and implement technical developments allowing products to be enhanced with new value.

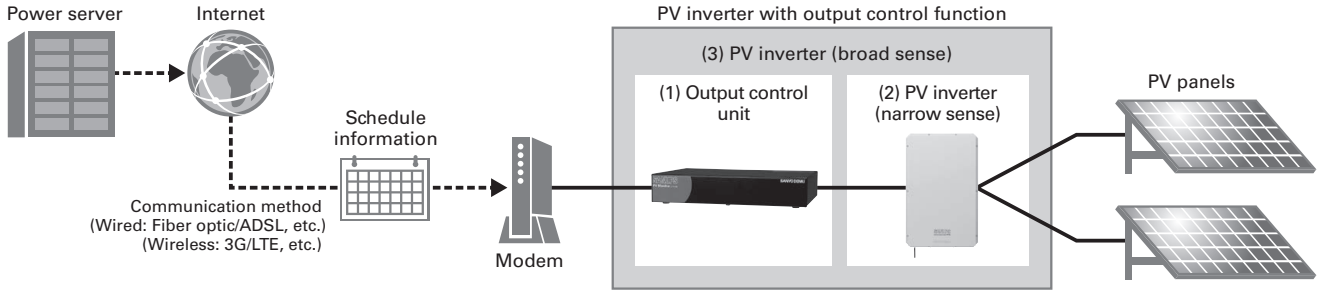

Fig. 7: Configuration of the PV Power System with an Output Control Function

Naohiko Shiokawa
Joined SANYO DENKI in 1989.
Power Systems Div., Design Dept. 3
Works on the development and design of power supplies.

Hiroshi Hirata
Joined SANYO DENKI in 1985.
Power Systems Div., Design Dept. 1
Works on the development and design of UPS.

Takeshi Hama
Joined SANYO DENKI in 1986.
Power Systems Div., Design Dept. 1
Works on the development and design of PV power systems.

Hiroyuki Hanaoka
Joined SANYO DENKI in 1988.
Power Systems Div., Design Dept. 2
Works on the development and design of UPS.

Shinichiro Yamagishi
Joined SANYO DENKI in 1991.
Power Systems Div., Design Dept. 2
Works on the development and design of UPS.