Energy Management System Using ICT

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Abstract

Our world is undergoing radical changes with the rapid spread of photovoltaic (PV) power generation and Japan's review of energy policy since the earthquake. We can say that it is becoming increasingly important to finely control a proper balance of the power grid as we shift from an age of merely "purchasing" electricity through a power company to an age of "producing" and "saving" electricity on the demand side. NEC is effectively using the basic technology cultivated for many years in the construction of monitoring control systems for social infrastructure equipment. Quick monitoring control technology is being developed over a wide area and is being demonstrated for energy equipment installed in various social infrastructure equipment or users' premises. This paper introduces its development and future product development.

Keywords

Energy Management System (EMS), smart grid, monitoring control system, transfer cutout

1. Introduction

The environment surrounding Energy Management Systems (EMS) is significantly changing with the rapid spread of new energy devices, such as photovoltaics (PVs), electric vehicles (EVs) and household energy storage batteries. At the same time, we have newly realized that a stable supply of electric power and efficient use of electric power are indispensable to leading a safe and comfortable life through the experience of the Great East Japan Earthquake.

NEC has been constructing various monitoring control systems for social infrastructure that use the newest innovations in well-cultivated, advanced and rich information and communication technology (ICT).

Section 2 gives an overview of the EMS. Section 3 introduces EMS-supporting energy equipment installed on users' premises during demonstration experiments. Section 4 describes the wide-area infrastructure for the EMS future development plan.

2. Overview of EMS

Since a variety of energy devices are in wide use, such as PVs, storage batteries, EVs and private electric generators, we believe it is necessary for comprehensive energy management to consider not only the one-way flow of electric power from the power company to the users, but also opportunities for producing and saving energy on the demand side.

NEC has cultivated superior monitoring control technology with high reliability and durability in the development of the electric power monitoring control systems currently managed by electric power companies. We are applying this know-how to monitoring control networks for energy equipment installed on users' premises and will be developing it into the next generation of wide-area monitoring control technology. **Fig. 1** shows an overview of NEC's EMS targets. We are moving toward highly flexible energy management that covers a wider field, i.e. not only equipment installed in the electric power grid, but energy equipment installed in factories, public facilities and homes.

NEC has a highly proven track record in the field of high-quality electric power monitoring control systems that once belonged to electric power companies.

In electric power monitoring control systems, the following points are significantly important:

1) Information loss prevention
2) Securing specified responses
3) Incorrect information transmission prevention
4) Security
5) Efficiency of maintenance and operation

NEC has constructed a high-quality and efficient monitoring control system using exclusive hardware and various protocol procedures and complicated packet processing, including IPs accumulated as software assets, to realize the items mentioned above. These systems are widely used in NEC's social infrastructure system as well as in our electric power

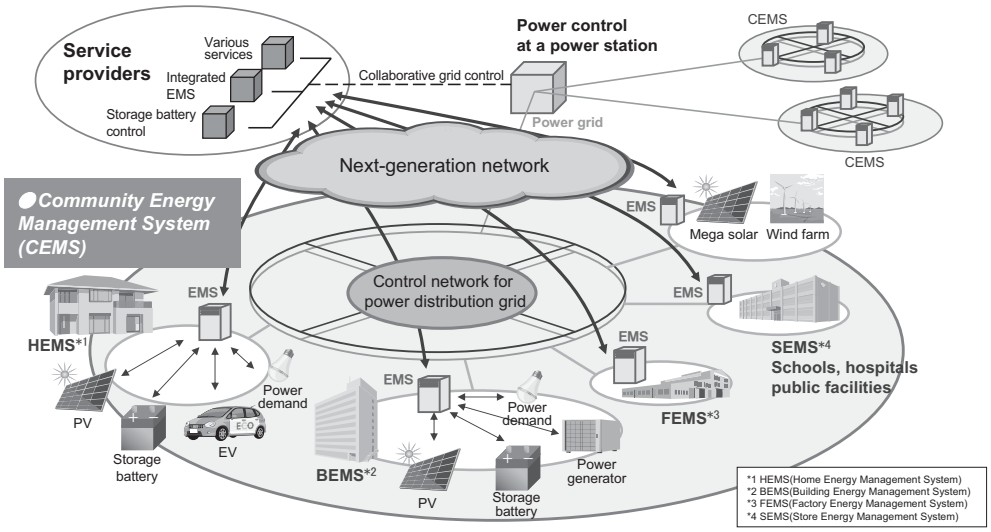

Fig. 1 Schematic diagram of EMS.

monitoring control system.

It is assumed that the next generation of wide-area monitoring control systems will apply this monitoring control technology to cooperate and harmonize between the existing electric power grid and local EMS. Under the old monitoring control system, only equipment installed in the electric power grid was regarded as a control target. However, when power generation from each user, such as PVs, is involved, it is necessary to control tens of thousands of devices on a regional basis. NEC is developing EMS that assumes control of many devices to conduct demonstration experiments. Below we introduce how we have been working towards this.

3. Demonstration experiments introducing EMS

We are conducting demonstration experiments introducing a transfer cutout system for distributed power sources. This is one of the management systems supporting the new energy devices being installed on the demand side.

Transfer Cutout System for Distributed Power Sources

The spread of PVs and the like is progressing quickly and when many distributed power sources, such as PVs, are introduced, various problems are expected to occur in the electric power grid. This system is effective at solving the problems that arise when new energy is widely distributed. In addition, it is also applicable to the development of new services for wide-area monitoring control of energy equipment, by taking advantage of its ability to "deliver information widely and all at once." Quick monitoring control is possible from the level of the electric power company to the level of each individual user.

(1) System configuration

This control system consists of the following: first, an "information communication master control unit" (master control unit) for the control system, located at the electric power company; second, an "intelligent concentrator" (Micro-DX) installed on a power pole; third, an "information slave unit for the control system" (slave unit) installed by each user. The slave unit is installed to support the interfacing of PVs between the grid and the user. Micro-DX serves as gateway (GW) equipment to support the final mile of the connection.

Joint research is being conducted between NEC and the Chugoku Electric Power Co., Inc. Energia Economic and Technical Research Institute. System effectiveness is scheduled to be verified by a Japan-U.S. smart grid demonstration in New Mexico, USA that is the contract research of the Independent Administrative Agency, New Energy and Industrial Technology Development Organization (NEDO). **Photo** shows Micro-DX and the

slave unit during a demonstration at Chugoku Electric Power Co., Inc.

(2) Functions

The following functions are realized in NEC's transfer cutout system for distributed power sources. **Fig. 2** shows a schematic diagram of this system.

1) Specifying the user connected with an existing system

Since the master control unit handles database management for the intelligent concentrator and the slave unit, it is possible to handle database management for a large number of new energy devices, such as PVs. In addition, when this system is connected with an existing power system, the power distribution grid status of each device can be identified and the device for which control is required can be specified instantly using information connected with an accident.

When the master control unit receives accident information, signals are transmitted through a global broadcast recognized as urgent information through the Micro-DX and then simultaneously to tens of thousands of slave units. The slave unit (user device) judges the details of the received signal and reacts and controls only when the signal is applicable. One of the features of this system is that only the target user device can be securely controlled even though the signals are sent to many control targets through a global broadcast. **Fig. 3** shows a simulated display of the information concentrator. The signals are sent to all groups, but the control targets are only groups A and C.

2) Information concentrator securing real-time capability

In this system, it is necessary to complete the disconnection of PVs within one second of the occurrence of an accident in order to prevent PV islanding. Even when low-speed PLC communication with a speed of 7.5 kbps is used for the "last mile," we confirmed that it can be controlled in less than 200 ms from the reception of accident information to the completion of PV disconnection.

Micro-DX realizes effective transmission by reliably adjusting between different speeds of IP communication, PLC communication and wireless communication. It is possible to transmit not only urgent control information but also low-priority monitoring information according to each application of the information concentrator in consideration of these balances.

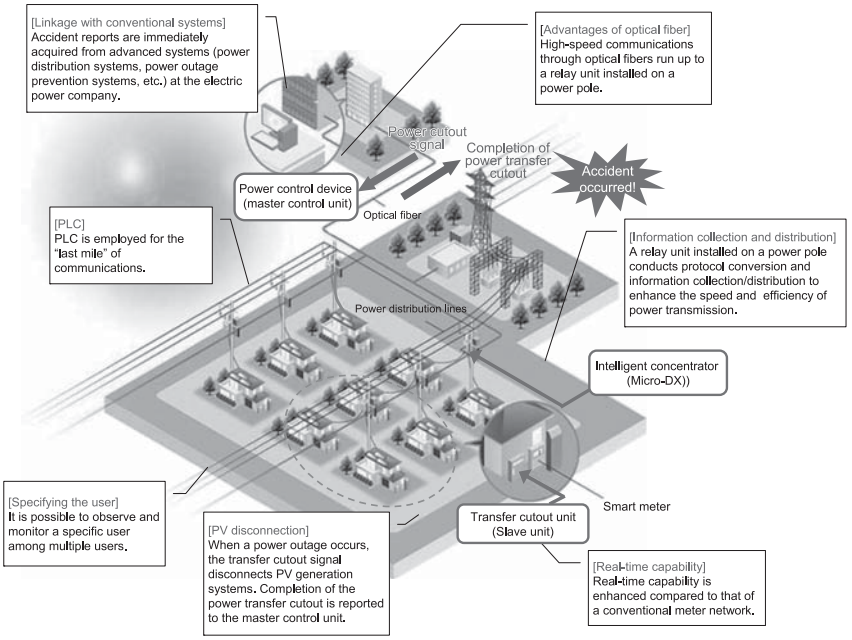

Fig. 2 Transfer cutout systems for distributed power sources.

Micro-DX (intelligent concentrator) Slave unit

Photo Demonstration experiment of a transfer cutout system for distributed power sources.

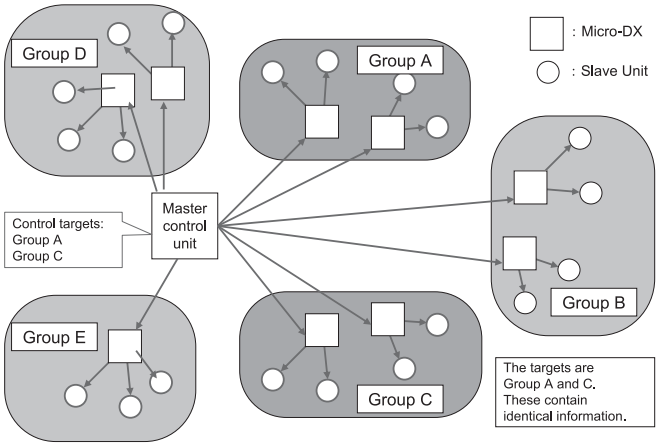

Fig. 3 Information distribution in NEC's transfer cutout system for distributed power sources (simulated display).

4. Wide-area Infrastructure for EMS Designed for Social Infrastructure Systems

NEC develops monitoring control systems not only for electric power fields but also for social infrastructure in general, such as river dams, water supply and sewerage, railways, roads, buildings, etc. Monitoring control technology using ICT is now favored for the construction of wide-area infrastructure for EMS to balance the supply and demand of energy between various devices. **Fig. 4** is a simulated display of the implementation considered by NEC.

When supply and demand are optimally balanced based on the electric power company's grid information, natural energy including PVs and the consumption status of each region,

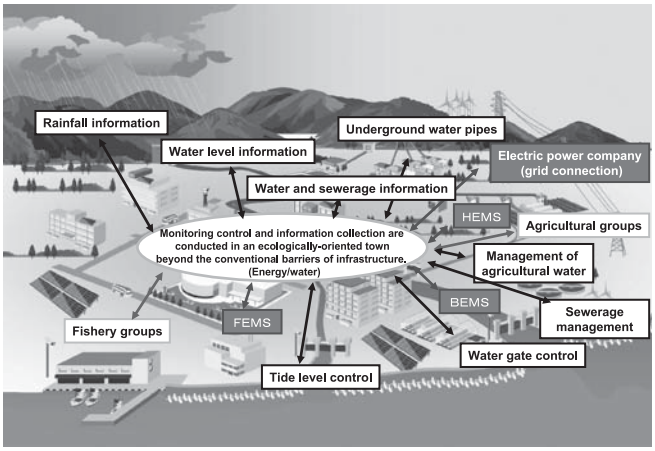

Fig. 4 Wide-area infrastructure for EMS (simulated display).

we believe an optimal EMS can be realized, which leads not only to solving the problem of the spread of natural energy but also to energy saving.

When the simultaneous multi-control mechanisms of a transfer cutout system for distributed power sources are used to quickly control a large number of energy devices and when the monitoring control system of the existing infrastructure is connected, the information to be managed can be consolidated. By doing so, the control target devices will no longer be tied to their location, so that management can be unified in local or community units. We believe it is possible to collect and deliver controls and information "widely and all at once" between various units based on managed information. Furthermore, we believe various additional applications will be realized once cloud computing information is connected.

5. Conclusion

In this paper, we have introduced our highly capable monitoring control technology for a social infrastructure system and next-generation EMS. Product development is currently underway through demonstration experiments.

Japan's energy policy has reached a turning point in response to global demands for CO_2 reduction, the nuclear power plant disaster, etc. When we take for granted the existence of natural energy, batteries and EVs in the world, we believe that the functions and roles required for a social infrastructure system will also change.

NEC will contribute to realizing a safe, secure and comfort-

able society by offering an EMS that meets today's needs through advanced ICT technical developments.

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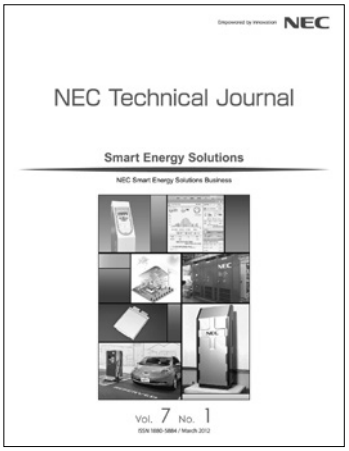

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