# Social Infrastructure

Power System and Distribution
Energy Management
Social Environment

## Outlook

In the power system and distribution field, stable system operation is more desired than ever for reasons including the impact of the suspension of nuclear power plants. Effective use of hydroelectric power plants is also important for the purpose of ensuring power resources. This has produced demand for highly efficient operation of dams and regulating reservoirs corresponding to the characteristics of water systems and more efficient generator operation achieved by introducing a water outflow forecasting function. What is also desired is international contributions in the form of applying power system control technology used in Japan to developing countries in Asia and other parts of the world that do not have sufficient power supply equipment.

Fuji Electric continuously delivers supervisory control systems in this field and strives to develop dam management systems and power generation centralized supervisory control systems. We have developed and delivered management systems and dam peripheral equipment for the Dashidaira Dam of Kansai Electric Power Co., Inc. and dams under the jurisdiction of the Ministry of Land, Infrastructure, Transport and Tourism and prefectures. In addition, we have delivered a power plant remote control system to the Bureau of Transportation Tokyo Metropolitan Government. For protection control systems, we have developed retrofittable unit relays and proposed a method of renewal that allows existing equipment to be used effectively. In view of complete digitization of electric station local area networks in the future, we are also working on the development of intelligent electronic devices (IEDs). Furthermore, for power distribution automation systems, we have developed software that can be used overseas and started rolling it out to Asian countries, where the average power outage time is longer than in Japan.

In the future, a reform of electricity systems will progress in the power system and distribution field and more efficient energy operation must be pursued. To that end, we have already developed an integrated management system for upstream and downstream dams of pumping-up power plants, which will be rolled out in Japan. In addition, we intend to make use of the gate control technology developed with dam management systems to work on remote supervisory control of floodgates and land sluices as measures against tsunami and contribute to the realization of a safe and secure society.

In the energy management field, effective use of energy is becoming increasingly important in Japan due to the impact of the rising electricity prices caused by the price hike of crude oil, in addition to the impact of the suspension of nuclear power plants. In developing countries in Asia and other parts of the world, growing populations and developing economies have caused energy demand to rapidly increase. In these circumstances, the need for energy management systems (EMSs) that ensure efficient use of electricity and heat is increasing all the more, which lead to cost reductions and environmental awareness.

In Japan, as a principal company participating in the Kitakyushu Smart Community Project, Fuji Electric has used independently developed cluster energy management system (CEMS). This system is the core of the Smart Community Center, to implement continuous field-test for the optimum operation of regional energy by means such as demand response, dynamic pricing and simultaneous balancing control. In addition, we are taking part in the Next-Generation Energy and Social System Demonstration Project run by the Ministry of Economy, Trade and Industry and have delivered a building and energy management system (BEMS) to Keihanna Plaza to work on the optimum operation of energy at facilities. As a new approach, we have developed an intelligent DC multiterminal power supply and verified the technology by using a DC power supply in the Mie University Smart Campus Project run by the Ministry of Economy, Trade and Industry. In the Demonstration Projects for Next-Generation Power Control Systems by Two-Way Communications of the Ministry of Economy, Trade and Industry, we implemented field-test for power output control of new energy power generation using

two-way communications. These two technologies can help to effectively utilize renewable energy. As part of overseas development, we have made use of the technologies and products accumulated and received an order for a micro-grid system from the Kingdom of Tonga and took part in a demonstration of new energy in Zhoushan, China.

In the future, we intend to roll out the CEMS developed in demonstration projects to help create new communities for earthquake disaster recovery and other purposes. In addition, we will make contributions to the provision of advanced energy services that accommodate the standardization trends in view of overseas development and new energy systems.

In the social environment field, the cost reduction effect of applying cloud computing to local government systems is being ascertained by looking at instances of its introduction in forward-thinking local governments. As social infrastructure to support daily life of people, the introduction of the Social Security and Tax Number System is gaining momentum.

In these circumstances, Fuji Electric has been striving to develop the cloud-based Local Government Integrated Address e-System, which accommodates the Social Security and Tax Number System. By enhancing mission-critical and internal information systems, many of which are already in operation as cloud services, with new services, we will accelerate cloud-based shared use that goes beyond the borders of prefectures and municipalities and help further reduce the costs of local governments.

## Power System and Distribution

### 1 Otozawa Power Station Dam Monitoring Console for Kansai Electric Power Co., Inc.

Fuji Electric worked in cooperation with Enegate Co., Ltd. to deliver an Otozawa Power Station dam monitoring console to Dashidaira Dam, which is located on the Kurobe River drainage system, for Kansai Electric Power Co., Inc. in March 2014.

The main features of the dam monitoring console are as follows:

(1) The console is a function distribution system with the outlet facility control function separated from the information function for recording and storing operation results and other data.
(2) The arithmetic processing unit responsible for the control function has a redundant configuration to improve system reliability.
(3) FL-net, an open network standard of the Japan Electrical Manufacturers' Association, is adopted for the inter-device communications of the control function.
(4) Information of dam water level and outflow discharge are linked with the load dispatching control center in real-time to realize smooth water operation of the entire Kurobe River drainage system.

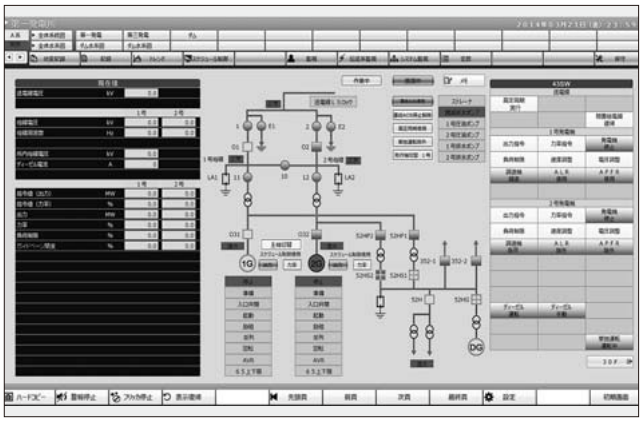
Fig.1 Dam monitoring console

### 2 Remote Control System for Power Plants of Bureau of Transportation Tokyo Metropolitan Government

For power plants of the Bureau of Transportation Tokyo Metropolitan Government, we delivered a hydroelectric power plant supervisory control system, remote supervisory control system and dam monitoring operation equipment. Remote supervisory control is provided for three hydroelectric power plants and one regulating reservoir dam in Okutama. The main features are as follows:

(1) The hydroelectric power plant supervisory control system is composed of redundant supervisory control servers (UNIX) and three display consoles.
(2) An IP network is used for communications between the hydroelectric power plant supervisory control system and the remote supervisory control system and PMCN, which is an industrial protocol of the Japan Electrical Manufacturers' Association, has been adopted as the transmission scheme.
(3) A universal design has been applied to the screen of the display consoles to improve operability and visibility.
(4) For supervisory control of the regulating reservoir dam, a dedicated dam monitoring operation device has been installed in view of emergency operation and backup operation.

Fig.2 Sample operation screen of the hydroelectric power plant supervisory control system

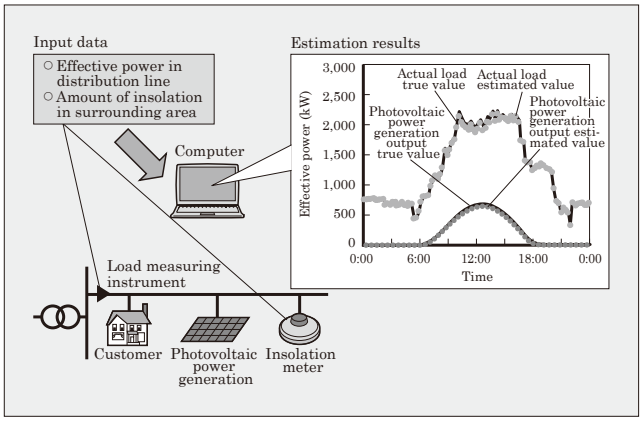


### 3 Technology to Estimate Photovoltaic Power Generation Output and Load for Power Distribution Automation System

Photovoltaic power generation is becoming rapidly widespread, supported by the Feed-in Tariff Scheme for renewable energy. In a power distribution system with photovoltaic power generation and customers mixed together, the load appears to be light in normal times, which makes it necessary to accurately isolate and grasp the actual load required for recovering from accidents. In reality, however, only the sum of the photovoltaic power generation output and the actual load of customers is measured. Accordingly, as an accident recovery function of the next-generation power distribution automation system, Fuji Electric is working on developing technology to isolate and estimate the respective values from the measured sum.

One main feature is that it estimates the output of photovoltaic power generation and the actual load of customers from the effective power of the distribution line and the amount of insolation in the surrounding area. As a result, it allows the user to grasp the load required for accident recovery without needing to install individual measuring instruments.

Fig.3 Example of photovoltaic power generation output and load estimation results

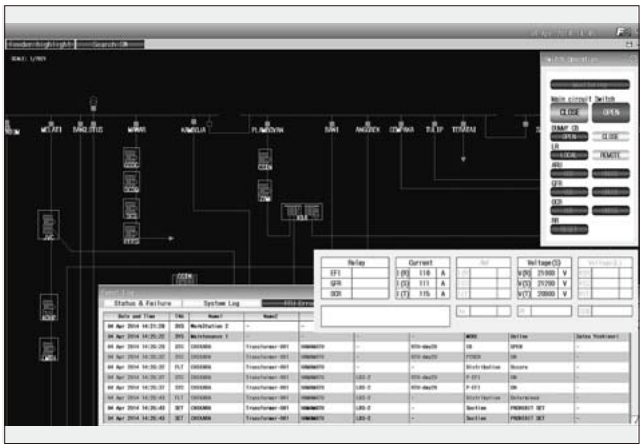


## 4 Power Distribution Automation System for Overseas Markets

Fuji Electric has made use of our proven track record of installations in Japan to develop a power distribution automation system for overseas markets. The main features are as follows.

(1) The functions have been packaged so that the system can be constructed according to the required function and scale ranging from a small scale to wide-area operation.
(2) The function of recovering from power outage accidents, which has a good track record in Japan, can be applied to power distribution systems in foreign countries to help reduce the power outage time.
(3) A global standard interface (compliant with IEC 60870-5-104) has been implemented to allow the system to be connected with field devices of various device vendors.
(4) A user authority management function provides flexible management of job functions such as the extent of jurisdiction and operations under charge.
(5) The drawing-type user interface can be used for maintaining substation single-line and power distribution system diagrams.

Fig.4 Example of supervisory control window



## 5 Retrofittable Digital Load Regulator Control Unit

Fuji Electric has developed a retrofittable digital load regulator control unit to be installed on the distribution board for distributing substations of Chubu Electric Power Co., Inc. The main features are as follows.

(1) The structure and interface are fully compatible with the existing model, which allows the unit to be replaced without changing the structure of the distribution board.
(2) Improved measuring accuracy has been realized by the DUJ Series of digital relay units, equipped with a 16-bit A-D converter and 5,760 Hz high-speed sampling function as standard.
(3) The input converter, power supply, arithmetic and other units, which were modularized individually, have been integrated into one module. Simplifying the components has successfully achieved a 10% reduction in the overall weight and 50% reduction in power consumption compared with the existing model.
(4) The noise resistance performance is compliant with JEC-2500 (2010).

Fig.5 Digital load regulator control unit

## 6 Power Line Communication (PLC) Evaluation Technology

The following technologies have been established, and they will be essential to field application of medium-speed power line communication (medium-speed PLC), a network for EMSs and smart meters.

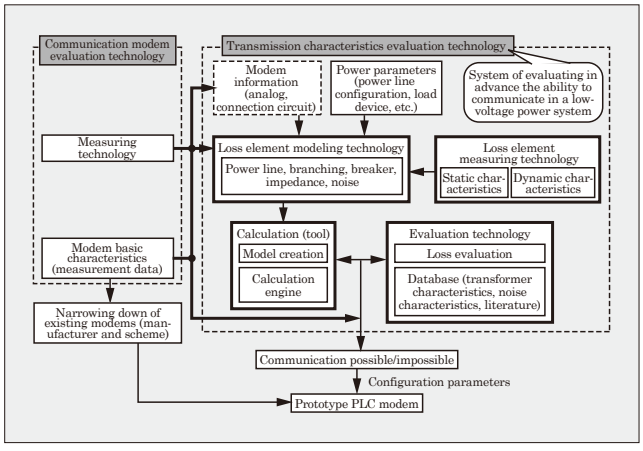
(1) Modeling of transmission line characteristics

Fuji Electric has established a method of measuring and technology for modeling the phase of transmission line characteristics (noise and impedance) and resonance characteristics, which may vary depending on the power line structure (phase wire system and branching) and devices connected. This has made it possible to conduct a preliminary evaluation by simulation and other methods and select configuration parameters.

(2) Verification using prototype

A prototype PLC modem has been used for verification in environments simulating fields such as a factory and a store. It has confirmed the ability to communicate even in the actual noise environment by setting the parameters selected in advance to reduce the communication error rate.

Fig.6 Framework of PLC evaluation technologies



## Energy Management

### 1 Results of Demonstration in Kitakyushu Smart Community Project

As a principal company participating in the Kitakyushu Smart Community Project, Fuji Electric has conducted field tests by introducing community storage batteries, EMS for stores, EMS for hospitals, EMS for factories (FEMS), CEMS for overall control, etc. In this project, we have performed a verification test of demand response using CEMS. Applying dynamic pricing which varies the electric fee to limit the power demand, 10% and 5% peak shaving has been achieved by the EMS for general customers and stores, respectively. Moreover, in consideration of the instability in power distribution system caused by a large-scale introduction of renewable energy in near future, we have implemented a demonstration experiment of load flow control by combining the CEMS and the storage facilities. A simultaneous equal amount control has been performed to aim at limiting the power demand-supply imbalance within 3% at the system interconnection points, and the limitation within 1% has been successfully achieved.

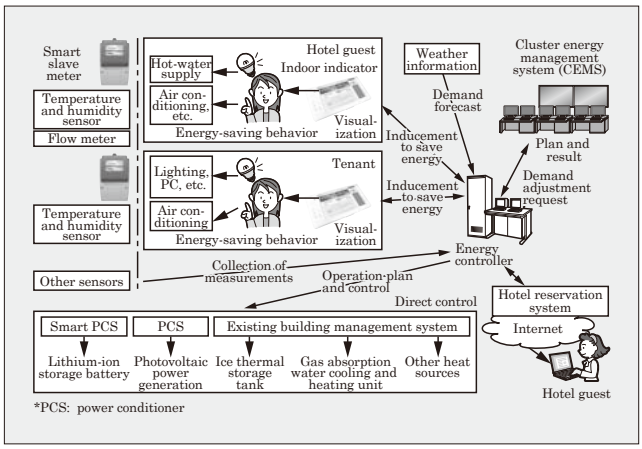
Fig.7 Community energy management system (CEMS)

### 2 Keihanna BEMS Demonstration Project

In the Next-Generation Energy and Social System Demonstration Project run by the Ministry of Economy, Trade and Industry, Fuji Electric has introduced a building energy management system (BEMS) in Keihanna Plaza to work on a field test. In FY2013, we confirmed the achievement of a peak reduction rate of 5% (75 kW reduction) and $CO_2$ reduction of 5% and are striving to achieve further effects. The main features are as follows:

(1) Optimum equipment operation based on a demand forecast and photovoltaic power generation forecast in electric and thermal energy supply equipment
(2) Load leveling using next-generation lithium-ion storage batteries using smart PCS for storage batteries
(3) Demand response by incentive programs targeting building tenants (offices, laboratories and stores including restaurants) and hotel guests
(4) Optimum use of regional energy by linking with CEMS

Fig.8 Overall configuration of BEMS

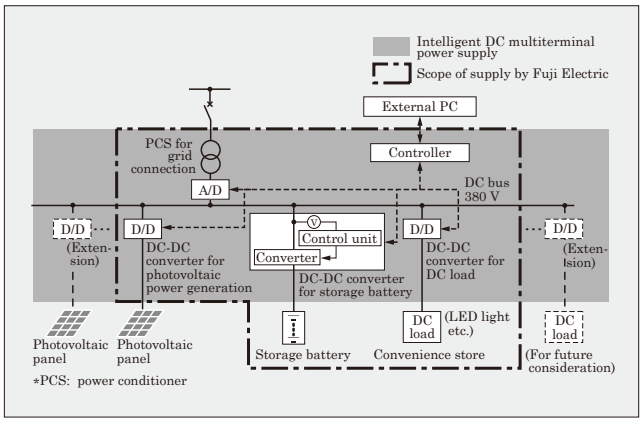



### 3 Intelligent DC Multiterminal Power Supply

In the Mie University Smart Campus Project run by the Ministry of Economy, Trade and Industry, Fuji Electric has implemented field-test of an intelligent DC multiterminal power supply, which raises expectations for high-efficiency use and power supply stabilization of renewable energy and for power supply at the time of disaster. We connected a power conditioner (PCS) for grid connection, DC-DC converters for photovoltaic power generation and storage battery and DC load (LED light) to a DC bus and obtained the following results. We intend to work on its commercialization in the future.

(1) Photovoltaic-generated power was directly supplied to the LED light as DC power and a power reduction of 18.1% as compared with AC power was confirmed.
(2) A continuous grid-isolation operation function by renewable energy during commercial power outage was demonstrated.
(3) Multiple devices were connected to the DC bus and stable operation against power generation and load fluctuation was confirmed.

Fig.9 System configuration of intelligent DC multiterminal power supply



## Energy Management

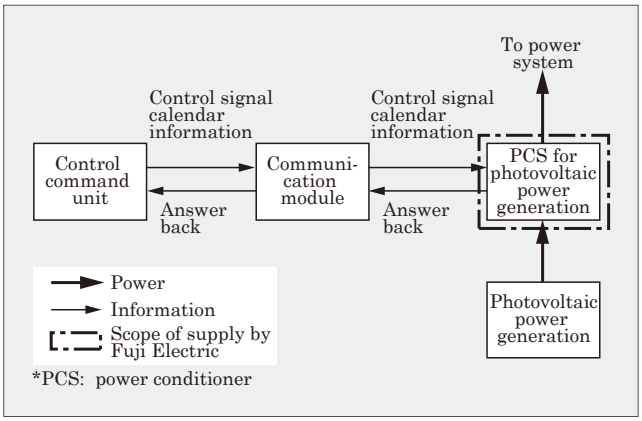
### 4 Demonstration Projects for Next-Generation Power Control Systems Using Two-Way Communications

In the Demonstration Projects for Next-Generation Power Control Systems by Two-Way Communications of the Ministry of Economy, Trade and Industry, utility companies and manufacturers worked on demonstrations relating to measures for stabilizing the system when photovoltaic-generated power is introduced in large amounts and obtained the following results.

(1) In view of future standardization and certification, a common communication scheme was determined and a power conditioner (PCS) for photovoltaic power generation equipped with the two-way communication function was developed. This PCS is capable of controlling output according to the control signals from the host server.

(2) The voltage-dependent constant power factor control method, in which leading reactive power is output according to the coupling point voltage and photovoltaic power generation output, was implemented in the PCS and the voltage rise control function was confirmed in a verification test. This raises expectations for a voltage rise suppression effect that does not hinder photovoltaic power generation opportunities of the PCS installer as much as possible.

Fig.10 Overall configuration of Demonstration Projects for Next-Generation Power Control Systems Using Two-Way Communications




## Social Environment

### 1 "Local Government Integrated Address e-System" Accommodating Social Security and Tax Number System

In line with the introduction of the Social Security and Tax Number System (My Number system), Fuji Electric has developed the "Local Government Integrated Address e-System" for local governments that meets the need for the My Number system. This system facilitates two tasks essential to handling of the My Number system by local public bodies: management of personal IDs and integrated address IDs; provision and query of specific personal information with the intermediate server. The main features are as follows.

(1) The system can manage personal IDs and integrated address IDs.

(2) The system can interact with intermediate servers having different data formats or communication schemes.

(3) Integrated management is possible including personnel/payroll management and tasks that have not been systematized.

(4) Flexible linking with other business systems has been realized.

Fig.11 Outline of "Local Government Integrated Address e-System"