

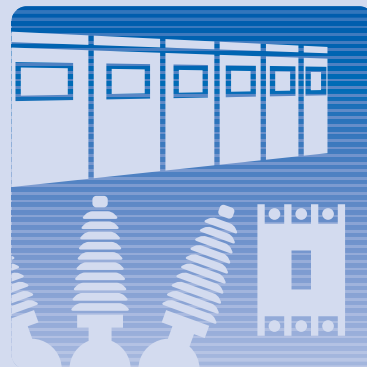
Power Electronics Energy

Energy Management

Transmission and Distribution Systems

Power Supply and Facility Systems

Electric Distribution, Switching and Control Devices



In the power electronics energy segment, Fuji Electric is committed to the technologies for power electronics, substations, and energy monitoring and control. Focusing on these technologies, Fuji Electric offers components such as switchgear, transformers, protection relays, uninterruptible power systems (UPSs), power conditioning systems (PCSs), and switchgear and control gear, as well as energy solutions that combine these. We provide one-stop solutions from system construction to maintenance services for power companies, material plants, and data centers, contributing to the construction of infrastructure that provides a stable supply of energy.

Energy Management

We offer solutions for increasing the use of renewable energy to customers pursuing carbon neutrality. In the field of power transmission and distribution, we have developed an operation support system for power distribution system planning to address the increasing complexity of power flow due to the expansion of renewable energy. In addition, we have delivered test equipment for verification of electric facilities consisting of reduced models of independent power systems on islands.

Geared toward operators targeting the growing real time market, we have developed the “PVI1400CJ-3/2600” PCS for large-capacity batteries, for which demand is expected to increase.

Transmission and Distribution Systems

We have been offering a solutions business that improves reliability, efficiency, and environmental friendliness through the use of substation equipment and power electronics equipment for the electric power, industrial, and transportation sectors.

We supplied a complete set of high voltage substation equipment, along with turbines and generators made by Fuji Electric, for one of the largest biomass power plants that use only wood pellets in Japan. Together with auxiliary equipment, we have delivered rectifiers for saline water electrolysis plants that have complied with harmonic regulations and achieved highly efficient operation. These facilities contribute to the car-

bon neutrality, a global challenge. We have delivered power transformers in response to transportation conditions that have become more severe due to the aging of bridges by significantly reducing transportation weight. In the replacement of the transformer rectifiers for direct current electric furnaces (DC furnaces), we completed the site works with the shortest power outage period. In the field of transportation, we have delivered operational notice transmission systems that use smart devices to support safe operation for local railways.

Power Supply and Facility Systems

Data centers (DC) and semiconductor manufacturing plants in Japan and overseas require power supply systems to deliver not only reliable and stable power supply, but also space saving and short construction periods. Fuji Electric’s “proposal of comprehensive electrical equipment,” including high voltage substation equipment, emergency power generation equipment, and UPS systems, optimizes systems, reduces installation areas, and shortens construction periods. We have delivered highly reliable UPS systems that can be maintained while supplying power for large-scale DC and computer centers. Furthermore, we have developed the “VC-V20 A-1,” the industry’s smallest 24-kV switchgear in compliance with IEC standards (IEC 62271-200) for the expanding infrastructure development in Southeast Asia.

Electric Distribution, Switching and Control Devices

In the field of electric distribution, switching and control devices, we offer electric distribution and switching devices for the efficient and safe use of electricity in renewable-energy-related equipment, electrical equipment in buildings and facilities, and control systems of plant production lines. We also provide control devices to automate and optimize manufacturing equipment and machinery.

Regarding low-voltage electric distribution equipment, we have developed and launched external operating handles and terminal covers with enhanced waterproofing, dust resistance and safety for molded case circuit breakers and earth leakage circuit breakers of

32 AF to 100 AF (ampere frame). These products meet the need for enhanced electrical safety protection degrees and the conformity with international electrical safety standards for industrial machinery and have acquired third-party certification, thereby promoting the safety of equipment and workers.

Demand is increasing for high-voltage electric distribution equipment that has improved reliability and reduce costs and work load of planned maintenance (preventive maintenance) as manufacturing equipment and

information network are highly developing. We have thus developed a high-voltage vacuum circuit-breaker that enables the equipment inspection cycle to be extended from the previous three years to six years by extending the life of the lubricating oil and optimizing the mechanisms.

We will continue to contribute to society by developing electric distribution, switching and control devices that meet social needs.

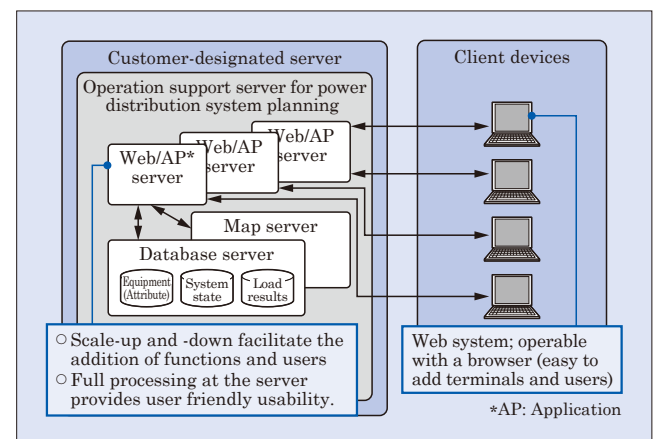
Energy Management

1 Operation Support System for Power Distribution System Planning

In order to maintain a stable supply of electric power against future demand changes, electric power companies are engaged in distribution system planning for the expansion and removal of distribution lines and the installation of voltage regulators. With the increasing complexity of electric power flow due to the expansion of renewable energy in recent years, distribution system planning work has become more difficult. To address this issue, Fuji Electric has developed an Operation support system for distribution system planning. The main features are as follows:

- (1) High-speed and high-precision power flow calculation and optimization technique enable analytical calculations, such as those for identification of voltage violations, optimum setting of voltage control equipment, short-circuit capacity calculation, thereby improving efficiency in system planning operations.
- (2) Adoption of the Web method eliminates the need for dedicated software for client devices, making it easy to add devices and users and reduce costs.

Fig.1 System configuration and features



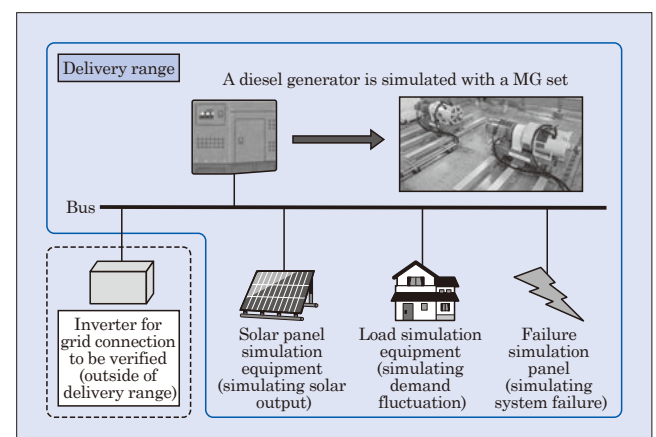
2 Delivery of Test Equipment for Power System Reduced Models

Fuji Electric has delivered test equipment for the verification of electrical equipment to a business facility operated by TEPCO Power Grid, Incorporated. The test equipment uses scaled-down models of independent electric power systems on islands. This system was made to check the performance of the control equipment developed for the project to demonstrate a 100% renewable energy power supply* on Hahajima Island before installation. The following features enable the reproduction of phenomena such as supply and demand of power and failures that occur in the system.

- (1) The same governor control and excitation control as the existing diesel generator employs can be simulated using a motor-driven synchronous generator (MG set).
- (2) It is possible to simulate solar power output, demand fluctuations based on local data, and system failure. The type and time settings of failure are variable.

* The Tokyo Metropolitan Government, Ogasawara Village, and TEPCO Power Grid participated in this project.

Fig.2 Configuration of test equipment



Transmission and Distribution Systems

1 Commercial Operation Started at Fukushima Iwaki Biomass Power Plant

As one of the measures to realize carbon neutrality, the practical application of power plants is advancing that are based on comprehensive CO₂ circulation biomass, which uses biological resources. Fuji Electric, through Sumitomo Heavy Industries, Ltd., has supplied high voltage substation equipment, turbine, generator, and other equipment to the Fukushima Iwaki Biomass Power Plant of Able Energy Limited Liability Company. The plant started commercial operation in April 2022. The order for a full set of Fuji Electric products allowed the design, prototyping, and evaluation to be carried out efficiently, enabling an optimal design that minimizes the power plant area and shortens the time from installation to start of operation. This power plant is one of the largest power plants in Japan that uses only wood pellets instead of co-firing with fossil fuels. It generates 770 million kWh of electricity annually, and is expected to significantly reduce annual CO₂ emissions (approximately 333 kilotons*) compared to fossil fuel power generation.

* Calculated using the national average CO₂ emission coefficient for FY2020 (0.433 kg-CO₂/kWh)

Fig.3 High voltage substation equipment

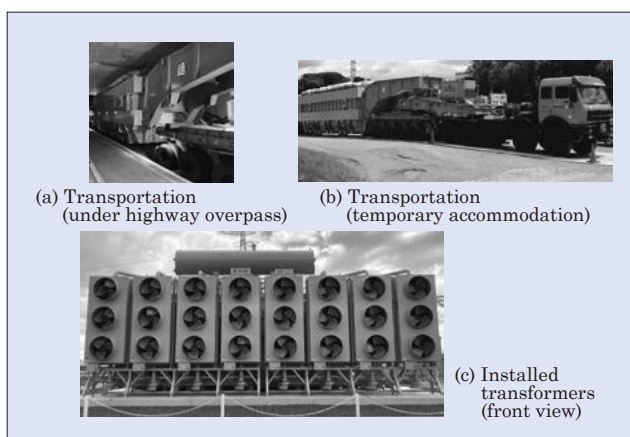


2 275-kV, 450-MVA Transformers for Shin-Kisarazu Substation, TEPCO Power Grid, Incorporated

Fuji Electric has delivered two transformers (275 kV, 450 MVA) for 5B and 8B in the Shin-Kisarazu Substation, which is operated by TEPCO Power Grid, Incorporated. We delivered transformers with the same specifications to the substation in 2000. This time, however, we took the following measures to meet the new mass restriction for passing vehicles on the bridge on the transport route to the substation:

- (1) The weight was reduced by redesigning the tank structure, eliminating the tertiary current-limiting reactor by devising windings, and using on-load tap change with a vacuum valve, thereby reducing the transport mass by 20 tons compared with the past product (below the mass limit of 220 tons).
- (2) We transported transformers by land for about 25 km from Kisarazu New Port to the substation using a 240 type Schnabel trailer running only at night, taking two nights per unit.

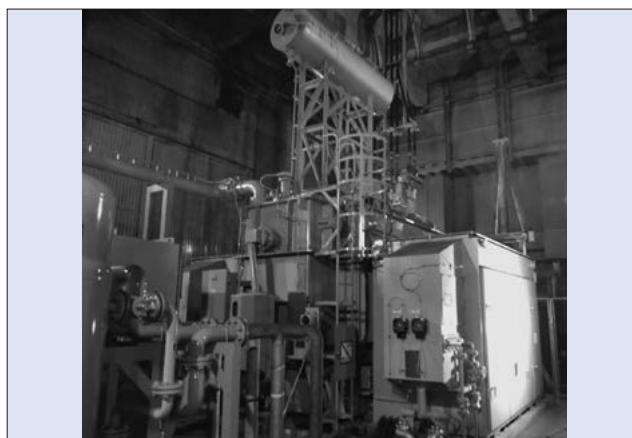
Fig.4 Transportation and installed transformers



3 Replacing a Transformer Rectifier for DC Furnace for Tokyo Steel Manufacturing Co., Ltd.

Fuji Electric has been manufacturing and selling transformer rectifiers, which integrate transformers and rectifiers, for direct current electric furnaces (DC furnaces) for more than 30 years. To reduce the risk of operation shut-down due to aging, we replace equipment that has been in operation for a long time. In August 2021, we replaced the transformer rectifier for a DC furnace at the Kyushu Plant of Tokyo Steel Manufacturing Co., Ltd. In order to prevent local overheat, this equipment uses Fuji Electric's unique technique of in-phase contra-polarity connection, which ensures high reliability. In addition, by conducting sufficient performance verification tests on the combination of transformers and rectifiers in a Fuji Electric's manufacturing plant, we reduced risks during operation and achieved vertical start-up.

Fig.5 Transformer rectifier for DC furnaces



Transmission and Distribution Systems

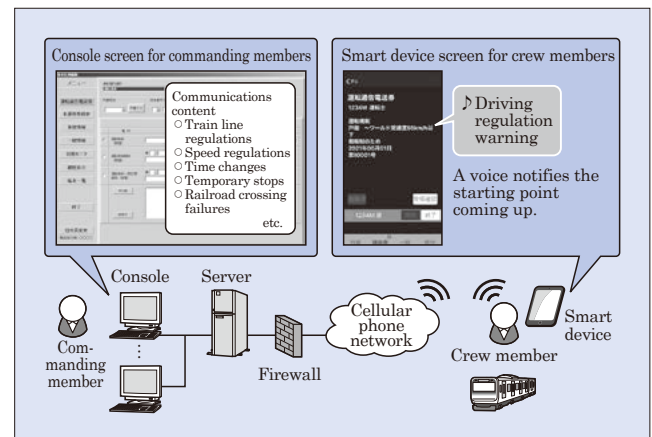
4 Operational Notice Transmission System for Local Railways of Kyushu Railway Company

The safe operation of trains is a top priority for railway companies, and, therefore, the prompt sharing of operational instructions is indispensable. Fuji Electric has supplied Kyushu Railway Company with an operational notice* transmission system for local railways that serves as a means of communication between directors at dispatching centers and train crews. The main features are as follows:

- (1) The function of transmitting operational notice data prepared by directors to smart devices carried by crew members has streamlined the equipment and at the same time improves convenience and maintainability.
- (2) By changing from a system in which character information is superimposed on the train radio to a communication system using a cellular phone communication network, the communication capacity has been increased and stabilized.
- (3) Safety is ensured through security measures such as unauthorized communications cutoff and spoofing prevention.

* Operational notice: A communication form to be used when operating conditions are changed, such as train line regulations, speed regulations.

Fig.6 Operational notice transmission system for local railways



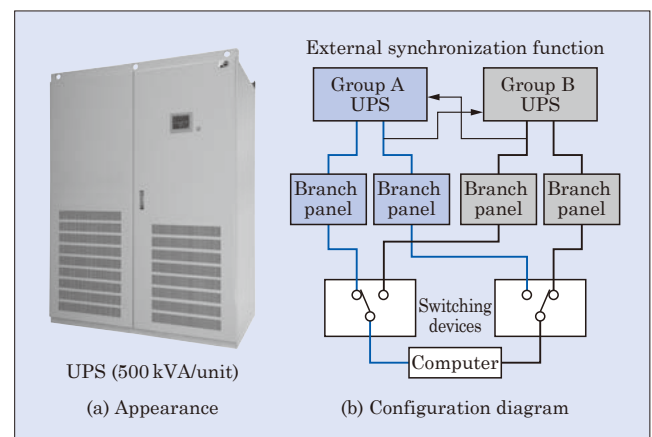
Power Supply and Facility Systems

1 Delivery of a UPS System to a Computer Center

With the globalization of the economy and the increase in electronic commerce, computer processing systems are being developed to deal with transactions 24 hours a day, 365 days a year. In addition to stable power supply, such systems require electric equipment to continue to supply power even during maintenance work. Fuji Electric has delivered a redundant system constructed with a four power system configuration at a computer service bureau. Stabilization of power supply to computers, including during maintenance, has been achieved by the following features:

- (1) The UPS system consists of two groups of parallel redundant UPSs, each of which has two output power branches (four systems in total).
- (2) A switching device is provided on the secondary side (computer side) of each UPS to continuously supply power through the two switching devices.
- (3) By synchronizing the UPS outputs of different groups (external synchronization function), voltage fluctuation at the time of power supply switching is suppressed.

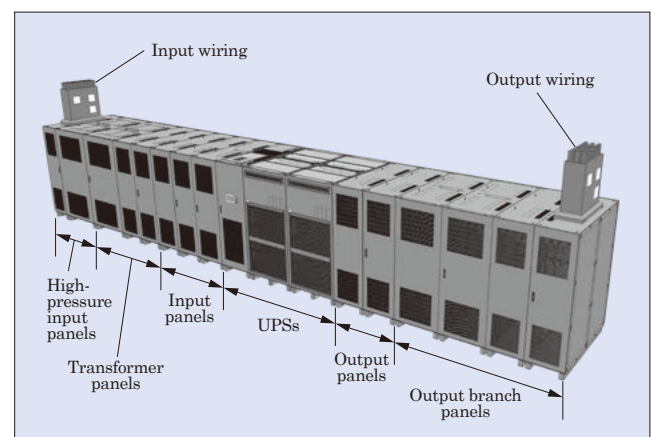
Fig.7 UPS and switch configuration



2 Delivery of a Large Capacity UPS System (1,200 kVA)

In recent years, the number of large-scale data centers (DCs) being constructed has increased, and the need for UPS systems necessary for stable operation of DCs has grown. Space-saving and reduced installation periods are required for UPS systems. Fuji Electric has developed a UPS system that uses a UPS whose single unit capacity has been increased from 500 kVA to 1,200 kVA and delivered it to a DC. By increasing the capacity of the single unit, the number of UPSs has been reduced from three to one, and the number of battery panels, from nine to seven. In addition, in response to the increase in heat generation due to the increase in capacity, the cooling efficiency has been improved by separating and arranging the internal equipment of the UPS according to the degree of heat generation, and space-saving has been achieved by reducing the size of the heat sink. In addition, the high-voltage input panels, transformer panels, UPSs, input and output panels, and output branch panels are directly connected to each other, reducing wiring work and significantly shortening the construction period.

Fig.8 Configuration of UPS systems (1,200 kVA)



Power Supply and Facility Systems

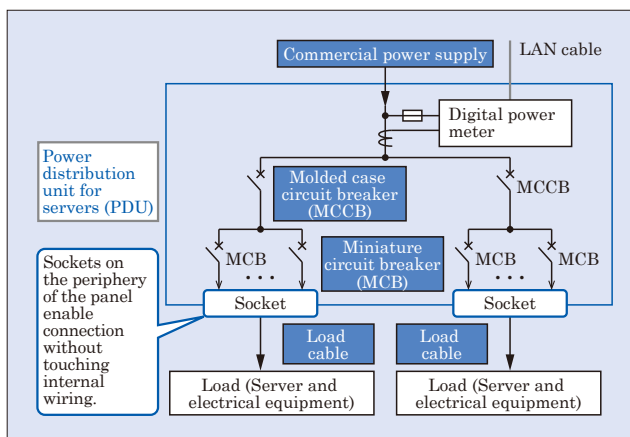
3 IEC-Compliant Power Distribution Unit (PDU) for IDC Servers, Marketed in Japan

Fuji Electric offers its Proposal of Comprehensive Electrical Equipment, which provides a full package for sub-station equipment, from optimal system design to installation, operation monitoring, and maintenance services. To help stabilize IDC* operation, we have offered a power distribution unit (PDU) for servers, made by Fuji SMBE, as an additional product for the Japanese IDC market. The PDU complies with IEC 61439-1: 2020. The main features are as follows:

- (1) Installation is easy because fault and measurement signals are transferred together through a LAN cable, instead of previously used separately-installed control cables.
- (2) Installation is safe because load cables can be connected to loads via the sockets mounted on the periphery of the panel top without contacting the internal wiring.

*IDC: Internet data center

Fig.9 Circuit configuration diagram



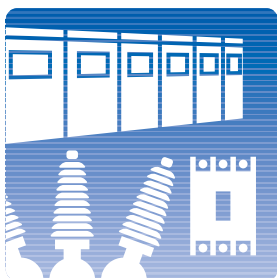
Electric Distribution, Switching and Control Devices

1 “HS2006X Series” Vacuum Circuit Breakers with Reduced Life Cycle Cost

High-voltage equipment is used for a long period of time, from 15 to 30 years. During this period, periodic maintenance such as cleaning and lubrication is recommended to prevent unexpected failure. On the other hand, there is a need to reduce the frequency of on-site maintenance work. To address this, Fuji Electric has developed the “HS2006 X Series” vacuum circuit breakers with reduced life cycle costs.

The recommended inspection period of this product has been extended from 3 years to 6 years by reducing friction in the operation mechanism parts and changing the lubricant for the internal mechanism to a type that takes longer to solidify.

Fig.10 “HS2006X Series”





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