Power Generation

Power Plants
New Energy

Outlook

Major topics in the Japanese electricity market in FY2016 include entry into the retail electricity business was fully liberated in April 2016 and all consumers can now freely choose utility companies and their service menu. Due to the liberalization of retail sales, electricity trading methods are changing. Moreover, in FY2016, in response to the change of the "Feed-in Tariff (FIT) scheme for renewable energy," the number of applications for entering into a grid connection agreement increased. Another major topic is that the government started inviting applications for the "subsidy project for the surveys for the development of geothermal resources" in March 2016 to promote geothermal energy development.

In the electricity markets outside Japan, regulations on greenhouse gas emissions have been tightened. The Working Party on Export Credits and Credit Guarantees of the Organisation for Economic Co-operation and Development (OECD) agreed the policy of limiting exports of coal-fired power generation equipment (started being applied in January 2017) in the wake of the Paris Agreement.

In the fields of thermal and geothermal power generation, as market conditions changed in this way, Fuji Electric worked on research and development with the focus on improving the efficiency of equipment and plants and expanding services, and this resulted in good results.

In the field of thermal power generation, we received orders for steam turbines and generators for biomass co-firing power generation in Japan, as well as 3 sets of steam turbines and generators from Asian countries outside Japan.

In the field of geothermal power generation, Fuji Electric received an order for binary power generation system, which is Fuji's second binary unit in Japan, and is moving ahead with work to complete it at the end of FY2017. Outside Japan, the only order received was that from Indonesia due to postponement of plans and other reasons, but we are working on many prospective projects to conclude contracts in FY2017. In the field of thermal and geothermal power generation services, we are continuously striving to broaden product range to address customer needs. In order to expand the range of services provided outside Japan, we have been offering engineering works by cooperating with affiliated companies. In addition, we have received orders for modifying turbines and generators in accordance with customers' operation, and these are in progress.

In the field of nuclear power generation, solutions are called for both in terms of resumption of operation and decommissioning of nuclear power plants since the Fukushima Daiichi Nuclear Power Station accident. Under the circumstances, Fuji Electric is offering technologies and products, including remote handling equipment and earthquake-proof panels, conforming to new regulatory requirements. There is also a need to promptly acquire an ability to safely dispose of and store the radioactive waste generated in the process of operation and decommissioning of nuclear facilities. Fuji Electric is working jointly with Amec Foster Wheeler plc of the United Kingdom to develop and apply in Japan a waste solidification technology using geopolymer materials with various characteristics.

In the field of photovoltaic power generation, while construction of mega-solar power plants in Japan is on the decrease after peaking in FY2014, there is still demand for plants of the 20-GW scale, and such demand is expected to continue in the future. In FY2016, the Kamikita Rokkasho Solar Power Plant (DC output 71 MW and AC output 51 MW) and Yamaguchi Hikari Solar Power Plant (DC output 19.6 MW and AC output 14 MW), for which we received orders as engineering, procurement and construction (EPC) projects, were both completed in February 2017. The most recent issues in this field include cost savings for ensuring profitability despite the reduction in the FIT purchase prices and power system stabilization that becomes necessary with the increased introduction of renewable energy. To solve these issues, we are developing and providing high-performance, low-cost power conditioning systems (PCSs) and power system stabilization systems.

In the field of wind power generation, construction of large-scale wind farms started in FY2016 and the market is expected to continue to grow in the future. We have been building up a good track record in delivery of power system stabilization systems combining storage cells and PCSs. In the future, we will work on EPC, in addition to sale of systems, in earnest by utilizing the know-how we acquired with photovoltaic power generation engineering.

In the field of fuel cells, we delivered 1 unit of phosphoric acid fuel cell (PAFC) for city gas and 3 units for sewage digestion gas, to which FIT applies. Outside Japan, fire protection systems that prevent fires by reducing the oxygen concentration in a room are becoming widespread in Germany and other countries. Fuji Electric focuses on applying fuel cells to this system and has delivered the first unit for cold storage warehouses, where application of the system is considered to be particularly effective. Furthermore, to realize solid oxide fuel cells (SOFCs) with high power generation efficiency, we have been participating in a project of the New Energy and Industrial Technology Development Organization (NEDO) and working on the development of field demonstration equipment of the 50 kW class.

Power Plants

1 Start of Operation of Units 5 and 6 at Lahendong Geothermal Power Plant in Indonesia

Fuji Electric has completed a handover of Lahendong geothermal power plant with net output of 40 MW (20MW × 2 units) in Indonesia, where geothermal development has been promoted increasingly. This project was ordered as an EPC contract to Sumitomo Corporation as a prime contractor. Fuji Electric took up the power plant entire engineering and delivered the major equipment of the power plant, such as geothermal steam turbines, generators, condensers, cooling towers, hotwell pumps and gas extraction system (GES). Commercial operation of Unit 5 started in September 2016 and Unit 6 in January 2017, which is about 3 months ahead of schedule. Employed axial flow exhaust steam turbines contributed to a lower height installation level comparing to an upward exhaust type installed in the existing units in Lahendong area and reduced the construction costs. In addition, the steam turbines and generators were delivered in skid-mount packages, and this contributed to shortening the construction periods.

Fig.1 Panoramic view of Units 5 and 6 of Lahendong Geothermal Power Plant

2 Reheat Steam Turbine Equipment for Suzukawa Energy Center

Fuji Electric received an order from IHI Corporation for one-casing reheat steam turbine equipment for a thermal power plant of Suzukawa Energy Center Ltd. (rated output: 112 MW, 3,000 r/min; main steam: 16.7 MPa [absolute pressure]/566°C; reheat steam: 566°C). We have completed its manufacturing, delivery and installation works. This power plant intended for the retail electricity business applies co-firing of coal and biomass, which is renewable energy, and it started commercial operation in September 2016.

Fuji Electric's medium-capacity one-casing reheat turbine was employed for the main turbine equipment, which requires high reliability and efficiency. It realizes a compact arrangement for a reheat turbine with the one-casing structure and direct mounting of the main steam valve on the turbine. Furthermore, we delivered condensing equipment and feed water heating equipment so that the steam turbine cycle could be optimized overall.

Fig.2 Reheat steam turbine

Power Plants

3 Reception of Orders for Steam Turbines and Generators for Thermal Power Plants in Japan

Fuji Electric received orders for steam turbines and generators for thermal power plants in Japan in FY2016. They include those for the Houhu Biomass & Coal Power Plant (112 MW) of Air Water & Energia Power Yamaguchi Inc. received from Sumitomo Heavy Industries, Ltd. and for the Buzen Biomass Power Plant (75 MW) of Buzen New Energy LLC. received from JFE Engineering Corporation. These are high-efficiency power generation facilities that employ a reheat system using biomass fuel as the main fuel and they are intended for the power selling business that makes use of the "Feed-in Tariff (FIT) Scheme for renewable energy." Fuji Electric intends to continue in the future to provide steam turbines and generators for high-efficiency power generation facilities that utilize biomass fuel and low-grade coal and allow for the effective use of resources and reduction of environmental burdens. In this way, we will contribute to the stable supply of power and help to prevent global warming.

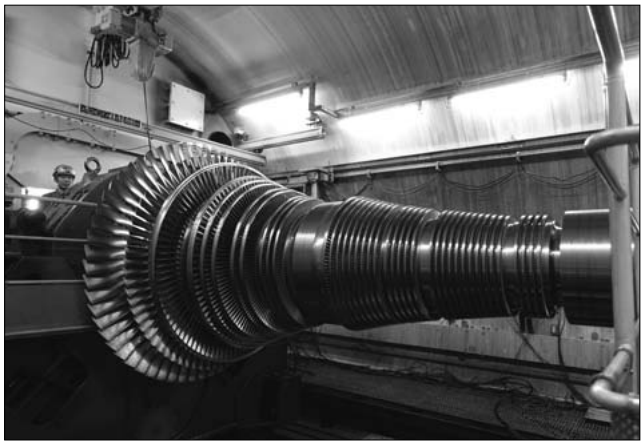
Fig.3 Architectural rendering of Buzen Biomass Power Plant

4 Replacement of Steam Turbine in Unit 2 of Hsinkang Powerplant of Taiwan's FCFC

This project involves replacement due to aging of the 56-MW steam turbine in Unit 2 of the Hsinkang Power plant of Formosa Chemicals & Fibre Corporation (FCFC) of Taiwan. The old turbine was delivered by another company in 1988. This is the first project for replacing another company's steam turbine with Fuji Electric's while making use of most of the foundation. Fuji electric received the order for the replacement of the steam turbine and auxiliary equipment and completed shipping of the products at the end of March 2017. In this power plant, Unit 3 (101 MW) and Unit 4 (147 MW), Fuji Electric delivered, are operating smoothly.

We were awarded the order because our good relationship of trust with the customer and maintenance were appreciated, and our proposal for replacement with the latest facilities came to fruition. This renewal project will be the new basis in the overseas thermal power generation services market, which is expected to expand in the future. We intend to continue building up know-how in new service fields to expand the services business.

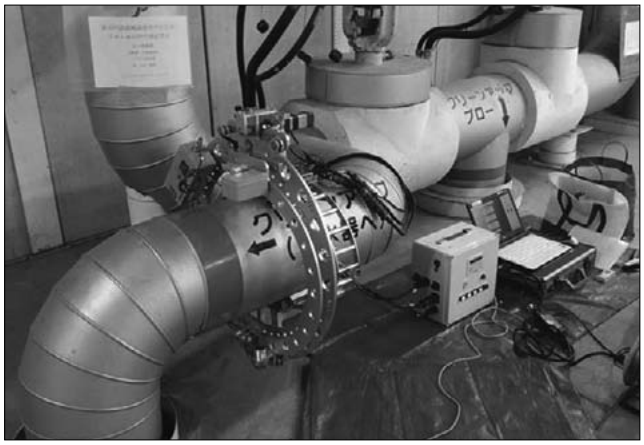
Fig.4 Steam turbine replacement (high-speed balance test)



5 Pipe Wall Thickness Measurement Technology Using Radiation – Three-Beam Method

Recently, it has become increasingly important to manage pipe wall thickness (thinning) from the perspective of ensuring stable operation of power plants. Conventionally, measurement of pipe wall thickness required thermal insulation materials to be removed from piping. Fuji Electric has used the attenuation characteristic of radiation observed as it passes through materials to develop a system capable of measuring pipe wall thickness without the need to remove thermal insulation materials. This system employs the three-beam method (Patent No. 5375541) that use radiation irradiated from three directions to find a numerical value of each wall thickness. We conducted research and development for the system jointly with Tohoku Electric Power Co., Inc. and it has been certified as a new test method in the Rules on Pipe Wall Thinning Management for Thermal Power Generation Facilities (JSME S TB1-2016). The system does not require qualifications for handling, designation of controlled areas or permission for use. This is because it is an approved device with certification label that uses low level radiation sources. It is an easy-to-handle small and lightweight device.

Fig.5 Example of installation of pipe wall thickness measuring device

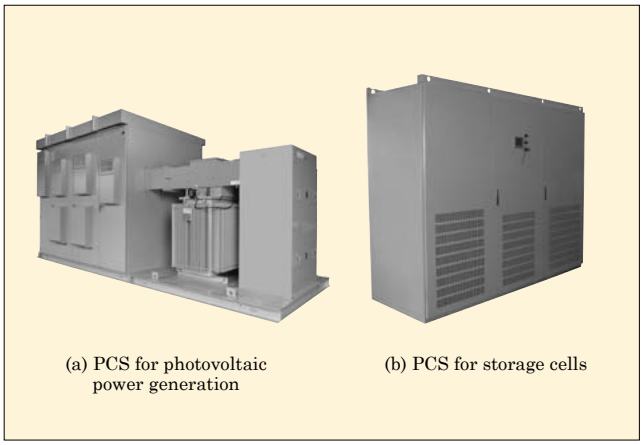


New Energy

1 Electrical Equipment for Hidaka Kuratomi Solar Power Plant

Photovoltaic power generation and wind power generation are power sources whose output fluctuates and required to suppress the fluctuation to reduce the impact on systems. Within the service area of Hokkaido Electric Power Co., Inc., those newly applying for interconnection with the power system have to install storage cells to control the power at the interconnection point to within a certain range of variation. The contract power at the interconnection point is 9 MW and the required regulation is within ±1% in one minute. Fuji Electric received an order from Kita Koudensha Corp. for electrical equipment including a control system for the Hidaka Kuratomi Solar Power Plant. This power plant, which is the first large photovoltaic power plant with fluctuation suppression in Hokkaido, started operating in April 2017. We delivered the PCSs for photovoltaic power generation, PCSs for storage cells, extra-high voltage power receiving and transforming system and system controller for fluctuation control and the customer installed lithium ion batteries with a total rated capacity of 3.6 MWh to construct the system.

Fig.6 PCS for photovoltaic power generation and PCS for storage cells



(a) PCS for photovoltaic power generation

(b) PCS for storage cells

2 Phosphoric Acid Fuel Cells for Wolf ButterBack KG of Germany

Fire prevention systems that prevent fires by reducing the oxygen concentration in a room are becoming widespread in Germany and other countries. Fuji Electric is focusing on the application of phosphoric acid fuel cells (PAFCs) to these fire prevention systems. In December 2016, we delivered the first unit for deep freezing warehouses, which is expected to be a major application, to Wolf ButterBack KG of Germany. Using the exhaust air with a low oxygen concentration discharged from fuel cells, this system is capable of suppressing compressor energy consumption (running costs), noise and vibration. It thus provides a higher degree of environmental friendliness and efficiency than conventional systems that use membrane separation and adsorptive separation to reduce oxygen concentrations. We intend to make the most of this achievement in further expanding applications of fuel cells to fire prevention systems of deep freezing warehouses.

Fig.7 Phosphoric acid fuel cell

3 Solid Oxide Fuel Cells for Industrial Use

In addition to the phosphoric acid fuel cells (PAFCs) with a power output of 100 kW currently on sale, Fuji Electric is developing solid oxide fuel cells (SOFCs). We have been participating in the "Technology Development for SOFC Commercialization Promotion" of the New Energy and Industrial Technology Development Organization (NEDO) since FY2014 and aimed at putting a cogeneration system of a few tens of kilowatt in practice. In FY2016, we evaluated the performance of verification equipment of the 45-kW class in the actual size. The results proved we had achieved a DC power generation efficiency of over 55% (equivalent to AC power generation efficiency of 50%) and exhaust heat recovery efficiency of over 30%, which were performance targets. In addition, we completed designing and building one-package demonstration equipment. Starting in FY2017, we have been conducting demonstrations using field demonstration equipment of the 50-kW class with the aim of bringing the product to the market in FY2018.

Reference: FUJI ELECTRIC REVIEW 2017, vol.63, no.1, p.30

Fig.8 Solid oxide fuel cell

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