

Electric Power Generation Systems

Thermal/Geothermal Power Plants
Nuclear Power
Renewable Energy and Power Stabilization
Fuel Cells



Outlook

In July 2015, the Ministry of Economy, Trade and Industry determined the “Long-term Energy Supply and Demand Outlook” and decided on the energy mix (power source mix) for 2030 in Japan. It also decided to fully liberalize the electricity retail market starting in April 2016. Based on these decisions, FY2015 is recognized as a turning point in the Japanese electric power industry and a year when the base for future development was made clear.

Fuji Electric, which has many eco-friendly power generation-related technologies, should be able to help bring about an energy mix with a high proportion of renewable energy in 2030.

In the overseas market, despite the low price of crude oil and new financial uncertainties, there are brisk business activities reflecting the increasing demand for power, mainly in Asia and Africa.

In the field of thermal/geothermal power plants, we received steady new orders. In the service business, in addition to receiving continued orders for maintenance and repair in Japan, we acquired the business of RTS Holdings, Inc. and its subsidiaries of the United States in the overseas market. Hence, the year was one in which we made a start to develop the service business in earnest.

Regarding the thermal power market, in Japan, we received orders from new customers for multiple steam turbines and generators together with peripheral equipment for biomass co-combustion power generation. We also received an order for 650-MW class ultra-super critical pressure large coal-fired power facilities. In the overseas market, we completed delivering many units of steam turbines and power facilities mainly in Southeast Asian countries and won new orders in South Korea.

For the geothermal market, in Japan, we made certain of an order for new geothermal binary power generation facilities and have continued providing support for achieving multiple future projects. In the overseas market, while there was a delay in an anticipated project, we successfully received orders for steam turbines and power generation equipment in Iceland, the

Philippines and Mexico. In addition, we continue developing projects to win orders for them in FY2016.

In the field of nuclear power, the new regulatory standards reflecting the lessons learned from the accident in Fukushima and the method of their operation were established. Power generation was restarted with Units 1 and 2 of the Sendai Nuclear Power Plant, which passed the screening by the Nuclear Regulation Authority. It has been decided that some power plants will be decommissioned, and some entities are launching the light water reactor-related business. On the Fukushima site, design and development for taking measures against contaminated water and removing debris are being conducted mainly by the International Research Institute for Nuclear Decommissioning (IRID).

In this situation, Fuji Electric has developed and delivered ocean monitoring equipment that is capable of continuously measuring and monitoring the radioactivity concentration in the ocean for Tokyo Electric Power Company Holdings, Inc. This equipment started operation at the periphery of the Fukushima Daiichi Nuclear Power Plant. In addition, we aim to contribute to safe processing and disposal of radioactive waste generated during operation of nuclear power facilities and in the process of decommissioning and are working to apply technology that uses geopolymer materials. This technology solidifies radioactive waste stably instead of using cement.

In the field of renewable energy and power stabilization, while the Japanese mega solar market is on a declining trend after the peak in FY2014, there is still construction demand for over 4 GW and construction of equipment is expected to continue in the future. In FY2015, as an EPC project, Tomakomai Yufutsu Mega-solar Power Plant (DC output: 29.8 MW, AC output: 21 MW) was completed in October. At this plant, 21 outdoor power conditioning sub-systems (PCSs) with a single unit capacity of 1,000 kVA have been installed to improve system efficiency. In addition, we have commercialized a new outdoor 555-kVA PCS that does not require any air conditioning system or container

to expand the high-efficiency PCS series. Regarding wind power generation, commencement of large-scale wind power generation projects and construction are expected.

In the field of fuel cells, we installed 8 phosphoric acid fuel cells on sewage digestion gas, which fall the Feed-in Tariff (FIT) Scheme for renewable energy. The fuel cell installed at the Tokyo Factory of Fuji Electric has a new function of supplying the exhaust, which is clean and contains high concentration CO₂, to a nearby experimental plant factory. The experiment of using

the facilities for growing strawberries is scheduled to start in October 2016. Regarding business overseas, we have financed N₂telligence GmbH, with which we had a cooperative relationship, and aim to promote sales mainly in Germany by taking advantage of the low-oxygen exhaust. Furthermore, for realizing a solid oxide fuel cell system featuring high power generation efficiency, we have been participating in a project of the New Energy and Industrial Technology Development Organization (NEDO) since FY2014 to work on the development of a system of a few tens of kW.

Thermal/Geothermal Power Plants

1 Steam Turbine and Generator for Kamojang Geothermal Power Plant Unit 5 of Indonesia

In 2007, Fuji Electric delivered to the Kamojang Geothermal Plant of Indonesia a steam turbine and generator for Unit 4. We received another order for providing equipment and teaching advisory service of installation and commissioning for Unit 5 (net electrical output: 35 MW) and completed the work in July 2015.

For Unit 5, we have delivered a combination of an axial exhaust flow turbine and low-level direct contact type condenser. An axial exhaust flow turbine allows the height of the turbine building to be lower than a downward exhaust flow type, and combining it with a low-level condenser eliminates the need for excavating a deep condensate pit. The delivery time was 23 months after the commencement of the contract, which is about one month shorter than the standard delivery time for similar size projects. However, this equipment configuration made it possible to reduce the period of civil and construction work, enabling us to successfully complete the work within the delivery time.

Fig.1 Steam turbine and generator



2 Power Generation Facility No.1 at Ishinomaki Hibarino Power Station of Nippon Paper Ishinomaki Energy Center Ltd.

In 2015, Fuji Electric received an order from IHI Corporation to design, procure, manufacture and install a steam turbine, generator and electric and control equipment for Power Generation Facility No.1 at Ishinomaki Hibarino Power Station of Nippon Paper Ishinomaki Energy Center Ltd. The generator output is 149 MW and Fuji Electric will deliver a one-cylinder reheat condensing turbine (axial exhaust type) and air-cooled generator, which have good track records. This power generation facility has been planned by Nippon Paper Ishinomaki Energy Center Ltd. established by Nippon Paper Industries Co., Ltd. and Mitsubishi Corporation. Coal-biomass co-combustion boiler and power generation facility will be installed on the site to the south of Ishinomaki Mill of Nippon Paper Industries Co., Ltd.

It will be a symbol of the reconstruction of Ishinomaki and is scheduled to start the operation in March 2018.

Fig.2 Rendering of Power Facility No.1 at Ishinomaki Hibarino Power Station



Thermal/Geothermal Power Plants

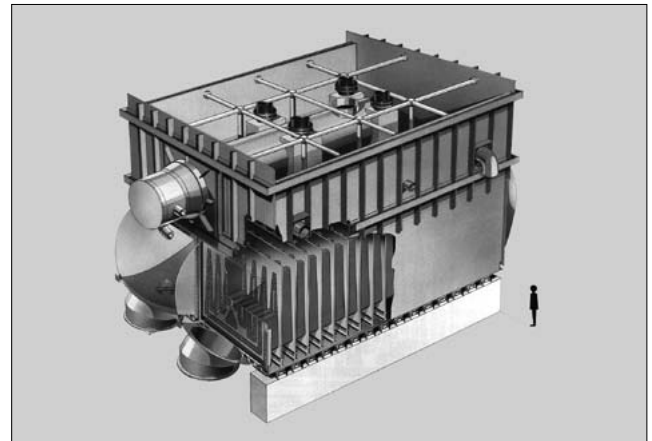
3 Seawater Leak Diagnosis System: Condenser Tube Leak Buster

A seawater leak in a condenser, which may be generated by condenser tube corrosion or collision between a foreign object and a condenser tube, causes a critical failure in power generation equipment. In recent years, seawater leaks due to aging of equipment have been on the increase.

Fuji Electric has developed “Condenser Tube Leak Buster,” a seawater leak diagnosis system equipped with a function to immediately detect any seawater leak online and identify the leak in a group of condenser tubes in a short time. This system has a configuration featuring improved detection accuracy and is capable of detecting any leak within a few minutes. In addition, it can quickly identify a leak with a detection method that uses helium. This allows damage to be minimized.

The detection technology applied to this system is patent pending.

Fig.3 Example of surface condenser to be diagnosed



Nuclear Power

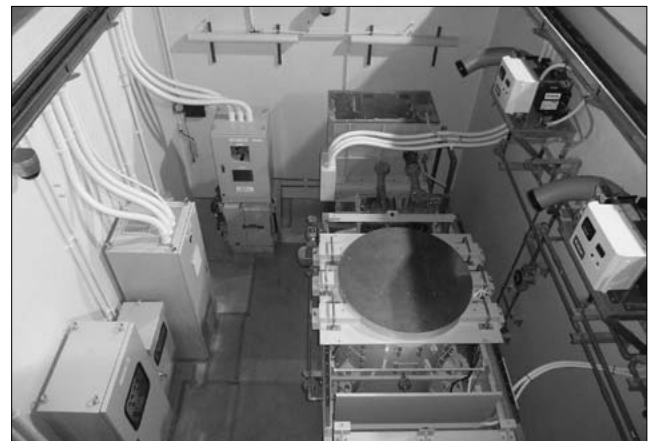
1 Seawater Radiation Monitor

Fuji Electric has developed and installed ocean monitoring equipment for seawater which is in the periphery of the Fukushima Daiichi Nuclear Power Station of Tokyo Electric Power Company Holdings, Inc.

The seawater radiation monitor is equipment capable of continuously measuring and monitoring the radioactivity concentration of cesium-134, cesium-137 and beta-ray nuclides, which are major nuclides causing seawater contamination. This equipment is composed of an intake pump that pumps up seawater, various filters to remove sand in the seawater, an UV sterilizer to restrain the growth of marine life and beta-ray and gamma-ray monitors. The equipment is characteristically installed at the tip of a breakwater and the cover that houses the equipment is provided with a structure that can withstand waves in stormy weather, not to mention being watertight.

Continuous monitoring operation was started in April 2015 and the actual measurement data are opened to public in the website of the customer.

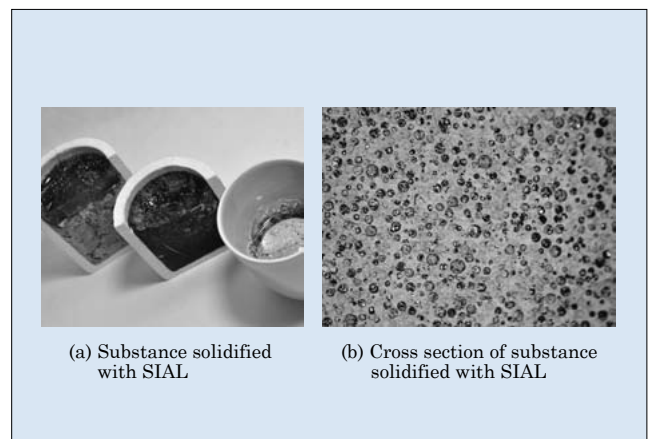
Fig.4 Full view of inside of seawater radiation monitor



2 Technology to Solidify Radioactive Waste

As a technology for solidifying and immobilizing radioactive waste, use of geopolymers is attracting attention. Fuji Electric is working on technology for immobilizing the radioactive waste generated at nuclear plants in Japan by using a product called SIAL, made by the UK company AMEC F&W and the only commercialized geopolymer in the world. The residue resulting from using “Fuji Resin Reducer,” a spent resin volume reduction and immobilization processing equipment, to process the simulated waste of an ion-exchange resin with cesium ions and cobalt ions absorbed in it was solidified with SIAL for evaluation. As a result, it has been confirmed to offer a compressive strength at least equivalent to that of a substance solidified with cement and to achieve a two-digit or more reduction in the exudation of the encapsulated cesium, cobalt, etc. into water. We are moving ahead with evaluating its applicability to various types of waste generated from nuclear power plants and other facilities.

Fig.5 Substance solidified with SIAL and its cross section



Renewable Energy and Power Stabilization

1 Construction of Tomakomai Yufutsu Mega-Solar Power Plant (21 MW AC)

Fuji Electric received an order from Tomakomai Yufutsu Mega-Solar Corporation, a subsidiary of Marubeni Corporation, to install a solar power plant with a capacity of 21 MW AC. The 535 days of work was completed safely with no accidents since the start of construction on site in April 2014 and commercial service was started in October 2015. The project site is located adjacent to Tomatoh Industrial Estate and is directly below the air route into New Chitose Airport. On the site of approximately 48 ha divided into three areas A, B and C, 114,440 photovoltaic cells have been installed. The output of 29.8 MW DC is converted into alternating current by using 21 power conditioning sub-systems (PCSs) with a single-unit capacity of 1,000 kW, which is boosted up with a transformer to be connected to a 66-kV power transmission line of Hokkaido Electric Power Co., Inc. This project is part of a 20-year electric power selling business, in which the customer is making use of the “Feed-in Tariff Scheme” of the Ministry of Economy, Trade and Industry.

Fig.6 Full view of areas A and B in Tomakomai Yufutsu Mega-Solar Power Plant



Fuel Cells

1 Fuel Cell for Tokyo Factory’s Main Building

A fuel cell with an output of 100 kW has been installed at the main building of Fuji Electric’s Tokyo Factory. The power output from this fuel cell constitutes a grid-independent system together with photovoltaic power generation and a battery, and allows power to be supplied to important loads even during a blackout. The high-temperature exhaust heat (90°C hot water) generated during power generation is cooled into cold water with an absorption refrigerator and used for the air conditioning of the main building together with medium-temperature exhaust heat (50°C hot water). The exhaust air of the fuel cell is clean and has a high concentration of CO₂, and an experiment is scheduled to start in October 2016 in which the exhaust air is sent to a nearby experimental plant factory growing strawberries.

This equipment was built with the Subsidy System for the Gas Co-Generation Promotion Program of the City Gas Promotion Center.

Fig.7 Fuel cell installed at Tokyo Factory



2 Atmospheric Pressure Solid Oxide Fuel Cell

Fuji Electric is developing an atmospheric pressure solid oxide fuel cell (SOFC) in addition to the phosphoric acid fuel cell (PAFC) with a power output of 100 kW that is currently on the market. With a commercial cogeneration system of a few tens of kW assumed, we have been participating in the “Technology Development for SOFC Commercialization Promotion,” which is a project of the New Energy and Industrial Technology Development Organization (NEDO), to work on the development since FY2014. We built SOFC module verification equipment with a capacity of 10 kW by FY2015 and evaluated its performance. The results showed the equipment achieved a DC gross electrical efficiency of over 55% (equivalent to AC power generation efficiency of 50%), which is NEDO’s target. In the future, we plan to design and build demonstration equipment of the 50-kW class and conduct field testing on it. We aim to launch it on the market in FY2018.

Fig.8 Solid oxide fuel cell





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