Electric Power Generation Systems

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

Outlook

In Japan, thermal power plants continued to remain in high operation in FY2014 while the year seeing continuous assessment of compliance to new regulatory standards for the restarting of nuclear power plants. At the same time, however, the study into energy mix technologies is also keeping pace as the United Nations Climate Change Conference (COP21) scheduled to be held in Paris in 2015 approaches. It is expected that aging thermal power plants will be upgraded and accelerated in usage. With regard to photovoltaic power generation, there is still big difference between facility certified capacity and construction facility capacity, and it is anticipated that construction work will continue in FY2015 and beyond. As for other types of renewable energy, small-scale geothermal binary power generation is continuing to advance, while it is expected that construction projects for large-scale geothermal power generation and wind power generation facilities will become more vibrant.

In overseas markets, the construction of large-capacity high-efficiency coal-fired power generation facilities and gas turbine combined cycle (GTCC) power generation facilities will continue, as well as projects for upgrading gas turbine power stations to combined systems. This trend is especially being supported by the long-term power demand growth in developing nations. Furthermore, the development of geothermal power generation facilities is not limited to Southeast Asia, but is also expected to take shape in other regions such as Africa.

In the field of thermal power generation, we received a large scale GTCC project. Furthermore, we also received orders (3 projects) of medium-capacity steam turbines and generator for coal and biomass-mixed thermal power facilities in Japan in FY2014. We also worked to expand and acquire projects in new markets overseas, besides those in Asian markets, and as a result, we successfully concluded receiving orders in Saudi Arabia. We continued our R&D in the development of elemental technologies for the high-temperature valves used in advanced ultra-supercritical (A-USC) steam turbines. In the field of geothermal power generation, we received an order for the first binary power generation facilities to be installed in the Takigami region in Kyushu, Japan. In addition, we also received several orders overseas, via our local partners, which included two projects in Indonesia and one project in Iceland.

As for photovoltaic power generation facilities, we completed an EPC project in December 2014 for Kisosaki Reclaimed Land Mega Solar, which included facilities with a capacity of 49.2 MW DC and 35 MW AC. We have also been pursuing increased efficiency for our power conditioning sub-systems (PCS) for photovoltaic power generation by adopting a configuration of 35 outdoor-type units with a single unit capacity of 1 MW. As for components, we have equipped chopper circuits with our SiC module and are now supplying the market with an indoor-type PCS equipped with an All-SiC module corresponding to 1,000 V DC with a single unit capacity of 1 MW and a conversion efficiency of 98.8%.

In the field of wind power generation, we are expecting to start construction and operations of large-scale wind power generation facilities, which have already completed the environmental assessment process. Fuji Electric is continuing to expand into the wind power business based on its component, system and prime contractor businesses. We are aiming to expand our market share for stabilization devices and have completed the development of a PCS for stabilization devices that has a capacity of 750 kVA and stand-alone operation functions.

In the field of fuel cells, we installed and started operations of a total of 10 fuel cells at four sewage treatment plants in FY2014. The fuel cells are compliant with the sewage digestion gas specification falling under the Feed-in Tariff (FIT) Scheme for renewable energy. In addition, we have also installed fuel cells compliant with city gas specifications in locations throughout Japan including hospitals, local heat supply businesses and universities (one fuel cell per location). In overseas markets, we have installed and started operations for fuel cells compliant with the nat-

ural gas specifications in South Korea and South Africa (one fuel cell per country).

In the field of nuclear power, four years have passed since the accident at Fukushima Daiichi Nuclear Power Plant, and in addition to gradually moving toward the maintenance phase for the site, a diverse range of technology development has begun, mostly under the efforts of the International Research Institute for Nuclear Decommissioning (IRID), which includes monitoring technology for the inside of containment vessels scheduled for decommissioning, as well as technologies for removing stagnant water and debris and methods for processing secondary waste resulting from contaminated water processing. Fuji Electric is focusing on several technologies which include the development of remote dismantling technology required in the decommissioning. We are also utilizing overseas technologies as we advance in developing applicable technologies, for example, stabilization technology for radioactive waste generated by nuclear power plants. Among efforts to be compliant with the newly enforced new regulatory standards, an enhanced standard design for various earthquake-resistant boards and function verification based on vibration tests are being promoted for nuclear power reactors. In light of these efforts, we have completed the development and are supplying nuclear power plants with medium-voltage switchgears capable of withstanding the seismic shocks required of nuclear power plants. With regard to nuclear fuel cycle related facilities, Fuji Electric is working with its customers to carry out various assessments for its installed facilities with regard to compliance with the new regulatory standards required in the restart of operations. Furthermore, we designed, manufactured and installed a piece of equipment for recovering an object that had been interfering with the reactor of the experimental fast reactor "Joyo" of the Japan Atomic Energy Agency. We successfully recovered the object while working in cooperation with members of the agency.

In addition to the efforts Fuji Electric is making to actively develop renewable energies such as geothermal, photovoltaic and wind based energies, as well as high-efficiency thermal power generation equipment and fuel cells for use in Japan and overseas, it is also contributing to society through its efforts in the field of nuclear fuel cycle and in the development of technologies required to maintain and decommission the Fukushima Daiichi Nuclear Power Plant.

Thermal/Geothermal Power Plants

1 Start of Commercial Operations of Sur IPP Power Plant in Oman

Commercial operations commenced in December 2014 for the Sur IPP power plant (2,000 MW combined cycle power plant) operated by Phoenix Power Company in Oman. The main business operations of the Phoenix Power Company are being overseen by Japanese companies which include Marubeni Corporation and Chubu Electric Power Co., Inc. It is predicted that the current demand for power in Oman will increase by an average of at least 9% per year, and in light of this, the power plant is expected to play an important role in providing approximately 25% of the total domestic demand for power.

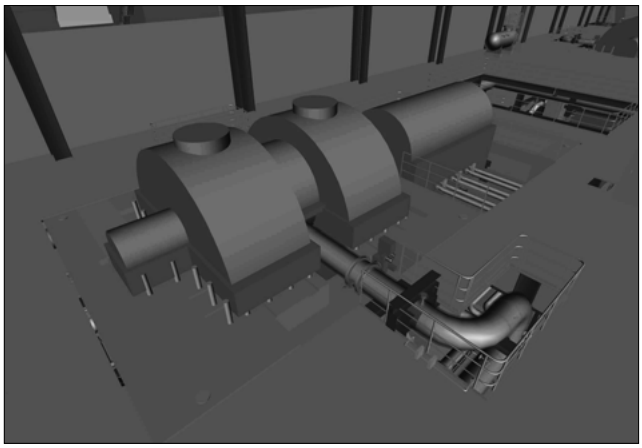
Fuji Electric has supplied the power plant, via Korean based Daewoo Engineering & Construction Co., Ltd., with a steam turbine and generator equipment set (328.2 MW×2, 161.7 MW×1). The steam turbine applies two casing reheat admission condensing double side exhaust. The condensers are located at the left and right sides of the low pressure turbine. The generator applies a hydrogen cooled type for 328.2-MW units and an air cooled type for 161.7-MW unit.

Fig. 1 Panoramic view of Sur IPP power plant

2 Unit 3 and Unit 4 at Ulubelu Geothermal Power Station in Indonesia

In August 2014, Sumitomo Corporation and PT Rekayasa Industri, a leading engineering company in Indonesia, contracted a full turnkey project with PT Pertamina Geothermal Energy (the Ulubelu Geothermal Power Plant Unit 3 and Unit 4 [58.8 MW×2] located in the southern Sumatra). Fuji Electric will supply main equipment such as geothermal steam turbine, generator and control units, and engineering service of the power plant as a subcontractor of Sumitomo Corporation. The completion of the power plant is scheduled in July 2016 for Unit 3 and in May 2017 for Unit 4. Fuji Electric has already installed the Ulubelu Geothermal Power Plant Unit 1 and Unit 2 (55 MW× 2), owned by an Indonesian state-owned power company, in the Ulubelu district in 2012. After the completion of the upcoming power plant construction work, Fuji Electric will have supplied main equipment of the geothermal power plant with a total output of over 220 MW in the Ulubelu district.

Fig. 2 Image of steam turbine and generator installation



3 Idemitsu Oita Geothermal Co., Ltd. Takigami Binary Geothermal Power Plant

Fuji Electric has received an order from Idemitsu Oita Geothermal Co., Ltd. to supply the Takigami Binary Geothermal Power Plant, which is schedule to start operations in March 2017, with the facilities and equipment at all stages of development including design, procurement, manufacturing and construction. Although high-temperature steam and hot water both gush out to the earth's surface, geothermal power generation has, up until now, only extracted high-temperature steam for utilization in power generation, but this power station will employ a binary system to make use of 130°C hot water (which, up until now, had been returned into the earth unused) in power generation. This system is planned to generate a maximum of 5.05 MW of electricity, for a yearly total of 31 million kWh. This amount of power generation, if converted in terms of general household consumption, is enough to supply approximately 8,600 households. After using the hot water in power generation, it will be restored to the earth, so the system has no more impact on geothermal resources than previous systems. This system is expected to contribute greatly to geothermal power generation in the future.

Fig. 3 Rendering of completed Takigami Binary Geothermal Power Plant

Thermal/Geothermal Power Plants

4 Renovation of Power Generation Equipment with Combined Cycle Upgrade

Fuji Electric performed work for the Shinko Kakogawa Power Station of Kobe Steel, Ltd., which included the renovation of the existing CDQ Unit 1 steam turbine power generation equipment as well as a combined cycle upgrade for the existing gas turbine installation based power generation equipment.

Since the combined cycle system receives steam, which is generated from the heat recovery steam generator (HRSG), into the existing condenser during gas turbine start-up and stop, a flush box was added to the condenser. Furthermore, in order to accommodate operation that differs from the existing equipment, we improved operability and reliability by modifying the steam turbine control system and adding monitoring functionality, as well as by adding protection interlock.

We finished the work on schedule and operations for the equipment started in February 2015.

Fig. 4 CDQ unit 1 steam turbine power generation equipment

Renewable Energy and Power Stabilization

1 Mega Solar Power Plant in Kisozaki Reclaimed Land (49.2 MW DC)

Fuji Electric received an order from Kisozaki MegaSolar Corporation, a subsidiary of Marubeni Corporation, to install photovoltaic power generation equipment with a capacity of 49.2 MW DC. The construction work is taking place on the reclaimed land in the town of Kisosaki, a region bordering Mie Prefecture and Aichi Prefecture. The photovoltaic power generation equipment has a total output of 35 MW AC, and 196,620 photovoltaic panels have been installed on a plot of land covering approximately 57 hectares (1,000 m×570 m). Construction started in July 2013 and was completed in December 2014. The 528 days of work were completed safely with no accidents. Fuji Electric is utilizing 35 power conditioning sub-systems (PCS) with a single unit capacity of 1,000 kW, and is performing interconnection, by means of a booster transformer, to the terminal of the 77 kV special high voltage network system of Chubu 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. 5 Panoramic view of mega solar on Kisozaki reclaimed land

2 Storage Battery Power Conditioning Sub-System “PVI800-3/750”

Fuji Electric has been undertaking the development and market deployment of power conditioning sub-systems (PCS) for large-capacity storage batteries in order to help solve output fluctuation problems that accompany renewable energy.

The storage battery power conditioning sub-system “PVI800-3/750” (800 V DC, 750 kW) is an indoor-only PCS with a single unit capacity of 750 kW and a maximum efficiency of 97.7%, which includes the internal power supplies (cooling fan power supply, control power supply). A system power factor compensation of 0.9 (833 kVA output) is possible when the storage battery is outputting 750 kW, and the system supports both compensation requests for the system power factor and a high operating rate for user equipment.

The PCS is distinguished by its stable waveform characteristics during stand-alone operation, and it can be utilized in micro-grid systems as a stand-alone power supply for wind farms and the like.

Fig. 6 “PVI800-3/750”

Nuclear Power

1 Retrieval for Bent MARICO-2 Test Subassembly Using Remote Control Device of Experimental Fast Reactor "Joyo"

In the experimental fast reactor "Joyo", the incident that the MARICO-2 test subassembly (the irradiation rig with an instrumental line that is inserted into the core) was bent in the reactor vessel occurred in June, 2007.

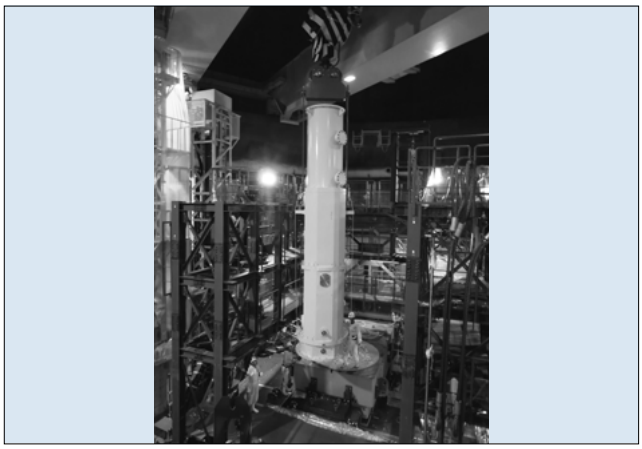
Fuji Electric has designed and manufactured the device to retrieve the bent MARICO-2 test subassembly from March, 2012 to March, 2014.

The retrieval works have had the restrictions that the work site was under the high temperature and high radiation environment that was isolated an atmosphere specific to the fast reactor, the bent test subassembly was not possible to lift straight and so on.

Therefore, the retrieval device was composed of various units which were adequately shared each function for the works.

Fuji Electric and Japan Atomic Energy Agency have jointly accomplished the retrieval works for the bent MARICO-2 test subassembly using remote control device in "Joyo" in September, 2014 after the works started in June, 2014.

Fig. 7 Retrieval works inside reactor containment vessel



2 Medium-Voltage Switchgear (Earthquake Resistant Specification) for Nuclear Power Plants

Fuji Electric has successfully developed and has started supplying medium-voltage switchgears that are earthquake resistant, a feature that is required by nuclear power plants. This medium-voltage switchgear was designed in consideration of the regulatory standards applied to nuclear power facilities, and can withstand a horizontal acceleration of 3 G and vertical acceleration of 2 G. This value is equivalent to an intensity of about 3 times the earthquake resistant performance required of conventional nuclear power facilities. This medium-voltage switchgear is characterized by its ability to verify function maintenance during times of vibration even when the circuit breaker is in standby mode (a state in which the circuit breaker is pulled out to the test position), as well as by its maintaining the same level of easiness as general specification switch boards even with regard to the ease of putting in and pulling out the circuit breaker. This means that the unit satisfies the seemingly contradictory requirements of being able to firmly fix the circuit breaker in place, while also allowing for easy putting in and pulling out of the circuit breaker without the use of tools.

Fig. 8 Medium-voltage switchgear (earthquake resistant specification)