TOSHIBA REVIEW

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Special Reports

Various Power Generation Systems Utilizing Renewable Energy

Application of Renewable Energy to Creation of Sustainable Society
KAZAO Yukihiko

Trends in Power Generation Systems Utilizing Renewable Energy, and Toshiba's Approach
SHIBAGAKI Toru
Power generation systems utilizing renewable energy respond to the demands of the present era from the perspective of Earth consciousness and low greenhouse gas emissions.
Toshiba has been engaged in the development and supply of a number of systems in this field, including wind and photovoltaic (PV) power generation systems, in addition to conventional hydroelectric and geothermal systems. We are also developing a wide variety of innovative technologies aimed at realizing new types of power generation including ocean current power generation. In response to a broad range of market needs, we are making continuous efforts to provide solutions to issues including improvement of efficiency, stable supply of electric power, and flexibility to cope with load variability.

Cutting-Edge Technologies for Development of Photovoltaic Power Generation Systems
HASEGAWA Yoshiaki / WATANABE Kenji / INABA Michihiko
In response to the rapid expansion of large-scale photovoltaic (PV) power generation systems and the shortage of experienced engineers in this field, Toshiba has been developing a PV engineering platform that allows even inexperienced engineers to design PV systems by applying information and communication technologies to a broad range of system designs. To accelerate the dissemination of large-scale PV power generation systems, we are also engaged in the development of an organic thin-film solar cell that will contribute to the reduction of solar module prices and reduce total system costs.

Latest Technologies for Large-Scale Photovoltaic Power Generation System in High-Snowfall Region
NIIMOTO Takeshi / WATANABE Setsuo / MINEGISHI Toshiaki
Toshiba has delivered a large-scale photovoltaic (PV) power generation system in a high-snowfall region for the Niigata Tobu Voltaic Power Plant Group No. 2, applying the following latest technologies: (1) an easy-to-assemble mounting structure with tall and tilted support for PV panels, to minimize the reduction of power generation due to heavy snowfall and shorten the installation period; (2) PV panels with 1.25 times the capacity of the power conditioning system, to maximize annual electricity generation by compensating for losses resulting from the weather conditions in the high-snowfall region; and (3) a PV string monitoring system to efficiently detect anomalies of modules and junction boxes under monitoring and maintenance. These technologies have made it possible to realize a large-scale PV power generation system that can efficiently generate electricity even in a cold region with heavy snowfall while achieving comprehensive cost reductions.

Toshiba's Approach to Deployment of Wind Turbine Generation Systems
MAEZAWA Shigeo / YAMADA Toshimasa / MURAKAMI Yuya
Toshiba is vigorously promoting wind power generation business activities both in Japan and overseas, and providing a comprehensive value chain in each development process from surveys of site locations and wind conditions to supply of equipment, construction, operation, and maintenance. We have developed the following wind turbine lineup: (1) 750 kW-type models equipped with a direct-drive wind turbine, and (2) 2 MW-type models equipped with a geared permanent-magnet synchronous generator (PMSG). Incorporating this lineup into our first wind turbine construction project, we have completed the construction of two 2 MW-type wind turbines in Ukraine that are now in full operation.

Advanced Control Technologies for Wind Turbine Generation Systems
OSAKO Toshiki / TANAKA Motofumi / MATSUDA Hisashi
Wind turbine generation systems are operated under constantly changing wind conditions, necessitating various functions and performance characteristics to achieve high reliability, high energy production, high grid stability, and the most advantageous specifications to meet the needs of the market concerned.
To meet these requirements and achieve comprehensive cost reductions, Toshiba is developing the following advanced technologies: (1) a plasma aerodynamic control technology to increase power generation efficiency by controlling plasma-induced airflow on the blades; (2) a wind farm control technology to optimize the total power generation of the wind farm by controlling the output of each wind turbine; and (3) a wind turbine control system with hybrid battery systems incorporating two types of batteries to suppress power fluctuations in the wind farm.

Latest Technologies Contributing to Realization of Large- to Small-Capacity Geothermal Power Plants
TAJIRI Junichi
Toshiba has been developing and supplying equipment for geothermal power plants in Japan and overseas in response to customers' requirements since its delivery of a turbine generator for Japan's first geothermal power plant in 1966. In recent years, we have received orders for turbine generators and auxiliary equipment, including for two units of the Te Mihi Geothermal Power Station in New Zealand, four units of the Olkaria Geothermal Power Plant in Kenya, and one unit of the Patuha Geothermal Power Plant in Indonesia, and applied turbine systems appropriate to the amount of steam flowing into the turbine in each case.
In addition to the development and supply of large-capacity turbine systems of 30 MW or more, we are also making efforts to disseminate small-capacity turbine systems for geothermal wellhead power plants, which can be used immediately after the development of steam production wellheads, based on our experience in the development of a 5 MW portable type geothermal turbine for a project in Mexico in 1987.

Latest Technologies for Hydroelectric Power Systems
HYUGA Takeshi / SATO Yusuke
About 120 years have passed since Japan's first hydroelectric power station started operation, and hydroelectric power generation still remains the major source of renewable energy in the country's total electric power output. In recent years, expectations have been rising for an expanded role for hydroelectric power generation due to its high responsiveness in maintaining stable power supply by compensating for power fluctuations resulting from the use of renewable energy sources such as wind and photovoltaic (PV) systems that are affected by weather conditions, as well as its ability to support peak electricity demand during the daytime. New development projects for small and medium-sized hydroelectric power plants have increased with the introduction of the feed-in tariff (FIT) system in the Japanese market, and demand has been growing both for new construction in developing markets and for high-performance equipment to renew aging systems in developed markets.
In response to this situation, Toshiba is promoting the development of technologies for equipment in hydroelectric power systems.

State-of-the-Art Technologies for Micro-Hydroelectric Power Generation Systems
NAKAHARA Yusuke / KUBO Koichi / SOMA Hiroaki
The number of micro-hydroelectric power generation systems is expected to increase for the purpose of selling electric power following the enforcement of the Act on Special Measures Concerning Procurement of Renewable Electric Energy by Operators of Electric Utilities in July 2012.
To meet this market requirement, Toshiba has developed the "Pico Hydraulic Power System" for open waterways. Unlike a conventional hydroelectric turbine installed in a water pipeline, in this system the hydroelectric turbine generator unit is installed in an open waterway such as a canal, where it converts the energy of the water flow into electrical energy. The system incorporates the following technological advancements: (1) a booster mechanism to increase output energy through the flow guide structure, (2) simple site assembly of the turbine generator, (3) a dedicated permanent magnet generator (PMG) for the control unit, and (4) a control system consisting of the PMG control unit and a power conditioning system (PCS) that can be connected to a low-voltage grid without the need for an initial starting power supply. We have also developed the Hydro-eKIDS$_{TM}$ series of axial-flow hydroelectric turbine generator units for micro-hydroelectric power generation stations of up to 200 kW in capacity, and delivered a number of systems since 2001. By using the control system of the Pico Hydraulic Power System, the Hydro-eKIDS$_{TM}$ series can be connected to a low-voltage grid for the sale of electric power.

Development of Floating Type Current Turbine System Using Ocean Current Energy
KABATA Yasuo / KUBO Koichi / UEDA Takashi
The Kuroshio is one of the ocean currents flowing near the coast of Japan throughout the year, and power generation technology using this ocean current energy is now attracting attention in Japan due to its potential as a clean and stable energy source.
Toshiba has been engaged in the research and development of a floating type current turbine system, moored on the seabed and floating on the sea. This system consists of large twin-turbines and a simple mooring for deep-sea deployment, and is expected to operate with a high level of system utilization. We have developed a high-efficiency turbine blade suitable for the slow velocity of ocean currents and have confirmed its performance through towing tank tests. In order to reduce environmental risk resulting from contamination by gearbox lubricating oil, we have also been developing both a direct-drive permanent magnet generator without a gearbox and a seawater-lubricated plastic bearing.

Feature Articles

Living Activity Recognition Technology Using Sensors in Smartphone
OUCHI Kazushige / DOI Miwako
The monitoring of everyday living activities is applicable to various context-aware services including self-care and care for the elderly. Several indoor living activities have so far been recognizable by installing numerous ambient sensors, or by wearing a dedicated sensor or a number of sensors on the body. However, the cost of the sensors and the burden of wearing sensors are critical issues.
To rectify this situation, Toshiba has developed an indoor living activity recognition technology using only off-the-shelf sensors; namely, an accelerometer and a microphone that are commonly installed in smartphones. By incorporating an outdoor migration activity recognition technology into this technology, it has become possible to continuously monitor in real time not only indoor activities such as brushing teeth, vacuuming, and so on, but also outdoor activities such as walking, running, boarding a train or bus, and so on, by processing data from a continuously carried smartphone.

Application of Perpendicular STT-MRAM to Cache Memory for Substantial Reduction in Power Consumption
KITAGAWA Eiji / FUJITA Shinobu / ITO Junichi
The increase in power consumption of cache memories for data retention is a serious issue accompanying the increase in their capacity. Magnetoresistive random-access memories (MRAMs), which are a nonvolatile type of cache memory that do not consume energy for data retention, are under consideration as a solution to this issue. However, they have the significant disadvantage of increased power consumption due to higher writing current.
Toshiba has now developed a perpendicular spin-transfer torque (STT)-MRAM using low-power writable perpendicular-magnetic tunnel junction (p-MTJ) devices, and confirmed through simulations that a reduction in power consumption of more than 80% can be expected while maintaining mobile processor performance equivalent to that of static RAMs (SRAMs).

Manufacturing and Decorating Technologies for Cases of Notebook PCs with Metallic Texture
KINJO Kazuyuki / MURAYAMA Tomomi / TAKAHASHI Ko
Toshiba has realized thin and light notebook PCs, including the dynabook$_{TM}$ R732/R632 compact notebook and Ultrabook^{TM} PCs, by using magnesium (Mg) alloys as the case material. In recent years, demand has been increasing among users for improvement of the texture of PCs, such as a more metallic feeling, in addition to thinness and light weight.
We have developed an AZ91 Mg alloy pressing technology and a high-brightness painting technology, and have also introduced a quantitative method for the evaluation of metallic texture using parameters such as variations in light, shade, and brightness as an alternative to the sensory evaluation method. We have now released the dynabook KIRA V632/V832 compact notebook and Ultrabook^{TM} PC models applying these technologies.

Noise Reduction and Sound Quality Improvement Technologies for Operation Sounds Emitted by MFPs
YAMAGUCHI Masao
Multifunctional peripherals (MFPs) integrating multiple functions including copying, printing, fax, and scanning functions in one unit are now widely used in offices. With the increasing quietness of offices in recent years, there has been growing demand for the operation sounds emitted by office equipment to be quieter and more pleasant. MFPs are no exception to this situation. In order to offer a comfortable environment to office workers, Toshiba TEC Corporation has been developing noise reduction and sound quality improvement technologies aimed at making the sounds emitted by MFPs quieter and more pleasant, using computer-aided engineering (CAE) including acoustics simulation and structural analysis. Through the application of these technologies, we have launched the e-STUDIO$_{TM}$ 2050C/2550C/2051C/2551C MFPs with the world's best class of quiet and pleasant operation sounds.

Frontiers of Research & Development

Development of Dysprosium-Free High-Iron-Concentration Samarium-Cobalt Magnet for High-Efficiency Motors