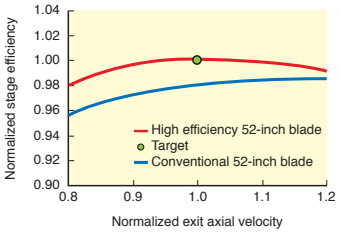
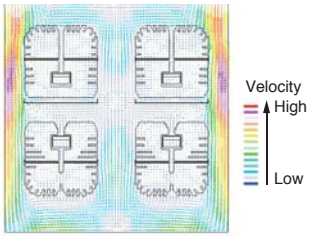
Power Systems

In the power systems field, Toshiba develops environment-conscious products, taking a leading role in power generation and distribution systems. Through continuous development efforts, we supply secure and safe nuclear equipment, and large-capacity and high-efficient power generation and transformation equipment to meet the growing demand for energy while reducing greenhouse gases.

AP1000 Steam Turbine for Advanced Light Water Reactor



Measured high efficiency of 52-inch turbine



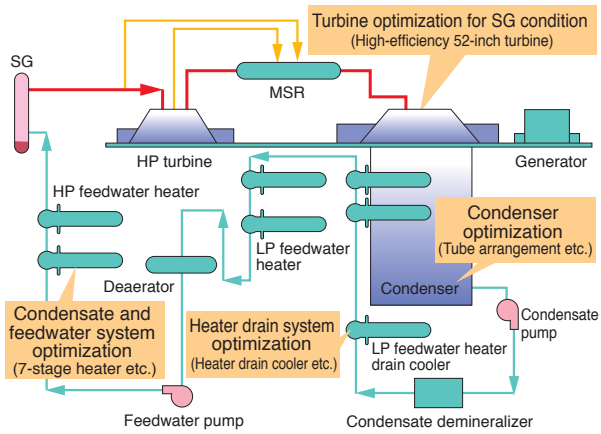
Hydrodynamic analysis of condenser

Toshiba has developed a turbine system for the advanced light water reactor, the AP1000, in collaboration with Westinghouse (WEC). The turbine system was optimized with regard to the steam condition of the steam generator and external conditions such as cooling water.

For the design of the turbine blades, the 52-inch last stage blade developed by Toshiba and the advanced flow pattern (AFP) blade design were incorporated, resulting in a 2% performance increase in the efficiency of the turbine stage. Based on these results, the overall plan for the entire plant including the turbine system and plant layout was studied with WEC and US power companies.

For the design of the condenser where the turbine exhaust steam is condensed, the hydrodynamic analysis of the condenser was performed on the assumption that the cooling tower is incorporated as a cooling source. The condenser tube arrangement used in domestic plants was optimized by using the multi-pressure design.

The results from these studies are reflected in the latest revision of the design control document (DCD), and were submitted to the Nuclear Regulatory Commission (NRC) in May 2007. The detailed design is now under way for the first unit of the AP1000.



SG : Steam Generator MSR: Moisture Separator Reheater
HP : High Pressure LP : Low Pressure

Turbine system optimization

Toshiba ABWR Contribution to US Nuclear Renaissance

Image of the South Texas Project

Following the establishment of the 2005 Energy Policy Act in the US, a nuclear renaissance is underway and US power utilities are now preparing to construct several nuclear power plants.

Among these, South Texas Project (STP) Nuclear Operating Company applied for a combined construction and operating license for two ABWRs to the US Nuclear Regulatory Commission in September 2007.

Toshiba received an order for basic engineering of STP Units No.3 and No.4, as well as the reactor pressure vessel for Unit No.3 in 2007, after continuous promotion based on Toshiba's reliable ABWR experience and technology. In March 2008, we were selected as the prime contractor to supply engineering and major equipment prior to the actual construction. In July 2008, US Nuclear Regulatory Commission public meeting was held and we were recognized as the nuclear vender for STP Units No.3 and No.4. We will continue to respond positively to not only the ABWR deployment in the US but the upcoming internationalization of the ABWR.

ABWR: Advanced Boiling Water Reactor

Commencing Commercial Operation of New Power Units of the Umm Al Nar Independent Water and Power Project, UAE

New power units of the Umm Al Nar Independent Water and Power Project

Central control room

The new power units of the Umm Al Nar Independent Water and Power Project by Arabian Power Company in the east of Abu Dhabi city, UAE started overall commercial operation in July 2007.

The new power units are the multi-shaft advanced combined cycle power plant with a total power generation capacity of 1550 MW comprising 5 gas turbines, 5 heat recovery steam generators (HRSGs) and two steam turbines. In parallel with electric power generation it also supplies low-pressure steam to 7 existing and 2 new desalination units having a total capacity of producing approx. 430 000 m^3 per day of potable water from sea water.

Toshiba was responsible for engineering, procurement, construction and commissioning of the power units, and also served as the contractor's technical leader of the overall project.

Outstanding features of the new power units (compared with others) are as follows:

- Large-scale plant system by integrating existing systems such as desalination units and sea water pumps
- Natural gas and distillate oil dual-fuel capability
- HRSGs equipped with large-capacity supplementary firing burners
- Single casing double-flow back pressure 300 MW steam turbines

In particular, the reliability of plant operation is greatly increased thanks to the sophisticated total plant load control implemented by Toshiba's distributed control and monitoring system, which enables flexible and optimized operation of all power units in response to the number of operating units, electrical power and water demands.

Successful Completion of Ultra-Supercritical Thermal Power Plant in China

Taizhou Ultra-Supercritical Thermal Power Plant, China

The first unit at the Taizhou Ultra-Supercritical Thermal Power Plant in China commenced commercial operation successfully in December 2007.

This is the first Ultra-Supercritical Thermal Power Plant in the country, and is expected to play a key role of stably providing electricity to the swiftly developing area including Shanghai.

This project was open to only domestic manufacturers, but technical collaboration with overseas leading manufacturers was required as an important contractual condition. Toshiba formed a consortium with Harbin Turbine Co., Ltd. (HTC) for steam turbines and with Harbin Electric Co., Ltd. (HEC) for generators. From a technical point of view, axial stability is a crucial factor for tandem steam turbines and generator units especially for such a large unit, which requires state-of-the-art technology and fine-tuned manufacturing capabilities. For this reason, large-capacity tandem units like this one are rare in the world.

The generator is not only the latest but also the largest machine as 50 Hz-2 poles units in our history, being at least 19% larger than our previous largest unit. HTC/HEC and Toshiba focused on expediting the construction to meet the request for earlier completion than the original schedule from China Guodian Taizhou Generating Co., Ltd., the owner, while maintaining superior quality and excellent performance. With all parties' cooperation, it took less than 24 months from commencement(*) to completion of construction, which is a world class record.

(*) Counting from the completion of underground work

4 × 225 MW Purulia Pumped Storage Project, India Enters Operation

Overview of Purulia Pumped Storage Power Station

The 900 MW (4 × 225 MW) Purulia Pumped Storage Project in the state of West Bengal in India has been successfully completed and in operation since January 2008.

This project is one of the largest pumped storage projects in India. This adds one more feather to the crown and is a major success story for the Toshiba Group outside Japan.

The electrical and mechanical portion was designed, manufactured, supplied, installed and commissioned by the Toshiba Group consisting of Toshiba, Toshiba Plant Systems & Services Corporation (TPSC) and TPSC (India) Prv. Ltd.

The scope of supply and ratings are as follows:

- Scope of supply: Static frequency converter, Control system, Power house equipment
- Pump-turbine rating: 230 MW, 177 m, 250 min^{-1}
- Generator-motor rating: 250 MVA, 16.5 kV, 50 Hz

Completion of Shop Manufacturing of No.1 Unit for Dayingjiang HEPP, China

Shop assembly of turbine stationary parts for Dayingjiang Power Plant, China

The first unit for Dayingjiang hydroelectric power Plant (HEPP) (4 × 175 MW) was completed in shop manufacturing and delivered to the site.

The fabricated turbine runner was assembled in Toshiba Keihin Product Operations, and other main parts were manufactured in Toshiba Hydro Power (Hangzhou) Co., Ltd. (THPC).

The latest “splitter runner” technology has been adopted to ensure high performance.

The other three units are scheduled for manufacturing and delivery, and commercial operation of all units will start in 2009.

The ratings are as follows:

- Turbine : 175 MW, 289 m, 300 min^{-1}
- Generator : 200 MVA, 13.8 kV, 300 min^{-1}, 50 Hz

Completion of 1000 MW Turbine Generator for the USA

2P-60 Hz-1000 MW generator under performance test

In February 2008, Toshiba successfully manufactured and shipped a compact and high-efficiency 2P-60 Hz-1000 MW turbine generator for a thermal power plant in the USA.

This turbine generator, having the same capacity and world-highest-class efficiency as those used by Japanese utilities for more than 6 years, was designed reflecting Toshiba’s wealth of experience in large-capacity generators while adding a number of fully verified advanced new technologies.

The turbine generator was designed as a 60 Hz-1000 MW standard machine (1120 MVA-0.9 PF), and four units of extra turbine generators have been ordered for the next two years.

A number of performance tests were carried out at Toshiba Keihin Product Operations. These tests confirmed that this standard series of 2P-60 Hz-1000 MW turbine generator fully satisfied all required specifications and performance, and so it was shipped in February 2008.

This thermal power plant will enter commercial operation in May 2009.

Completion of Construction for Unit 1 of Maritsa East II Rehabilitation Project

Maritsa East II Coal-Fired Power Plant, Bulgaria

Toshiba has the contract for the rehabilitation project to modernize the biggest coal fired thermal power plant, Maritsa East II, in Bulgaria.

Toshiba has been executing this project jointly with Mitsui & Co., Ltd. and IHI Corporation. Toshiba replaced the old steam turbine and generator, which had been made by a Russian manufacturer about 40 years ago and suffered low thermal efficiency due to aging, with new ones made by Toshiba to increase the power output with high-efficiency technology. IHI Corporation supplied FGD to reduce the level of emissions from the power plant to meet the standards of the European Union. The contract started in October 2004, and the rehabilitation work for the steam turbine and generator of Unit 1 was completed in September 2007. To achieve the target, longer last stage blades were used for the steam turbine, and an air cooling system was used for the generator instead of the water cooling system of the existing one to improve the maintainability.

FGD: Flue Gas Desulfurization

Commercial Operation of Hellisheidi Geothermal Power Plant Started in Iceland

Turbine and generator set for 33.6 MW Low-Pressure Unit of Hellisheidi Geothermal Power Plant, Iceland

Hellisheidi Geothermal Power Plant Unit 11 (Low-Pressure Unit, 33.6 MW, owned by Reykjavik Energy) was successfully put into commercial operation in November 2007. In Iceland, renewable energy sources such as geothermal and hydro power are primary energy sources and are helping to reduce global carbon dioxide emissions.

Toshiba has completed the project as the consortium leader and the supplier of the turbine and generator set. The world's longest class of 31.2-inch last-stage blade was selected for the steam turbine of the project. Furthermore, the erection period was successfully minimized by applying a packaged steam turbine set.

Completion of 400 kV Substation of Purulia Pumped Storage Project, India

Overview of 400 kV substation

The 400 kV gas-insulated switchgear (GIS) substation of the Purulia Pumped Storage Project (4 × 225 MW) by the West Bengal State Electricity Board (WBSEB) in India contracted in July 2003 was energized from a 400 kV transmission line in October 2007. The substation then successfully entered commercial operation in March 2008 after completion of testing of the generators.

The project is separated into eight lots, including Civil, Generator, etc. Toshiba's scope of work for the substation part is the supply of substation equipment, erection and testing on a turn-key basis.

The main scope of work for the substation part is as follows:

- 420 kV GIS: 9 bays
- 400 kV substation equipment: 1 lot
- 420 kV GIS building
- 255 MVA transformer: 4 banks + spare tank
- Erection and testing work

For the 420 kV GIS, we used one break type circuit breaker for the first time in India, which reduces the dimensions of the GIS building. In addition, point-on-wave (POW) systems were applied to transmission line feeders to reduce the surge level upon operation of the gas circuit breaker (GCB).

For 255 MVA transformers, we selected special three-phase water-cooled transformers because of transportation limitations.

Backed by the successful experience of this one break type circuit breaker, the technology will be extended to other projects in India in the future.

Completion of 220 kV Brazi Vest Substation Upgrading Project (Stage-2) for Romania Transelectrica S. A.

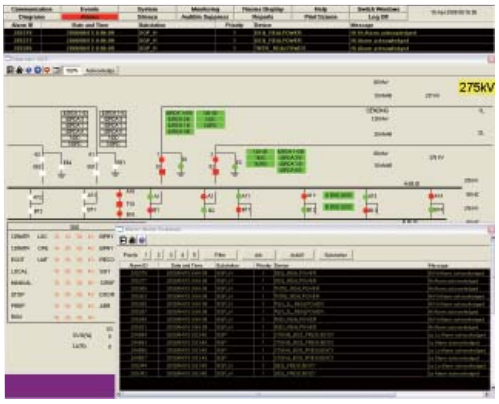
245 kV GIS at Romania Brazi Vest Substation

Toshiba has completed construction of the 220 kV substation as the second stage of the project to upgrade the 400/220 kV Brazi Vest Substation for Romania National Power Grid Company Transelectrica S. A. in April 2007, followed by its successful energization in July 2007.

This was an upgrading project of the aged existing air-insulated substation and we finished the 400 kV substation as the first stage of the project in April 2006. This time, we completed the 220 kV substation as the second stage, and supplied and installed the 245 kV GIS. As a result, the substation occupies just one-third of the area before this upgrading project.

With the end of this second stage of the project, the entire 400/220 kV GIS substation, the first in Romania, was completed and put into commercial operation.

Development of Web-Enabled SCADA System for Electric Power System



Screens of one-line diagram and alarm list

Toshiba has developed a Web-enabled supervisory control and data acquisition (SCADA) system for the power transmission market.

By introducing this system, the user can easily configure a highly reliable SCADA system for an electric power system, and it is possible to operate power transmission facilities anywhere in the intranet.

The International Standard IEC-60870-5-104 is used as the communication protocol with the remote substations.

In addition to SCADA functions such as data acquisition, data monitoring, control, alarms and recording of the KEMA (N.V. Tot Keuring Van Elektrotechnische Materialen) standard specifications, this system has the following features for good maintenance and customization:

- Engineering tools
  The user can create one-line diagrams efficiently by using the pre-installed symbol library which contains symbols for the shapes and behaviors of devices.
- Localization
  Labels of buttons, error messages, and so on are replaced according to the local language, which provides a user-friendly graphical user interface.
- Web-based client
  The Web-based client enables clients to be added easily and securely thorough the intranet.
- User authentication by security token and/or biometrics
  This system authenticates an operator by security token and/or biometrics. Authenticated operators can access only those functions that the system grants for his role. The administrator can define each operator's role and can assign each function to each role.

SCiB™ New Type of Rechargeable Battery

SCiB™ cell

SCiB™ battery pack

Toshiba has launched the Super Charge ion Battery (SCiB™), a breakthrough rechargeable battery primarily targeting the industrial systems market that can recharge to 90% of full capacity in less than five minutes. The battery also offers excellent safety and a long-life of over 6 000 cycles even under conditions of constant rapid charging. In order to realize the outstanding characteristics of the SCiB™, a new negative electrode material, a new separator, a new electrolyte, and new manufacturing technology were all adopted.

The SCiB™ is also packaged in the SCiB™ battery pack comprising of ten 4.2 Ah SCiB™ cells aligned in series connection, together with a battery management system (BMS) that monitors the voltage and temperature in order to protect the cells in case of emergency and balances the state of charge in each cell.

Potential applications include e-bikes, automated guided vehicles, electric forklift trucks and broadcast applications which already use rechargeable batteries. The SCiB™ is also a promising candidate for emergency power sources, electric power regeneration in wind power systems and the stabilization of electric power supply. Moreover, we have developed a battery cell for hybrid electric vehicles with a view to extension to electric vehicles.

Major specifications of SCiB™

	SCiB™ cell	SCiB™ battery pack
Nominal voltage	2.4 V	24 V
Nominal capacity	4.2 Ah	4.2 Ah
Size	Approx. 62 mm × 95 mm × 13 mm	Approx. 100 mm × 300 mm × 45 mm
Mass	Approx. 150 g	Approx. 2 kg