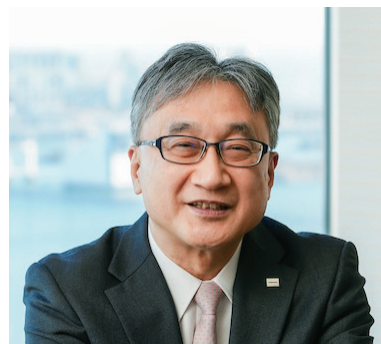


## Technologies Playing a Leading Role in the Realization of Carbon Neutrality and Resilient Infrastructure



Executive Fellow, Former Corporate Senior Vice President and CTO

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A global transition to renewable energy and green technology is accelerating with the aim of achieving carbon neutrality. At the 26th session of the Conference of the Parties to the United Nations Framework Convention on Climate Change (UNFCCC COP 26) held in 2021, the participating parties agreed to pursue efforts to limit global warming to a maximum of 1.5°C above pre-industrial levels by 2100. The need for infrastructure resilience is increasing as our lives are being greatly affected by an upsurge in severe floods, earthquakes, and other natural disasters (many of which are attributable to global warming), aging social infrastructure, declining labor population, supply chain interruptions due to the new coronavirus (COVID-19) pandemic, and cyberattacks.

Under these circumstances, the Toshiba Group is taking the initiative toward realizing carbon neutrality and resilient infrastructure in accordance with the Basic Commitment of the Toshiba Group, “Committed to People, Committed to the Future.” We are pursuing the “Energy × Digital” and “Infrastructure × Digital” strategies to accelerate the progress of the energy and infrastructure fields by leveraging digital technologies. Our focus is to take advantage of our cyber-physical system (CPS) technologies so as to offer optimal solutions to the issues faced by society and our customers. Specifically, our solutions include differentiated electronic devices that underpin the progress of social and information infrastructures, components and systems that stand out from those of other contenders, and infrastructure services of the TOSHIBA SPINEX brand based on the open Toshiba Internet of Things (IoT) Reference Architecture.

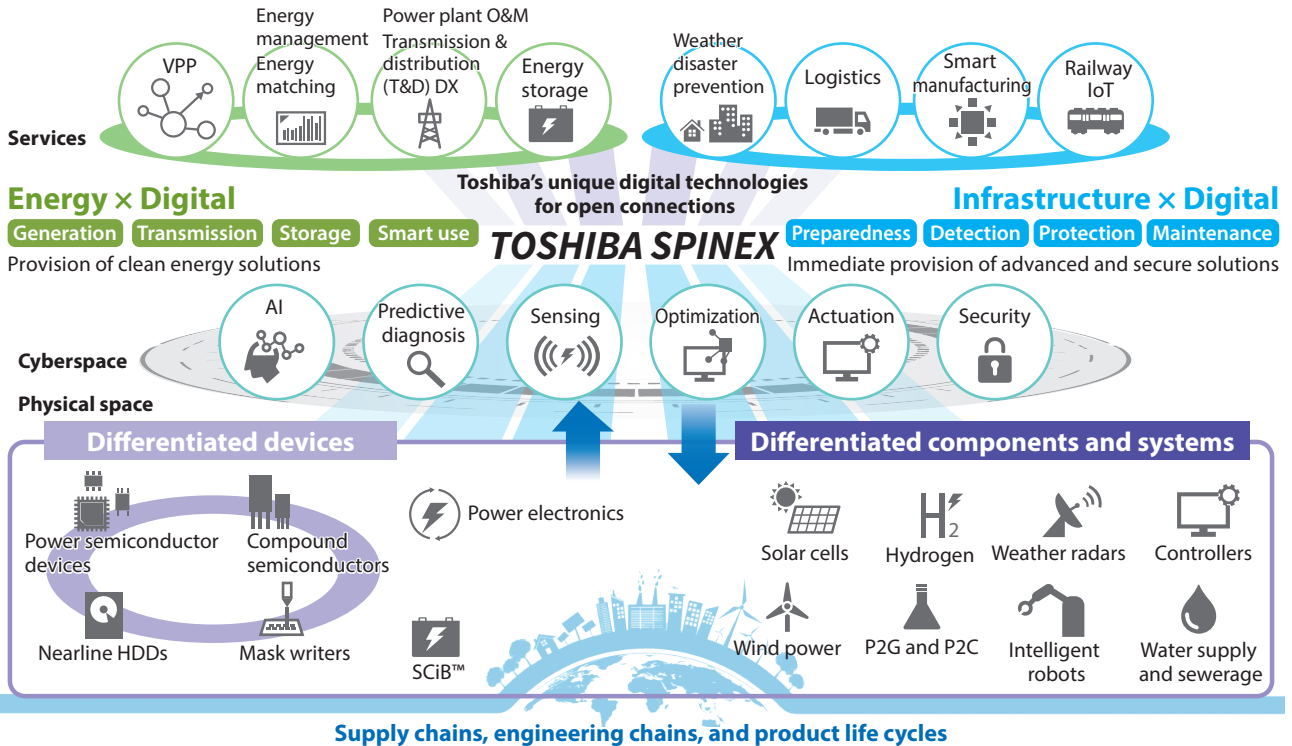
The following provides snapshots of some of our technological innovations achieved as of March 2022 in each of the R&D and business domains of the Toshiba Group.

In the R&D domain, Toshiba Corporation has developed a film-based perovskite photovoltaic module with the world’s highest power conversion efficiency of 15.1%; a cuprous oxide (Cu<sub>2</sub>O) tandem solar cell using a Cu<sub>2</sub>O cell with the world’s highest power conversion efficiency; automatic flexible depalletizing robots, a suite of autonomous transportation robots, and control system technologies that help improve logistics productivity; and a cyberattack emulation technology to evaluate security risks. The company has also demonstrated quantum key

**Contribution to solution of social and customer issues in accordance with the Basic Commitment of the Toshiba Group, "Committed to People, Committed to the Future"**



Committed to People, Committed to the Future.



P2G: power-to-gas P2C: power-to-chemicals O&M: operation and maintenance DX: digital transformation  
 SCiB™: Toshiba's rechargeable lithium-ion battery VPP: virtual power plant AI: artificial intelligence

distribution (QKD) over an optical fiber exceeding 600 km in length, the longest fiber-based QKD on record; developed a distributed data storage technology for sensitive bulk genome analysis data that combines secure cryptographic communication and data storage; and created a technology to evaluate the design of production lines using three-dimensional (3D) data.

In the energy business domain, Toshiba Energy Systems & Solutions Corporation has developed the third-generation 100 kW carbon dioxide (CO<sub>2</sub>)-free H2Rex™ pure hydrogen fuel cell system, which is smaller and less costly than the previous model, and supplied the equipment required for a high-voltage DC (HVDC) link interconnecting regions that use different grid frequencies (50 Hz and 60 Hz).

In the social infrastructure business domain, Toshiba Infrastructure Systems & Solutions Corporation has developed the BISCADÉ™ dongle, which provides both possession and biometric authentication, and deployed traction energy storage systems (TESS) for a mass rapid transit (MRT) system in Dhaka.

In the electronic devices and storage business domain, Toshiba Electronic Devices & Storage Corporation has developed a highly reliable and compact silicon carbide (SiC) power module, as well as hard disk drives (HDDs) for data centers with a maximum storage capacity of 20 Tbytes (T: tera =  $10^{12}$ ) applying flux-control microwave-assisted magnetic recording (FC-MAMR) and shingled magnetic recording (SMR) technologies.

In the digital solutions business domain, Toshiba Corporation has released the TOSHIBA SPINEX Design System to help improve the efficiency of development of user experience (UX) and web applications, while Toshiba Digital Solutions Corporation has added a new function to the Meister Cloud series compliant with asset administration shells in order to help improve the “smartness” of factories and plants.

In the retail and printing business domain, Toshiba Tec Corporation has released a cloud service to improve the efficiency of maintenance of multifunctional peripherals (MFPs).

In the building solutions business domain, Toshiba Carrier Corporation has developed variable-refrigerant-flow (VRF) building air-conditioning systems for cold regions that provide an extended heating mode temperature range and a higher heating capacity at low outdoor temperatures than the previous model.

The Toshiba Group is endeavoring to co-create differentiated devices, components, and systems as well as energy and infrastructure services with its partners and provide them to customers so as to contribute to the solution of social issues. We hope that you will enjoy reading *TOSHIBA REVIEW Science and Technology Highlights 2022*, and would appreciate your feedback, suggestions, and comments.