



Toshiba Group IR Day 2022

# Toshiba Group Technology Strategy

February 7, 2022

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Corporate Senior Vice President and CTO

**Toshiba Corporation**

# Forward-looking Statements and Other Cautionary

- This document has been prepared solely for the purposes of providing information regarding the strategic reorganization described herein (“Reorganization”) and does not constitute an offer to sell or a solicitation of an offer to buy any security of Toshiba Corporation ("Toshiba"), its subsidiaries or any other company in Japan, the United States or any other jurisdiction.
- This document has been translated from the Japanese-language original document for reference purposes only. In the event of any conflict or discrepancy between this document and the Japanese-language original, the Japanese-language original shall prevail in all respects.
- This document contains forward-looking statements and prospects concerning the future plans, strategies, and performance of Toshiba group.
- These statements are not historical facts; rather, they are based on assumptions and judgments formed by the management of Toshiba group in light of currently available information. They include items which have not been finalized at this point and future plans which have yet to be confirmed or require further consideration.
- Since Toshiba group promotes business in various market environments in many countries and regions, its activities are subject to a number of risks and uncertainties which include, but are not limited to, those related to economic conditions, worldwide competition in the electronics business, customer demand, foreign currency exchange rates, tax and other regulations, geopolitical risk, and natural disasters. Toshiba therefore cautions readers that actual results may differ from those expressed or implied by any forward-looking statements. Please refer to the annual securities report (yuukashoken houkokusho) and the quarterly securities report (shihanki houkokusho) (both issued in Japanese only) for detailed information on Toshiba group's business risks.
- Unless otherwise noted, all figures are 12-month totals on a consolidated basis.
- Results in segments have been reclassified to reflect the current organizational structure, unless stated otherwise.
- Since Toshiba is not involved in the management of Kioxia Holdings Corporation (formerly Toshiba Memory Holdings; hereinafter "Kioxia") and is not provided with any forecasted business results for Kioxia, Toshiba group's forward-looking statements concerning financial conditions, results of operations, and cash flows do not include the impact of Kioxia.
- The execution of the Spin-off described in this document is subject to approval at Toshiba's general shareholders' meeting and the fulfillment of all review requirements of the relevant regulatory authorities.
- Depending on the applicable laws and regulations (including securities listing regulations and U.S. laws and regulations), developments in the application, revision and enforcement of various regulatory regimes including tax regulations, interpretations by the relevant authorities, further considerations in the future and other factors, the implementation of the Reorganization may take longer than expected and there may be changes in the structure of the reorganization.

# Agenda

- 01 Toshiba Group Technology Strategy
- 02 Cutting-Edge and Fundamental Technologies
- 03 An R&D Structure that  
Demonstrates Combined Strengths
- 04 In Closing

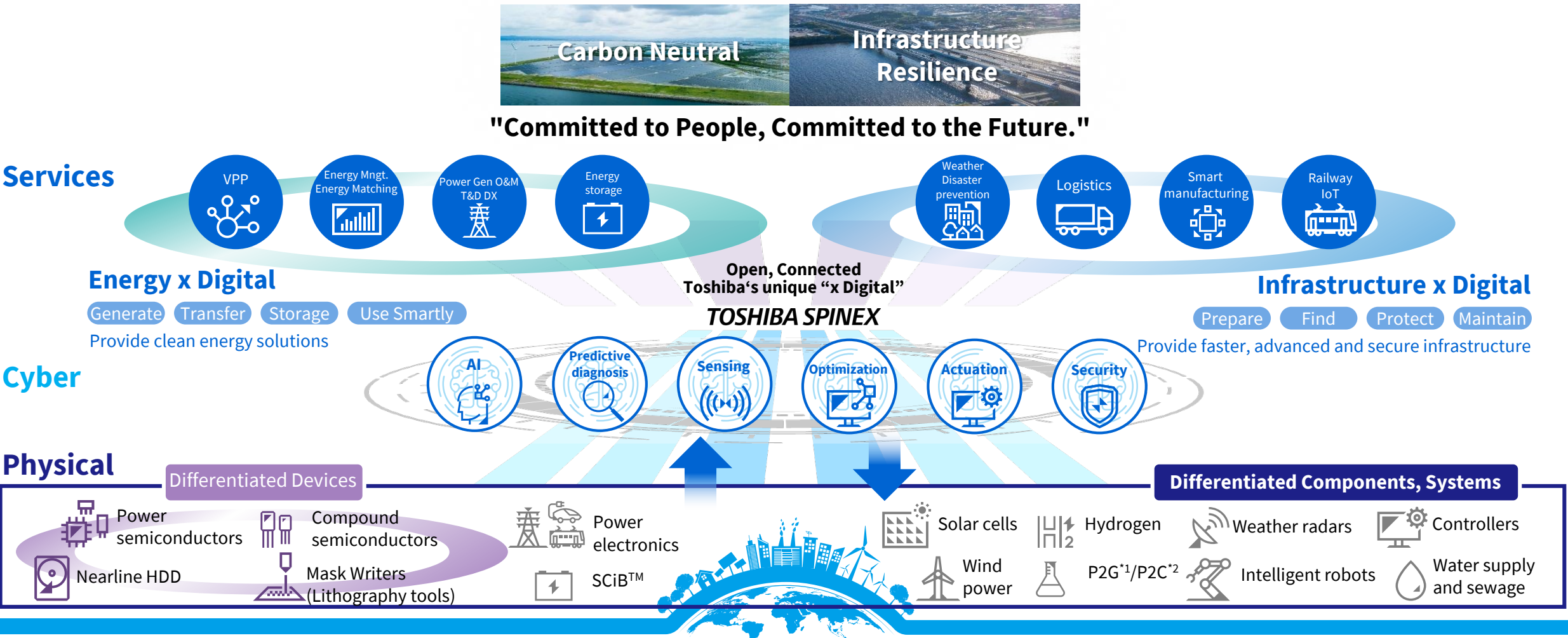
# 01

## Toshiba Group Technology Strategy

- Toshiba Group Technology Policy
- Further Emphasis on Focus Technologies: R&D Investment
- R&D to Strengthen Competitiveness of Key Growth Areas
- Initiatives to Visualize ROI in R&D and Enhance Efficient Investment

# Toshiba Group Technology Policy

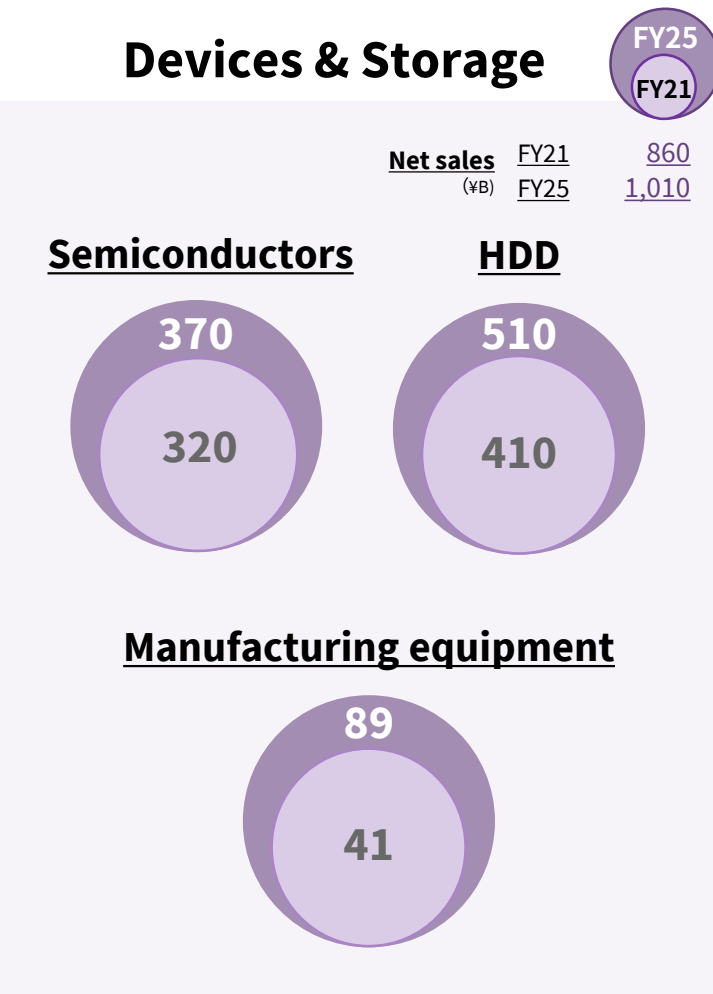
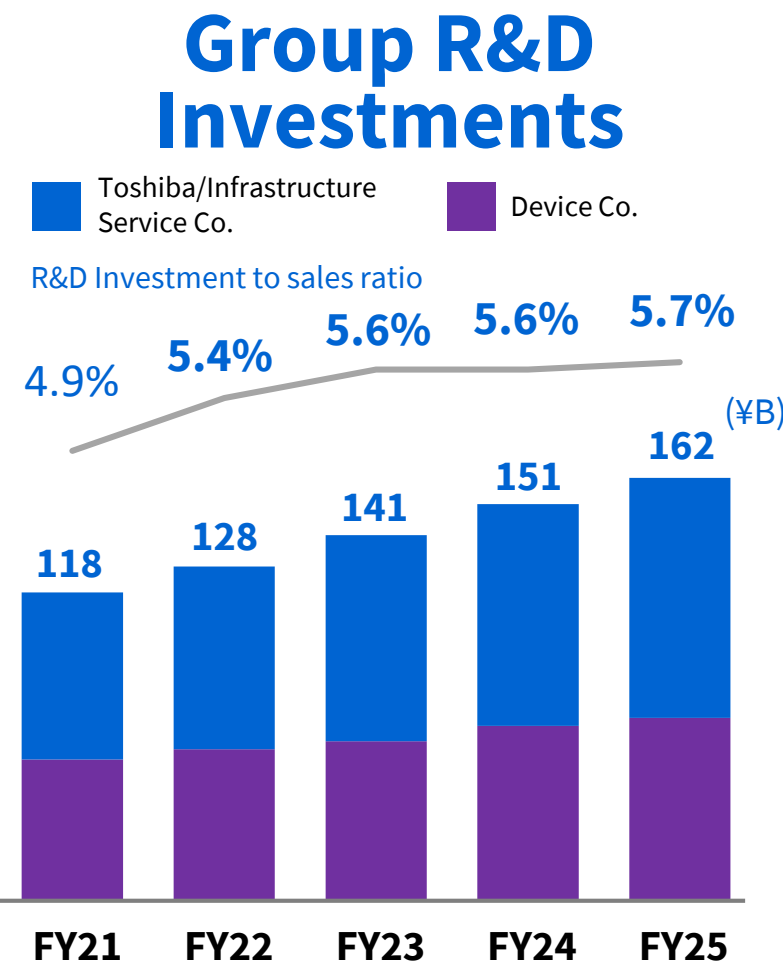
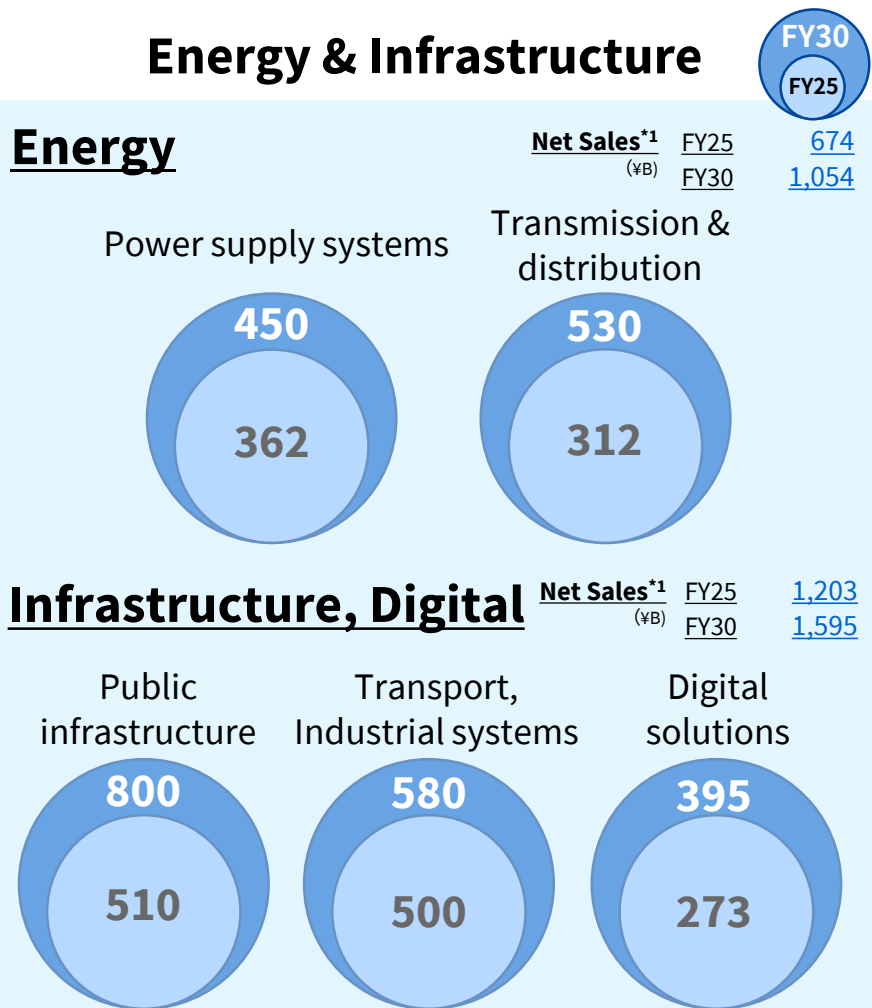
Contribute to solving social and customer issues guided by the Basic Commitment of the Toshiba Group "Committed to People, Committed to the Future."



\*1 : Power to Gas    \*2 : Power to Chemicals

# Further Emphasis on Focus Technologies: R&D Investment

Increase ratio to sales and strengthen competitiveness of growth areas  
in energy & infrastructure and devices & storage



\*1 : Sales amount of each segment include other businesses other than energy, infrastructure and digital, as well as common accounts and inter-segment eliminations

# R&D to Strengthen Competitiveness of Key Growth Areas

Strengthen competitiveness of product & services by linking cutting-edge, product development and fundamental initiatives

## Cutting-edge

- Future new business creation
- Contribution to business development

## Product Development

- Contribution to business growth, and product/services expansion

## Fundamental

- Overarching support to business growth and expansion of products and services

### Energy and Infrastructure

NG-QKD<sup>\*1</sup>, quantum computing, superconductivity, neuromorphic HW, quantum machine learning, MI<sup>\*2</sup> etc.

NG solar cells (perovskite, tandem type), P2C<sup>\*3</sup>  
Aqueous Li-ion rechargeable batteries, SBM<sup>\*4</sup>

### Devices and Storage

NG-semiconductors (Si, SiC, GaN), NG-HDD

#### Carbon Neutral



Solar



Offshore wind



Water supply & sewerage



Logistics Robots



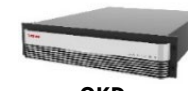
CCU/S<sup>\*5</sup>



Hydrogen solutions



Factory IoT Platform  
Smart manufacturing



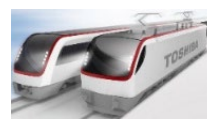
QKD



VPP



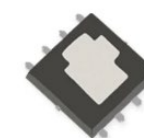
SCiB<sup>TM</sup>



Railways

#### Infrastructure Resilience

#### Power semiconductors



Si-MOSFET<sup>\*6</sup>



IGBT<sup>\*7</sup>



SiC module<sup>\*8</sup>



Motor control IC



Nearline HDD

#### Manufacturing



Multi-beam mask writers

AI, IT, security, materials, manufacturing, software, etc.



# Initiatives to Visualize ROI in R&D and Enhance Efficient Investment

Monitor changes over years by introducing KPIs in each target group

## R&D Investment

## Objectives

## KPI ▶ Monitoring and evaluation of annual changes

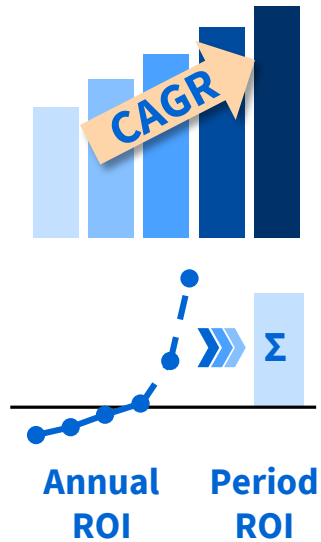
### Product Development

To contribute to business growth

- ROI in R&D      **Period ROI**    **Annual ROI**
- Business growth    **CAGR**

$$\text{Period ROI} = \frac{\sum \text{operating profit (sum of total period)}}{\sum \text{R\&D investment (sum of total period)}}$$

$$\text{Annual ROI} = \frac{\text{operating profit (every fiscal year)}}{\text{annual R\&D investment (every fiscal year)}}$$



### Cutting-edge

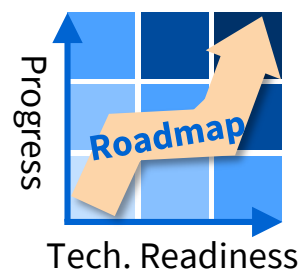
To contribute to future new business deployment

- **Benchmarking**
  - ✓ Evaluation based on megatrends and business strategy

### Fundamental

To provide overarching support in all business growth

- **Consistency with the roadmap in product development**
  - ✓ Progress level(Business Contribution)
  - ✓ Technology Readiness level





# 02

## Cutting-edge and Fundamental Technologies

- Cutting-edge Technologies
- Fundamental Technologies
- Recent Major Awards from Third Parties

# Cutting-edge Technology Initiatives

## Frontier technology development initiatives that also utilize open innovation

### Quantum

#### ★ Quantum Key Distribution



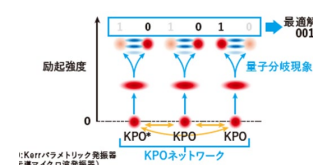
Cabinet Office (SIP<sup>\*1</sup>), Ministry of Economy, Trade and Industry, Ministry of Internal Affairs and Communications, ToMMo<sup>\*2</sup>, Tohoku University Hospital, NICT<sup>\*3</sup>

#### Q-STAR<sup>\*4</sup>



#### ★ Quantum and quasi-quantum computers

##### Quantum computers



Ministry of Education, Culture, Sports, Science and Technology, Ministry of Economy, Trade and Industry, Q-II<sup>\*5</sup>

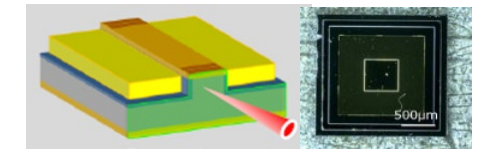
##### Simulated bifurcation machine™



Dharma Capital. K. K.

#### Quantum technology applications

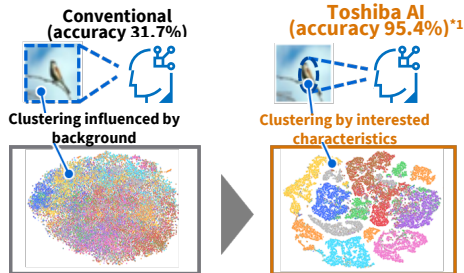
##### Quantum cascade laser



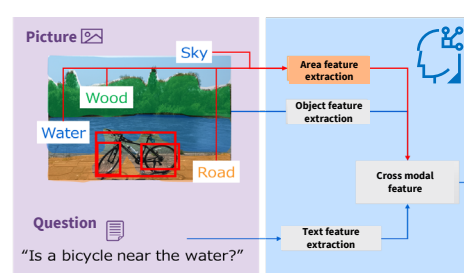
NIMS<sup>\*6</sup>, Tokyo University of Technology, Acquisition, Technology and Logistics Agency, Ministry of Education, Culture, Sports, Science and Technology

### AI

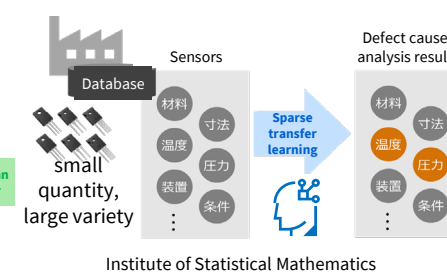
#### Deep clustering



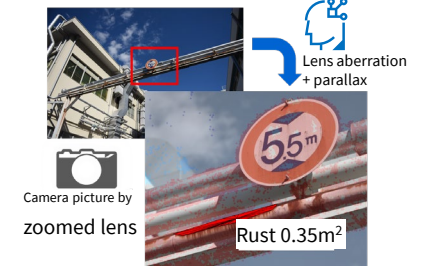
#### VQA<sup>\*7</sup> AI



#### Sparse transfer learning

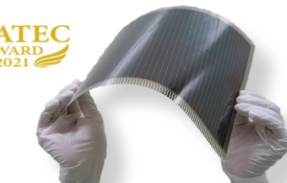


#### Monocular 3D measurement AI



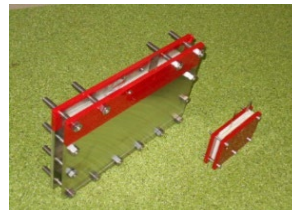
### Materials Devices

#### ★ Film-Based Perovskite Photovoltaic Module

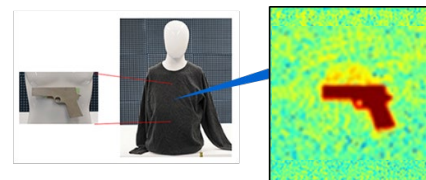


NEDO<sup>\*8</sup>

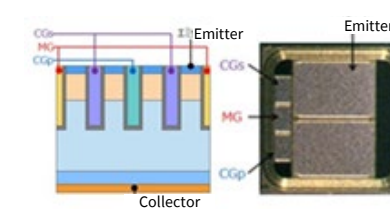
#### ★ Aqueous Li-ion rechargeable batteries



#### Millimeter-wave imaging



#### Power semiconductor Triple-gate IGBT



#### Next gen. HDD



\* 1: Cross-Ministerial Strategic Innovation Promotion Program, \* 2: Tohoku University Tohoku Medical Megabank Organization, \* 3: National Institute of Information and Communications Technology, \* 4: Quantum STRategic industry Alliance for Revolution, \* 5: Quantum Innovation Initiative Council, \* 6: National Research and Development Agency - National Institute for Materials Science, \* 7: Visual Question Answering, \* 8: New Energy and Industrial Technology Development Organization

★ details explained in the next 2 slides

# Examples of Cutting-edge Technologies in Quantum & Quasi-Quantum

## Promote spread of quantum & quasi-quantum technologies and their safe and secure application

### Quantum Key Distribution (QKD)



BT Group plc, Quantum Xchange,  
SpeQtral Pte Ltd, etc.

**Commercialized in 2021**

World's fastest speed  
in key distribution  
\* in long distance case

**300kb/s**  
@10dB loss

World's longest distance  
in key distribution  
\* in long distance case

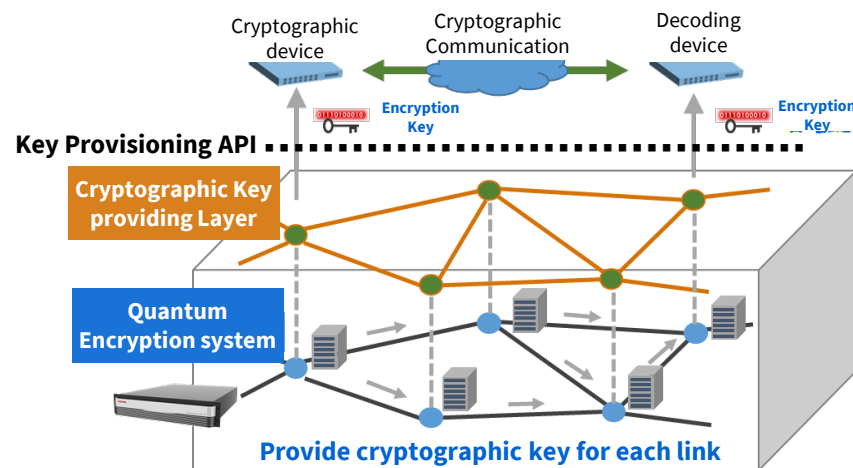
**120km**

**WW No.1** Longer distance

communication distance,  
over 600km<sup>\*1</sup>

**WW First** Miniaturization

chip-based quantum key  
distribution system<sup>\*2</sup>



**Aiming to establish a quantum key distribution platform for the realization of end-to-end secure encrypted communication**

### Simulated Bifurcation Machine™



Dharma Capital. K.K.

**Providing the same performance as a quantum computer  
using computers that is commercially available**

Finds the optimal solution to a one-million-bit problem in  
30 minutes; a typical algorithm would take 14 months<sup>\*3</sup>



**WW First**

**Started to validate effectiveness of quasi-quantum  
computing for high-speed, high-frequency stock market  
trading for the first time in the world**

\*1: Part of this achievement is supported by the EU through the Horizon 2020 project OpenQKD.

\*2: Part of this achievement is supported by Agile Quantum Safe Communications, an InnovateUK joint research and development project through the Industrial Strategy Challenge Fund of the UK Government.

\*3: Goto et al. Science Advances 2021. Compared to our algorithm in 2019.

# Examples of Cutting-edge Technologies in Materials and Devices

## Toshiba's unique technologies save energy and achieve security and safety in energy and infrastructure

### Perovskite Solar Cells



NEDO

Commissioned by New Energy and Industrial Technology Development Organization(NEDO)

### Low Cost x Lightweight x Flexible

Improve efficiency and productivity through one-step film formation based on meniscus technology<sup>\*1</sup>

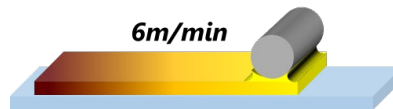
WW No.1

Large area film type module efficiency: **15.1%** (current)

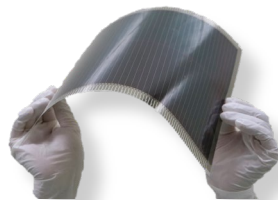
Power generation cost target: **20 yen/kWh** (2025)



- Minister of Economy, Trade and Industry Award
- Carbon Neutral category Grand Prix

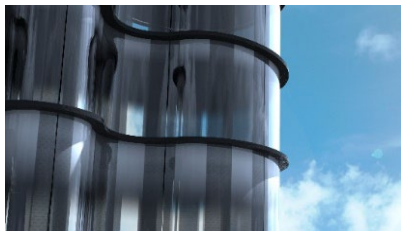


One-step process based on meniscus application



### Expand applications based on the advantages of light weight, film-type cell

Buildings



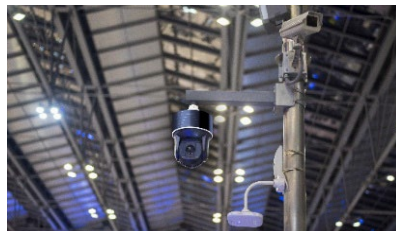
Transparent walls, even curved surfaces

Greenhouses



Low load structure

Factories



Low load roofs

### Aqueous Li-ion Rechargeable Batteries

### Striving for safety

non-combustible electrolyte

long life  
low-temp(-30°C)  
operation,  
(current SCiB)

non  
Com-  
bustible

⇒

Aqueous  
Li-ion  
Battery

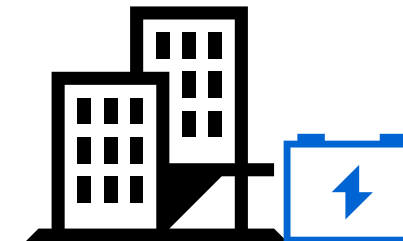


Easy to install in many facilities with fewer safety restrictions under the Fire Service Act in Japan<sup>\*2</sup>

Hospitals, Facilities



Buildings, Factories



<sup>\*1</sup> : Press release on September 20<sup>th</sup>, 2021, <https://www.global.toshiba/jp/technology/corporate/rdc/rd/topics/21/2109-01.html> (in Japanese)

<sup>\*2</sup> : Technical standards for facilities with charging and discharging of Li-ion batteries in case that numbers of batteries are over the criteria in the Act



# Fundamental Digital Technologies

## Fundamental digital technologies that support competitiveness of products and services

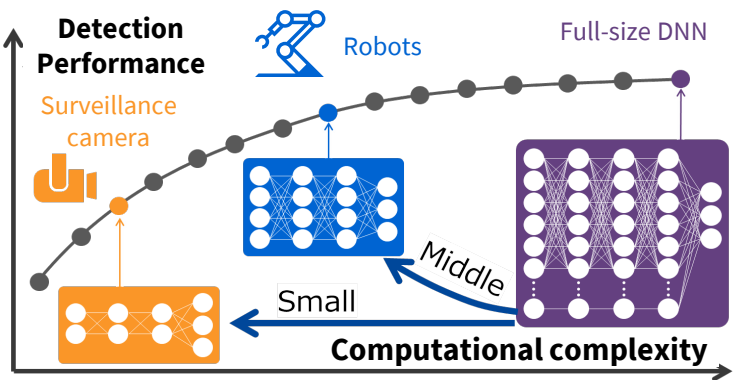
### AI

#### AI model according to size of systems and hardware



#### e.g. Compact AI model

Automatically convert to optimum AI model depending on edge device computing performance



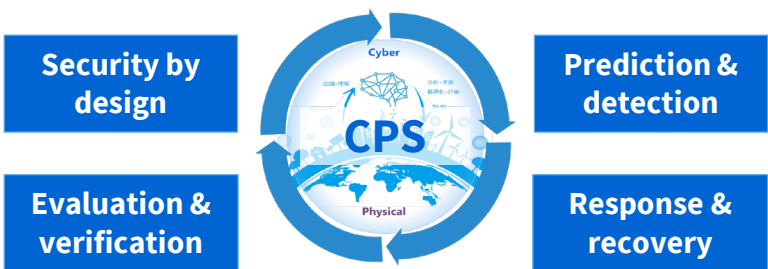
Joint research with RIKEN AIP  
Reported by top academic society in the field of AI\*1

\*1: A. Yaguchi et al., "Decomposable-Net: Scalable Low-Rank Compression for Neural Networks", IJCAI2021

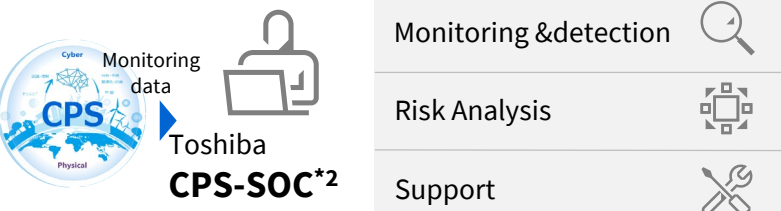
\*2: Security Operation Center

### Cybersecurity

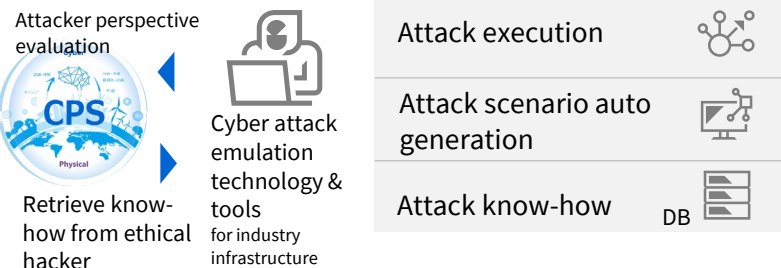
#### CPS management through lifetime protection



Security Operation Center based on CPS knowledge

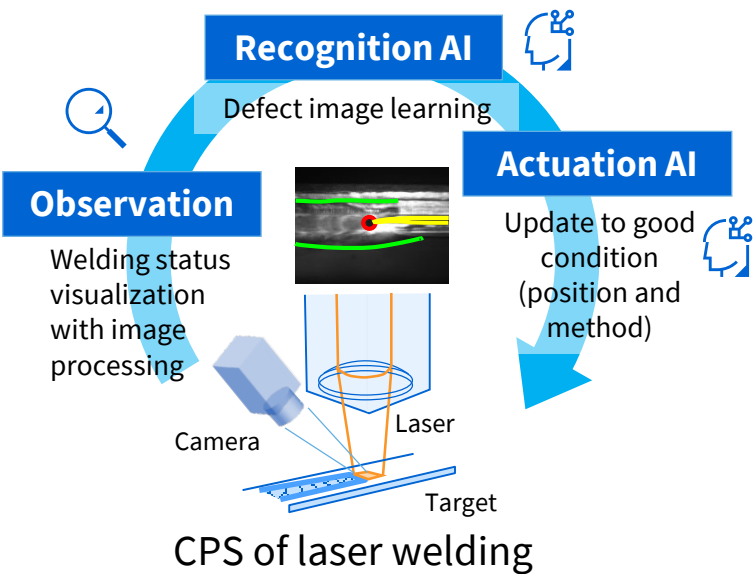


Cyber attack emulation based on CPS attack know-how



### Digital Manufacturing

#### CPS-based manufacturing equipment that imitates know-how of skilled engineers



#### Applications



# Recent Major Awards from Third Parties

## Film-Based Perovskite Photovoltaic Module

Japan Electronics and Information Technology Industries Association (JEITA)  
Minister of Economy, Trade and Industry Award and  
Grand Prix in the Carbon Neutral Category in CEATEC AWARD 2021\*1



## Air-cooled Heat Pump Chillers "EDGE32 series"

Japan's Energy Conservation Center (JEC)  
2021 Energy Conservation Grand Prize, Agency for Natural Resources and  
Energy Director-General's Award\*2



## Carbon dioxide Capture, Utilization and Storage

CCUS demonstration facility construction project team  
(Toshiba Energy Systems, Chiyoda Corporation)

The Engineering Advancement Association of Japan (ENAA)  
2021 Encouragement Awards\*3



## Nb/Ti Superconducting Magnet for freezers

14th One Step on Electro Technology\*4



## Ultra High Voltage substation equipment

(joint award of 5 companies inc. Toshiba Energy Systems)

14th One Step on Electro Technology\*4

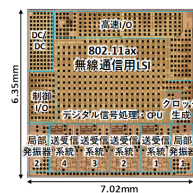


Source: TEPCO PG, UHV test site

## Wireless LAN Communication

Development of high speed and high efficient wireless LAN

Minister of Education, Culture, Sports, Science and Technology  
Science and Technology Award of Development Category\*5

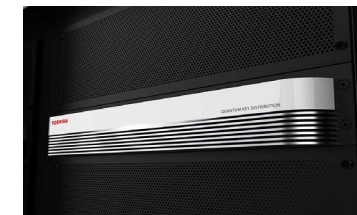


## QKD

Japan Electronics and Information Technology Industries Association (JEITA)  
Semi Grand Prix of Solutions Category  
in CEATEC AWARD 2021\*1

The institute of physics  
Business Innovation Award 2021\*6

MM Research Institute  
The Winner of Next Generation Social Infrastructure,  
Smart Solution Category in MMRI Awards 2021\*7



## Water and Sewerage Treatment

Design, Build, Operate & Maintain and Transfer of Salori Sewage Treatment Plant  
and related facilities in Allahabad

First Prize (Minister of Land, Infrastructure, Transport and Tourism Commendation)  
in 4th Japan Construction International Award\*8



## Derwent Top100 Global Innovator 2021\*9

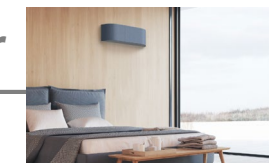
Selected by US research firm Clarivate Analytics. Recognized as one of the world's 100  
most innovative companies and research institutes for ten consecutive years

## Traction energy storage system for railways, with SCiB™

Japan Institute of Design Promotion  
GOOD DESIGN AWARD 2021\*10

## HAORI inverter air conditioner

Japan Institute of Design Promotion  
GOOD DESIGN AWARD 2021\*10



\*1: <https://www.global.toshiba/ww/news/corporate/2021/10/news-20211019-01.html>

\*2: <https://www.toshiba-carrier.co.jp/news/press/211222/> (in Japanese)

\*3: [https://www.toshiba-energy.com/info/info2021\\_0713.htm](https://www.toshiba-energy.com/info/info2021_0713.htm) (in Japanese)

\*4: [https://www.toshiba-energy.com/info/info2021\\_0310.htm](https://www.toshiba-energy.com/info/info2021_0310.htm) (in Japanese)

\*5: <https://www.global.toshiba/jp/news/corporate/2021/04/news-20210415-02.html> (in Japanese)

\*6: <https://www.toshiba.eu/pages/eu/Cambridge-Research-Laboratory/toshiba-quantum-key-distribution-technology-wins-prestigious-institute-of-physics-business-award>

\*7: <https://www.global.toshiba/jp/company/digitalsolution/news/2021/0623.html> (in Japanese)

\*8: <https://www.toshiba.co.jp/infrastructure/news/20210618.htm> (in Japanese)

\*9: <https://www.global.toshiba/jp/news/corporate/2021/02/tp2401.html> (in Japanese)

\*10: <https://www.global.toshiba/ww/news/corporate/2021/10/news-20211020-01.html>

# 03

## R&D Structure that Demonstrates Combined Strengths

- Combined Strengths in R&D
- Combined Strengths: Post Spin-off R&D Structure
- Combined Strengths: Co-creation in Power Electronics
- Combined Strengths: Opportunities Offered by the New R&D Building



# Combined Strengths in R&D

## Combined strengths to focus in the spin-off transition

1. Business cooperation in devices and systems (e.g. power electronics)
2. Applications of common technologies (e.g. AI, cybersecurity, manufacturing etc.)

## Policies for continuing demonstration combined strengths after the spin-off

### Organization

Manage common technologies through **cooperation** where both companies have R&D functions for each unique area, including basic research

### Agreement

Promote inter-company activities for **co-creation**, based on agreement

### Environment

Provide **opportunities** for communication among researchers.

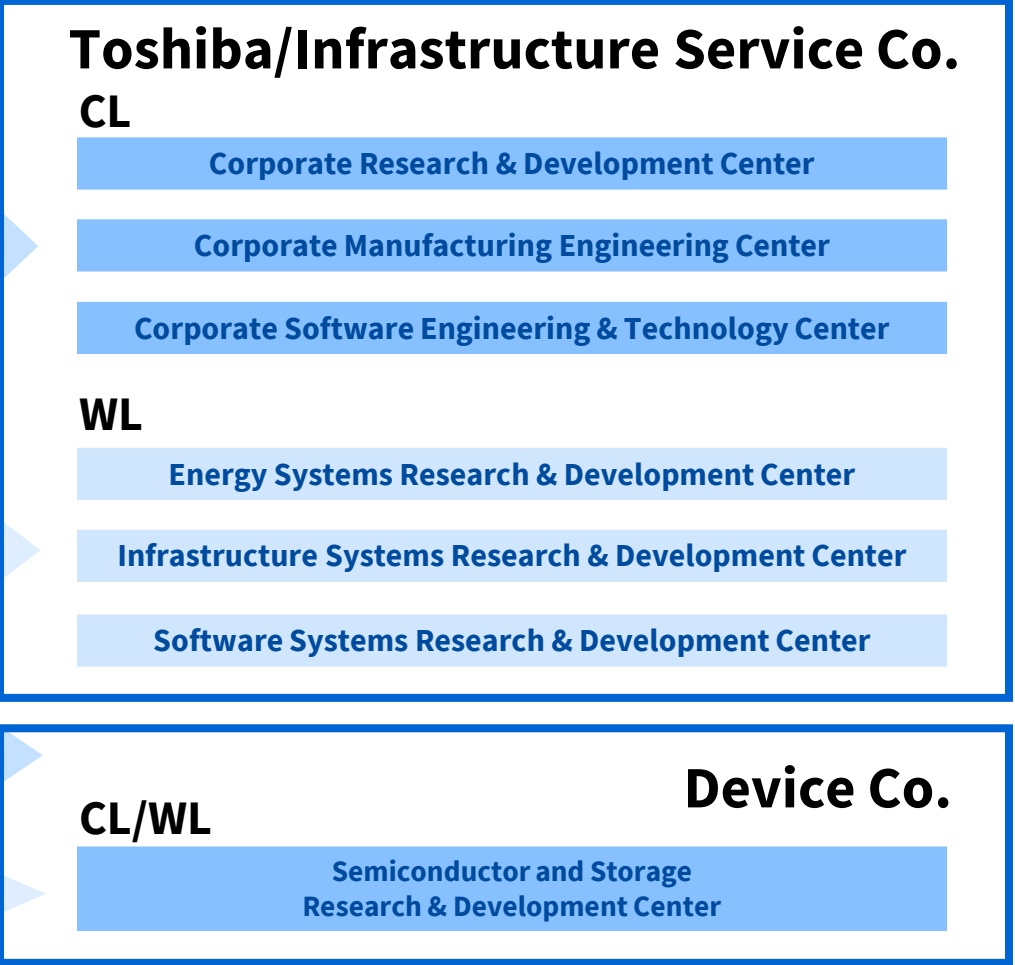
# Combined Strengths: Post Spin-off R&D Structure

Redesign R&D structure to maximize value in both Toshiba/Infrastructure Service Co. and Device Co.

## Current

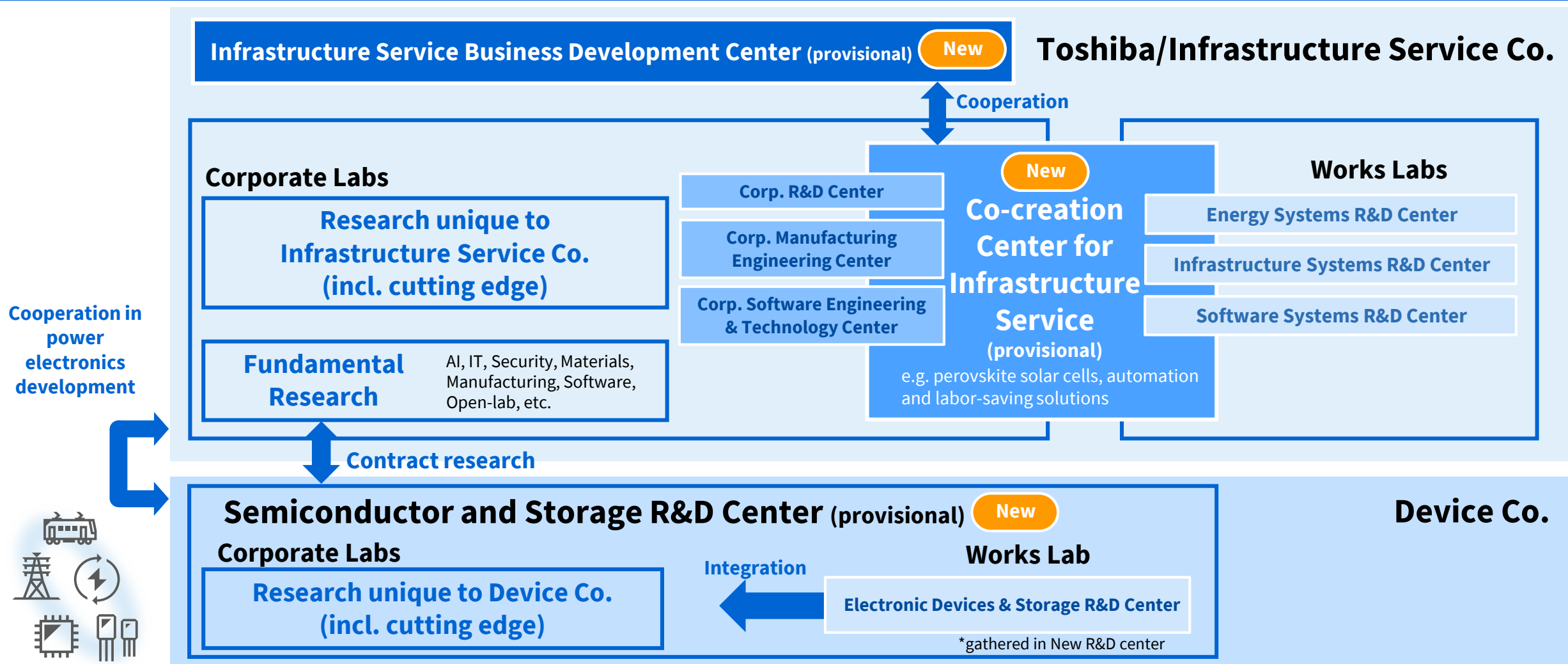


## Post spin-off



# Combined Strengths: Post Spin-off R&D Structure

- Maintain an R&D function that covers the value chain, from fundamentals to commercialization, in both Co.
- Introduce an R&D function for fundamental technologies in Infrastructure Service Co. and provide its outcomes to both Co.

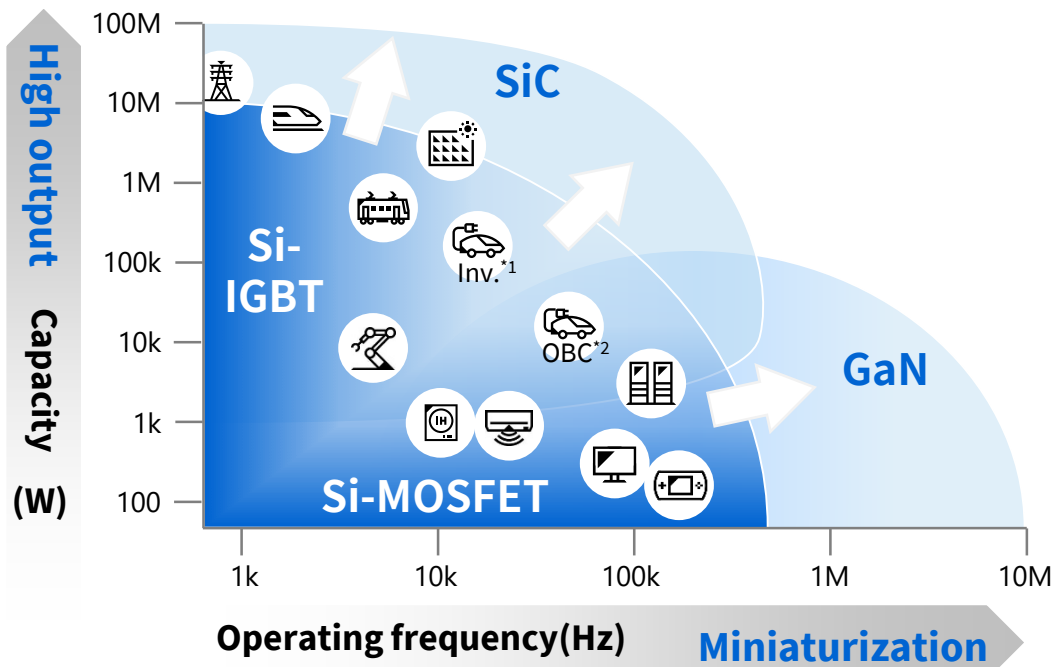


# Combined Strengths: Co-creation in Power Electronics

Integration of devices and systems sustained by agreement  
and provision of energy-saving solutions

## Power Electronics

Covering numerous applications in  
energy and infrastructure systems



\*1 : Inverter \*2 : On Board Charger \*3 : Variable Voltage Variable Frequency control  
\*4 : Injection Enhanced Gate Transistor

## Railway drive systems that save energy



SiC module



Permanent Magnet  
Synchronous Motor  
(PMSM)



VWF<sup>\*3</sup> inverter  
with all-SiC devices



Battery for power failure operation  
mode with regenerate energy function

## HVDC (high voltage direct current) that expands the electricity network



Press Pack IEGT<sup>\*4</sup>





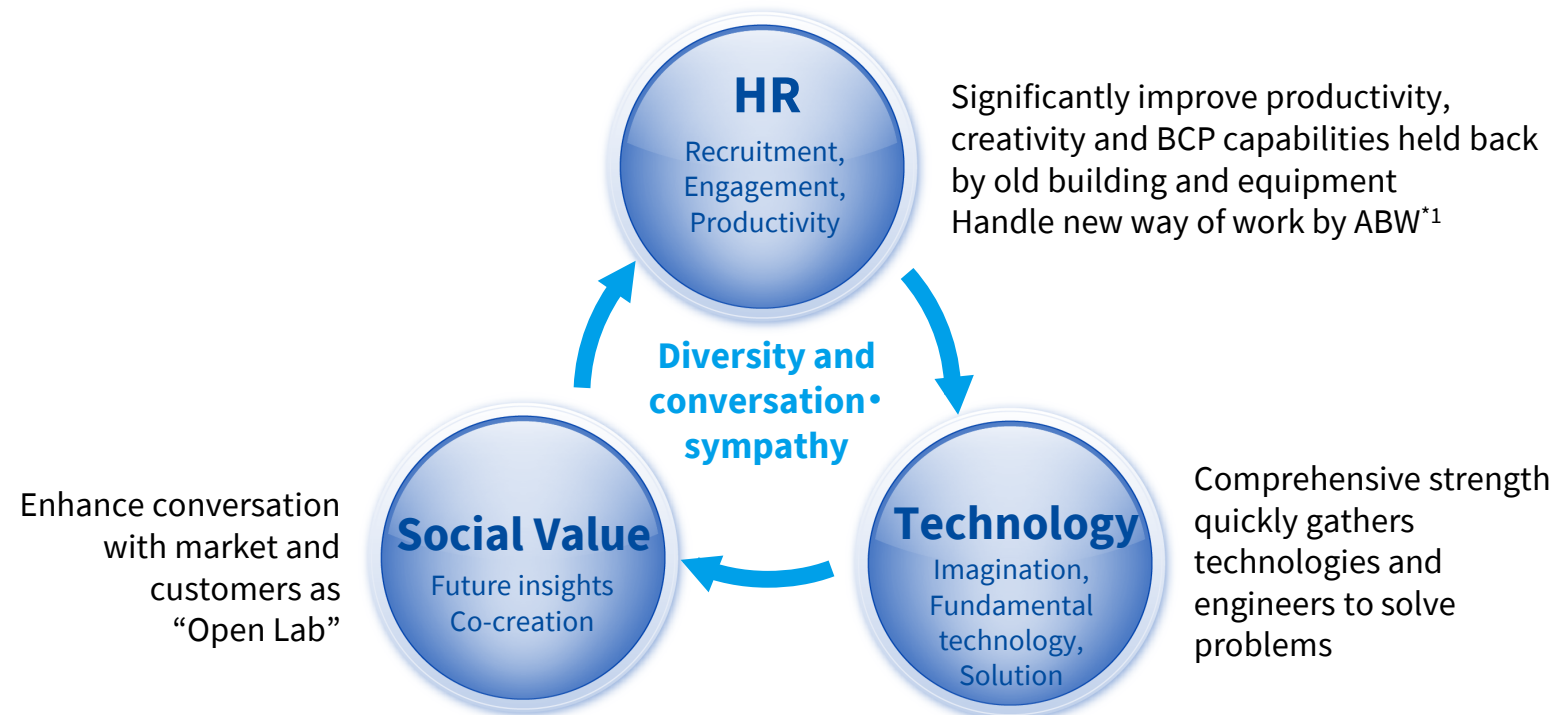
# Combined Strengths: Opportunities Offered by the New R&D Building

A center to advance diverse concepts, ideas, proposals and people  
An open-minded source of value for society



## Innovation Palette

“Convergence of diverse expertise and knowledge”



<sup>\*1</sup>: Activity-Based Working

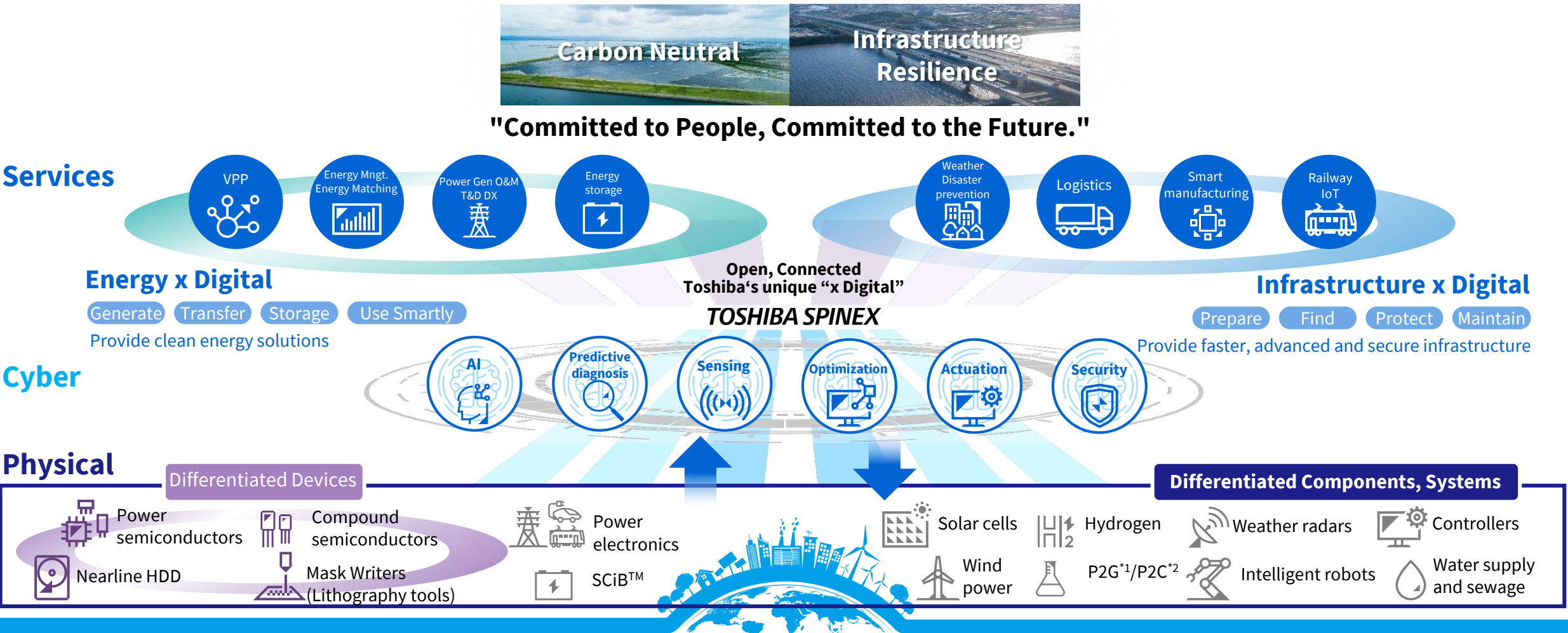
<sup>\*2</sup>: The new R&D building is at the design stage. Start of operation, appearance, and technology demonstration items are subject to change

# 04

In Closing

# Toshiba Group Technology Policy

Contribute to solving social and customer issues guided by the Basic Commitment of the Toshiba Group "Committed to People, Committed to the Future."



\*1 : Power to Gas   \*2 : Power to Chemicals





**Committed to People,  
Committed to the Future.**

# **TOSHIBA**