TOSHIBA

日独経済シンポジウム

Toshiba's Initiatives toward Carbon Neutrality and a Regenerative Society

Regenerative Innovation Centre, Toshiba Europe GmbH

General Manager

Kohei Onizuka, PhD

Toshiba Group's Vision

Committed to People,
Committed to the Future.

At Toshiba, we commit to raising the quality of life for people around the world, ensuring progress that is in harmony with our planet.

Future

For our children

Social Challenges	Toshiba Initiatives
Achieving sustainability of people and the planet	**Achieving carbon neutrality and a circular economy**

People

Safe, secure lifestyles for everyone

Poverty, human rights, disasters, disputes	**Building an infrastructure that everyone can enjoy**

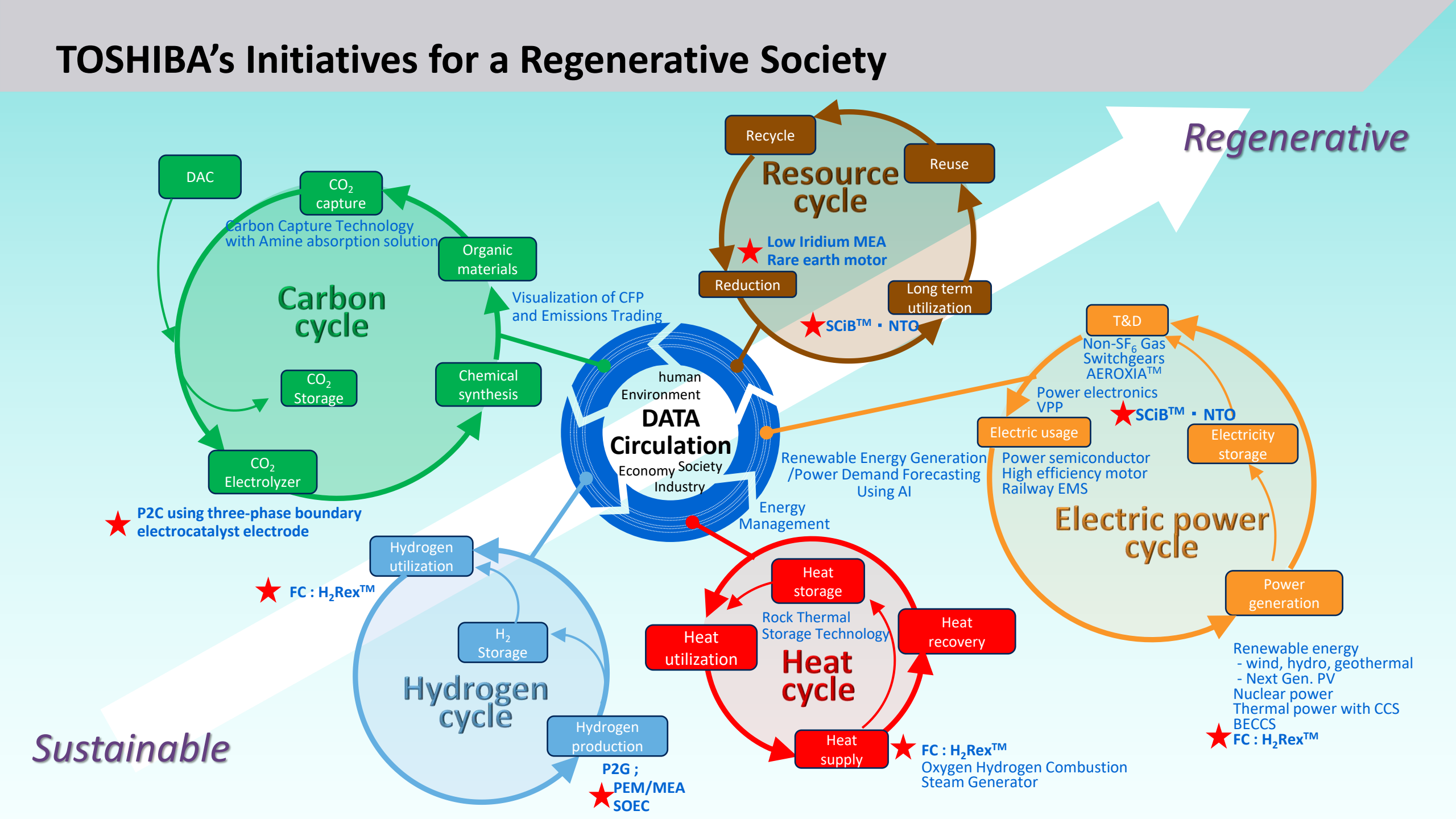
Planet

Social and environmental stability

Education, equality & fairness, climate change, resource depletion	**Building a society connected by data**

Contribute to the achievement of carbon neutrality & circular economy through digitization

TOSHIBA's Initiatives for a Regenerative Society



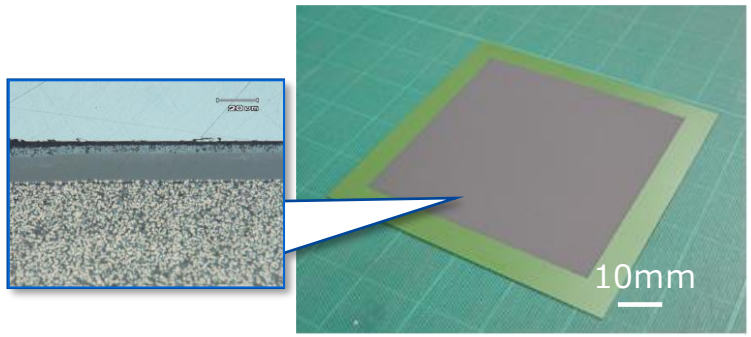
SOEC (Solid Oxide Electrolyzer Cell)

Hydrogen production

Highly efficient hydrogen production with the lowest power requirement

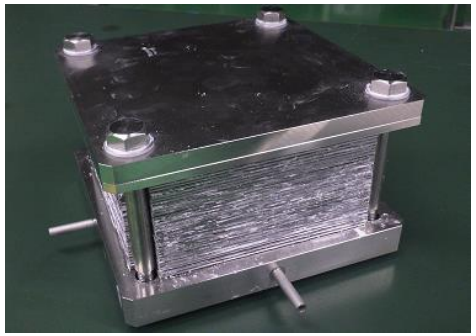
※A part of this work is based on results obtained from a project (JPNP14021) commissioned by the New Energy and Industrial Technology Development Organization (NEDO) in Japan.

Devise (SOEC Cell)



Developing high durable cell by clarifying the material degradation mechanism

Stack, Module



Developing high performance cell-stack and module by clarifying the flow pattern in the stack and module

System

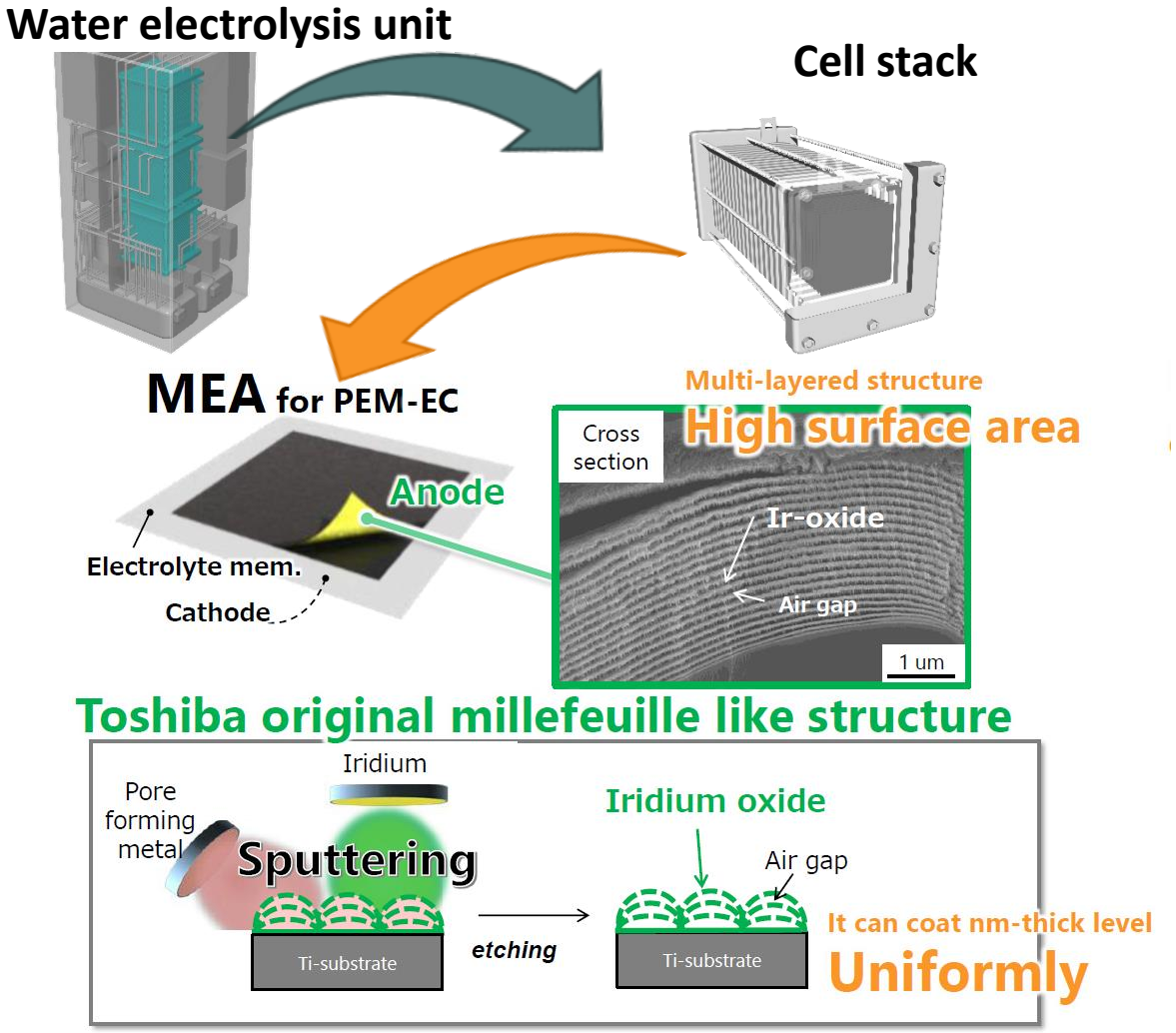
Developing the large-scale hydrogen production system by CFD and plant engineering

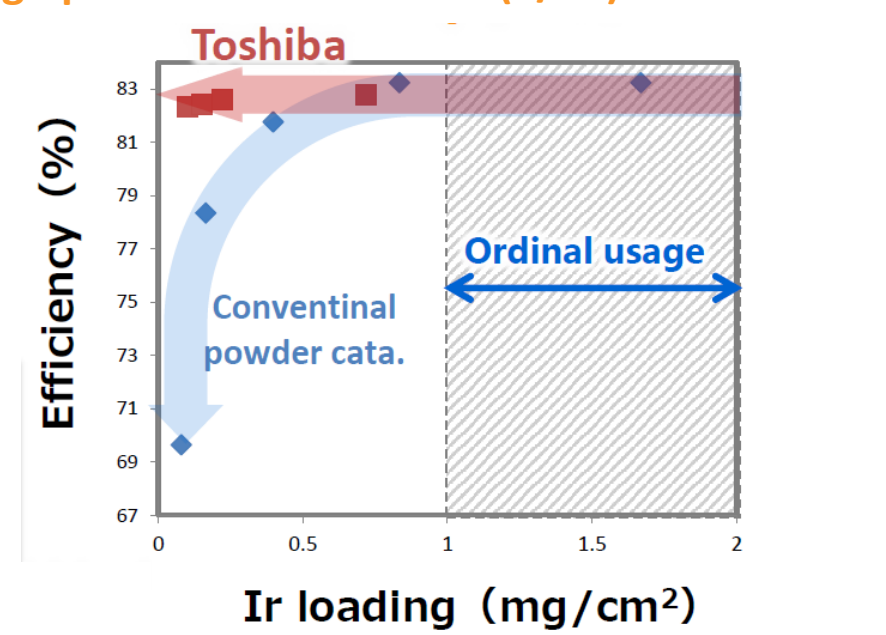
Water electrolysis type	Alkaline	PEM	SOEC
Maturity	Implementation phase	Demonstration phase	**Development phase**
Efficiency at rated operation	Stack: up to **4.8** kWh/Nm³ System: up to **6.5** kWh/Nm³	Stack: up to **5.1** kWh/Nm³ System: up to **6.5** kWh/Nm³	**Stack: up to 3.2 kWh/Nm³** **System: up to 4.0 kWh/Nm³**
Operating temperature	up to **80** °C	up to **80** °C	approx. **700** °C *After startup, heat is recovered inside the system, therefore, heat requirements are low

PEM-type water electrolysis device and MEA

Hydrogen production | Resource reduction

Hydrogen is produced by proprietary MEA that can suppress rare iridium material to 1/10.
Toshiba and Bekaert sign a partnership on MEA for PEM electrolyzers





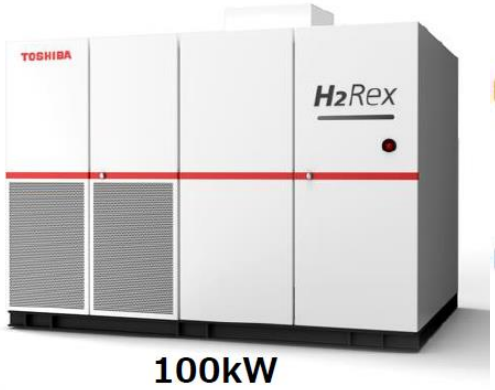
Efficiency at rated operation
Stack: up to 5.1 kWh/Nm³
System: up to 6.5 kWh/Nm³

MEA: Membrane Electrode Assembly PEM: Polymer Electrolyte Membrane

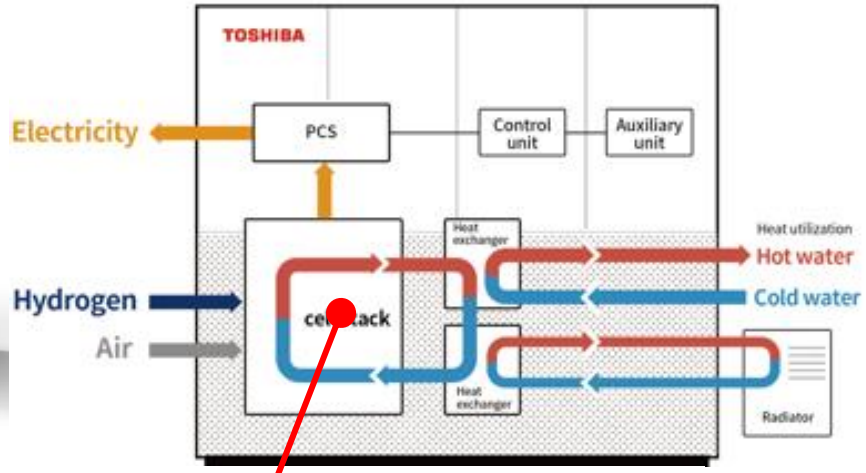
Hydrogen Fuel Cell Systems : H_2Rex^{TM}

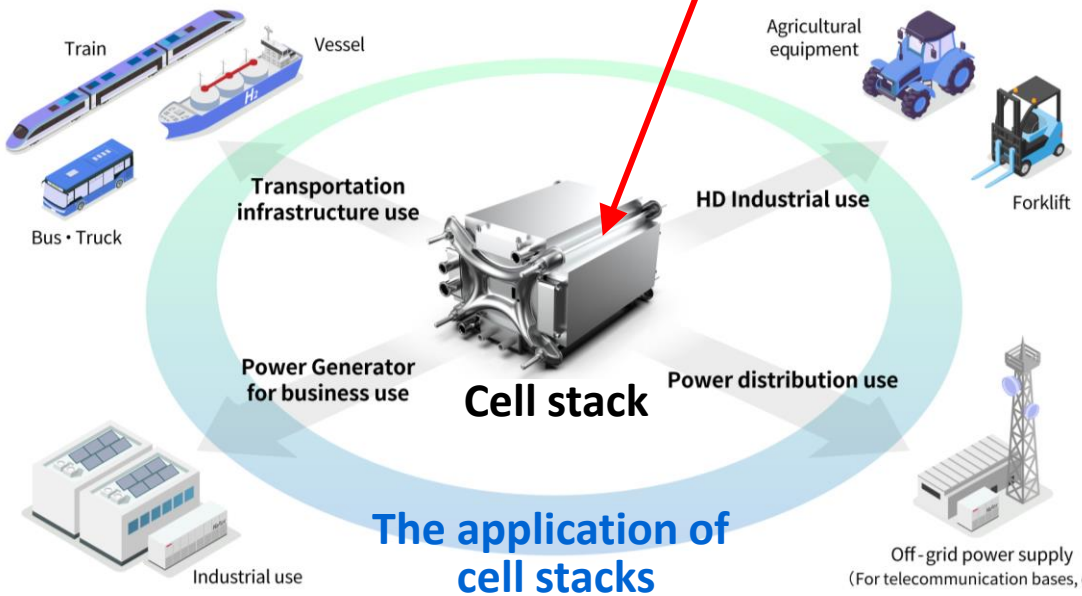
Hydrogen utilization | Heat supply | Power generation

Achieve advanced durability and stability.
Delivered over 80,000 units in the market.



100kW

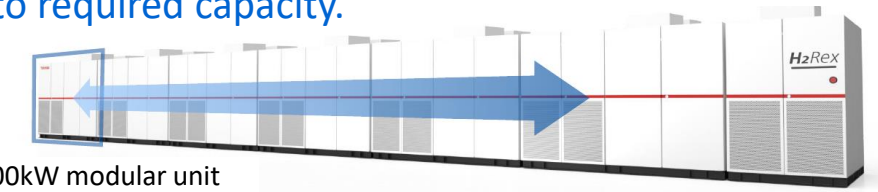




The application of cell stacks

- ✓ Stable and long life due to the adoption of a highly durable cell stack
  - 1)10+ years life cycle
  - 2) Less than 3% voltage drop after 1 week of continuous operation
- ✓ Total energy efficiency of 95% or more
- ✓ Flexible operation by shortening the startup time
- ✓ Supports series up to MW size

Units can be flexibly increased or decreased according to required capacity.



100kW modular unit

MW size

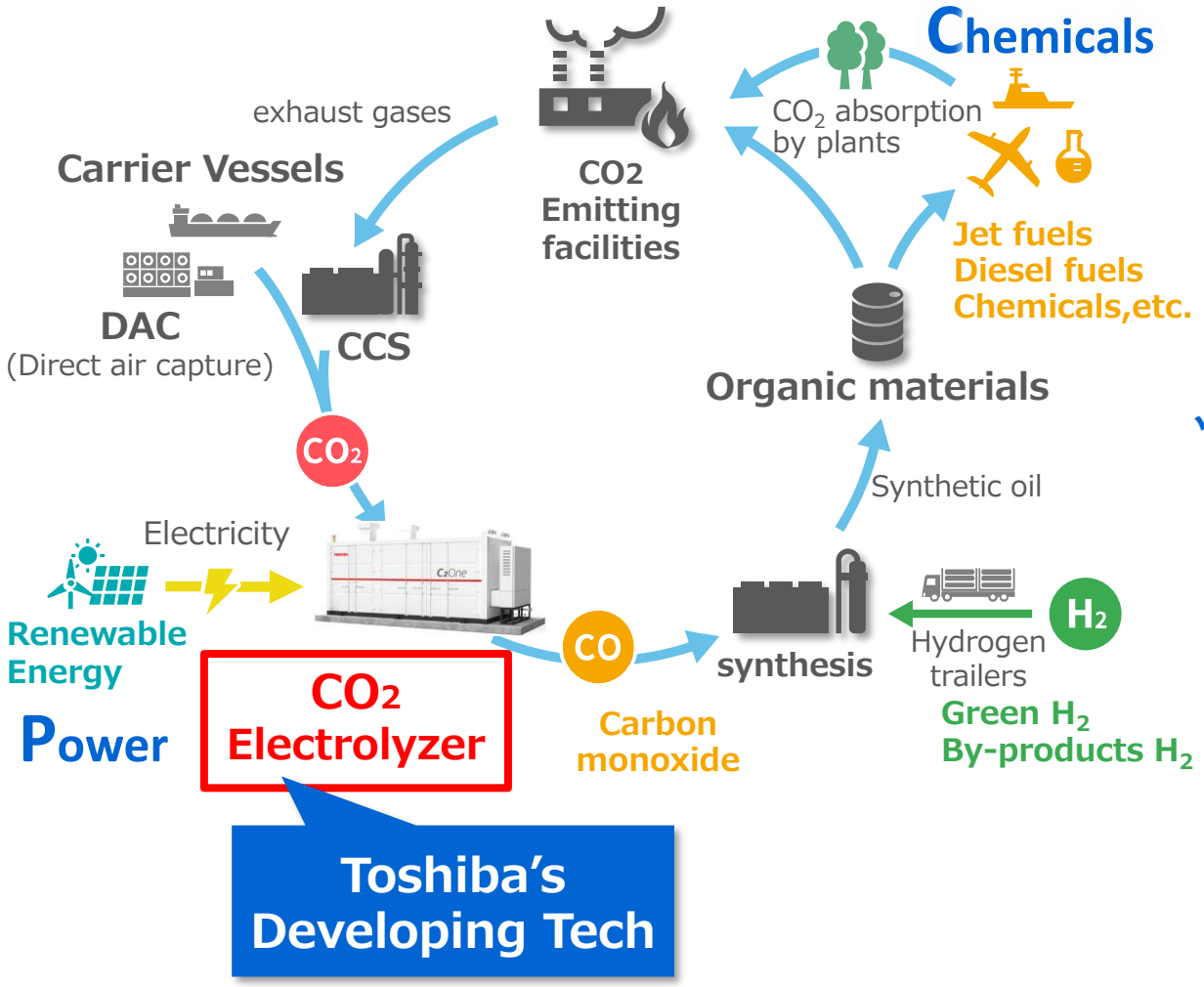
CO_2 Resource Utilization through P2C

CO_2 Electrolyzer

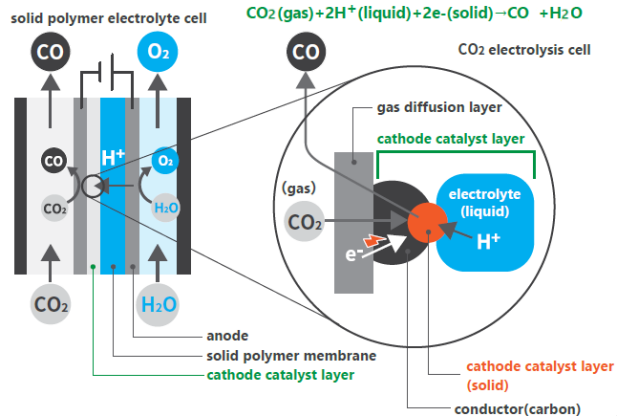
Synthesize SAF etc from CO_2 toward breaking free from fossil fuels.
Direct electrolysis of CO2 gas improves processing speed.

SAF : Sustainable Aviation Fuel

P2C : Power to Chemicals

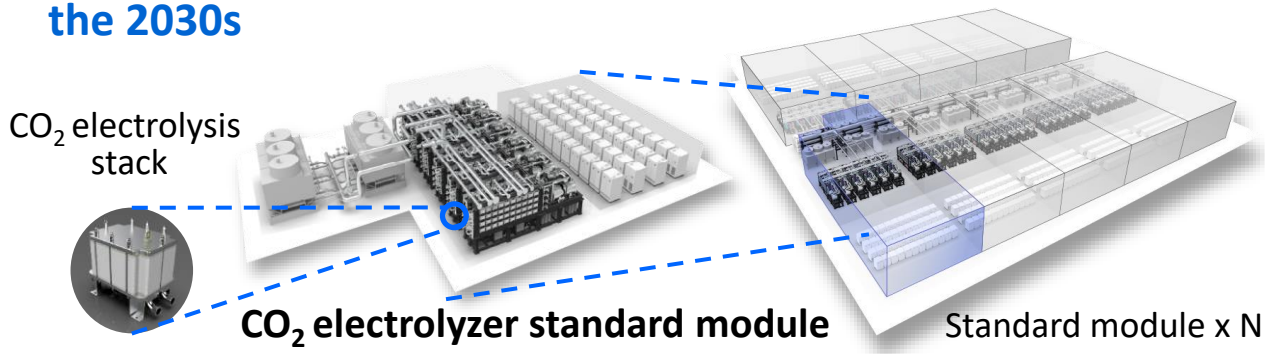


✓ **Improve the process speed by development of electrocatalyst that enable insoluble CO_2 gas to react directly.**



Three-phase boundary electrocatalyst electrode

✓ **Scale up CO_2 electrolysis equipment for commercialization in the 2030s**



CO production amount : 20,000 tons/Year
SAF production volume : Equivalent to 5,000 kL/Year
Electrolytic power : 16.5MW

Long-term battery circulation

Contribute to a circular society through reuse and repurpose by taking advantage of SCiB™ 's long-life performance

High Energy Density

(Test Sample cell)

SCiB™ *Nb* (NTO)

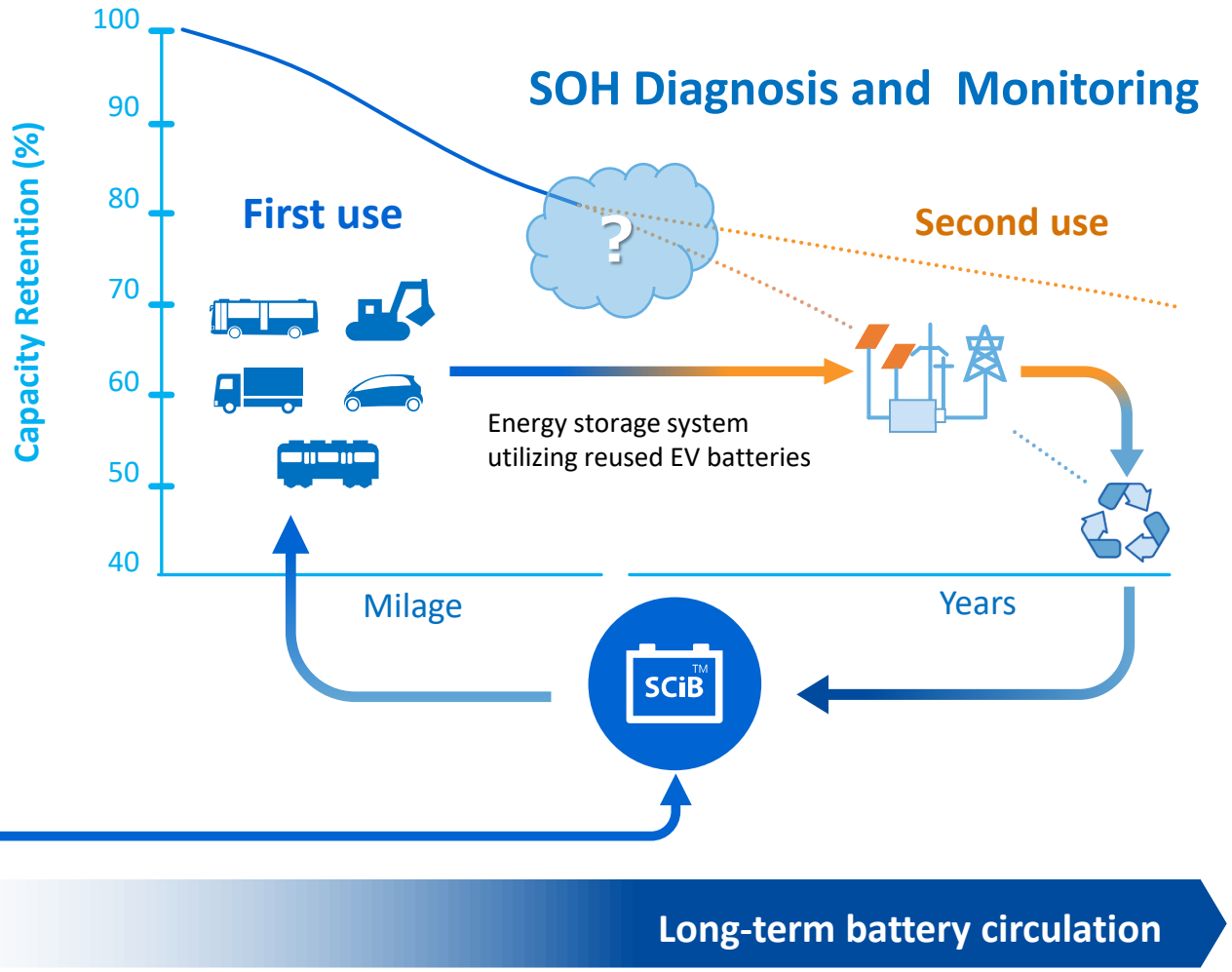
High power &
high energy density

NTO : Niobium Titanium Oxide

SCiB™

SCiB™ is lithium-ion rechargeable battery that uses Lithium Titanium Oxide (LTO) in its anode material.

Safety Low risk of fire or explosion	**Long life** 20,000+ cycle life	**Rapid charge** Rapidly recharges approximately 80% of capacity in min. 3 minutes* *Based on high power 10Ah cell
Low-temperature performance Can be used even at min. –30 °C* *Based on 20Ah cell	**High I/O** Large current can be inserted and removed	**Wide effect SOC* range** SOC 0 to 100% available *SOC: State of Charge



Many advantages are realized by using LTO

Reduced rare earth magnet motor/generator

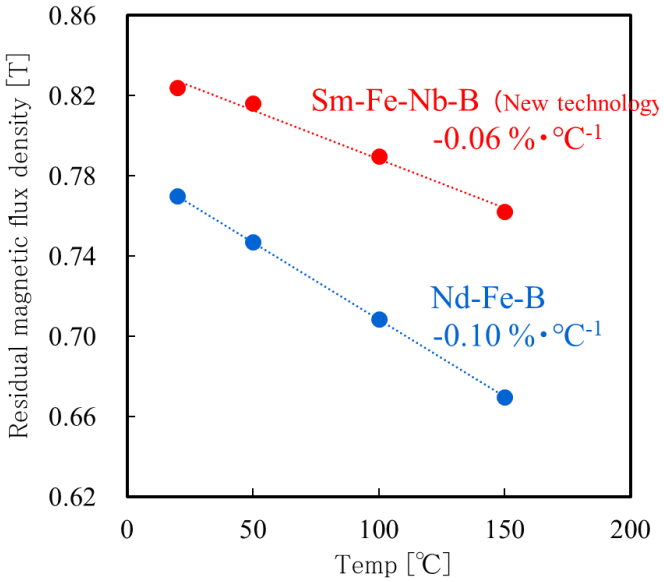
Resource reduction | Electric usage

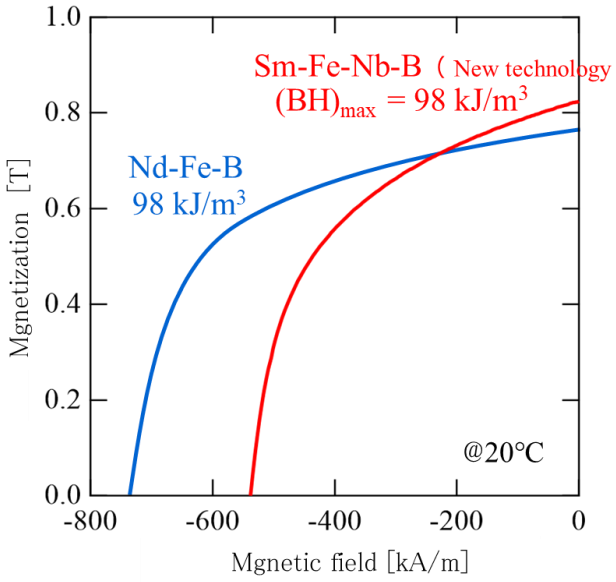
Enhance supply chain resilience for EV motor by using magnets with reduced rare earth element

Innovative Material Technology

Nd → Sm

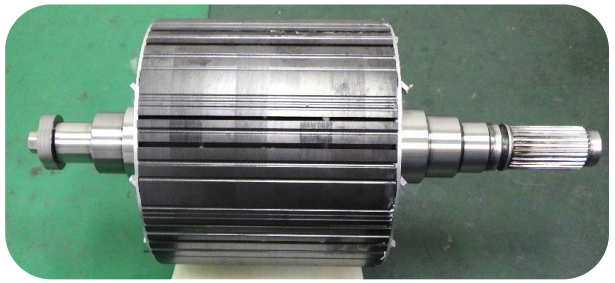
- Better heat resistance than neodymium magnets
- Achieving the same magnetic force as a neodymium magnet with a samarium-based isotropic bonded magnet





Magnet Volume Reduction through Design Technology

Top-bridgeless rotor



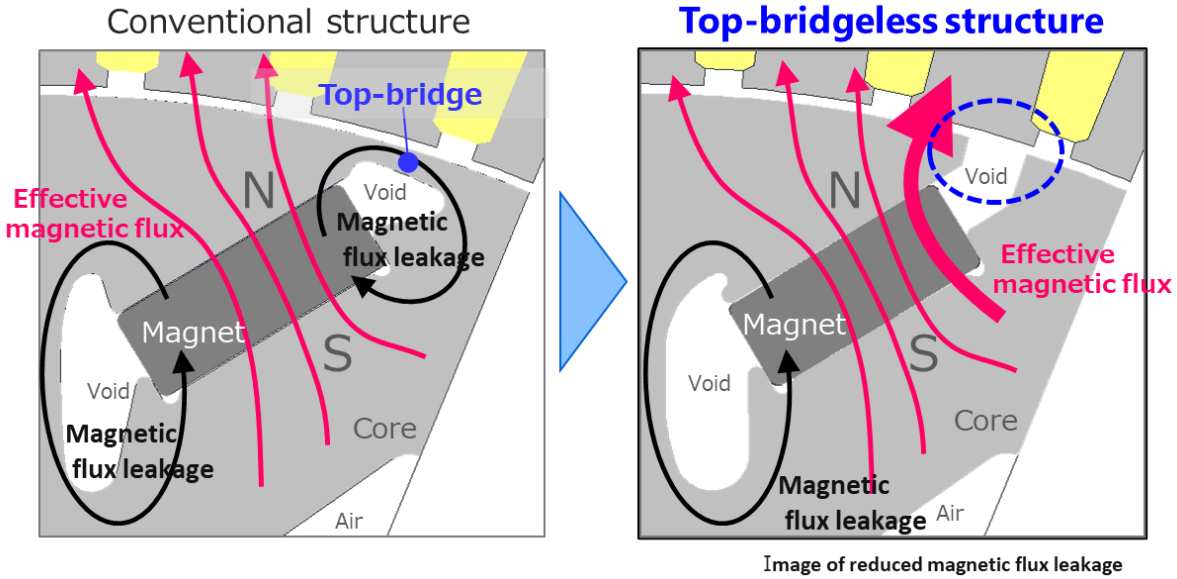
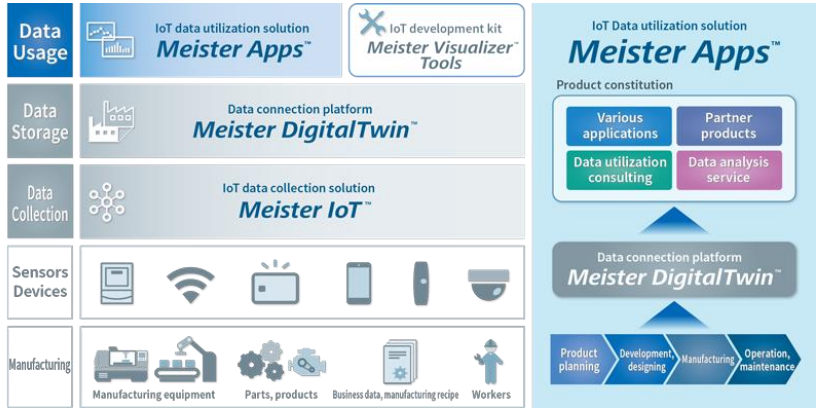


Image of reduced magnetic flux leakage

Digital solutions to realize Regenerative Society

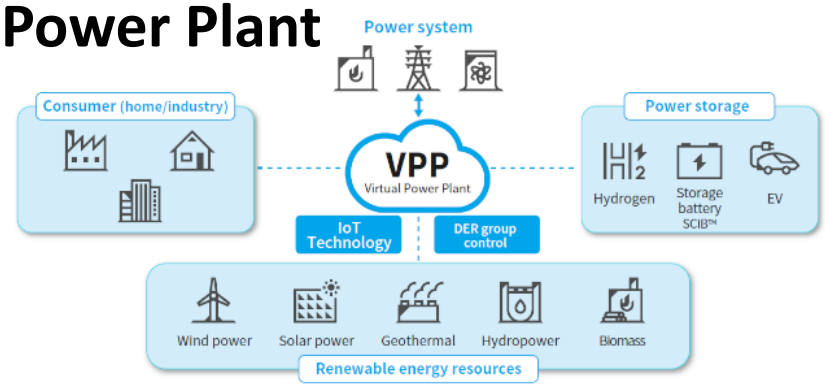
Collect and analyze industrial data
Transmit data securely and optimize with quantum technology

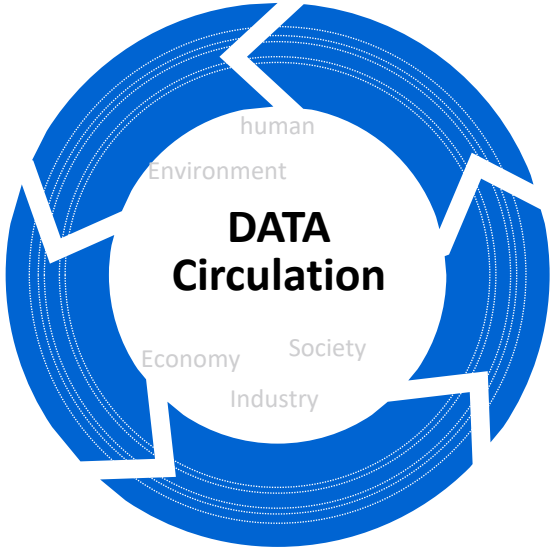
Manufacturing IoT data utilization application

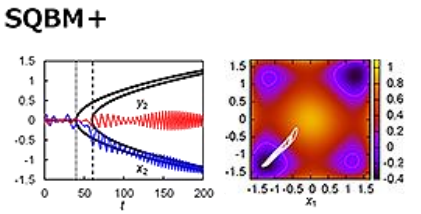


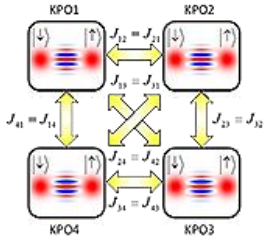
Quantum Key Distribution

Virtual Power Plant





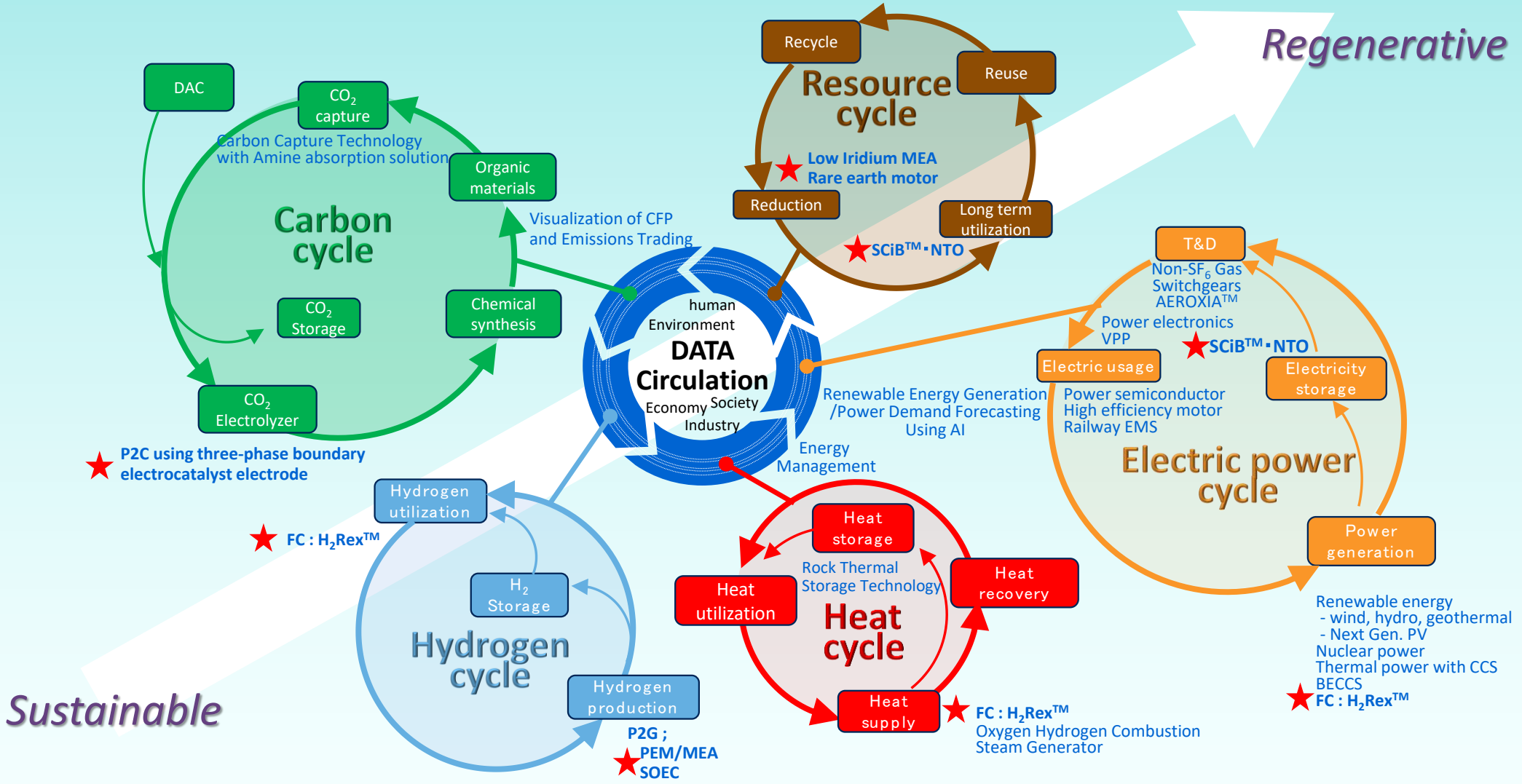




SQBM+
Quantum-Inspired
Optimization Solution

Summary

Aim to create various applications and solutions in collaboration with partners who make up the value chain, with core technology as the centerpiece



RIC “Regenerative Innovation Centre”

Establish new technology hub in Germany in 2023 to foster advanced development for Carbon Neutrality / Circular Economy

RWTH AACHEN UNIVERSITY

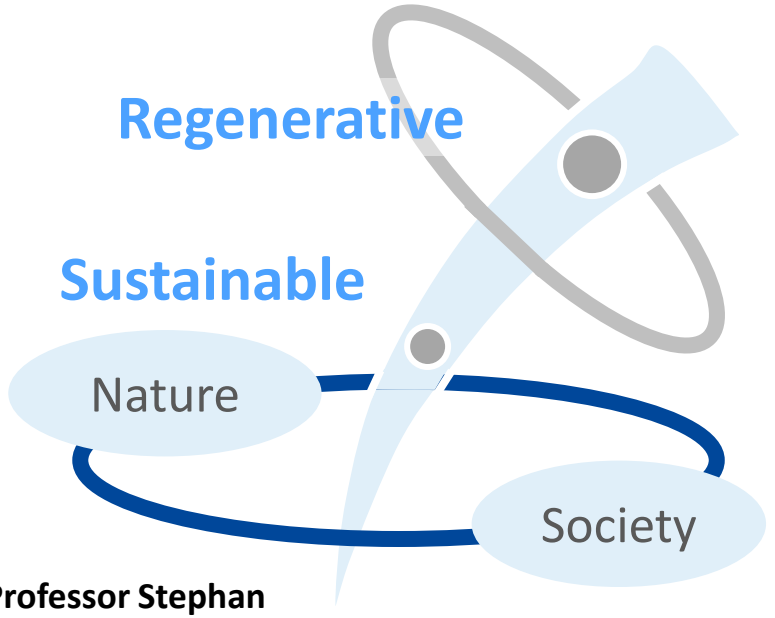
World leading multidisciplinary R&D in energy, green tech, and industrial digital transformation.

Wuppertal Institut

World leading think tank for sustainability and transformation research. Our execution advisor of regenerative innovation.

“**Regenerative**” refers to initiatives that aim to achieve positive impact, contribute to, and enhance the global environment and society. In an era marked by indisputable climate change and depletion of natural resources, the term “regenerative” is gaining prominence as a proactive approach that transcends the neutral connotation of the term “sustainable.” Instead, it fundamentally advocates a comprehensive approach to realizing its goals, encompassing both nature and social systems.

2023/9/20
Breidenbacher Hof Dusseldorf at opening ceremony



Professor Antonello Monti of RWTH Aachen University and **Professor Stephan Ramesohl** of Wuppertal Institute have joined as ADR

Basic Commitment of the Toshiba Group

Committed to People, Committed to the Future.

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