CDTI-NEDO online Joint Workshop on Hydrogen Technology
- Green Hydrogen Production & Mobility -

Development of Solid Oxide Electrolysis Cell System at TOSHIBA

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NEDO

AeH2 ASOCIACIÓN ESPAÑOLA DEL HIDRÓGENO

About TOSHIBA

Toshiba Corporation

- Toshiba Infrastructure Systems & Solutions Corporation
- Toshiba Electronic Devices & Storage Corporation
- Toshiba Digital Solutions Corporation

Toshiba Energy Systems & Solutions Corporation

As of June 1, 2021

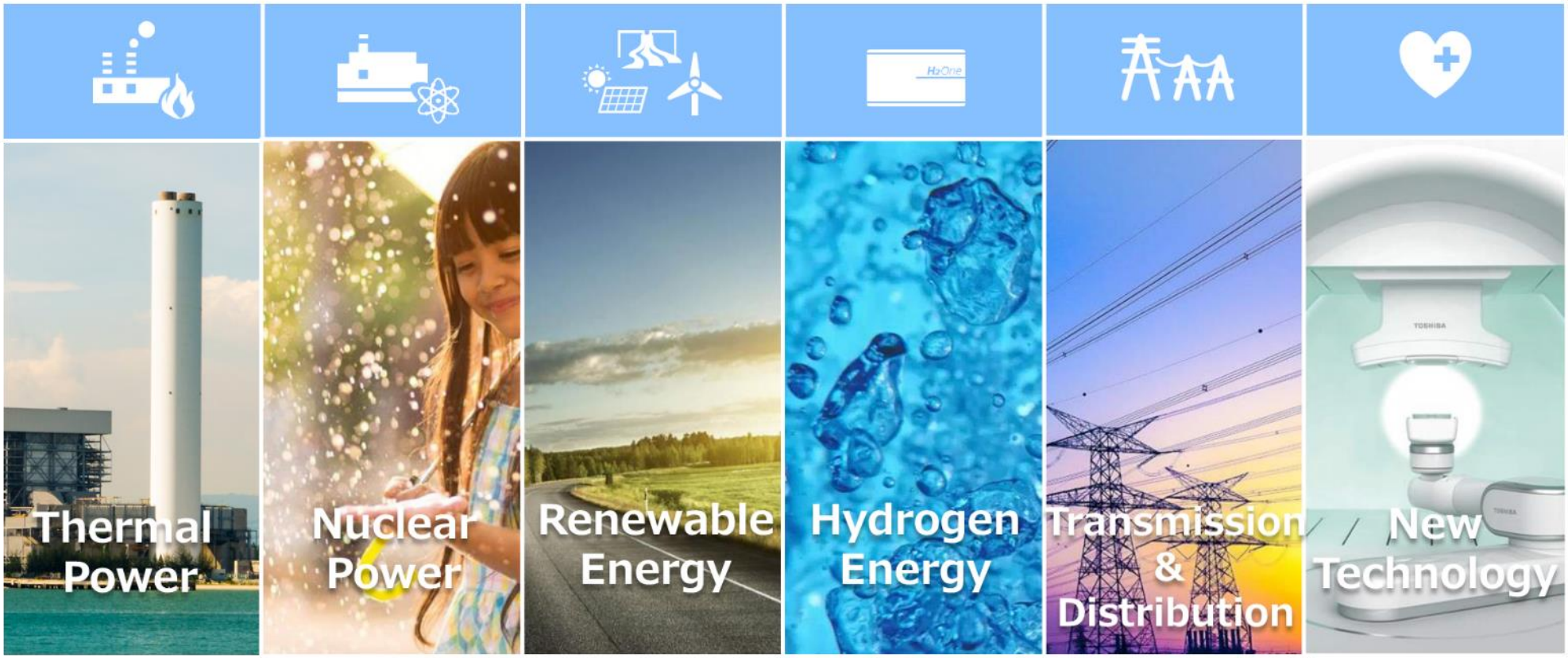
Takao Konishi
President and CEO
Toshiba Energy Systems & Solutions Corporation

- Power Systems Div.
  - Isogo Nuclear Engineering Center
  - Keihin Product Operations
- Grid Aggregation Div.
  - Hamakawasaki Operations
  - Fuchu Operations
- Hydrogen Energy Business Div.
- Digital Transformation Div.
- Global Marketing & Planning Div.
- Energy Systems Research & Development Center

Hokkaido Branch Office	Kansai Branch Office
Tohoku Branch Office	Chugoku Branch Office
Chubu Branch Office	Shikoku Branch Office
Hokuriku Branch Office	Kyushu Branch Office

Business Domains of Our Company

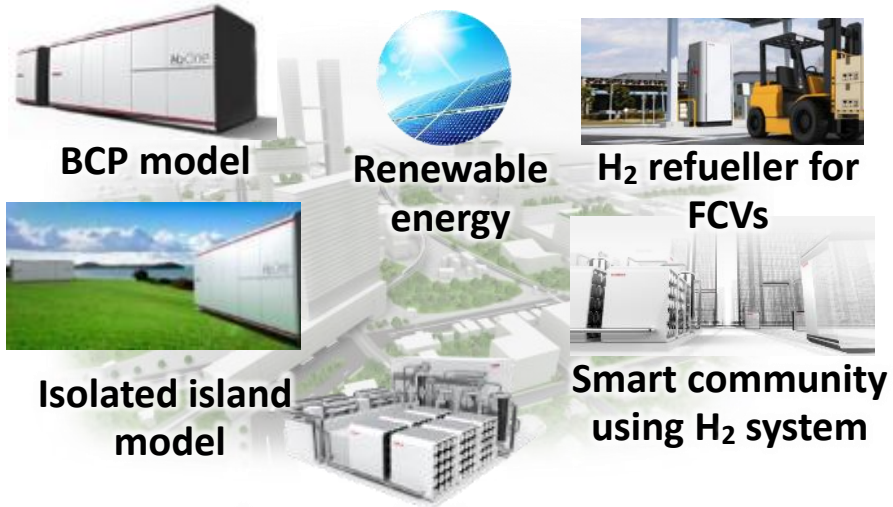
Toward the realization of sustainable society



Toshiba's Hydrogen Business Models

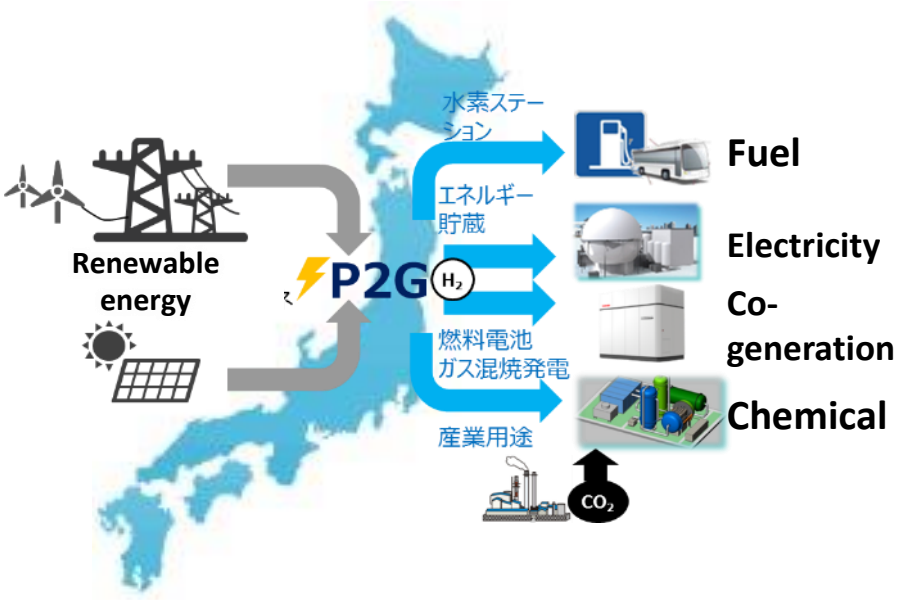
Sustainable and Reassuring Society with RE Hydrogen

Local Energy Solution Business using RE and H_2 Power Storage



Spread of Hydrogen aenergy system: H_2One™

H_2 Supply Chain Business



Spread of RE Hydrogen & Fuel Cell system

Toshiba's Hydrogen Business Domain

Production	Storage	Utilization

Hydrogen EMS Hydrogen Energy Management System

Renewable Energy

Water Electrolysis

Pnoto Voltaic

Wind Power

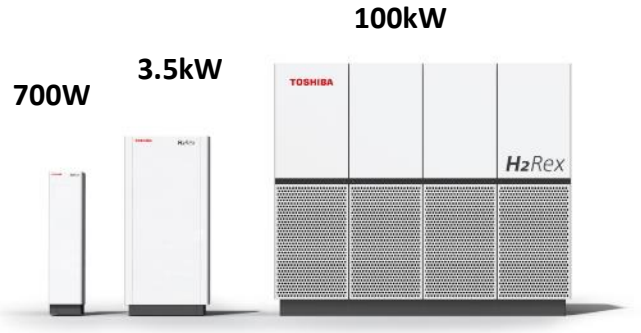
Large Scale Demonstration

H_2 Power Storage

Hydrogen Power Storage System, H2One™

H_2 Supplier

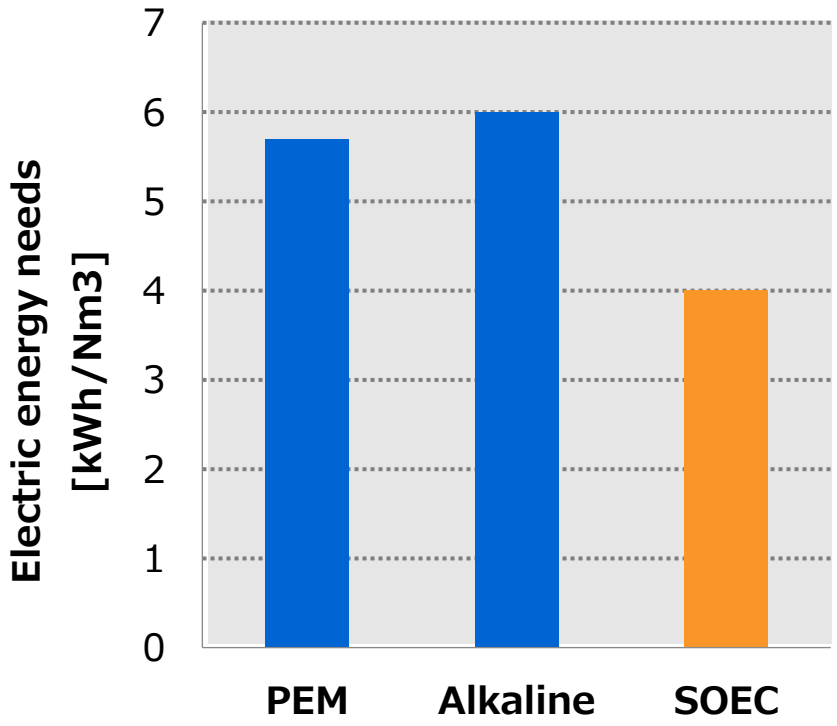
Fuel Cells (PEMFC)

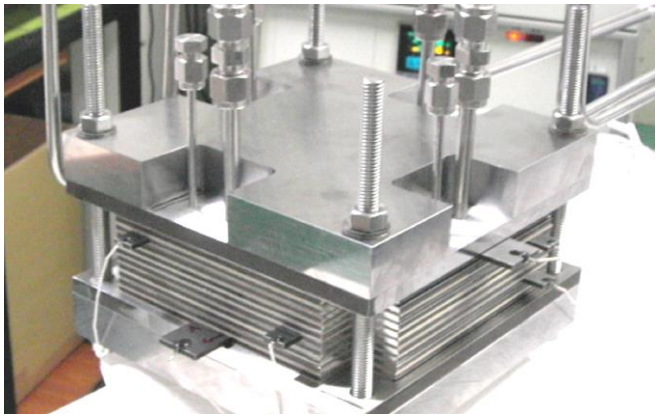


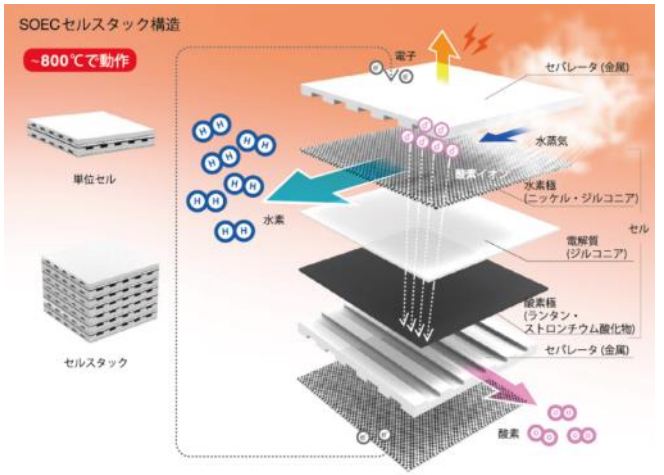
Hydrogen Fuel Cell System, H2Rex™

Hydrogen Production Method

SOEC* can reduce electric energy needs by 30%







We have comprehensively developed SOEC.(From cell materials to stack/system)

*SOEC: Solid Oxide Electrolysis cell

History of SOEC development in TOSHIBA

FY2003 **2007** **2011** **2014** **2021**

Tubular type Cell/Stack → Planar Type Cell/Stack

FY2003: Started development of SOEC technologies as one of the H_2 production methods using waste heat from nuclear energy power plant

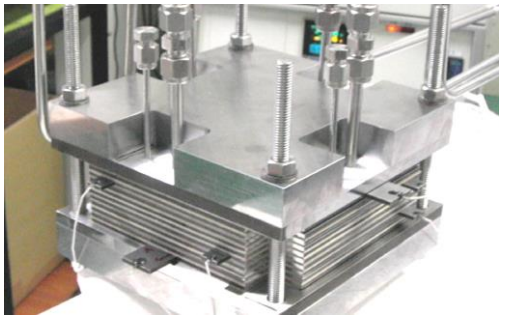
FY2007: Started study of renewable energy storage system using hydrogen (Planar type cell/stack)

FY2011: Develop Ni-GDC based Hydrogen electrode with long-term durability

FY2013: METI Project

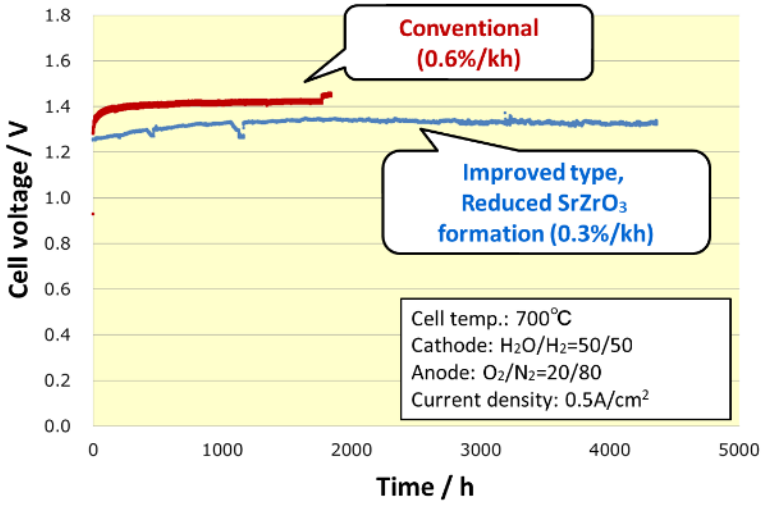
FY2014-18: NEDO Project (Phase 1)

FY2019-: NEDO Project (Phase 2)

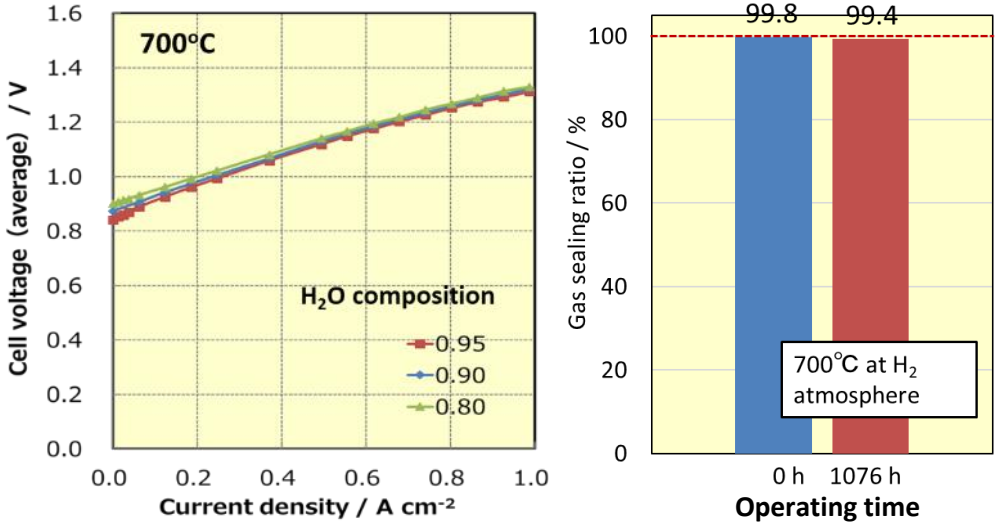


Main challenges and solutions in the SOEC project/case presented

- ✓ To clarify the degradation part and mechanism of SOEC
  - By studying cell materials especially at the anode/interlayer interface, the degradation rate was improved to under 0.3%/kh.
- ✓ Long-term stability for SOEC cell and stack materials
  - The developed stack showed high gas tightness and expected good durability.



Long-term stabilities for SOEC

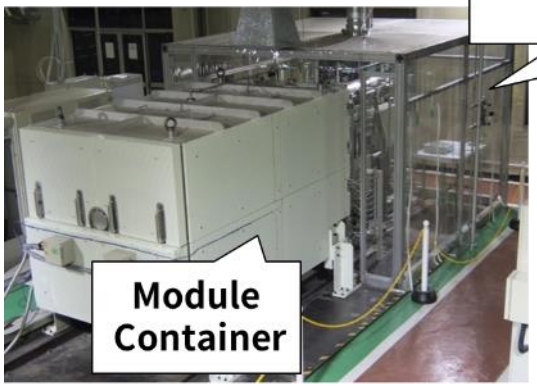


IV properties and gas tightness for SOEC stack

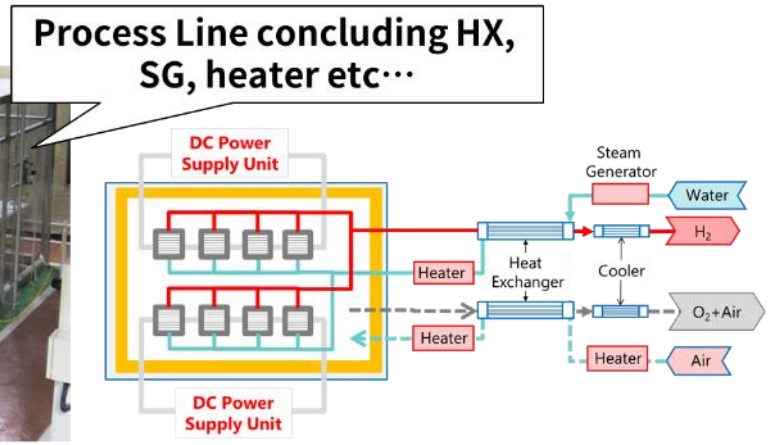
A part of this work is based on results obtained from Advancement of Hydrogen Technologies and Utilization Project commissioned by the NEDO.

Main challenges and solutions in the SOEC project/case presented

- ✓ High efficiency system design for SOEC
  - In the demonstration with 10kW-class test system, hydrogen production rate of max.5Nm^3/h @750℃ was achieved
  - The high efficiency of the 200kW-class SOEC hydrogen production system was confirmed by the design study.
    - The system's efficiency under 4 kWh/Nm^3 is confirmed in the design study of 50 Nm^3/h-class system



10kW-class test system



Schematic diagram of test system

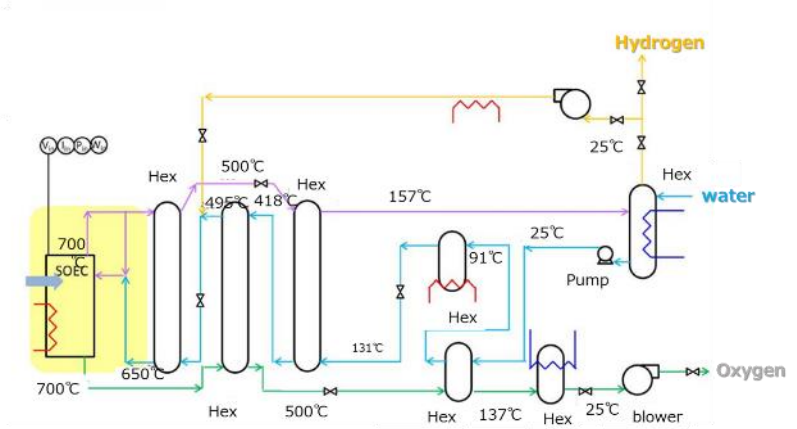


Diagram of 200 kW (50 Nm^3/h)-class system

A part of this work is based on results obtained from Advancement of Hydrogen Technologies and Utilization Project commissioned by the NEDO.

Ideas for a Japan – Spain collaboration for SOEC technology

- ✓ Work together to conduct research and development on SOEC
  - Low-cost ceramic manufacturing process
  - Analysis of SOEC system degradation part
  - Development of novel material technologies for SOEC system
  - Design study of SOEC field test system
  - Field operation of SOEC system (evaluation of property, degradation, economy)