Japan's Energy Transition toward Carbon Neutrality by 2050

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Yasuo Tanabe

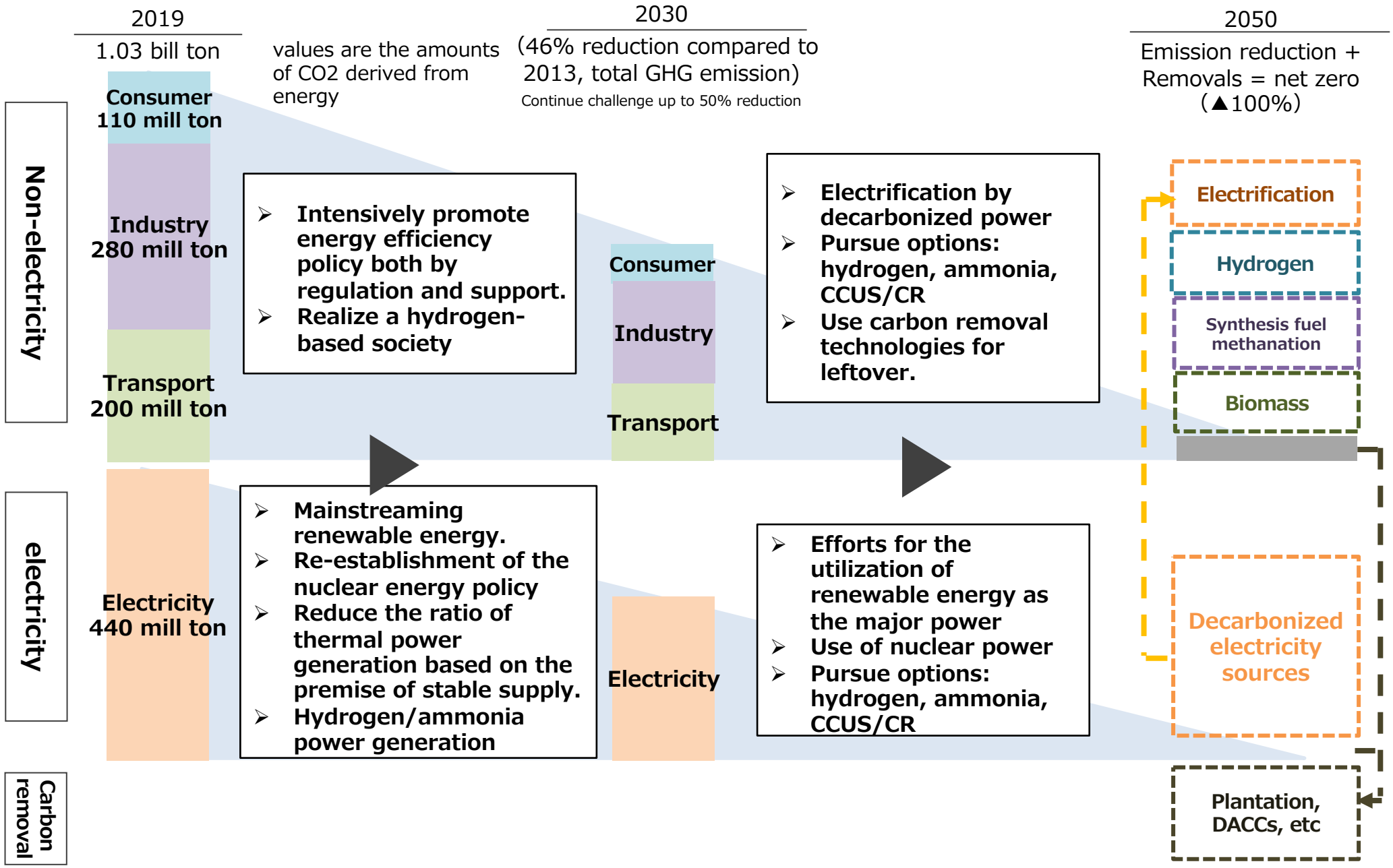
CEO, Global Link Lab, Inc.

Councilor, The Institute of Energy Economics, Japan

2050 Carbon Neutrality Goal and Revised 2030 Energy Mix Target

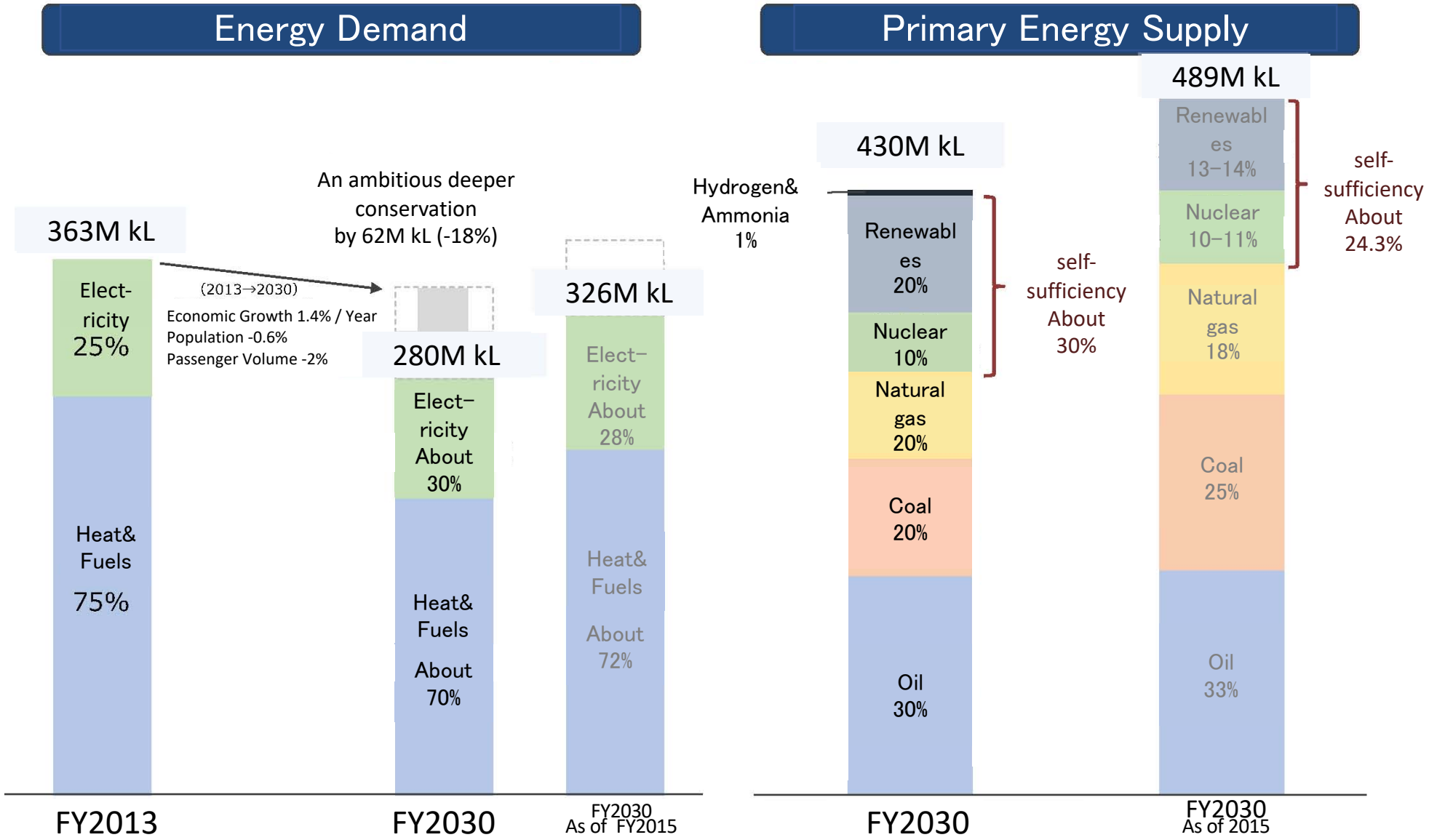
- October 2020, PM Suga declared net-zero GHG by 2050 goal.
- December 2020, updated in June 2021, Green Growth Strategy covering 14 sectors, e.g. offshore wind, fuel ammonia, hydrogen, nuclear, mobility/battery
- April 2021, PM Suga announced 46% GHG reduction target in 2030
- May 2021, CN 2050 is enacted (Law on Measures to Cope with Global Warming) by consensus
- October 2021, Kishida government has decided Basic Energy Plan and 2030 Energy mix
- May 2022, Kishida government has announced provisional Clean Energy Strategy

Path to 2050 CN through 2030



Source: METI

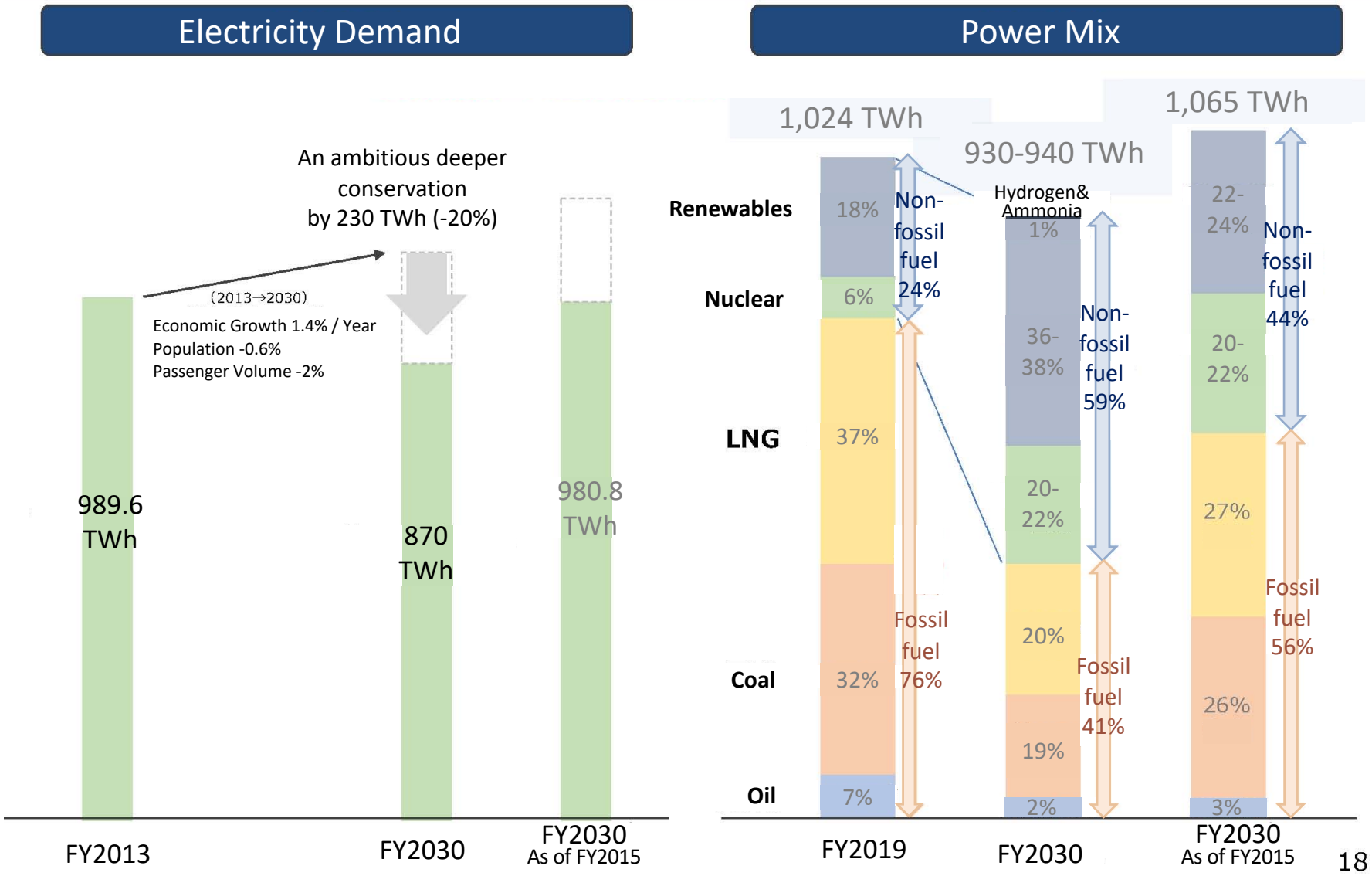
Revised Energy Mix in 2030



Source: METI

- The self-sufficiency rate is about a little over 30% on a comprehensive energy statistics basis and about a little under 30% on an IEA basis.
- Note that the integrated energy statistics have been revised since the formulation of the Long-Term Energy Supply and Demand Outlook in 2015, and the actual figures for FY2013 as the starting point for the FY2030 estimates are different, so simple comparisons cannot be made.

Revised Energy Mix in 2030 (2): Power Mix in 2030



Source: METI

14 sectors in the Green Growth Strategy (Dec. 2020, June 2021)

Energy

Offshore wind power
Wind turbines, parts,
floating wind turbines

Ammonia fuel
Combustion burner
(as fuel in transition period
to hydrogen-powered society)

Hydrogen
Turbines for power generation,
hydrogen reduction steel-
making, carrier ships,
water electrolyzers

Nuclear power
SMR (Small Modular Reactor),
nuclear power for hydrogen
production

Transport/Manufacturing

Mobility and battery
EV (electric vehicle), FCV (fuel cell vehicle),
next generation batteries

Semiconductor and ICT
Data centers, energy-saving
semiconductors (demand-side efficiency)

Maritime
Fuel-cell ships, electric propulsion ships,
gas-fueled ships

Logistics, people flow and infrastructure
Smart transportation, drones for logistics,
fuel-cell construction machinery

Foods, agriculture, forestry and fisheries
Smart-agriculture, wooden skyscrapers,
blue carbon

Aviation
Hybrid electric, Hydrogen-powered, Aircraft

Carbon Recycling
Concrete, biofuel, plastic materials

Home/ Office

Housing and building,
Next generation PV
(perovskite solar cell)

Lifestyle-related industry
Local decarbonization business

Resource circulation
Biomaterials,
recycled materials,
waste power generation

Source: METI

Clean Energy Strategy (provisional) (May 2022)

- Society, economic and industrial structure has to be converted.
- Necessary decarbonization investment : 17 trillion yen (130 billion US$) /2030 (3% of GDP)

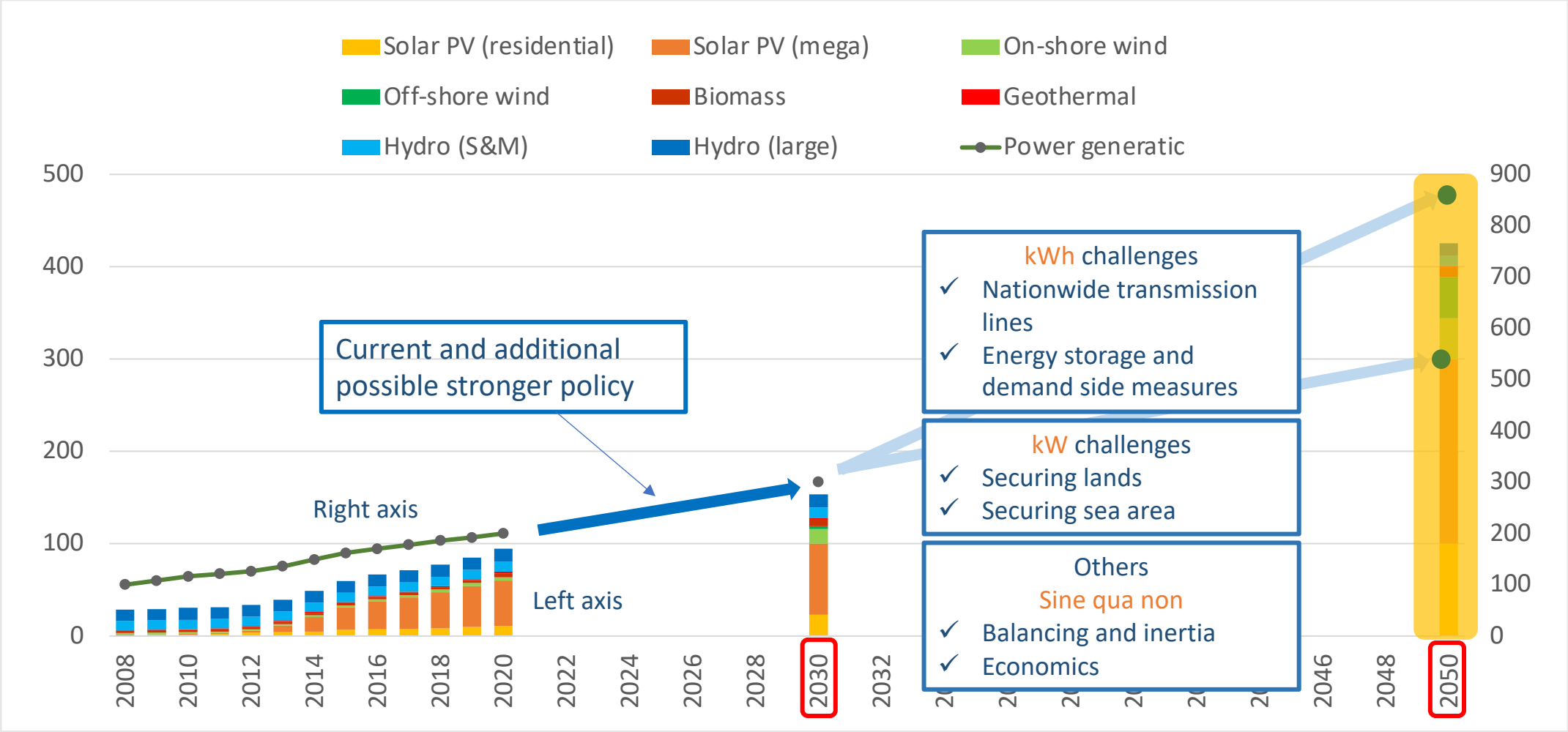
- power gen. / fuel conversion (renewables, hydrogen/ammonia, batteries, etc: 5 trillion yen
- manufacturing process (steel, chemical, etc.) : 2 trillion yen
- end-use (buildings, autos, etc.) : 4 trillion yen
- infrastructure (grids, charging stations, etc.) : 4 trillion yen
- R&D: 2 trillion yen

- 150 trillion yen (1.2 trillion US$) /next 10 years
- Fiscal stimulas, regulatory/market design, finance, GX League development, global strategy

Source: METI

Challenge: Renewables

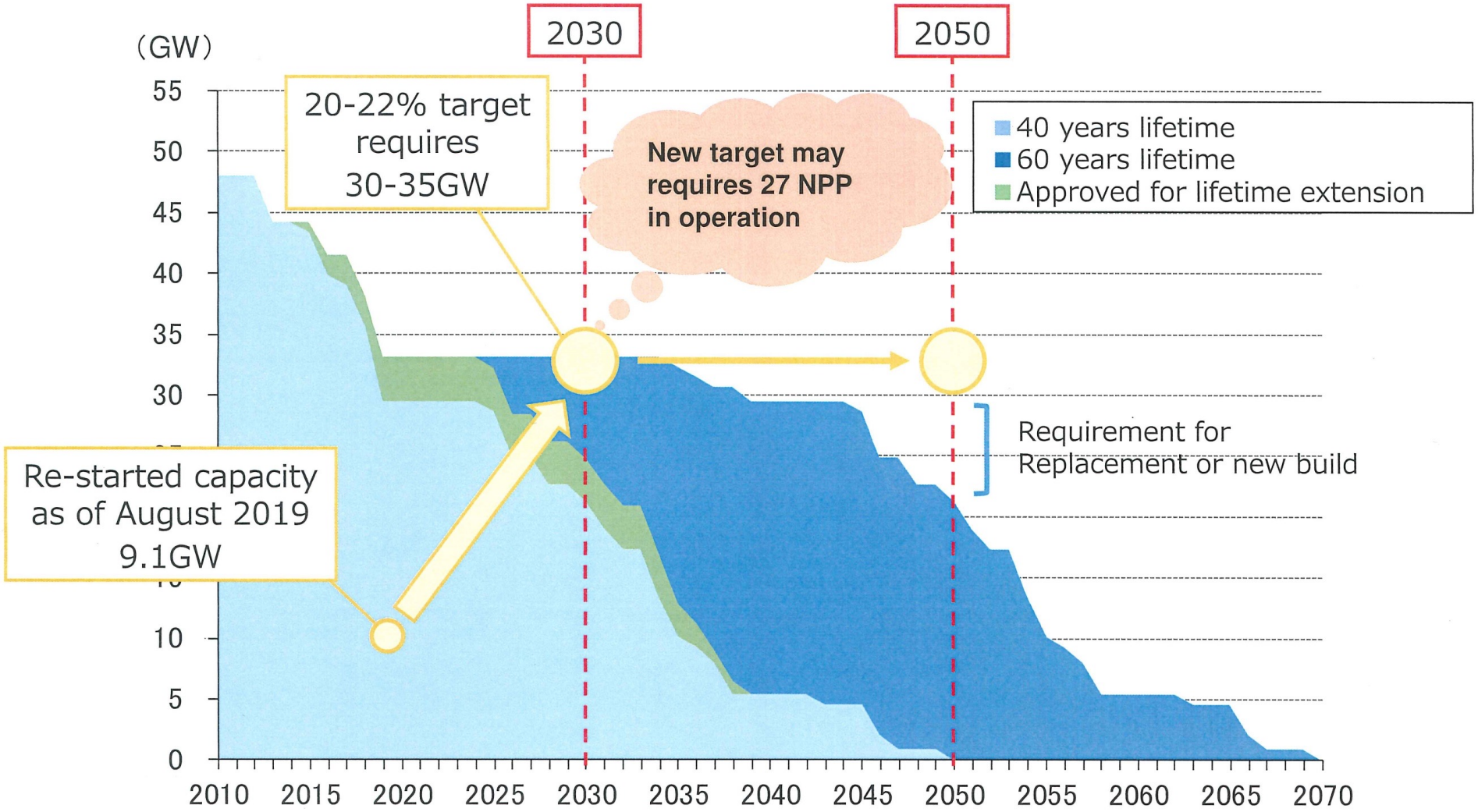
- 330-350TWh in 2030 by the current and the additional stronger policies
- Toward 2050 is unknown horizon. A variety of challenges face, kW and kWh.



Source: IEEJ

Challenge: Nuclear (1) Existing Plants

❖ **Extension of lifetime or construction of new reactors is required**



Source: IEEJ

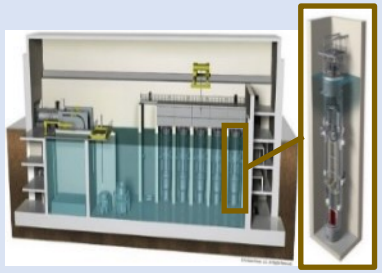
Challenge: Nuclear (2) Innovation

- Through **NEXIP** and other programs, METI supports various types of nuclear reactor technologies including **international cooperation projects**.
- The Japan Atomic Energy Agency (JAEA) possess **important test facilities**.

Small Modular LWR

- Smaller size, modular type
- Passive safety

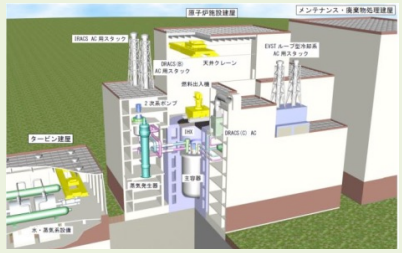
➡ ✓ Affordable capital cost
✓ Smaller EPZ



Fast Reactor

- Sodium-cooled reactor
- Fast neutrons

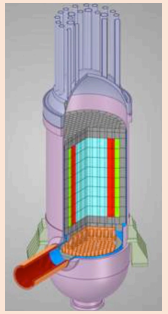
➡ ✓ Effective use of resources
✓ HLW management



High Temperature Gas-cooled Reactor

- Helium gas-cooled reactor (chemically stable)
- Coated particle fuel
- Very high temperature

➡ ✓ Heat/hydrogen use
✓ Smaller EPZ



France

Fast reactor R&D cooperation based on simulations and experiment

U.K.

High-temperature Gas-cooled Reactor

U.S.

Versatile Test Reactor (VTR) cooperation

International Cooperation

Joyo: Experimental Fast Reactor

HTTR: Experimental HTGR

JAEA's Facilities

Source: METI

Challenge: Hydrogen & Ammonia

- **Basic Hydrogen Strategy (2017)**
  - ✓ **First comprehensive national strategy**
  - ✓ **H_2 as a future energy option toward 2050**
  - ✓ **Goals : making H_2 affordable**
    - ➢ **Cost: $10/kg ⇒ $3/kg by 2030 & less than $2/kg by 2050**
    - ➢ **Scale up: up to 3 Mts by 2030 & around 20 Mts by 2050**

3 conditions for realizing affordable hydrogen

【Supply】
① **Inexpensive feedstock** (unused resources, renewables)
② **Large scale H_2 supply chains**

【Demand】 ・・・ ③ **Mass usage** (Mobility ⇒ Power Generation ⇒ Industry)

- **Key Technologies**

Production
- Electrolysis System
- Gasification + CCS

→

Transportation
- Energy Carrier (LH_2, MCH, NH_3, etc.)

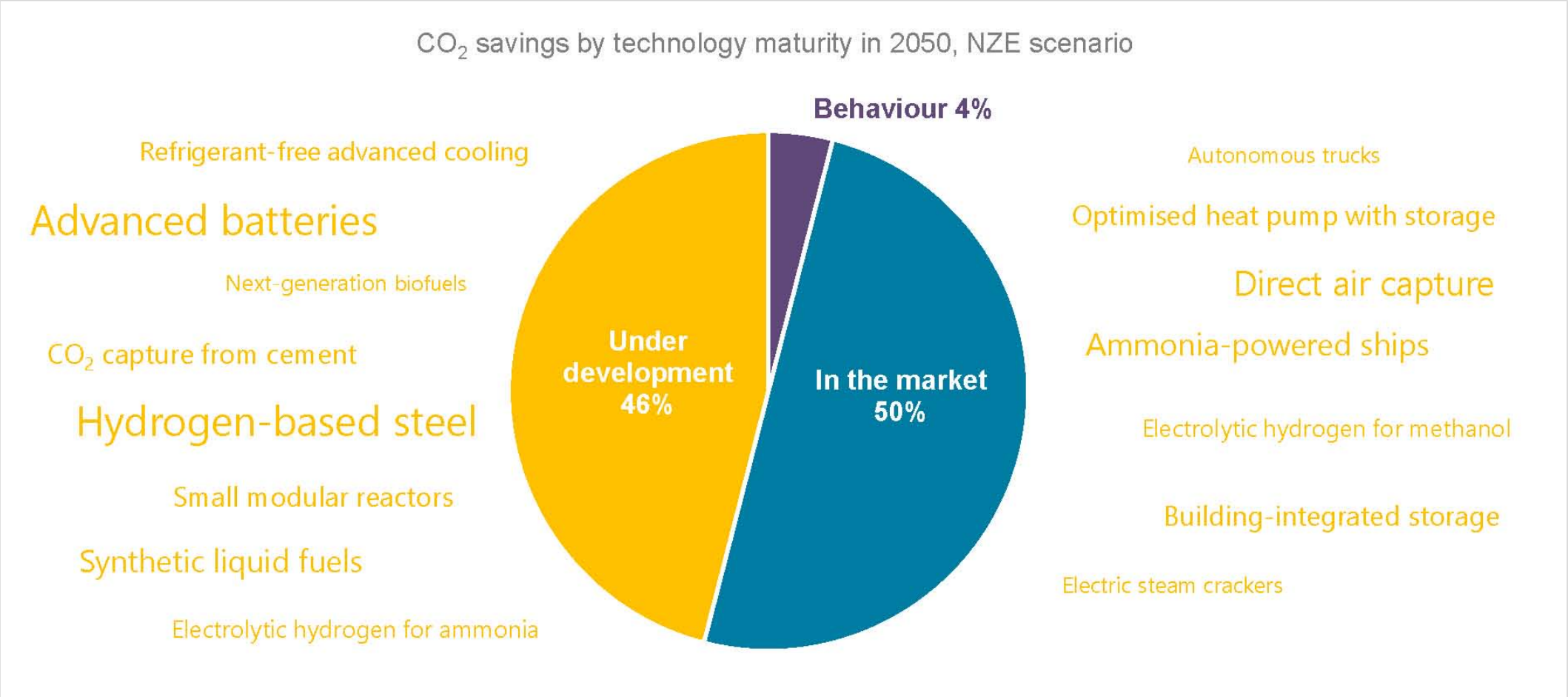
→

Use
- Fuel Cells (Mobility, Generation)
- H_2-fired Generation

Source: METI

Challenge: Technology & Innovation

It is important to accelerate innovation and prepare for the next generation of further actions.



In order to realize the practical use of next-generation low-carbon technologies, it is important to accelerate technology development and promote demonstration facts on the scale of 90 billion dollars by 2030. To achieve this, more international cooperation is essential.

Source: IEA

Challenge: Cost

2050 Electricity cost analysis by scenario

	Power generation	RE: %	Nuclear: %	H2/ Ammonia: %	CCUS power: %	Electricity cost JPY / kWh
Reference Case	1,350 TWh	54	10	13	23	24.9
RE: 100%	1,050 TWh	100	0	0	0	53.4
RE innovation	1,500 TWh	63	10	2	25	22.4
High nuclear	1,350 TWh	53	20	4	23	24.1 (Max nuclear 19.5)
H2 innovation	1,350 TWh	47	10	23	20	23.5
High CCUS	1,350 TWh	44	10	10	35	22.7
Demand transformation	1,350 TWh	51	10	15	24	24.6

Source: IEEJ

Challenge: Carbon Pricing

- PM Kishida instructed ministries to conclude carbon pricing policy (Jan. 2022)
- MOE has proposed to raise carbon tax level (289 yen/CO2 t)
- METI has proposed GX League (voluntary commitments and carbon market)
- Clean Energy Strategy (provisional) has suggested to develop GX League to stronger framework, continuing discussion on carbon tax

Challenge: International Cooperation: AETI and Asia Zero-Emission Community

- Japan announced "**Asia Energy Transition Initiative (AETI)**" in **the Special ASEAN Ministers meeting** in June 2021 and **the 1st Asia Green Growth Partnership Ministerial Meeting of ASEAN Ministers** in October 2021
- **PM Kishida announced "Asia Zero-Emission Community" based on AETI**

1. **Tech. development: roadmaps for transitions, hydrogen/ammonia, zero-emission thermal power, etc.**
2. **Co-investment, Co-finance: Asia Transition Finance rules, disclosure rule, building hydrogen/ammonia supply chains, Asia CCUS networks, etc.**
3. **Standardization: international standards, human resource development, emission data collaboration, etc.**
4. **Carbon credit market : assisting market mechanism, expansion of JCM partners,**

Source: METI

Challenge: International Cooperation: JUCEP

- **JUCEP** was established under the two partnerships of the **"Japan-U.S. Competitiveness and Resilience (CoRe) Partnership"** and the **"Japan-U.S. Climate Partnership on Ambition, Decarbonization, and Clean Energy"** announced at the Japan-U.S. summit meeting in April, 2021.
- JUCEP is a framework to help Indo-Pacific countries utilize **clean, affordable and secure energy technologies to accelerate decarbonization while promoting a stable energy supply and sustainable growth.** It aims to contribute to the realization of the "**Free and Open Indo-Pacific (FOIP)**" through an open, competitive and transparent energy markets.

<Key Cooperation Areas>

1. **Renewable Energy**: Geothermal, wind, solar, hydropower, and critical minerals
2. **Power Grid Modernization**: Grid stability, energy management technology including battery storage, and transmission
3. **Nuclear Energy**: Advanced technologies such as small modular reactors and light water reactors.
4. **Decarbonization technologies**: CCUS/Carbon Recycling and other abatement technologies, as well as advanced fuels like ammonia, hydrogen, and others

Source: METI

Conclusion

- Japan's goals of Carbon Neutrality 2050 and 46% reduction 2030 are extremely tough mission .
- Toward 2030, existing technologies have to be deployed with utmost political, industrial and the public efforts.
- Toward 2050, Japan, as a technology leader, has to contribute to the world with new technology development.
- For global emission reduction on cost-effective basis and technology development, international cooperation is key.
- Article 6 of Paris Agreement (Market Mechanism) has to be utilized.