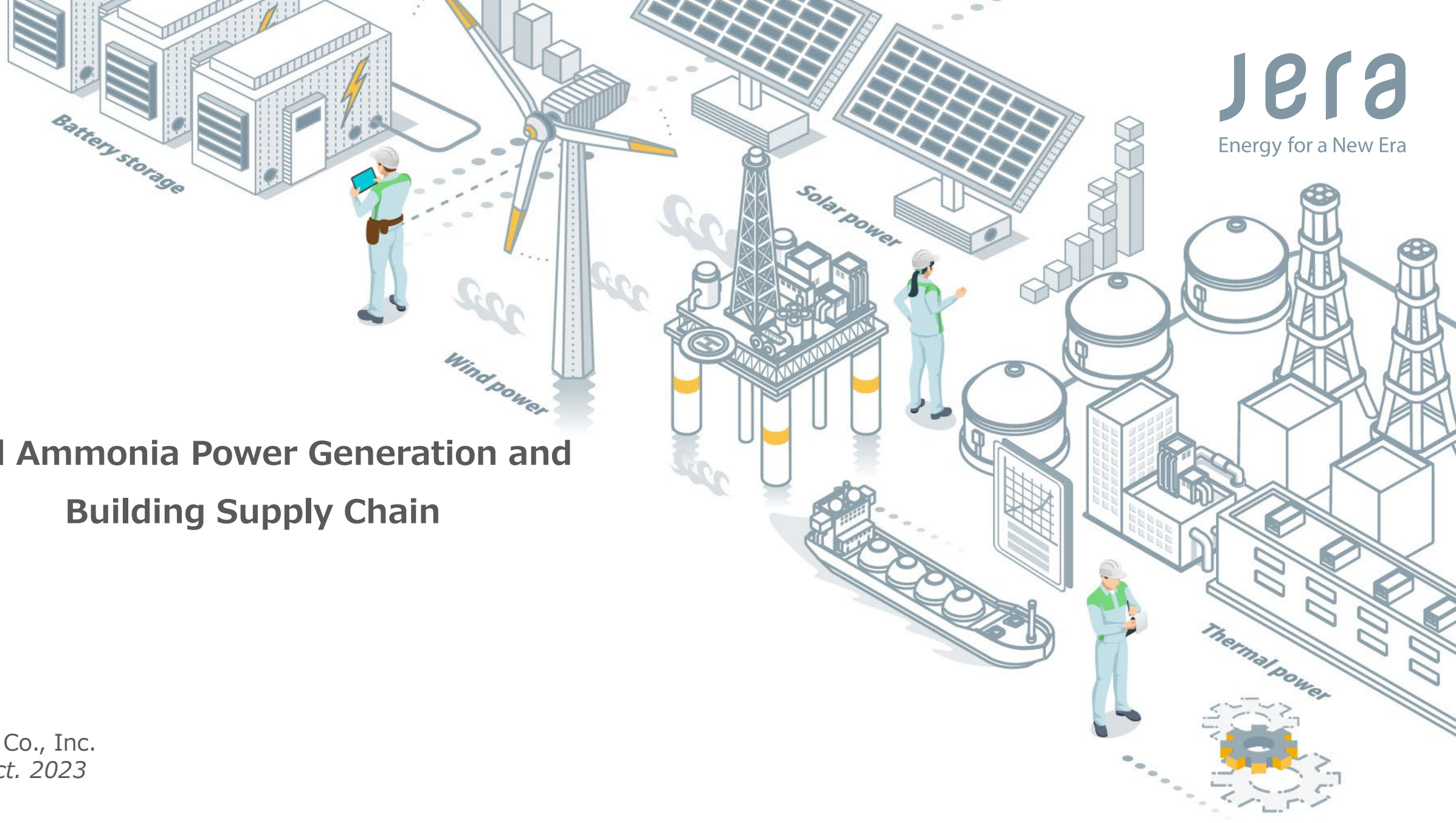


# Jera

Energy for a New Era

## Fuel Ammonia Power Generation and Building Supply Chain

JERA Co., Inc.  
11.Oct. 2023



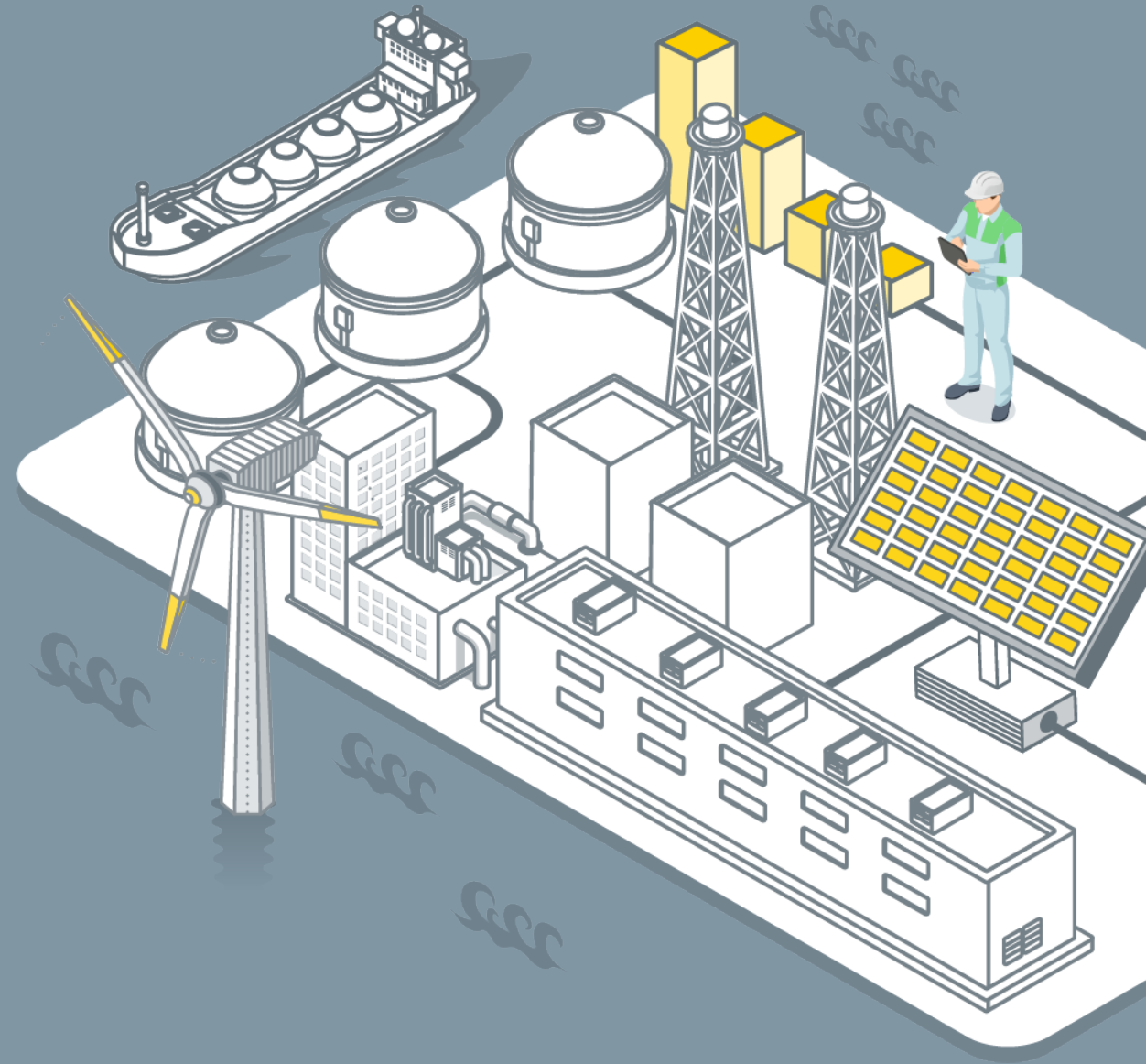
Jera

# Overview of JERA

**J**JAPAN

**E**ENERGY

**NEW ERA**



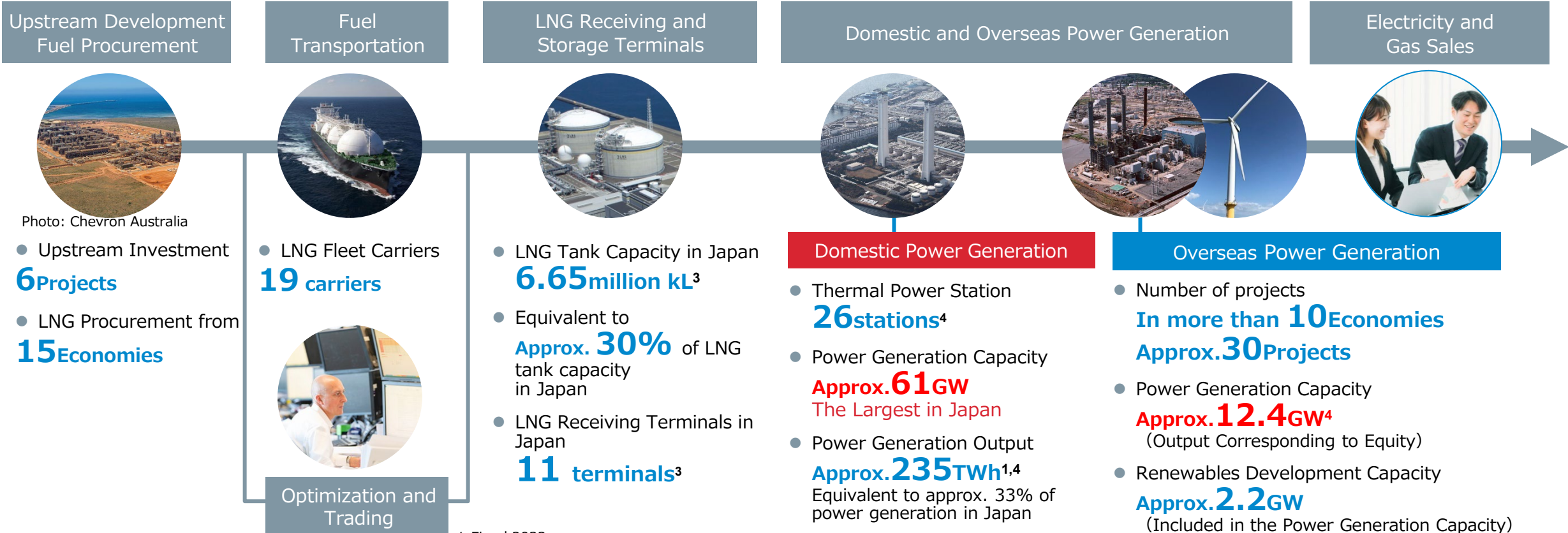
# JERA's Value Chain covers from upstream to downstream

**LNG Transaction Volume<sup>1</sup>**  
**Approx. 35 MTPA**  
 Among the largest in the world

**Total Assets**  
 Approx. JPY  
**9.1 trillion**

**Sales**  
 Approx. JPY  
**4.7 trillion<sup>1</sup>**

As of March 31, 2023

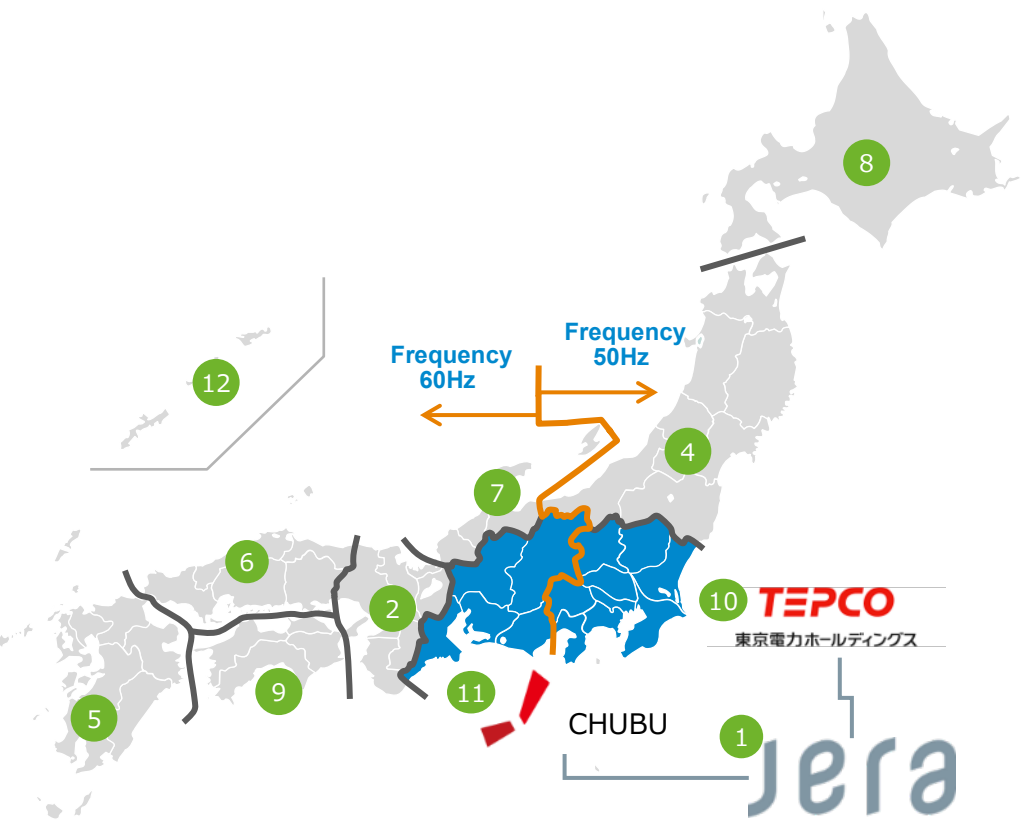


1: Fiscal 2022  
 2: Represents the number of economies that imported LNG to LNG receiving terminals of JERA.  
 3: Includes jointly operated terminals in Chita and Yokohama  
 4: Includes capacity under construction. Excludes joint thermal power in Japan.

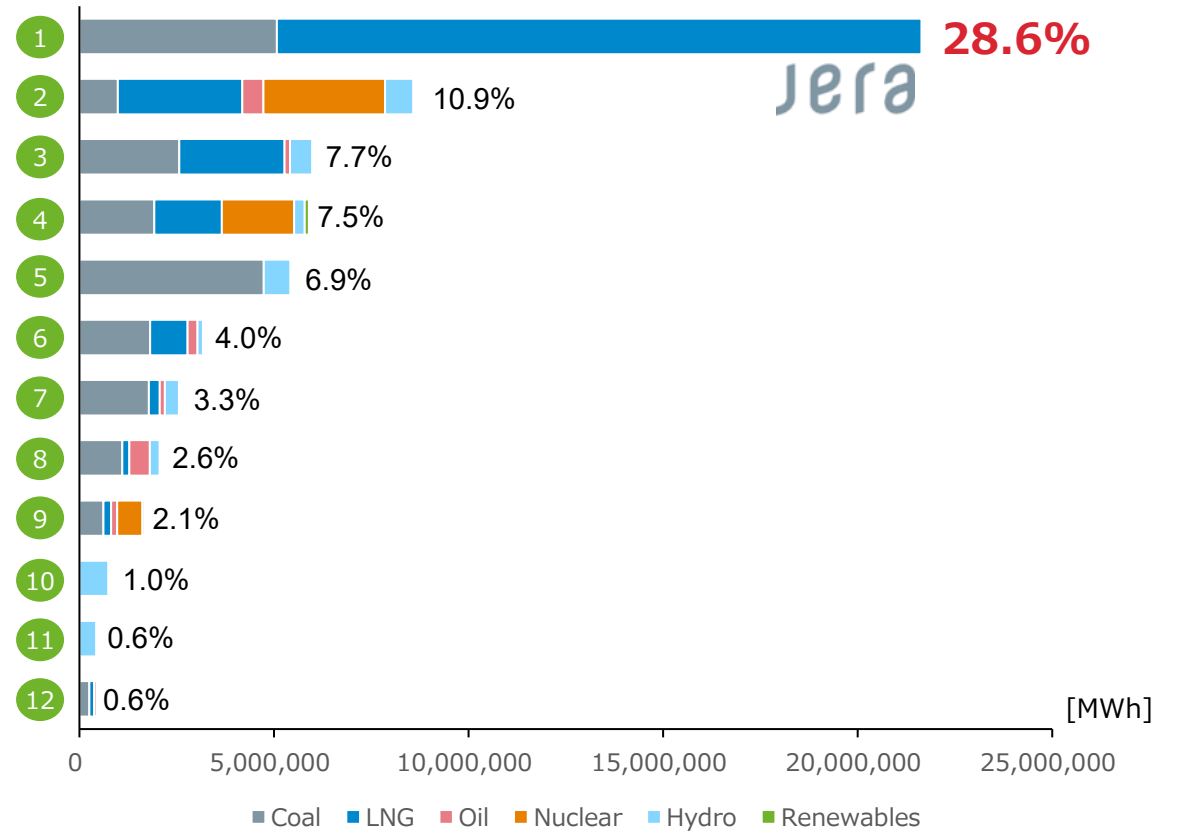


# Power Generation Business in Japan

- JERA is the largest power generation company in Japan, generating around 30% of domestic electricity
- JERA plays an important role in the stable supply of electricity in Japan, where there are no international transmission lines
- JERA is also the largest CO2 emitter company in Japan

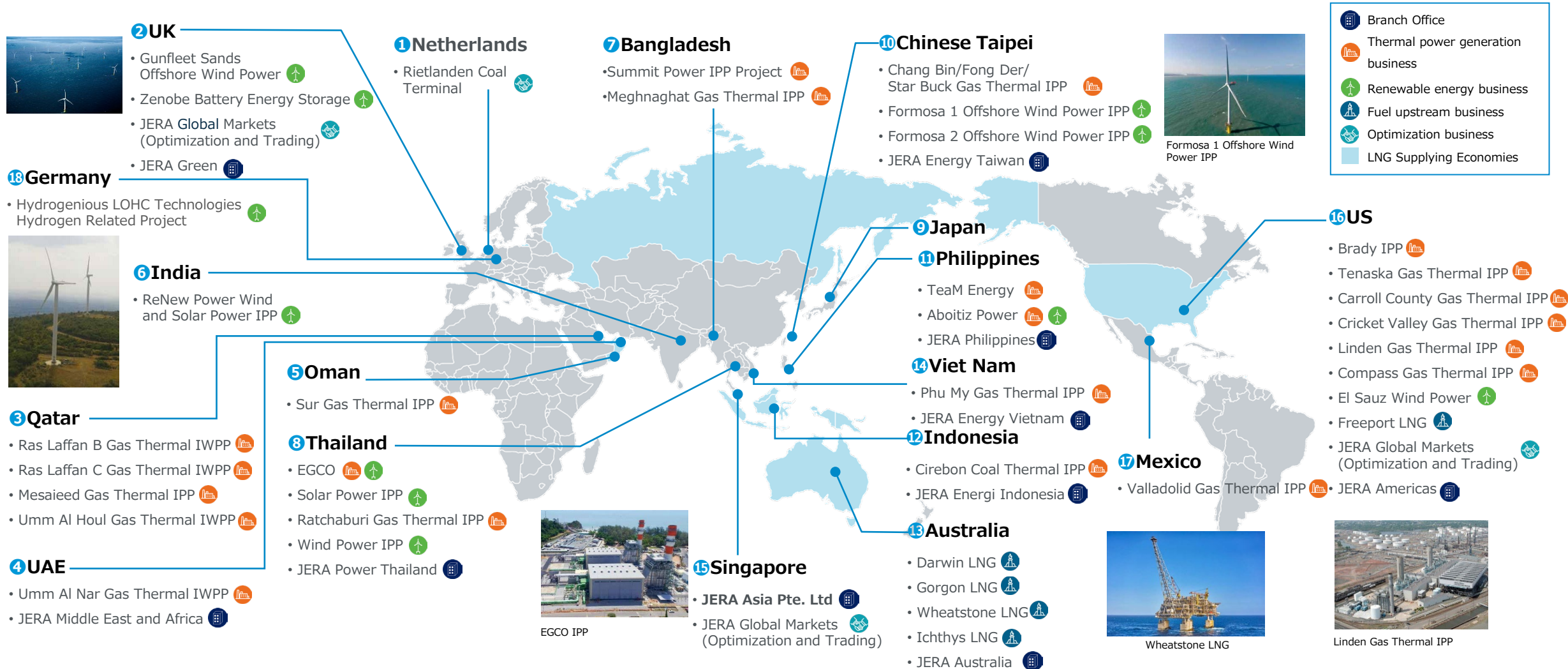


Domestic Power Generation Share and Power Generation Mix



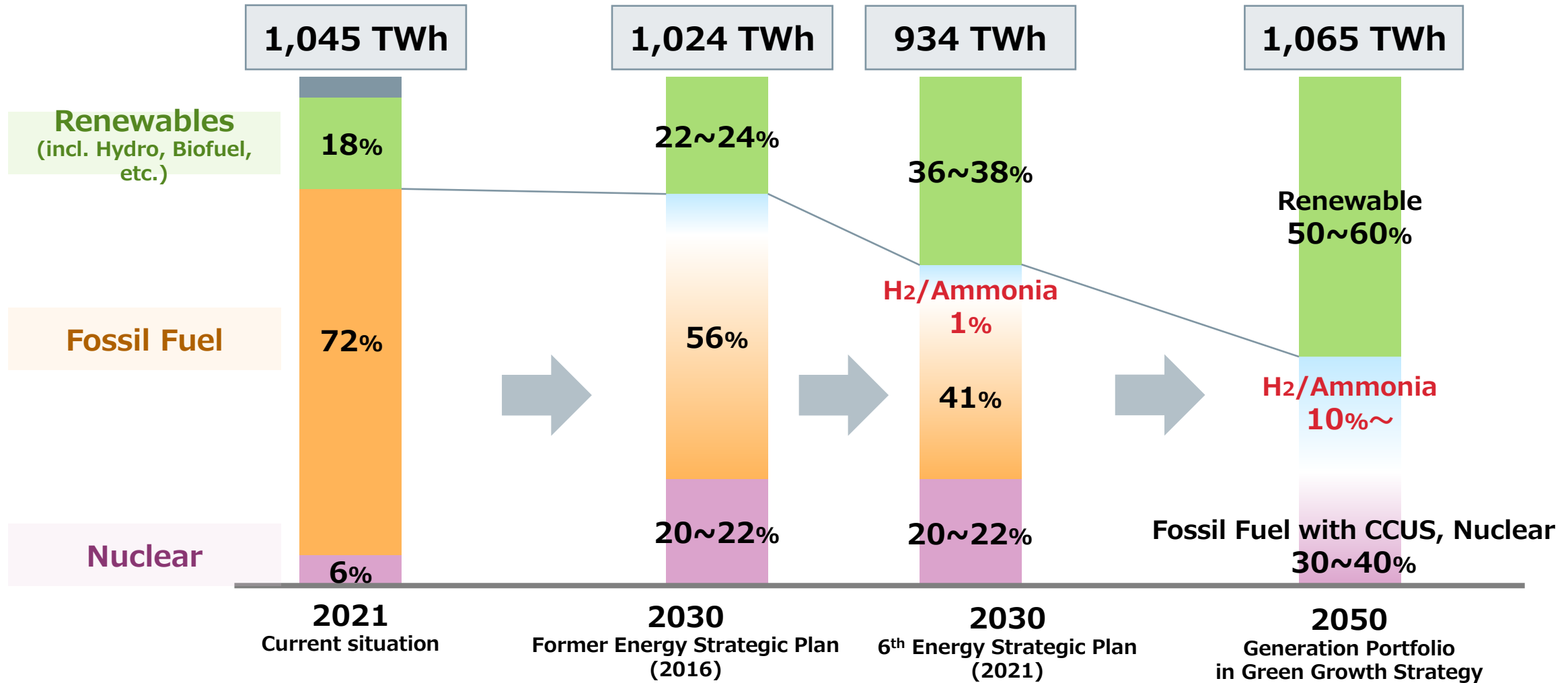
# Overseas Businesses

- From fuel sourcing to power generation, JERA holds assets in economies across the world.
- We aim to increase our renewable energy assets from the current 2.2GW to 5GW by 2025.



# Japan's Energy Mix Policy for Electricity

- Japan is aggressively pursuing renewables to decarbonize power – but renewable energy alone is not enough
- For grid stability and seasonality, hydrogen/ammonia and CCUS are needed



# IEA - The Role of Low-Carbon Fuels in the Clean Energy Transitions of the Power Sector (October 2021)

iea

## The Role of Low-Carbon Fuels in the Clean Energy Transitions of the Power Sector



International  
Energy Agency

**“Using low-carbon hydrogen and ammonia in fossil fuel power plants can play an important role to help ensure electricity security in clean energy transitions.”**  
**“Developing markets for low-carbon fuels and their supply chains by 2030 will establish significant opportunities in many economies and economic sectors.”**

### Contents of the report

- Executive summary
- The role of thermal generation in clean energy transition
- Technical options for decarbonizing thermal power plants
- Production and transport of low-carbon hydrogen and ammonia
- Case studies
- System value aspects of low-carbon thermal plants
- Resource requirements and other uses of low-carbon fuels
- Conclusions

# The challenge of achieving zero CO<sub>2</sub> emissions by 2050

- JERA will take on the challenge of achieving, by 2050, zero CO<sub>2</sub> emissions in Japan and overseas.<sup>1</sup>

## The Three Approaches of JERA Zero CO<sub>2</sub> Emissions 2050

**1**

Complementarity between  
Renewable and Zero CO<sub>2</sub> Emission  
Thermal Power Generation

**2**

Establishment of Roadmaps  
Suitable for Each Economy  
and Region

**3**

Adoption of  
“Smart Transition”

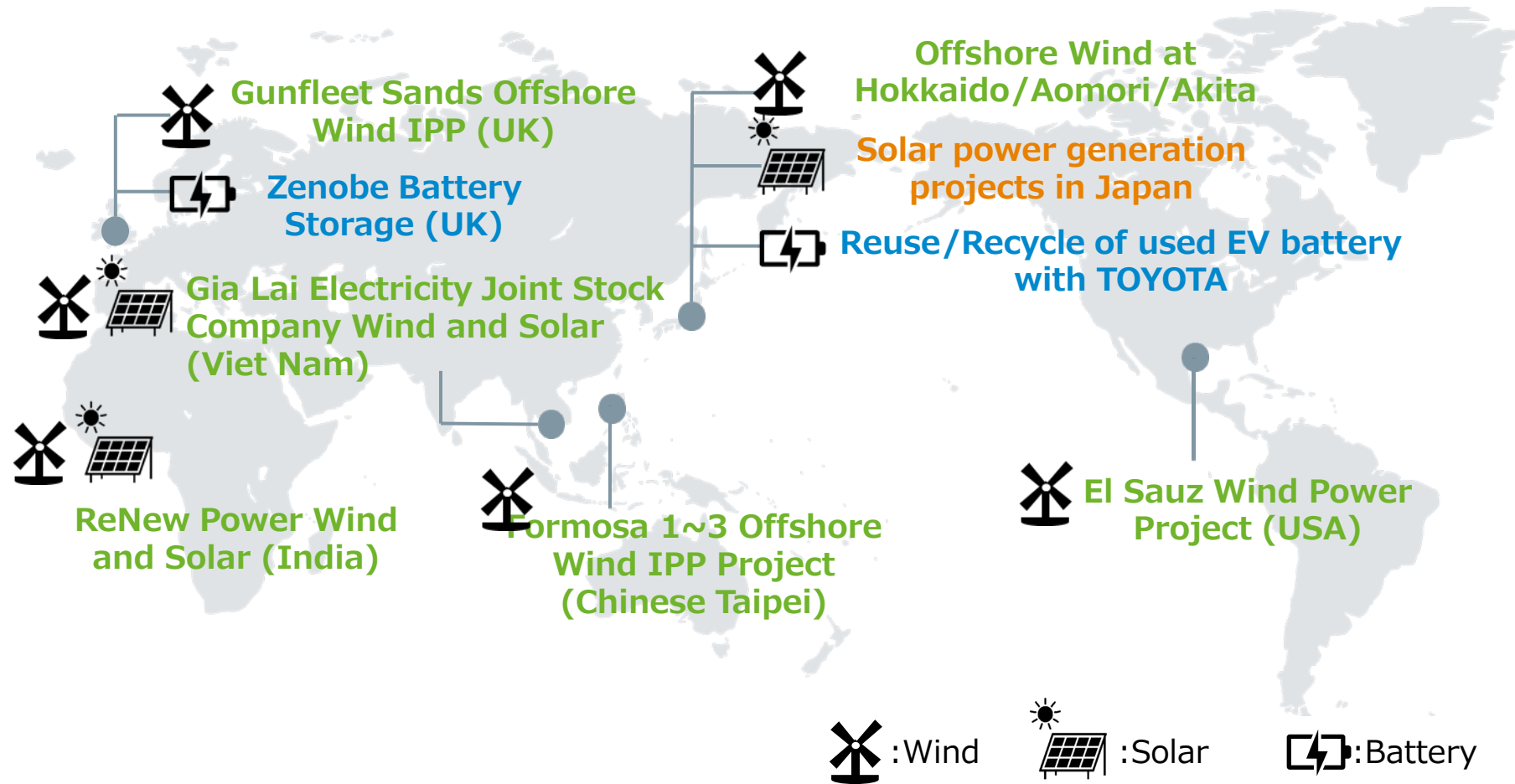


<sup>1</sup> JERA Zero CO<sub>2</sub> Emissions 2050 is premised on the continual development of decarbonization technology, economic rationality, and consistency with government policy. JERA is continuing to develop original decarbonization technologies and is taking the initiative to ensure economic rationality.



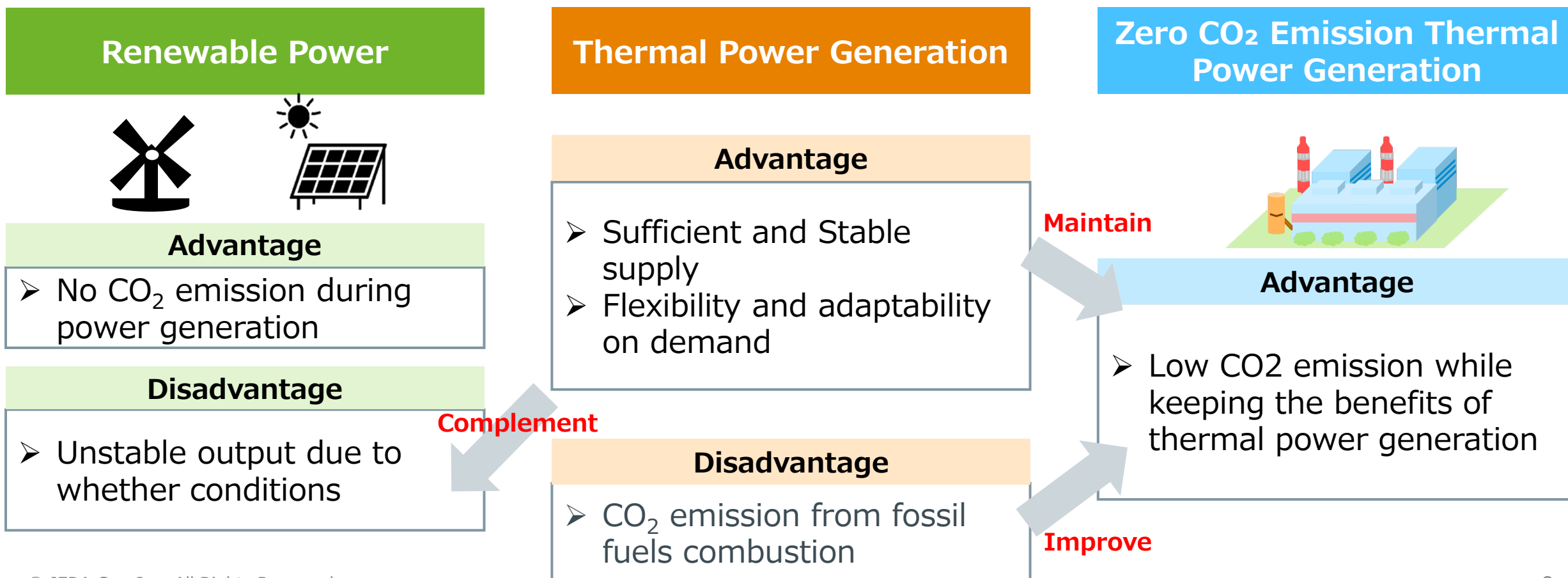
# First initiative: Renewable Energy

- We are developing renewable energy widely, such as wind/solar/battery around the world.
- Development target is **5.0GW by FY2025**.



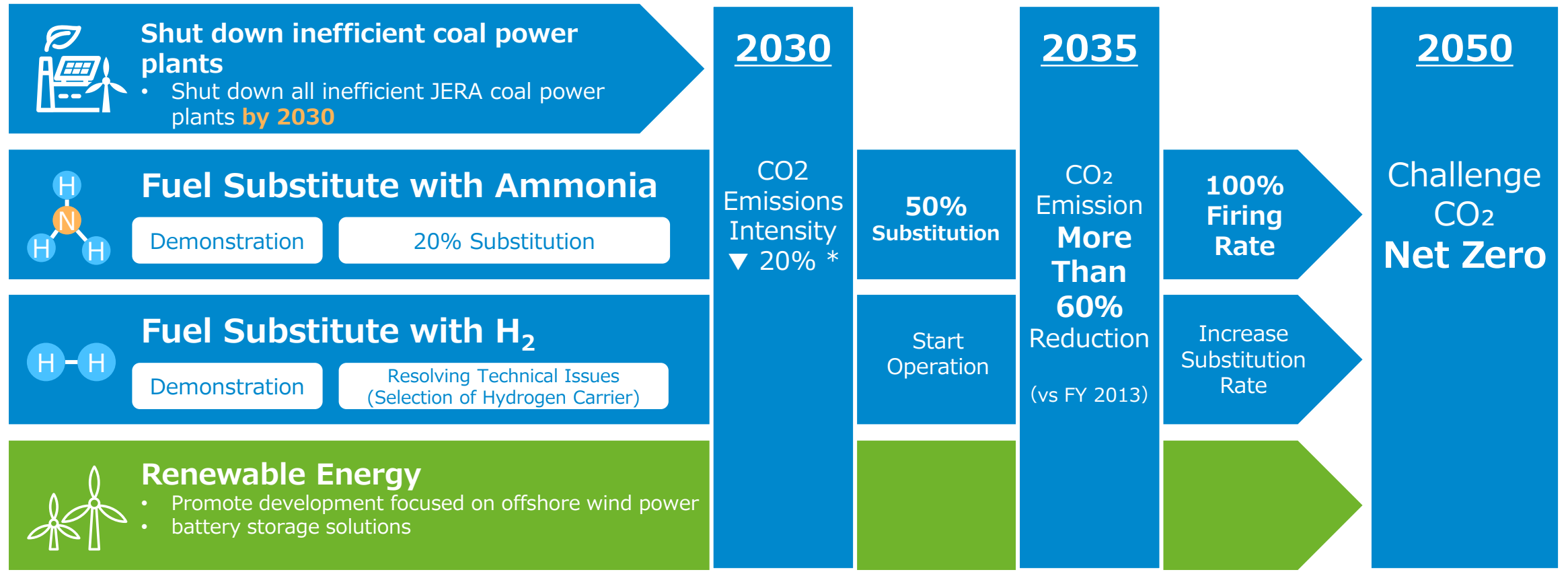
# Second initiative: Zero CO<sub>2</sub> Emission Thermal Power Generation

- Renewable power alone is not enough to cover the entire electricity demand Japan, due to limited potential, power grid unconnected to other regions, etc.
- **By introducing “clean fuel (Hydrogen/Ammonia)” into thermal power generation, we can realize CO<sub>2</sub> reduction while securing stable electricity supply.**



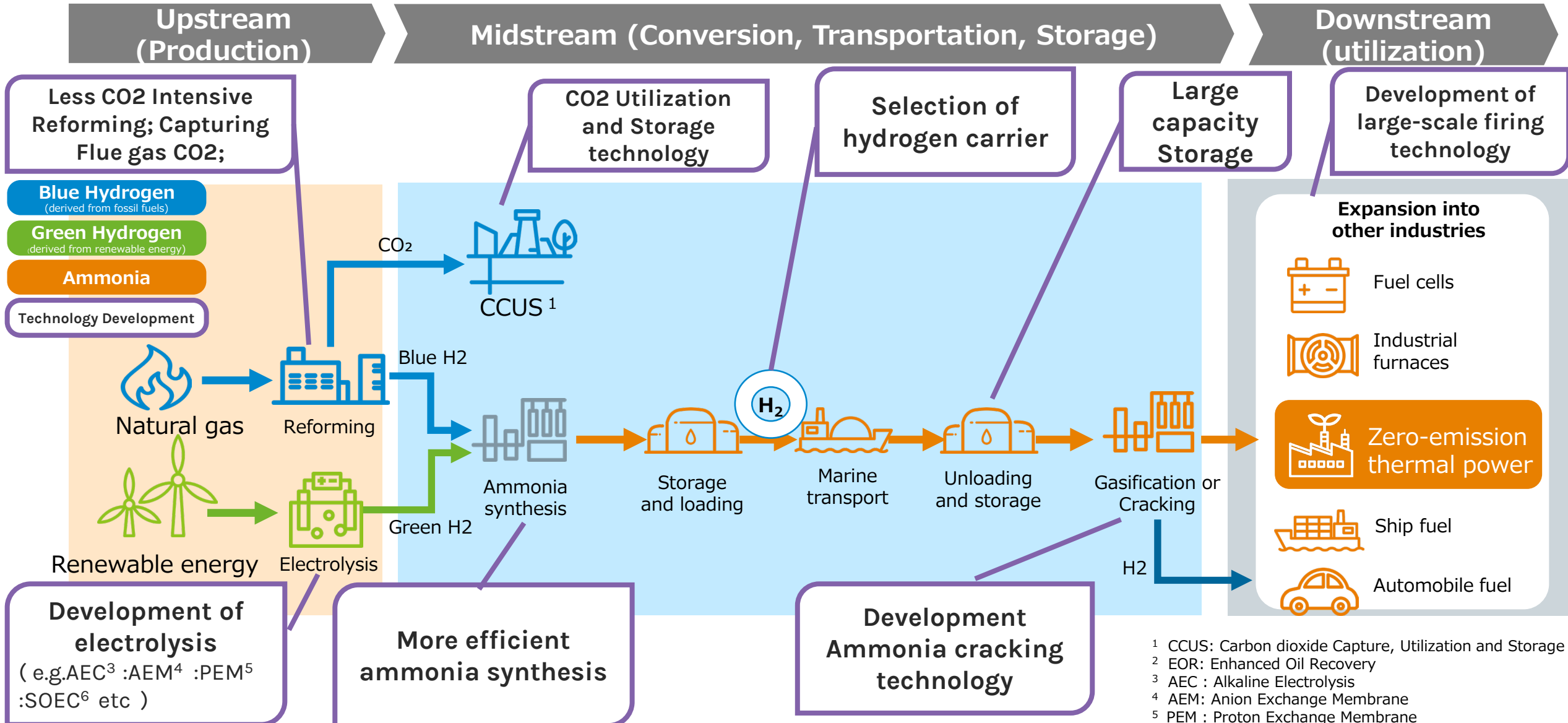
# JERA Zero CO<sub>2</sub> Emissions 2050 Roadmap for its Business in Japan

- Achieve net zero emissions in Japan through low-efficiency coal elimination, ammonia and hydrogen substitution, and renewable energy
- The path to zero emissions varies depending on the situation of the economy or region. Develop optimal roadmap overseas sequentially



\*Compared with the emissions intensity of thermal power generation for the whole economy based on the long-term energy supply and demand forecast for FY 2030 presented by the government.

# Hydrogen/Ammonia Supply Chain Development



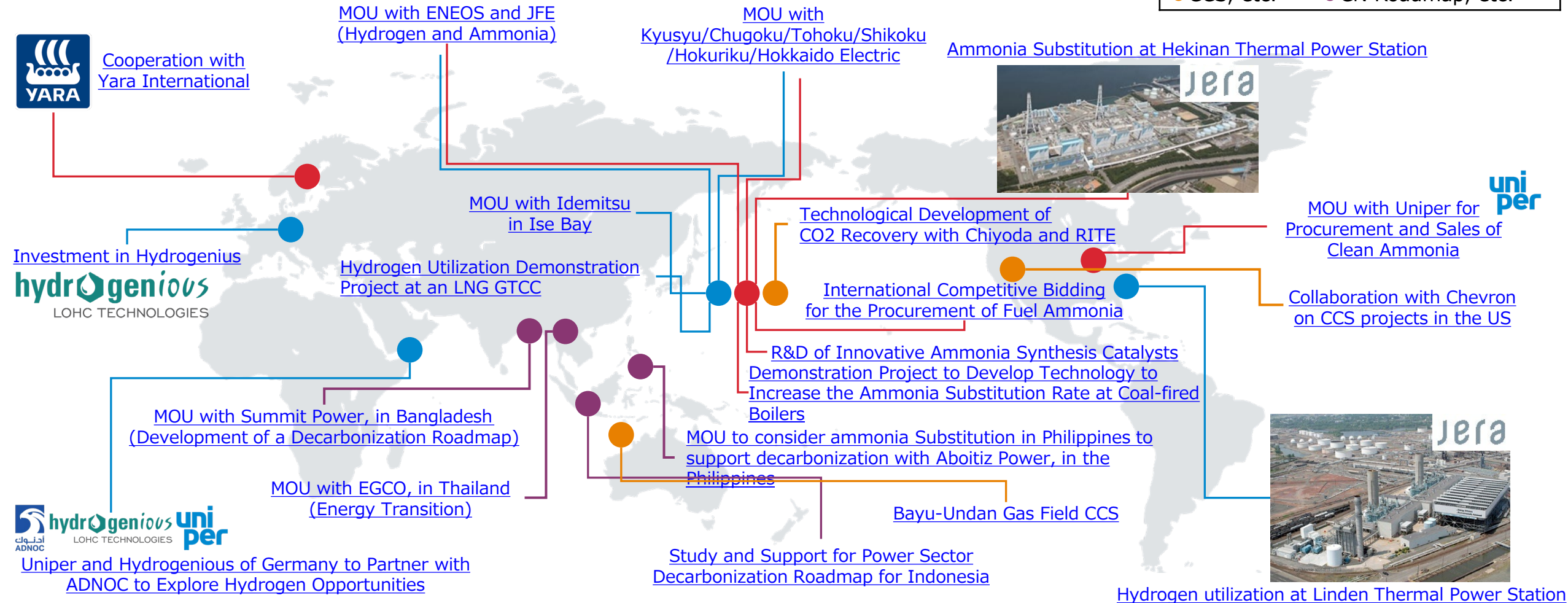
1 CCUS: Carbon dioxide Capture, Utilization and Storage  
2 EOR: Enhanced Oil Recovery  
3 AEC : Alkaline Electrolysis  
4 AEM: Anion Exchange Membrane  
5 PEM : Proton Exchange Membrane  
6 SOEC : Solid oxide electrolysis cell



# Initiatives to Establish Hydrogen and Ammonia Supply Chain

- JERA is collaborating with many players to develop a low-carbon fuel supply chain.

● Ammonia	● Hydrogen
● CCS, etc.	● CN Roadmap, etc.



# Initiatives to Establish Hydrogen and Ammonia Supply Chain cont...



## Cooperation in Upstream Area

- JERA has conducted an international competitive bidding process for the procurement of fuel ammonia. (2022.2-)
- In Jan 2023, JERA has executed MOUs with CFI and Yara, as a result of bid for development and sales of clean ammonia.

Number of bids sent	Approx. 30 companies
Duration	Long term from FY2027 into 2040s
Quantity	Up to 500,000 t/year
Delivery	FOB
Others	<ul style="list-style-type: none"> <li>- CO2 is not generated during ammonia production, or captured and stored.</li> <li>- JERA has the opportunity to participate in ammonia production projects.</li> </ul>

## Cooperation in Shipping Area

- JERA has signed MOU with “NYK” and “MOL” to cooperate in transporting fuel ammonia. (2022.11)

MOU covers :

- ✓ Developing fuel-ammonia carriers suitable for domestic thermal power plants and receiving stations
- ✓ Building a fuel ammonia transportation and receiving system
- ✓ Installing and operating propulsion engines that use ammonia as ship fuel
- ✓ Working with related parties to foster the formation of rules related to the reception of fuel ammonia

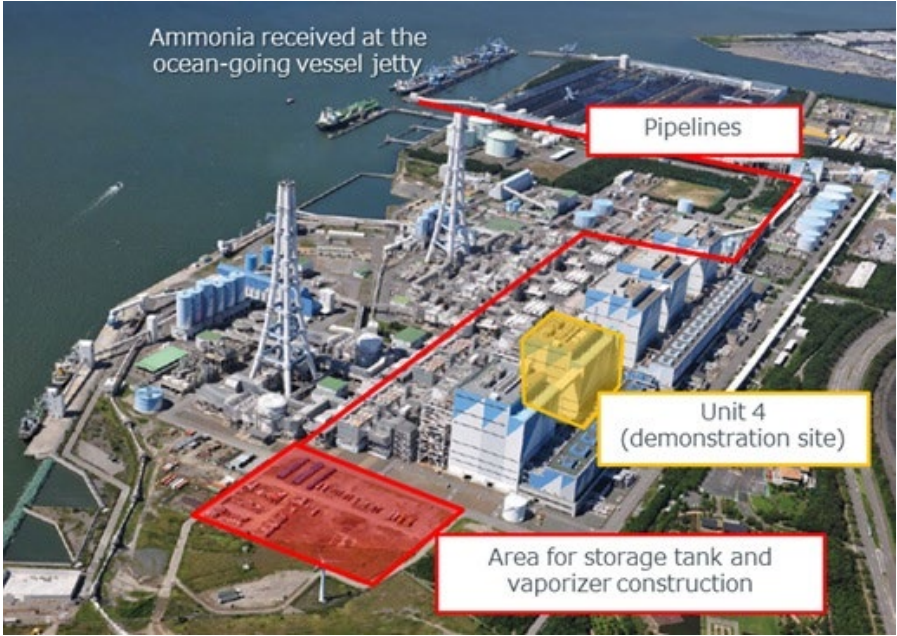


# Initiatives to Establish Hydrogen and Ammonia Supply Chain cont...



## Demonstration for Ammonia Substitution

- Small-scale ammonia substitution test has been completed. (2022.7)
- Preparations are underway to conduct a large-scale 20% substitution demonstration in FY2023.

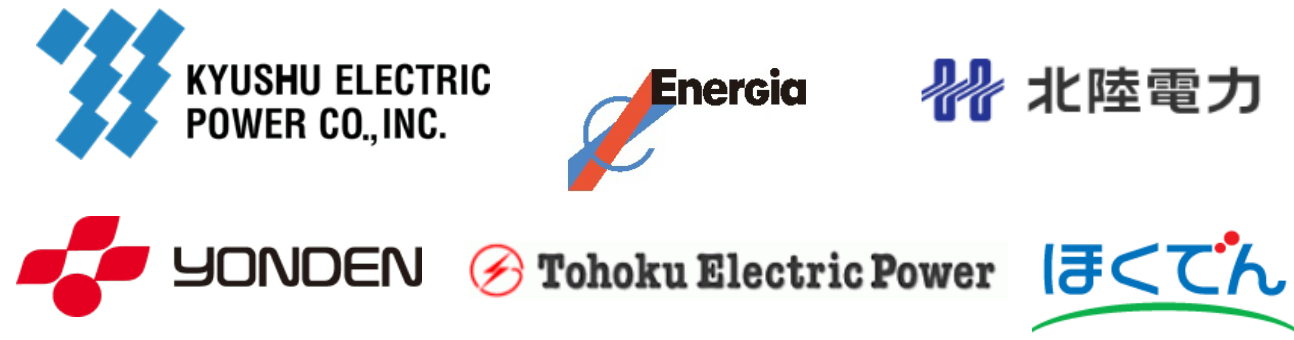


## Collaboration with Utilities

- JERA has signed MOU with 6 Japanese utility companies to consider collaboration aimed at the adoption of hydrogen and ammonia as fuel for power generation.

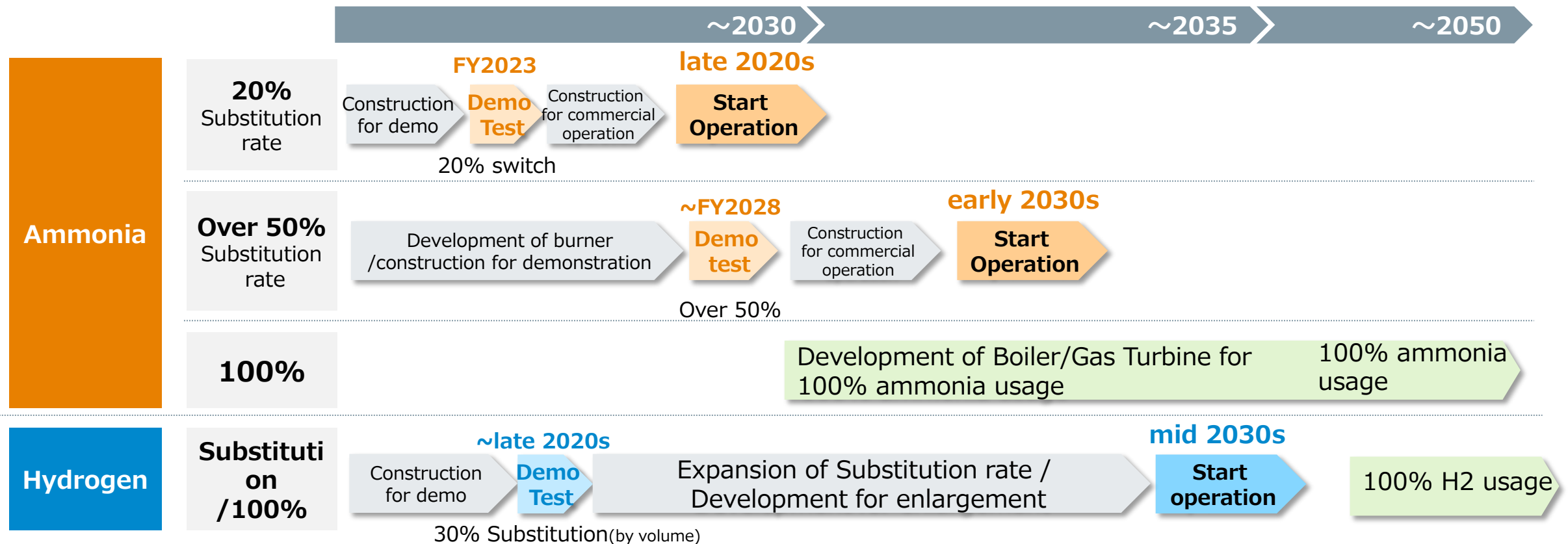
**MOU covers :**

- Joint procurement to reduce LCF costs
- To establish transportation and storage methods for LCF
- Working to gain policy support and to develop rules related to LCF
- Exchanging opinions and considering collaborative projects regarding the introduction of LCF in Japan



# JERA's Zero Emissions Technologies' Development Timeline

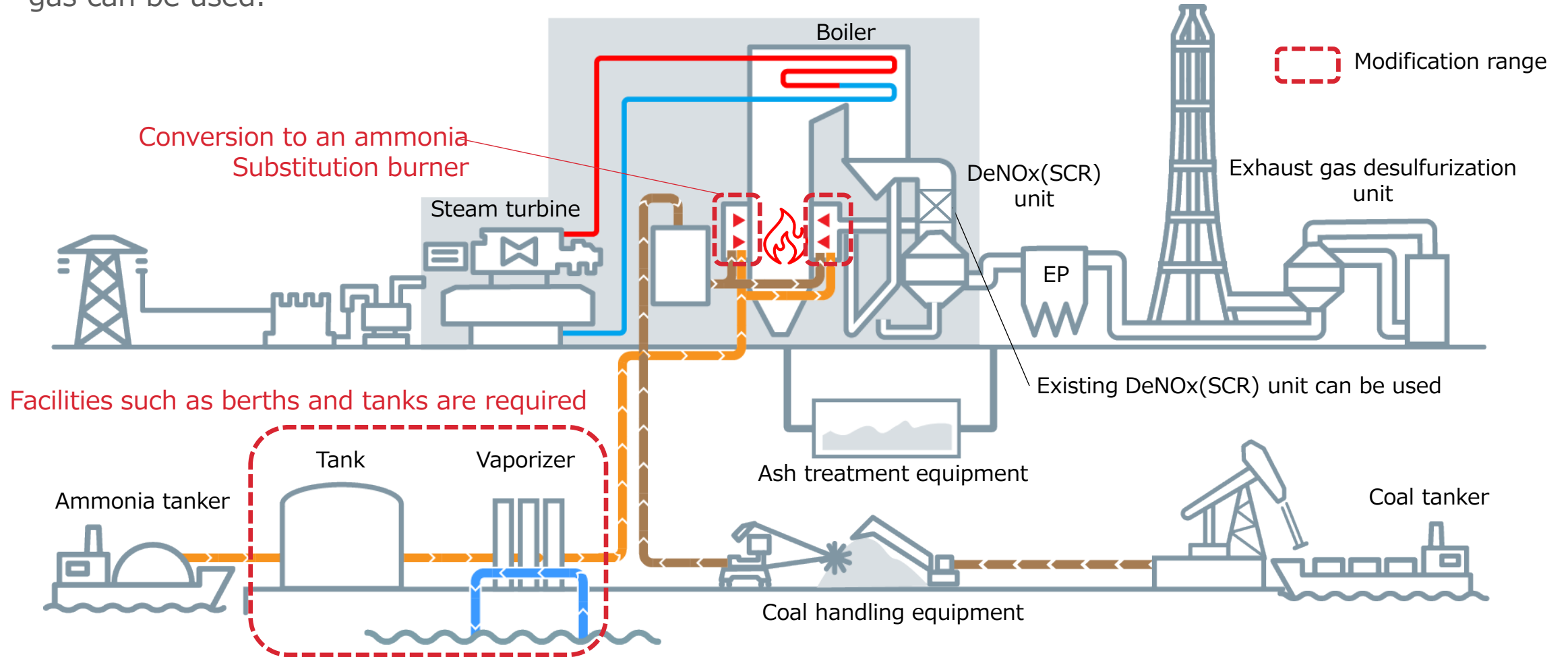
- **20% ammonia generation Demonstration test** will start by **FY2023**. Demonstration test of ammonia generation over **50%** will conduct by **FY2028** at **Hekinan and other Power Plants**.
- After the demo tests, commercial operation will start at the power plants.





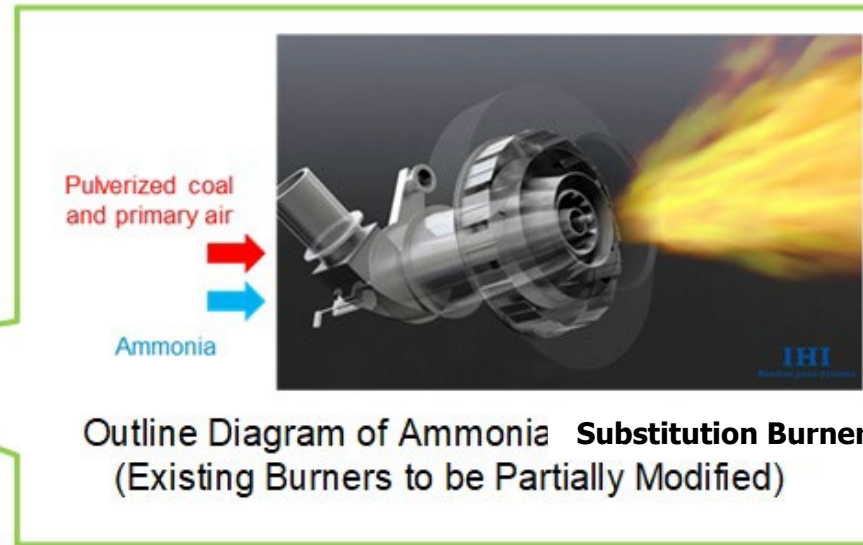
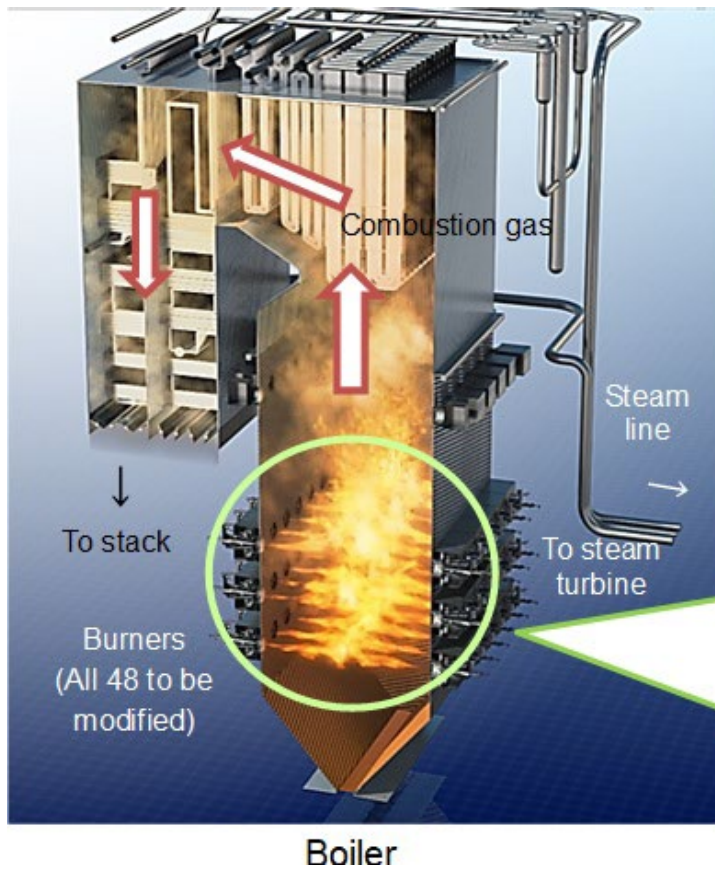
# Outline of required modification for Ammonia

- JERA makes modification works for Ammonia in Hekinan Unit 4
- Small modification is required, but the most of existing facility and DeNOx(SCR) unit for treatment of exhaust gas can be used.



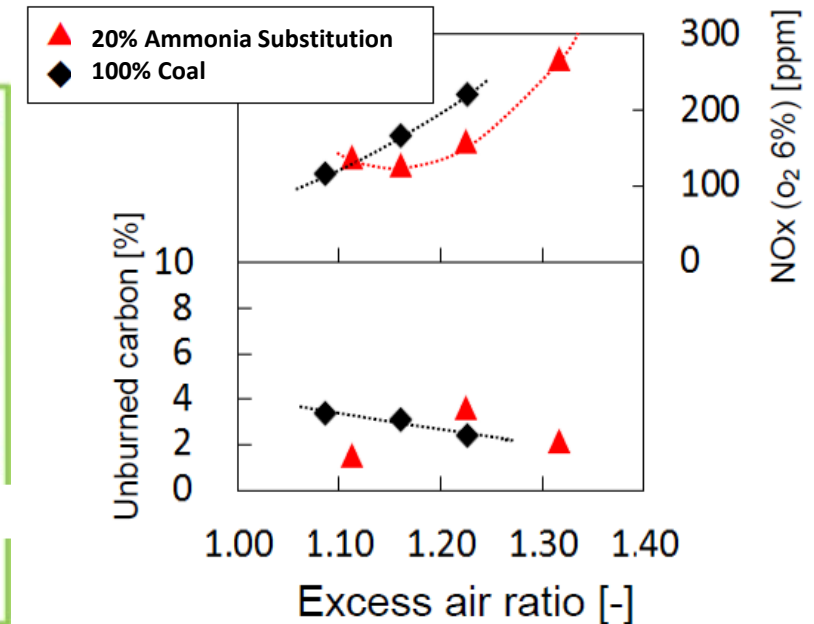
# Development of Ammonia Substitution technology

- A challenge of using ammonia in a blended fuel is controlling NOx emissions
- JERA's demonstration test program will use modified burners that inject ammonia at the center of a stream of pulverized coal and air



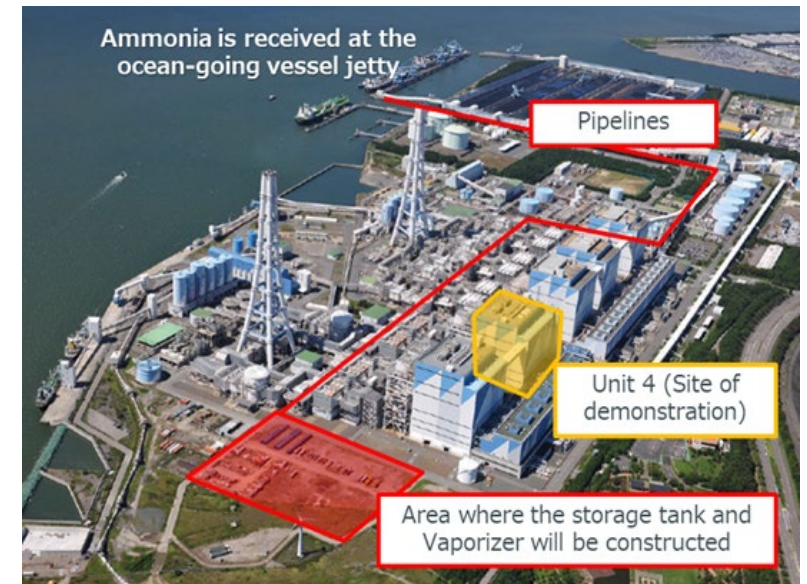
Ministerial Strategic Innovation Promotion Program (SIP)

Concentration in 20% ammonia substitution is as same as coal firing



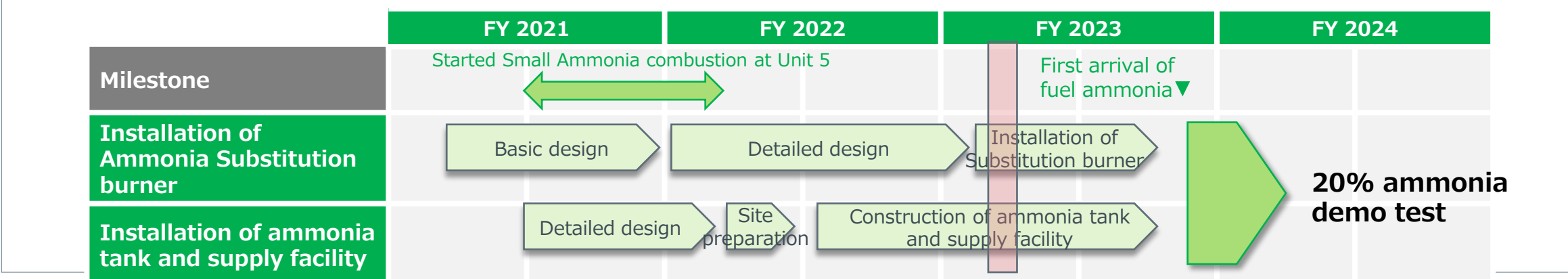
# The Demonstration Test for Ammonia Generation (FY 2021-FY 2024)

NEDO project "R&D and Demonstration of Technologies for Ammonia Substitution Thermal Power Generation"	
Companies	<b>JERA and IHI</b>
Place	<b>Hekinan Thermal Power Station</b> (1,000MW) in Aichi prefecture, Japan
Contents	- Installation of Ammonia Substitution burner & supply facility - <b>20% coal as fuel will be replaced by ammonia.</b>
Ammonia Consumption	<b>30,000 to 40,000 tons</b> during the test



NEDO: New Energy and Industrial Technology Development Organization

## Schedule of the demonstration



# Procurement of Fuel Ammonia

- JERA conducted an international competitive bidding for the procurement of fuel ammonia.

Main T&Cs	Number of bids RFP sent	Approx. 30 companies
	Contract duration	<b>FY2027~2040's Long term</b>
	Quantity	Max. <b>500,000 ton/year</b>
	Delivery	FOB
	Others	<ul style="list-style-type: none"> <li>In principle, CO2 is not generated during ammonia production, or is collected and stored.</li> <li>JERA's opportunity to participate in the ammonia production projects</li> </ul>

- In January 2023, JERA has executed MOUs with **Yara** and **CFI**, as a result of bid process, for potential collaboration for the joint project development and sales & purchase of clean ammonia.  
**The joint development of 1 million mtpa blue ammonia project in US.**





# JERA's efforts to support Asia's Energy Transition

**Indonesia** - Nov 2021  
 • JERA concluded an agreement with JICA regarding a "Data Collection Survey on Power Sector in Indonesia for Decarbonization."



**Thailand** - January 2023  
 • MOU signed with EGCO for collaboration on decarbonization initiatives  
 • MOU signed with multiple parties for conducting feasibility study for ammonia Substitution at the BLCP thermal power station



**Thailand** - May 2023  
 MOU signed with PTT to  
 • Study on the construction of hydrogen and ammonia supply chain in Thailand  
 • Evaluation of the feasibility of ammonia cracking technology supplying hydrogen  
 • Development of hydrogen/ammonia production business assuming supply to Thailand



**Singapore** - August 2022  
 • MOU with MHI and Jurong Port to jointly explore establishing 100% ammonia fired power plant combined with bunkering operations in Singapore



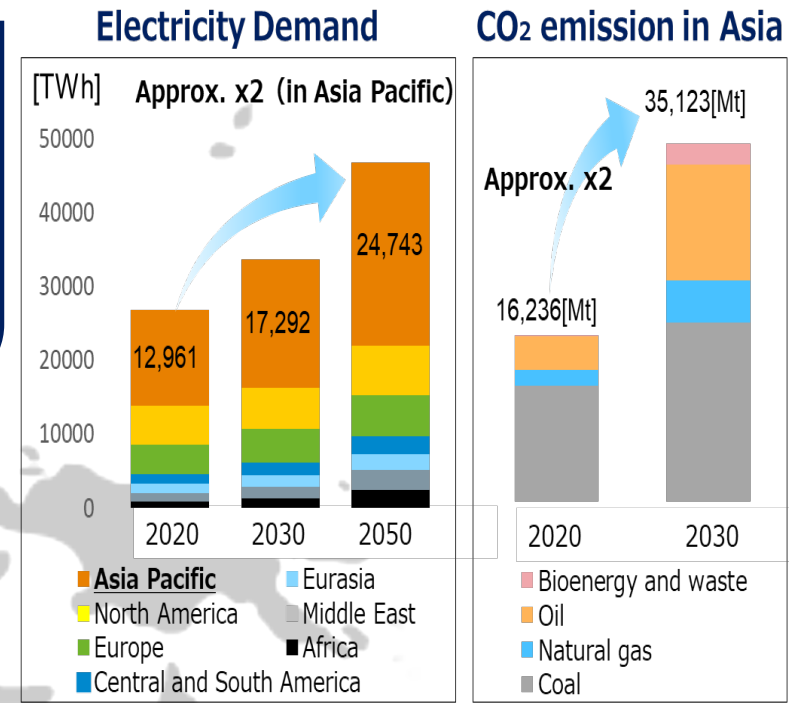
**Philippines** - February 2023  
 • MOU signed under witness of President Marcos to consider ammonia Substitution in Philippines to support decarbonization



**Bangladesh** - April 2022  
 • Signed of MOU for Cooperation on Decarbonization Roadmap  
 • Acquired 22% of shares of Summit Power, the largest IPP in Bangladesh

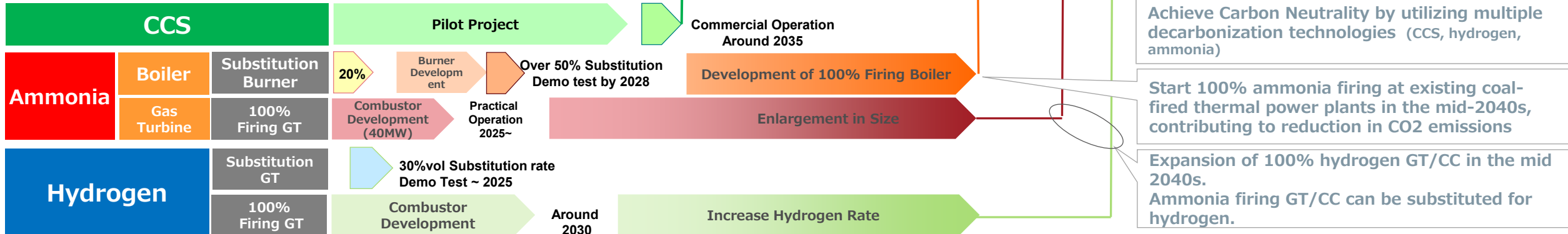
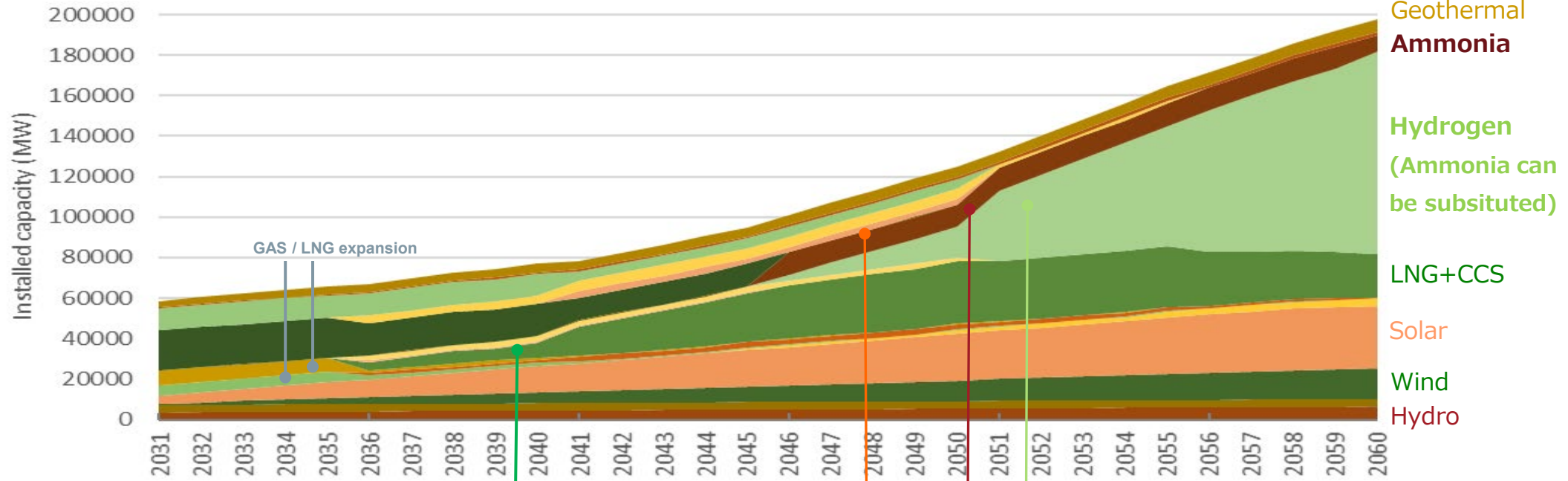
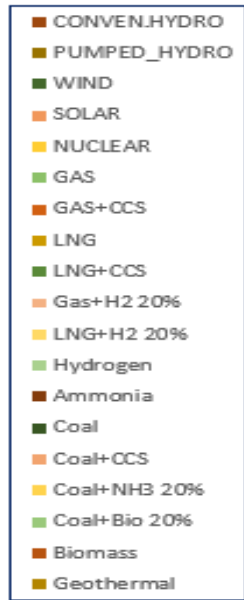


**Malaysia** - October 2022  
 • MOU with IHI for collaboration towards expansion of ammonia in Malaysia's energy sector to support decarbonization



# Study for Zero Emission Thermal Power Development Timeline

## "Data Collection Survey on Power Sector in Indonesia for Decarbonization"(2021.11)



Achieve Carbon Neutrality by utilizing multiple decarbonization technologies (CCS, hydrogen, ammonia)

Start 100% ammonia firing at existing coal-fired thermal power plants in the mid-2040s, contributing to reduction in CO2 emissions

Expansion of 100% hydrogen GT/CC in the mid 2040s. Ammonia firing GT/CC can be substituted for hydrogen.

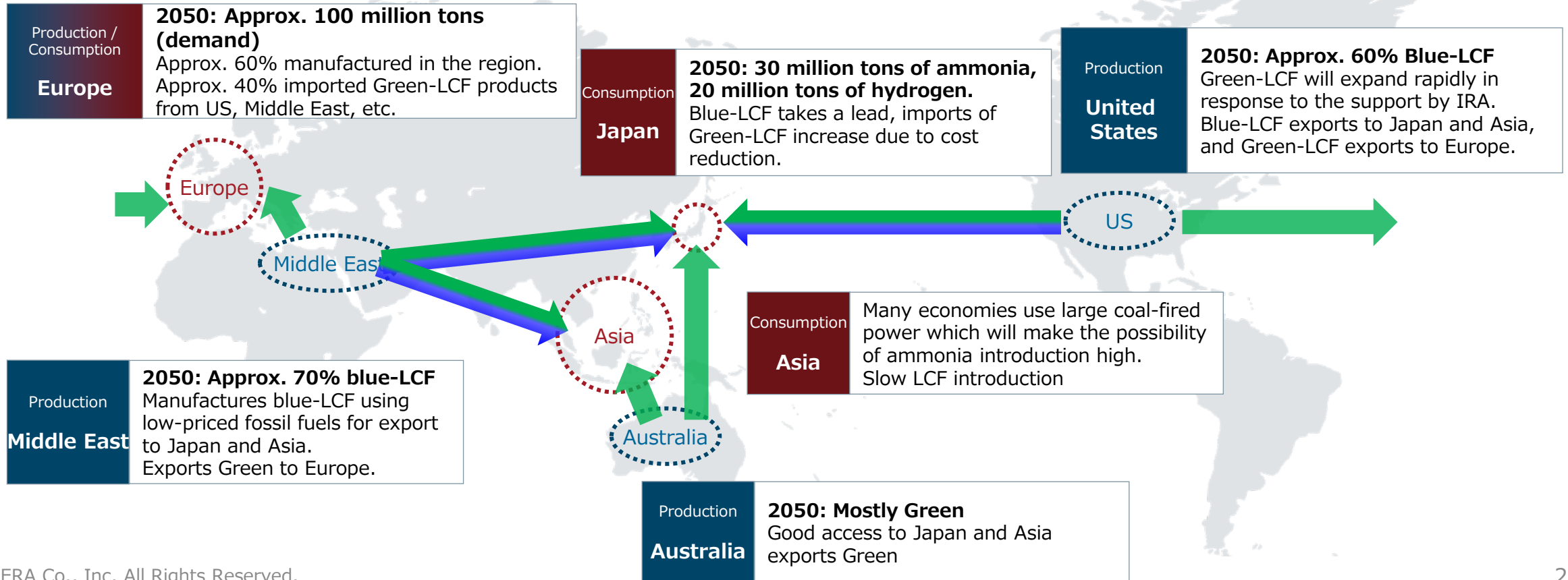
# Green & Blue Hydrogen/Ammonia flow projection for 2050

Due to the current mechanism and cost, two commercial flows will occur simultaneously:

Blue-Hydrogen/Ammonia (LCF) : U.S./Middle East to Japan/Korea

Green-Hydrogen/Ammonia (LCF) : U.S./Middle East to Europe

The cost of Green-LCF will go down, and the commercial flow of Green-LCF and Blue-LCF will mix and optimize the global commercial flow.





**Thank you for your attention!**