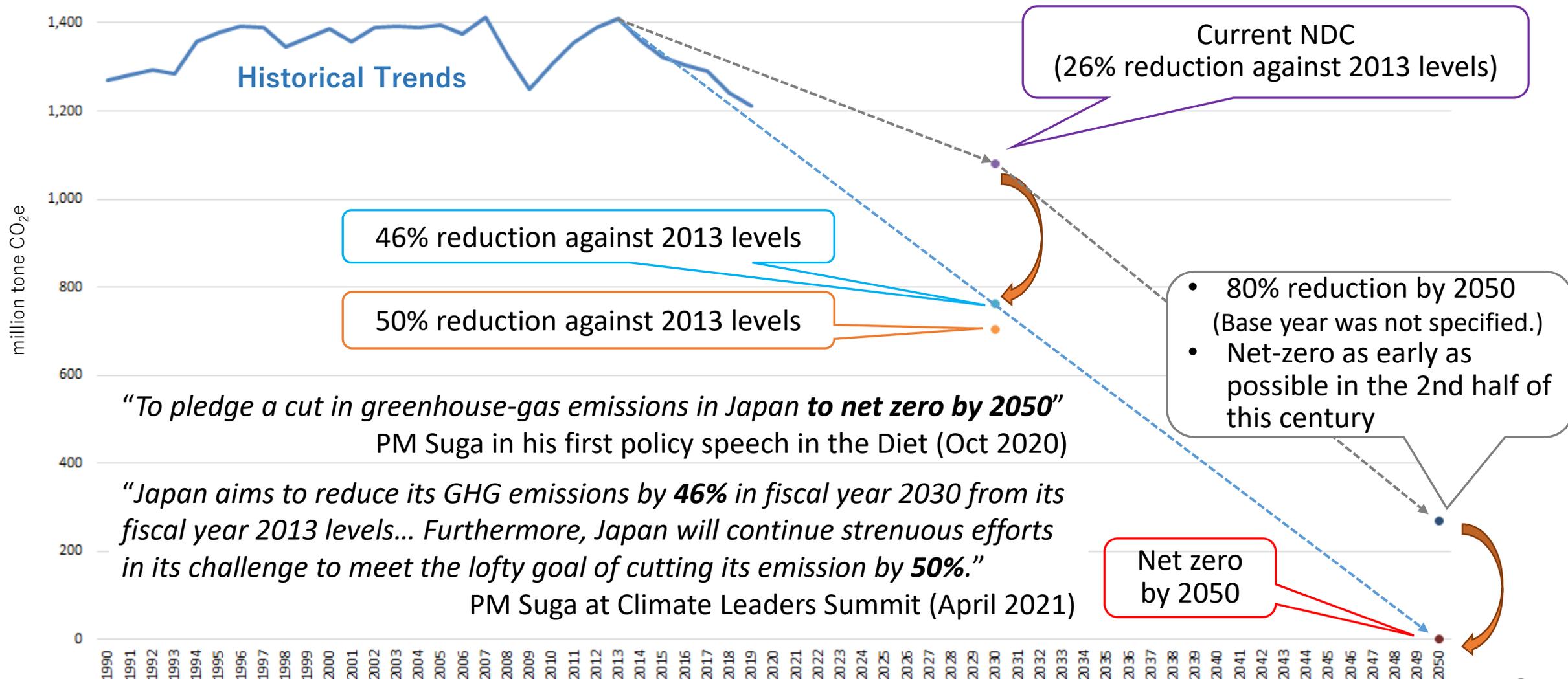


Japan's Contribution to Carbon Neutrality and Energy Transition

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Japan's GHG Emissions: Historical Trends and Reduction Targets



Draft 6th Strategic Energy Plan: Perspectives for Carbon Neutrality in 2050

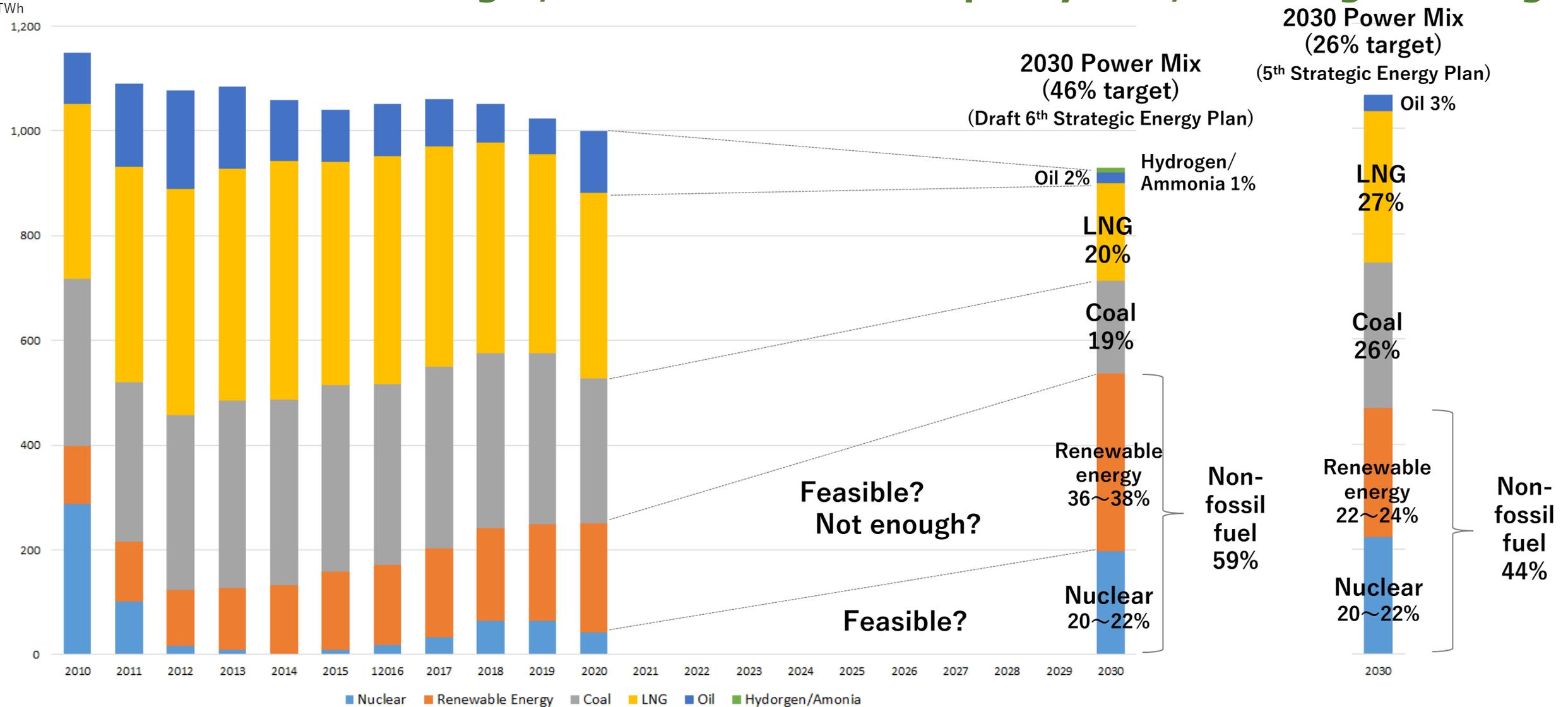
- Decarbonizing the power sector = Exploring all options
 - Maximum use of renewable energy as “top priority of a main power source”
 - Decarbonize thermal power plants by carbon capture, utilization and storage (CCUS) and hydrogen/ammonia
 - Continuously use nuclear power at the necessary scale and develop new generation of reactors, while reducing dependence on nuclear as much as possible
- Electrification in all the sectors
- Promoting hydrogen-related technologies
 - Hydrogen for high temperature heat in the industrial sector, hydrogen-based steelmaking, etc
- DACS, BECCS and reforestation for offsetting residual emissions



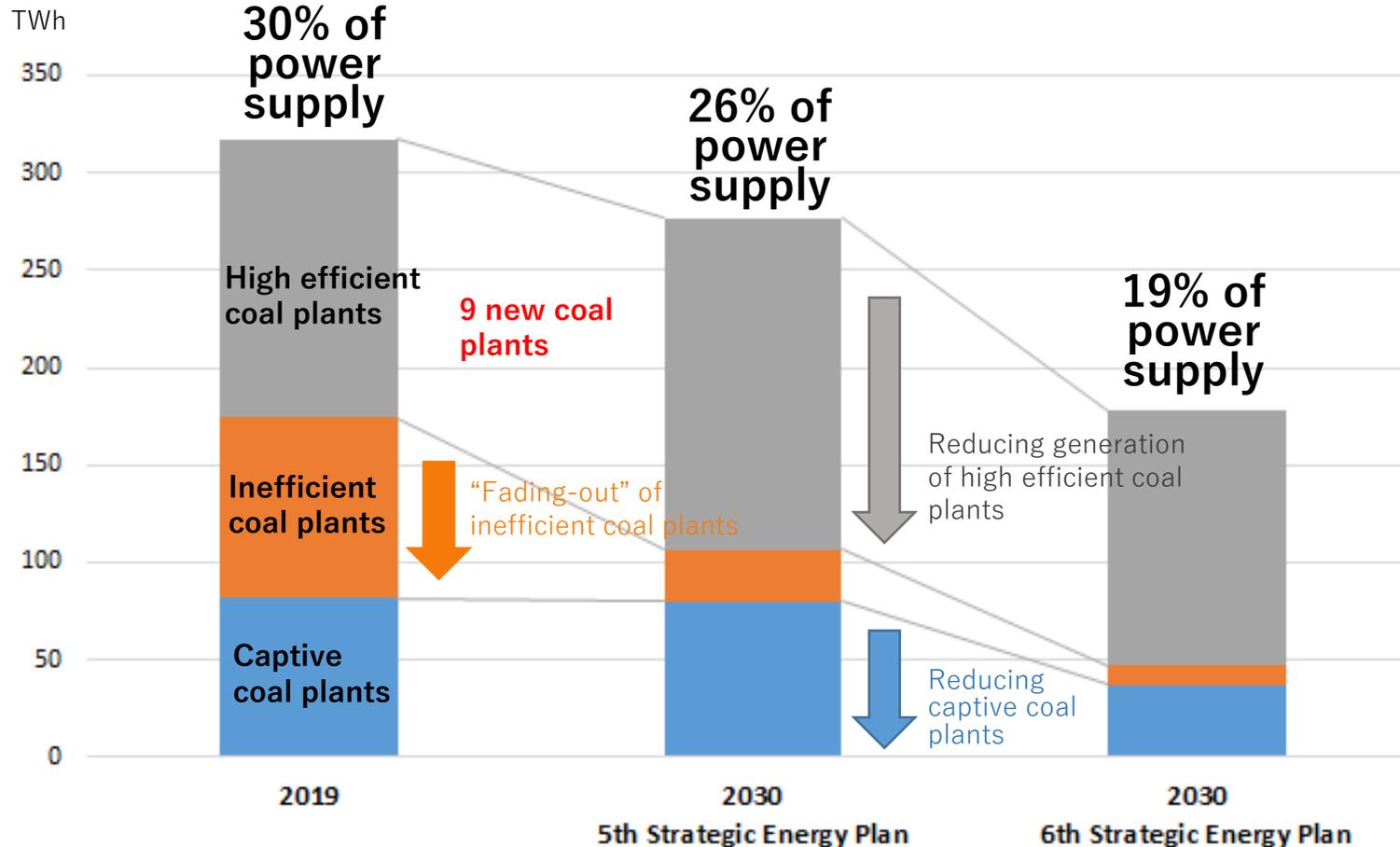
Focus on industry-oriented technological innovation; Emphasize the int'l competitiveness of industries in a decarbonized economy; few specific discussion of innovation in socio-economic systems or lifestyles

Draft 6th Strategic Energy Plan: Power Supply Mix

The more ambitious target, the more ambitious policy. But, challenges emerge.



Role of Coal in 2030 Power Supply Mix



5th Strategic Energy Plan

- Share of coal in power supply mix will decrease from 30% to **26%**.
 - “Fading-out” of inefficient coal plants (supercritical pressure and subcritical pressure)
 - New 9 high efficient coal plants

6th Strategic Energy Plan

- Further action will be required to reduce the coal share to **19%**.
 - Reducing generation from high efficiency coal plants
 - Further “fading-out” of inefficient coal plants
 - Reducing captive coal plants



But, specific policy measures are still under consideration

Changes in Japan's Stance on International Coal-related Assets

Japanese government decided to stop public support for new, unabated international coal power projects, reflecting the G7 Communique.

- “an end to new direct government support for unabated international thermal coal power generation by the end of 2021, including through ODA, export finance, investment, and financial and trade promotion support”

Major private banks and trading companies also started withdrawing from international coal-related assets.

Trading Company	Coal-related Assets
Sumitomo Corp.	<ul style="list-style-type: none">• Sold a 12.5% stake in the Rolleston thermal coal mine in Queensland, Australia, to Glencore (Switzerland) in August 2021
Mitsui Corp.	<ul style="list-style-type: none">• Sold stake in Moatize coal mine and Nacala Corridor rail and port projects in Mozambique to Vale (Brazil-based iron ore miner) in January 2021• Sold stake in Indonesia's PT Paiton Energy to Thai energy firm Ratch group PCL by the end of March 2022.
Itochu Corp.	<ul style="list-style-type: none">• Sold a stake in the Rolleston thermal coal mine in Queensland, Australia, to Glencore (Switzerland) in June 2021• Decided to sell all the stakes in thermal coal mines by April 2024, including Drummond in Colombia, Maules Creek and Leavenworth North in Australia
Mitsubishi Corp.	<ul style="list-style-type: none">• Decided to pull out of the Vinh Tan 3 coal power plant in Vietnam in January 2020

Growing Interest in Ammonia/Hydrogen-fired Power Generation

Basic Stance: As ammonia and hydrogen do not emit CO₂ when they are burned, they are expected to play significant roles in decarbonizing the power sector.

Roadmap (Green Growth Strategy of 2020)

- By 2030
 - Establish ammonia co-burning (20%) technology for coal power plants; later hydrogen co-burning for LNG
 - Establish international supply chains for hydrogen/ammonia
- Around 2030 and afterward
 - Export ammonia co-burning technology to Southeast Asia and other regions
- Around 2050
 - Establish 100% ammonia- and hydrogen-burning technology

Japanese companies' international projects of hydrogen/ammonia production and transport

Country	Japanese company	Hydrogen / Ammonia	Type
Brunei	Chiyoda Corp., Mitsubishi Corp., etc	Hydrogen (MCH)	Blue
Australia	Kawasaki Heavy Industries, J Power, etc	Hydrogen	Blue
Saudi Arabia	ENEOS	Hydrogen/Ammonia	Blue
Indonesia	JOGMEC, Mitsubishi Corp., etc	Ammonia	Blue
UAE	INPEX, JERA	Ammonia	Blue
Australia	Marubeni Corp., IHI, etc	Ammonia	Green
Australia	JERA	Ammonia	Blue
Russia	Itochu Corp., Toyo Engineering Corp. etc	Ammonia	Blue

Growing Interest in Ammonia/Hydrogen-fired Power Generation

Why?

- Can take the lead in technology development of ammonia/hydrogen co-burning
- Can maintain the existing hydrocarbon-based energy system infrastructure in Japan
- Can contribute to the decarbonization of the coal- and gas-dominant power sector in Asia
- Can be huge market (JPY 500bln (USD 4.6bln) market, if 1% of coal-fired power plants introduce co-burning technology in Southeast Asia (METI's estimate))

Caveats

- How cost effective are they?
 - Blue hydrogen and ammonia: CCS
 - Green hydrogen and ammonia:
 - ▣ RE (Power) electrolyzer → H₂ → Power
 - ▣ RE (Power) electrolyzer → H₂ → NH₃ → Power→ Can they compete with other (“simpler”) options such as RE + battery?
- How green are blue hydrogen and blue ammonia?
 - Recent studies of life-cycle-assessment indicate “not green”. (Stocks, et al. 2020; Howarth & Jacobson 2021)

Summary

- More ambitious emissions reduction target can lead to a more ambitious plan for power mix, which in turn poses lots of challenges. Such challenges, however, need to be overcome if we want deep emissions cut anyway.
- Japan will reduce share of coal power further, and stop new unabated international coal power projects.
- Hydrogen and ammonia co-burning technologies can contribute to decarbonization of the power sector in Japan and other Asian countries, but there are caveats in terms of cost-effectiveness and greenness (esp. blue hydrogen/ammonia).
- It is necessary to carefully consider how CO₂-free hydrogen/ammonia will be used.