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ARGENTINA

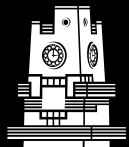
Engineering a Better World

THE FUTURE OF ENERGY

September 17-24, 2021

# Hydrogen for massive dissemination of renewable energy sources

## A case study on Japan's Hydrogen strategy for 2050 Carbon Neutrality Goal

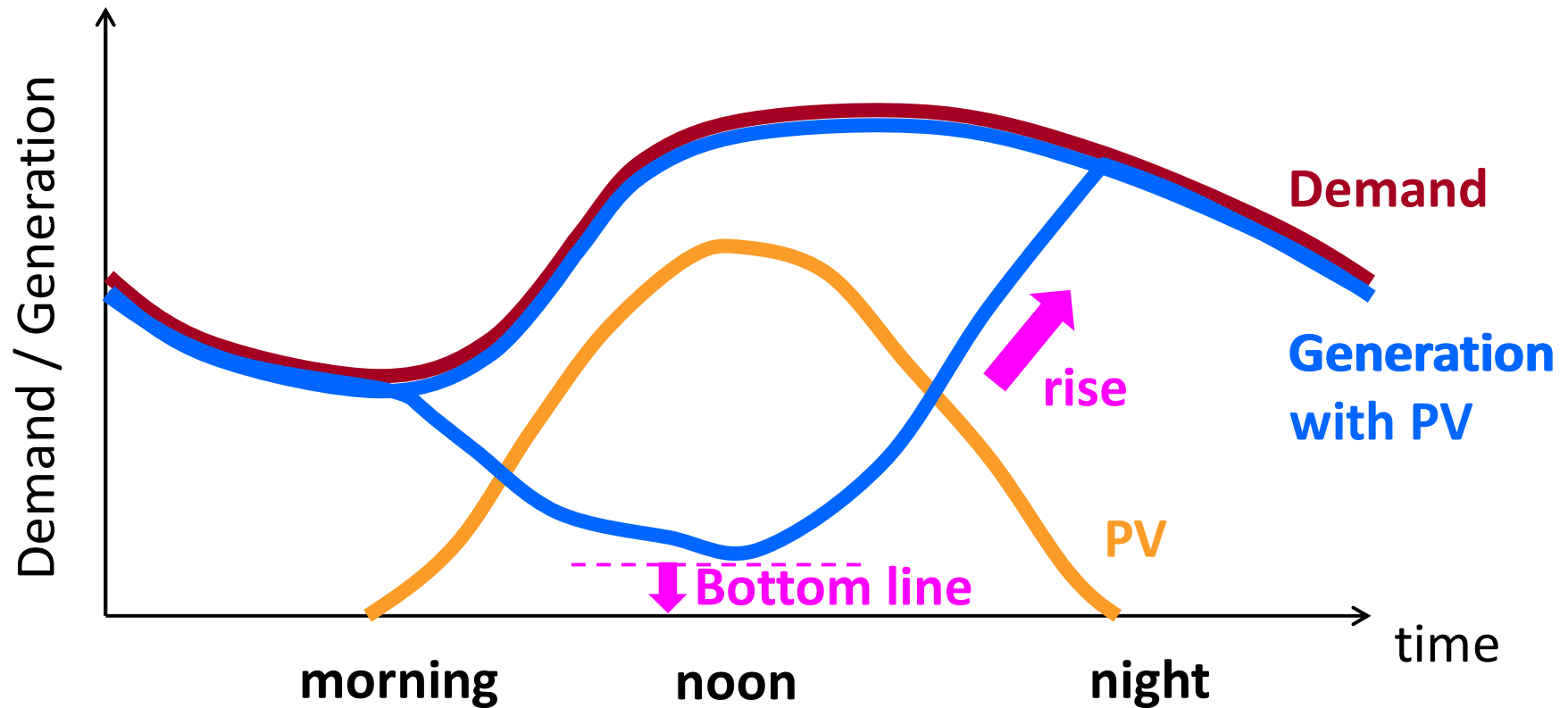


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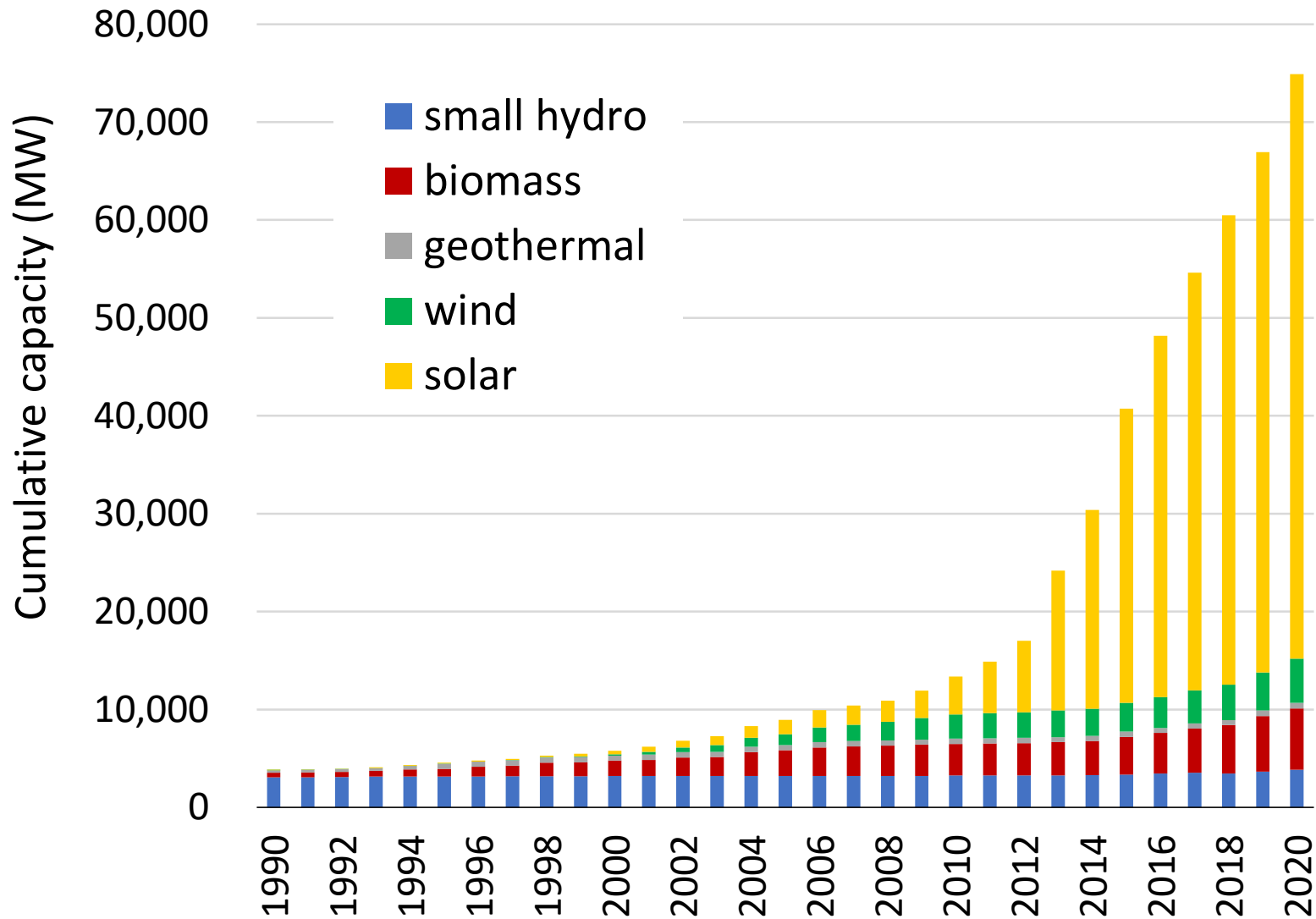
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# Electricity management with massive PV



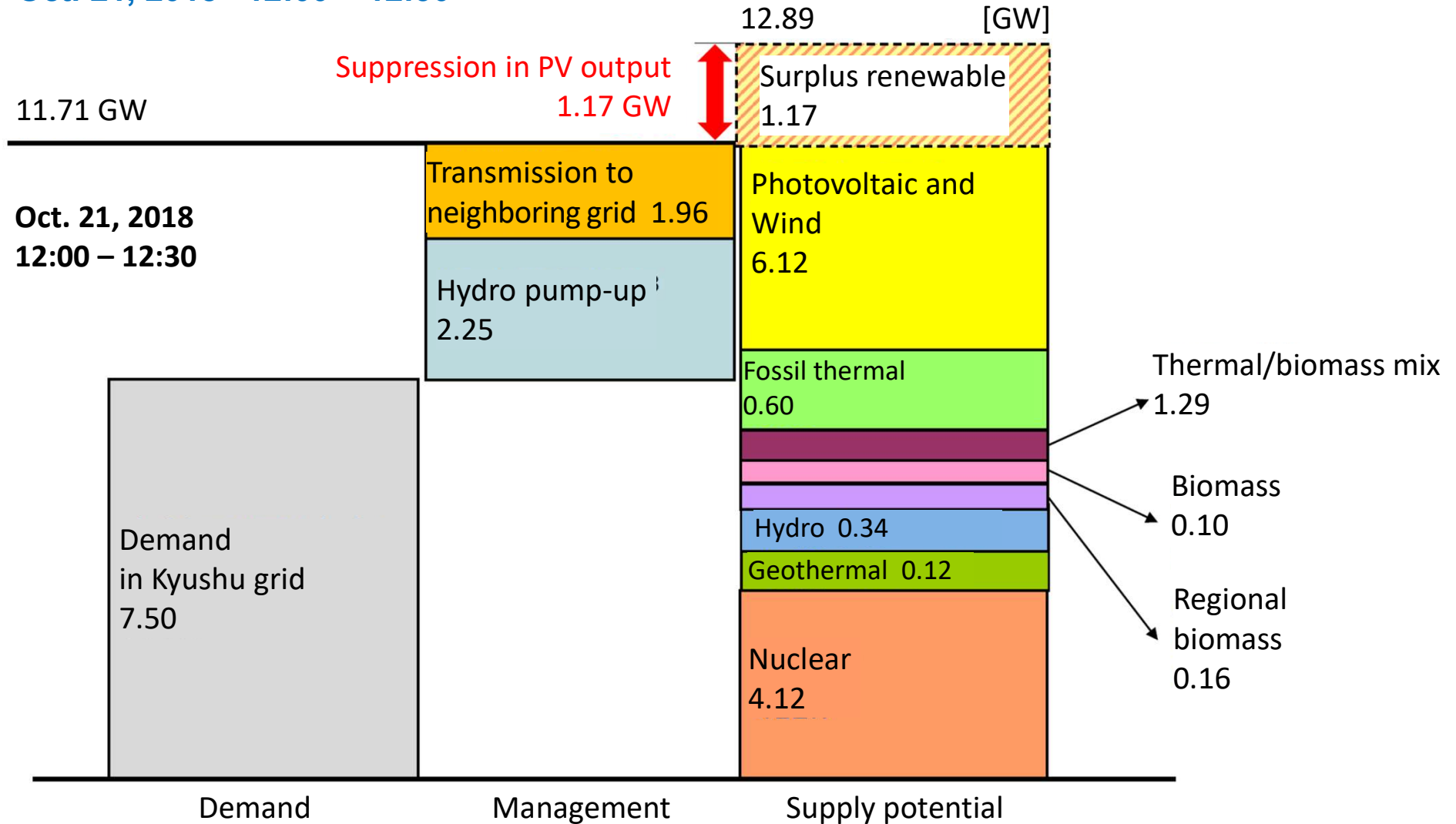
# Renewable electricity installation in Japan



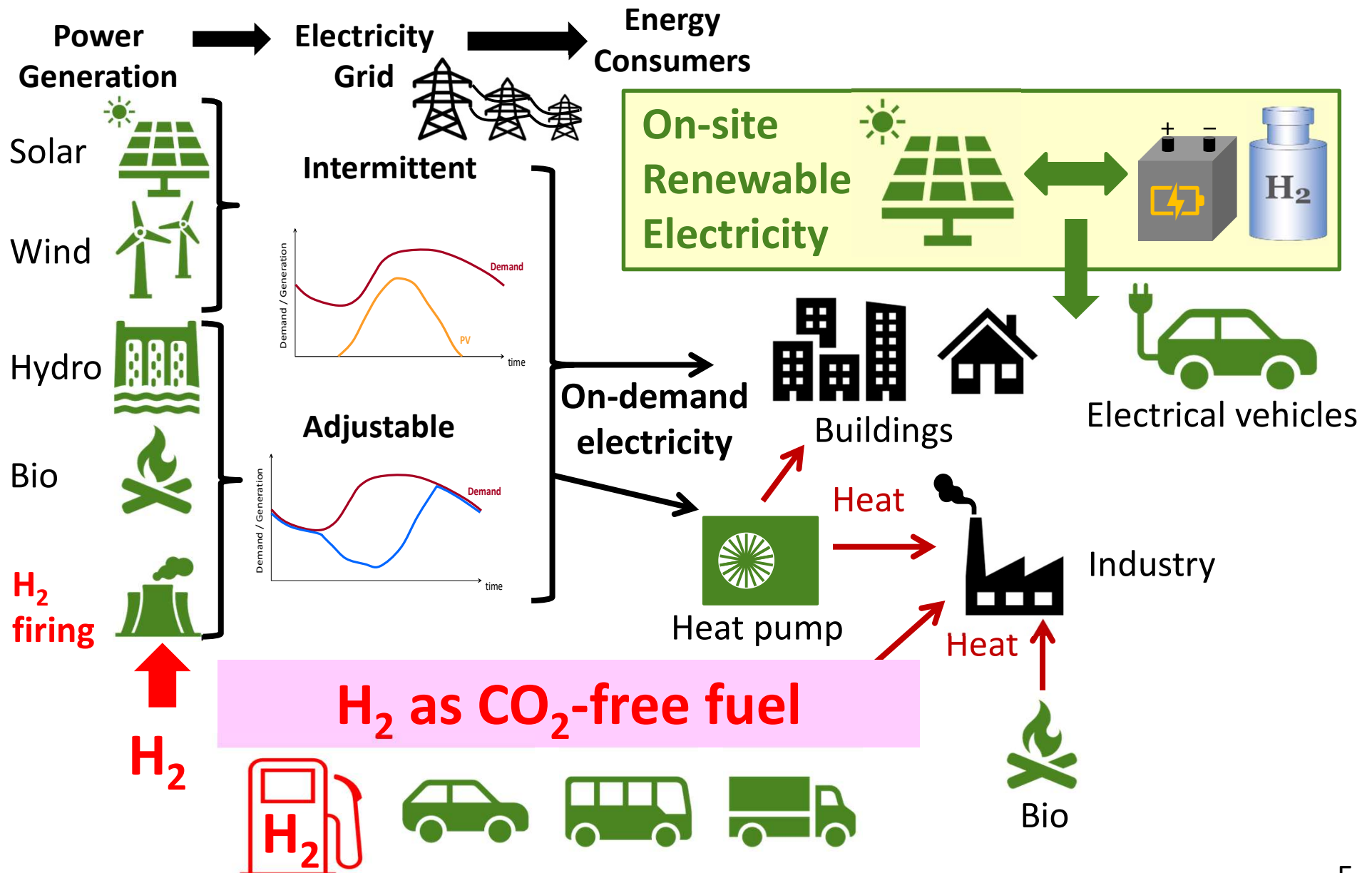
Maximum electricity generation in Japan: 165 GW (2018)

# Suppression of PV power generation

Oct. 21, 2018 12:00 – 12:30



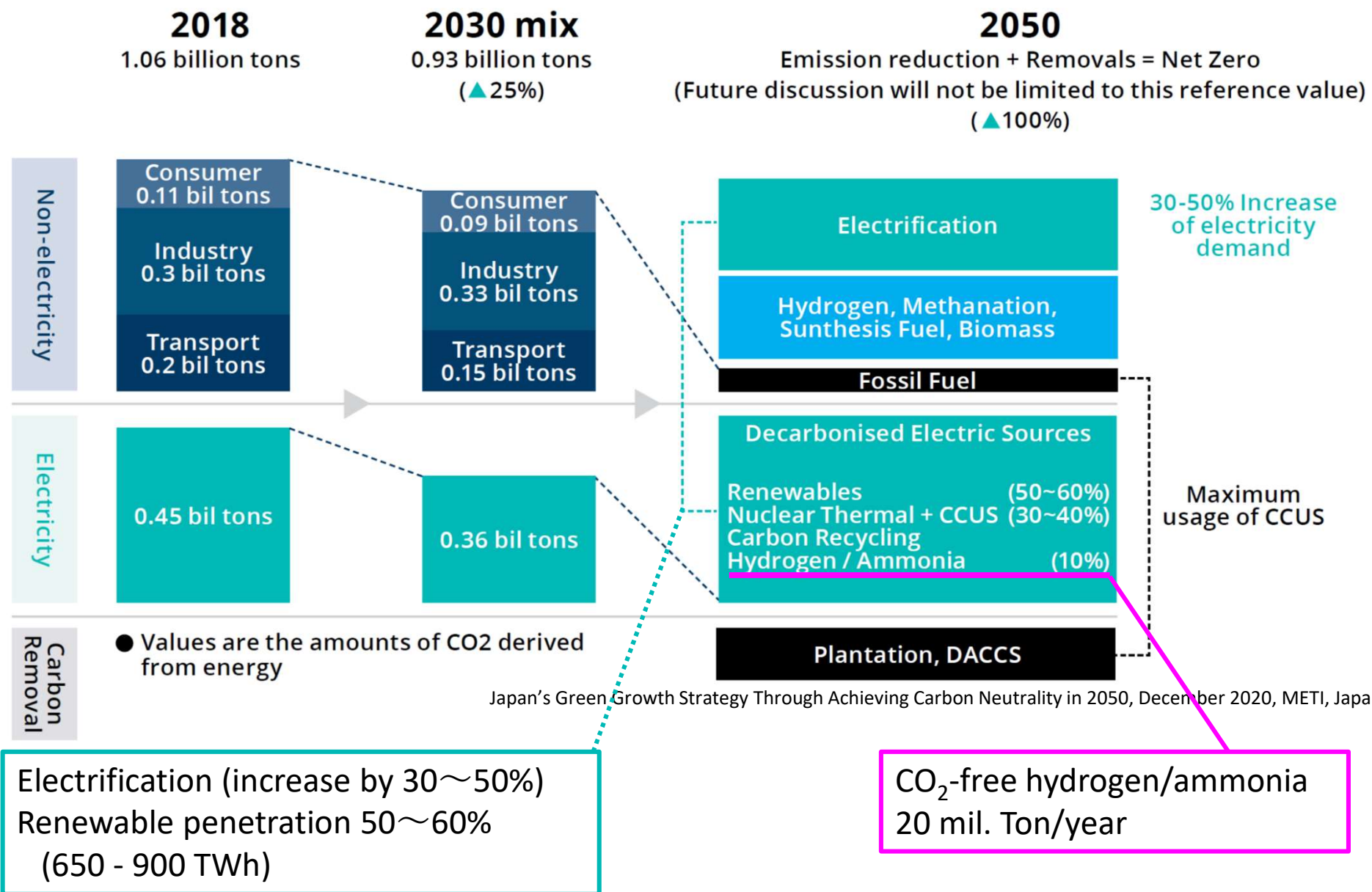
# For massive installation of renewable energy



# A scenario for carbon neutrality



RE global



Japan's Green Growth Strategy Through Achieving Carbon Neutrality in 2050, December 2020, METI, Japan

# Renewable power generation in Japan



Intermittent  
Adjustable

Renewables	Installed up to 2020 <sup>*1</sup> (GW)	Generation in 2020 <sup>*1</sup> (TWh)	Max. expectation in 2050 <sup>*2</sup>	
			Capacity (GW)	Annual generation (TWh)
Photovoltaic	59.8	69.1	272.5	304.5
Wind	4.5	8.0	70.0	153.3
Hydro	21.4	73.0	31.3	30.5
Geothermal	0.1	0.5	79.2	49.6
Biomass	4.0	18.1	7.4	43.1
Sum	89.8	168.8	460.4	676.2

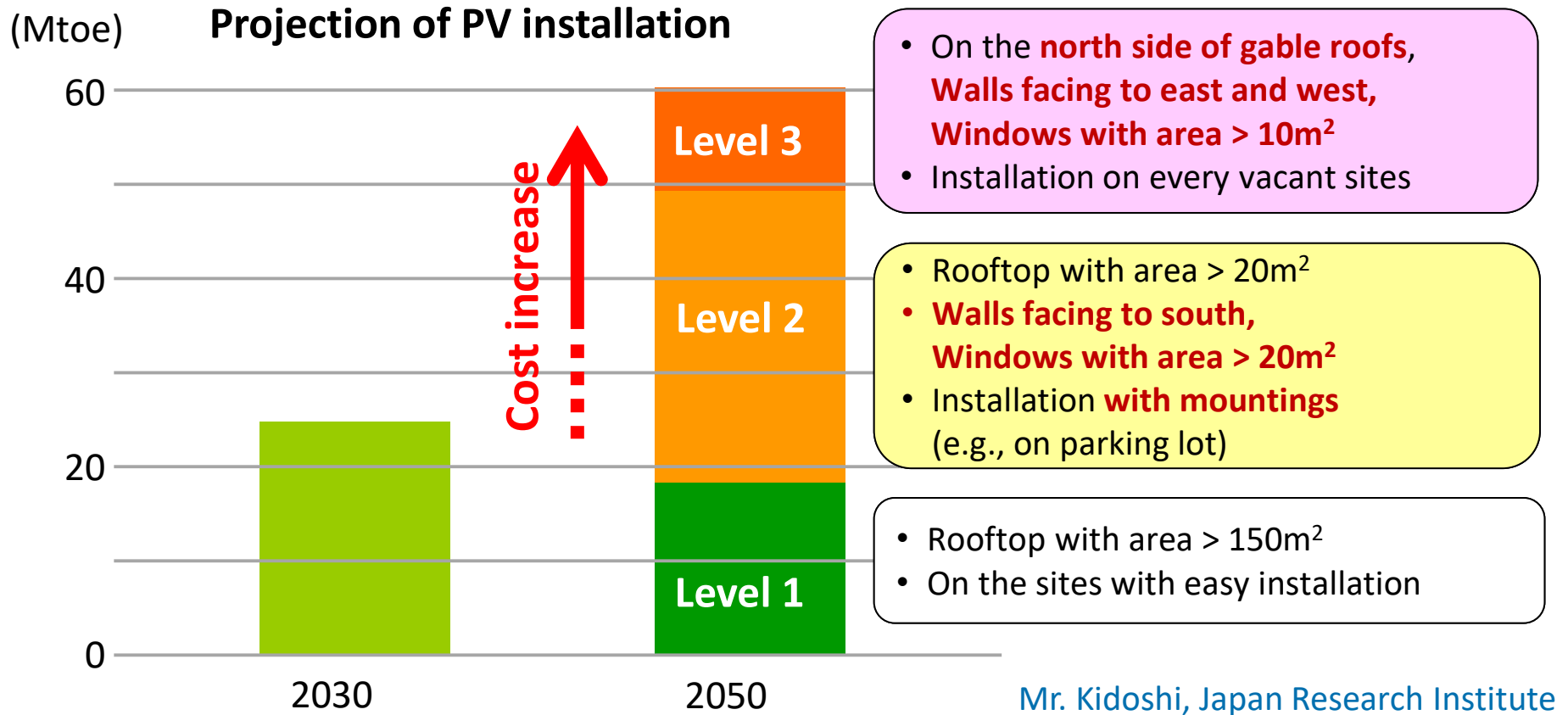
<sup>\*1</sup> <https://www.fit-portal.go.jp/PublicInfoSummary>

<sup>\*2</sup> <https://www.env.go.jp/earth/report/h27-01/>

+ off-shore wind 30 – 45 GW (65 – 99 TWh)

cf.) Electricity demand in Japan: ca. 1100 TWh

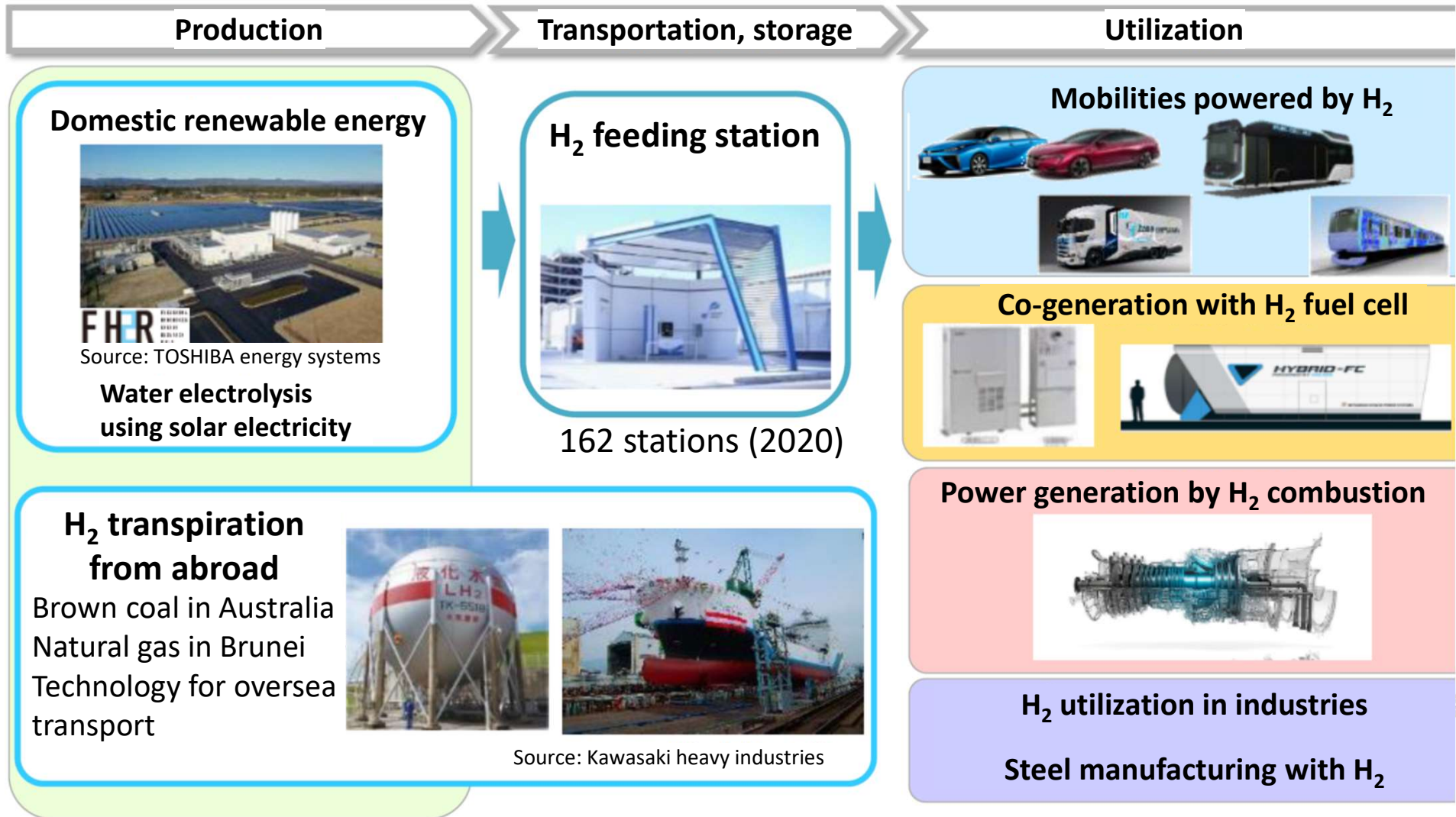
# Limitation in Japanese domestic RE (e.g. PV)



- Very aggressive PV installation is needed to meet the targeted renewable penetration.



# Japanese government policy for the realization of H<sub>2</sub> society

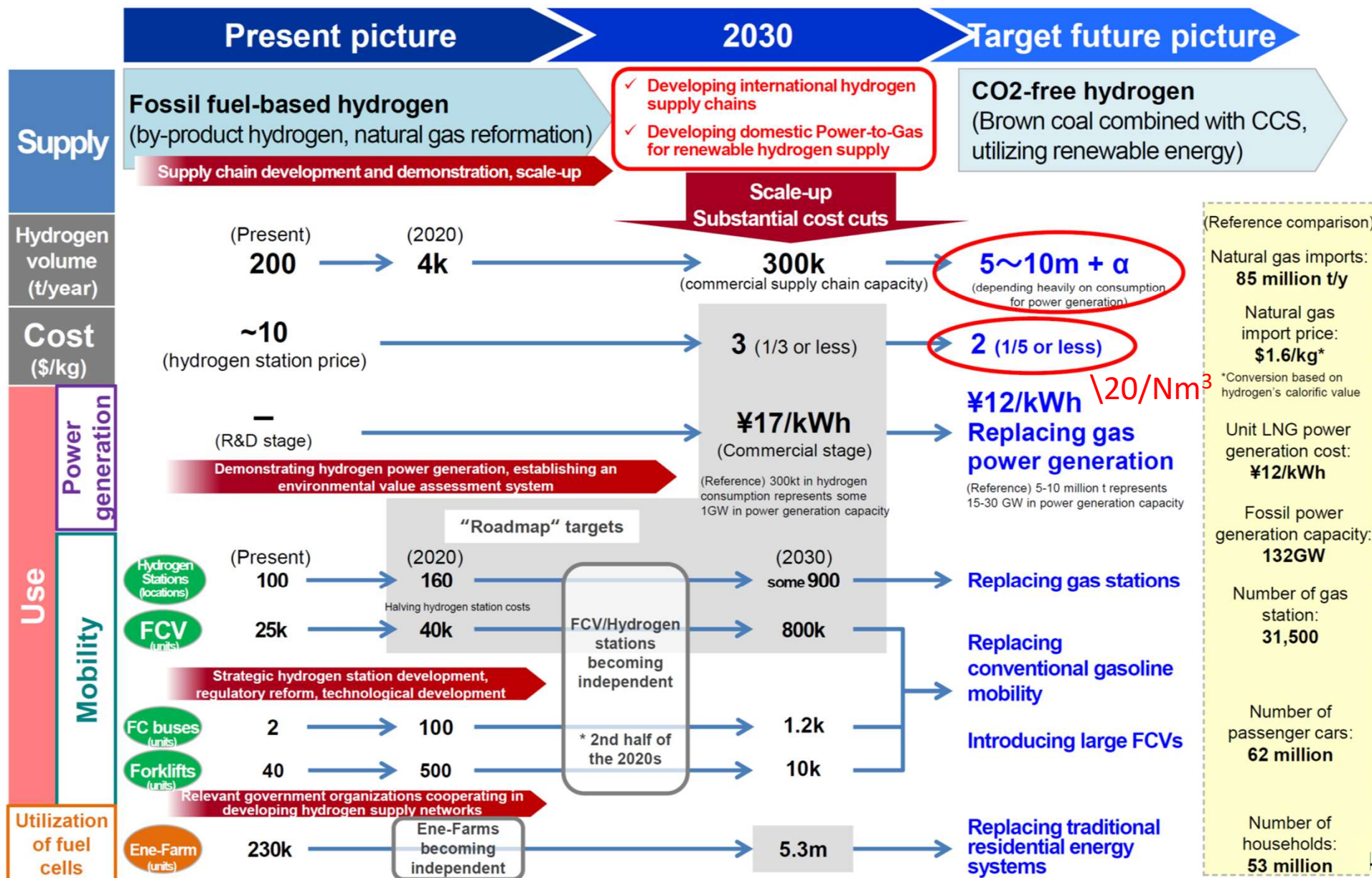


H<sub>2</sub>/FC strategy office, METI, Japan (2021)

# Basic Hydrogen Strategy (METI, 2017)



RE global



# Update of H<sub>2</sub> roadmap towards 2050 carbon neutral



- Expanded usage
  - FCV → Power generation, variety of mobilities, industry
- Cost reduction
  - $\backslash 20/\text{Nm}^3$ , competitiveness against fossil fuel @2050
- Massive usage
  - 3 mil. Ton @2030, 20 mil. Ton @2050
    - CO<sub>2</sub>-free H<sub>2</sub>: over 420 kton (German renewable-H<sub>2</sub> target @2030)

20 mil. Ton H<sub>2</sub>  
@2050

- Power generation fueling by H<sub>2</sub> or NH<sub>3</sub>  
10% of 1300 – 1500 TWh → ca. 7 mil. Ton
- Commercial vehicles such as long-haul trucks  
6 mil. Ton
- steelmaking using hydrogen  
Under development, potentially 7 mil. Ton



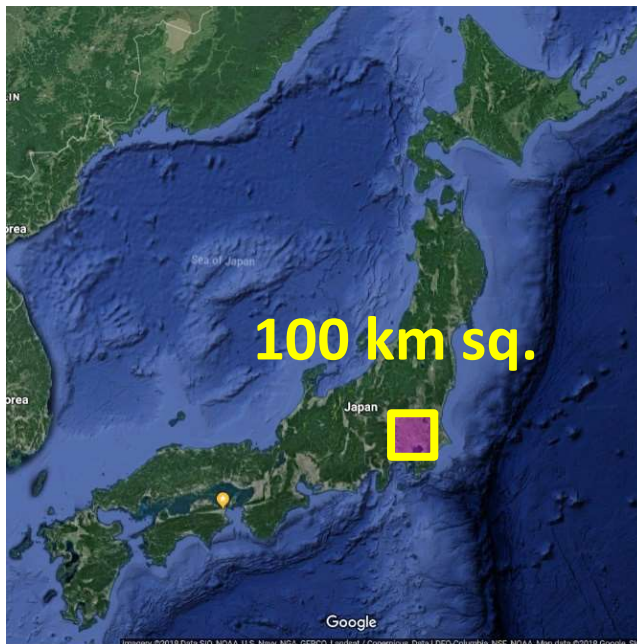
# Where to produce CO<sub>2</sub>-free hydrogen

H<sub>2</sub> demand: 20 million ton/year ← 1000 TWh/year electricity

H<sub>2</sub> by water electrolysis using renewable electricity

## In Japan

PV capacity ~900 GW  
(13% system utilization ratio)

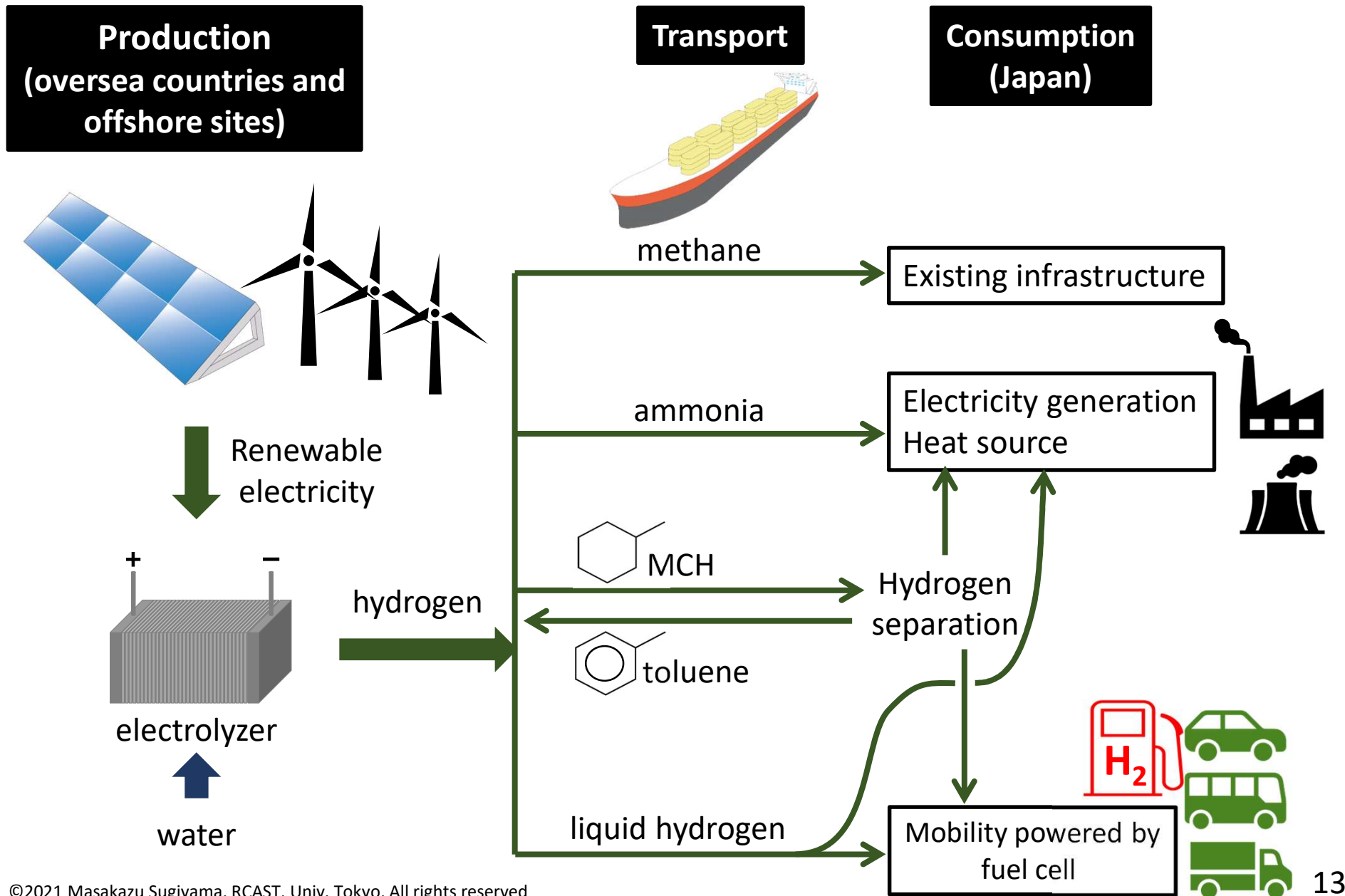


## In Australia

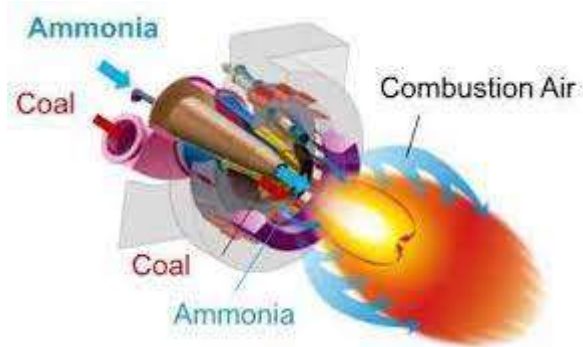
PV capacity ~600 GW  
(19% system utilization ratio)



# Intercontinental hydrogen transport and usage



# NH<sub>3</sub>-coal mixed combustion



Mixing 20% NH<sub>3</sub> to coal-firing power generation  
Commercialization @2030



Increase in NH<sub>3</sub> mixing ratio, 100% NH<sub>3</sub> combustion  
(technology establishment in 2030 targetted)

## Necessity for a novel NH<sub>3</sub> supply chain

1 unit of coal firing power generator, 20%-NH<sub>3</sub> mixed combustion  
→ 0.5 mil. ton NH<sub>3</sub>

All the coal firing power generator in Japan, 20%-NH<sub>3</sub> mixed combustion  
→ 20 mil. ton NH<sub>3</sub>

↖ Equivalent to the worldwide NH<sub>3</sub> trade

Target by fuel-NH<sub>3</sub> consortium: 3 mil. ton @2030, 30 mil. Ton @2050

## Necessity

Exploring new CO<sub>2</sub>-free NH<sub>3</sub> production facilities  
Cost reduction (<\20/Nm<sup>3</sup>-H<sub>2</sub>-equivalent)

# Low-carbon hydrogen



<https://www.certifhy.eu/>

