# Future Energy System
# - Decarbonization, Energy Security and Industry

2025 IERE-TPC Taipei Net-Zero Workshop
"Towards Net-Zero: Strategies and Innovations in the Power Industry"

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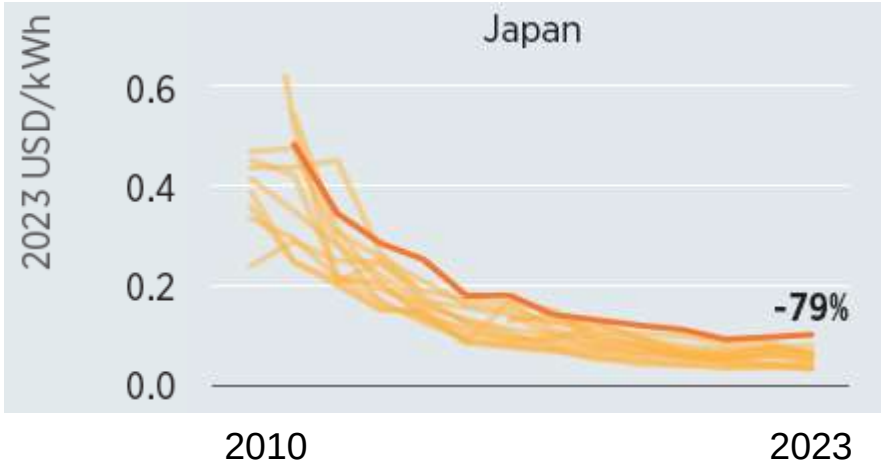
# Viewpoints

- Best mix of renewable energy integration measures
- Recycling critical materials
- Are clean fuels import cheap and no-risk ?
- Future energy system –stable supply, energy security, circular economy and domestic industry

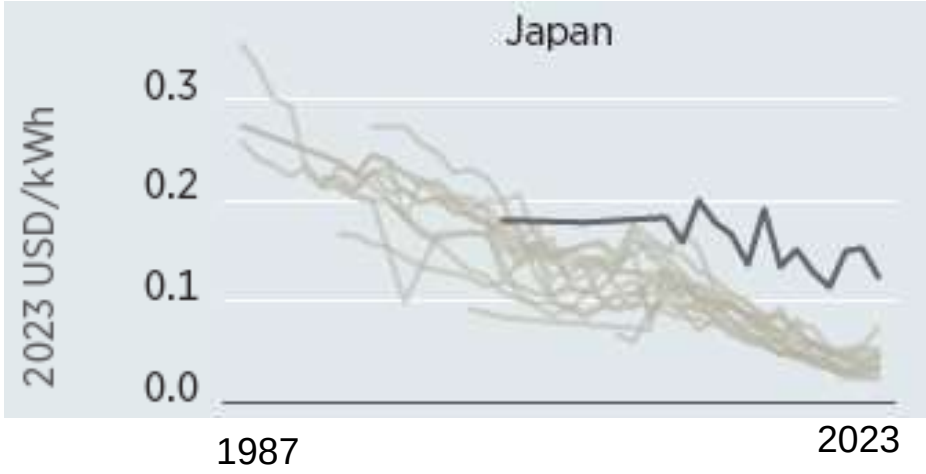
# Japan's Renewable Energy needs drastic change

- Still highest cost in the world. Construction cost is the hugest contributor.
- More competition is needed in the related industry.
- Domestic supply chain, multi-layered contractor structure, should be drastically reformed/reshuffled.

## LCOE of Utility-scale Solar PV




## LCOE of On-shore Wind

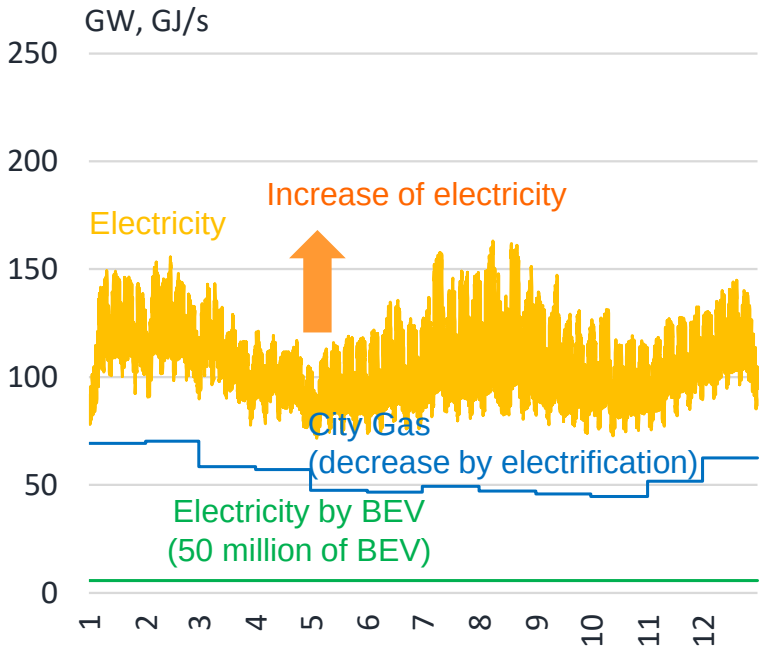



Source: "RENEWABLE POWER GENERATION COSTS IN 2023" (IRENA)

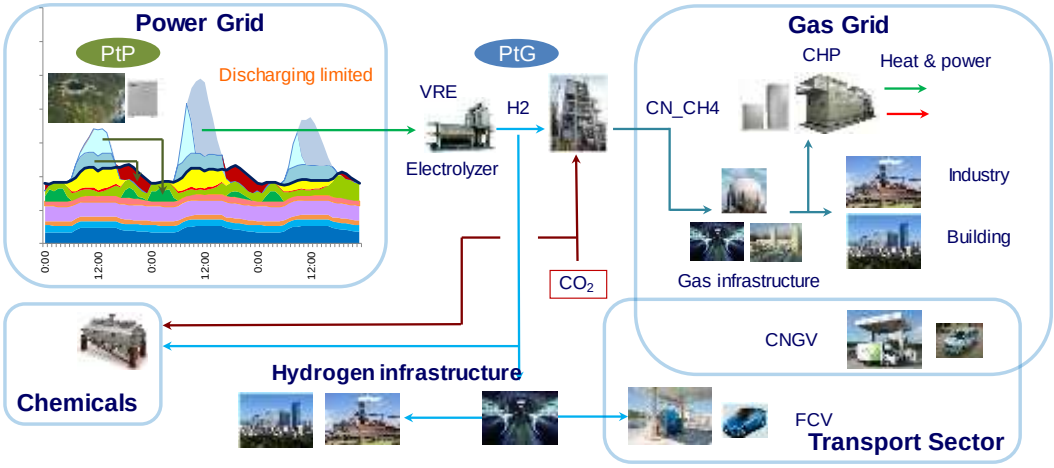
# Energy System Integration (Sector Coupling)

- Energy System Integration (Sector Coupling) contributes to expansion of capacity to accommodate renewables.
- Power to Gas (PtG), through electrolyzers, allows city gas and mobility sector to use renewables, while providing balancing function.

## Comparative Hourly Demand Scale

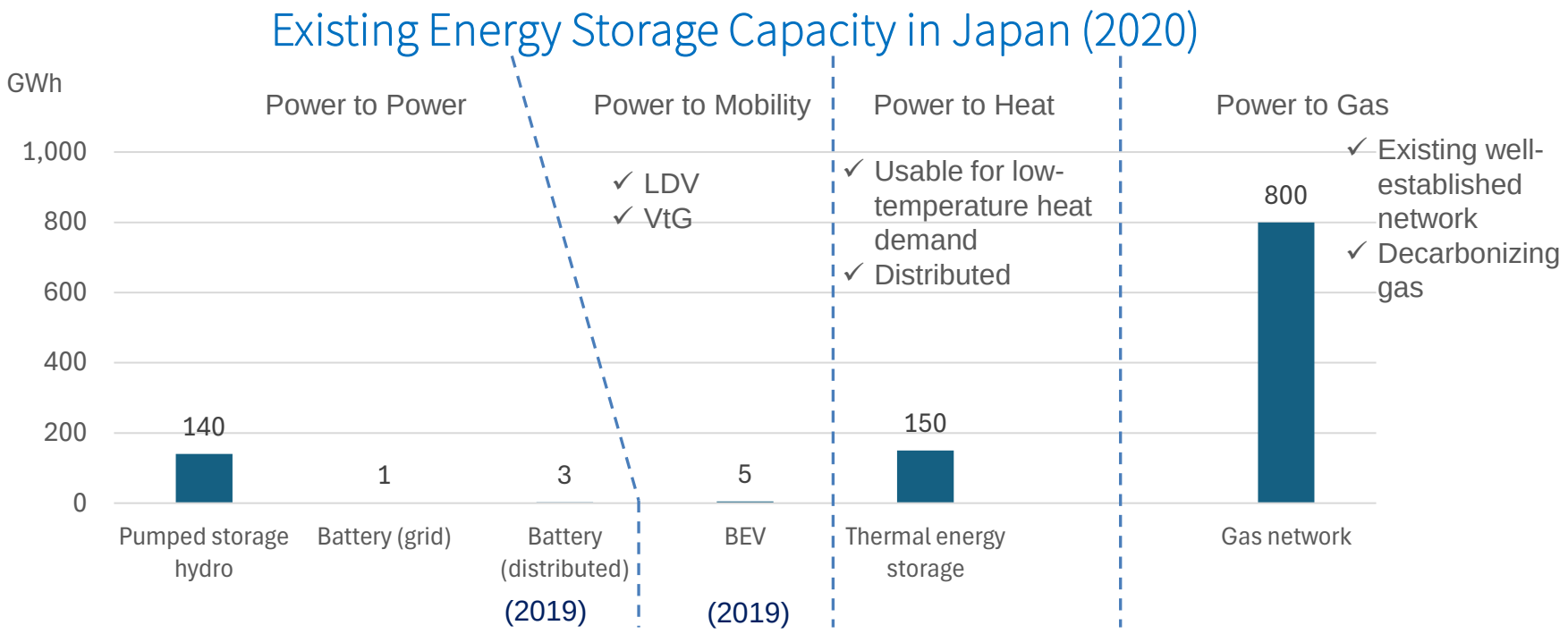



## Energy System Integration by Power to Gas



# A variety of energy storage are already there

- Existing storage should be fully employed, though new storage is needed.
- Energy storage best mix should be discussed based on functions (short or long duration) and also on critical minerals supply chain risks.



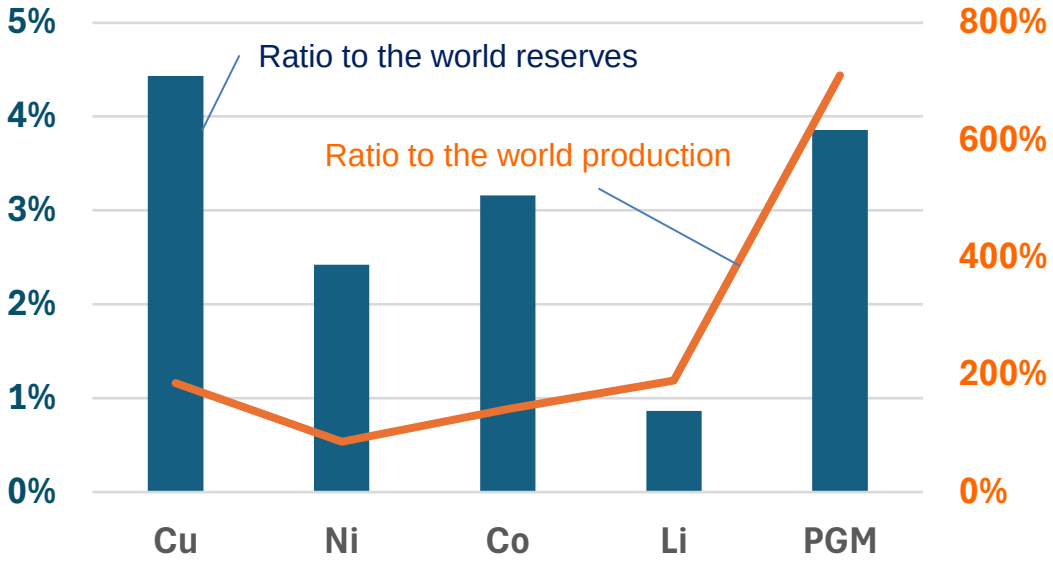

Storage capacity is expressed by physical maximum capacity, not taking into account of the availability.

Note: Based on; Committees of METI, DOE Global Energy Storage Database, JEMA (The Japan Electrical Manufacturers' Association), New Generation Vehicle Promotion Center, JARIA (The Japan Refrigeration and Air Conditioning Industry Association), HPTCJ (Heat Pump & Thermal Storage Technology Center of Japan) , Statistics of Machinery (METI), Gas Statistics.

# Circular Economy: Critical Materials

- Japan's urban mine is huge. If recycling system and technology are developed, new industry and supply chain will be established, enhancing security.
- Domestic closed-loop circular system is required.

## Japan's Urban Mine Stock




- ✓ *Critical minerals demand increase, and only recycling cannot solve the problems.*
- ✓ *However, after market saturated, recycling roles become significant.*
- ✓ *Before that, recycling technology should be developed.*
- ✓ *Policy and regulation to promote domestic closed-loop are required.*

Source: Based on the data from National Institute for Materials Science and https://susdi.org/wp/data/post-194/

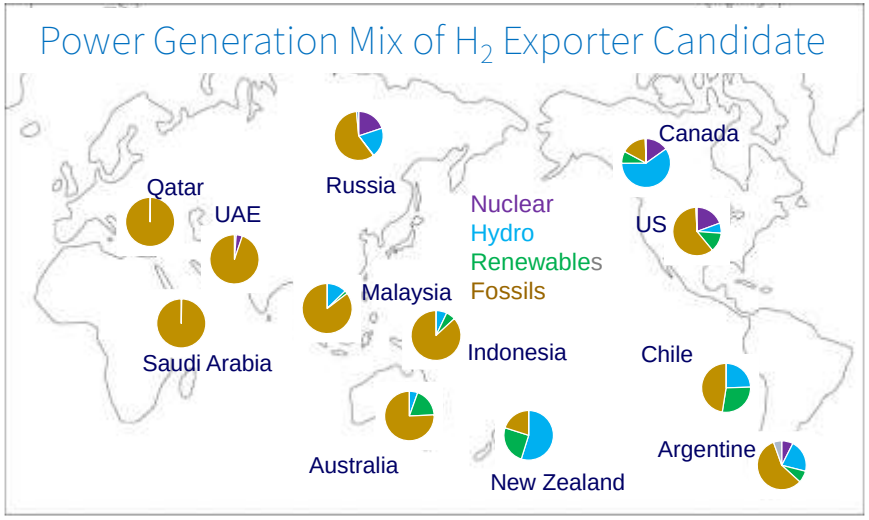
# Risks in Clean Fuels ($H_2$ and derivatives) Import

## Exporters priority on their renewables and CCS

- ✓ *Premium on renewables and CCS of exporters*

## Exporters strategy

- ✓ *Higher blue $H_2$ price to compensate future deficit of oil money.*
- ✓ *Intention to earn through green $H_2$ as new export commodity.*




## Lower bargaining power of importers

- ✓ *World competition for clean fuels*
- ✓ *Importers are regarded as low carbon resource-poor country.*
- ✓ *Economy decline and currency depreciation of importers*

## Cost

- ✓ *The world first green $NH_3$ import cost is € 1,000 /t-$NH_3$ (H2Global, Egypt to Rotterdam), which is 10 times the price of coal import by Japan*

## $CO_2$ emissions

- ✓ *$CO_2$ from $H_2$ production process is responsible for exporters.*
- ✓ *Exporters may be reluctant.*

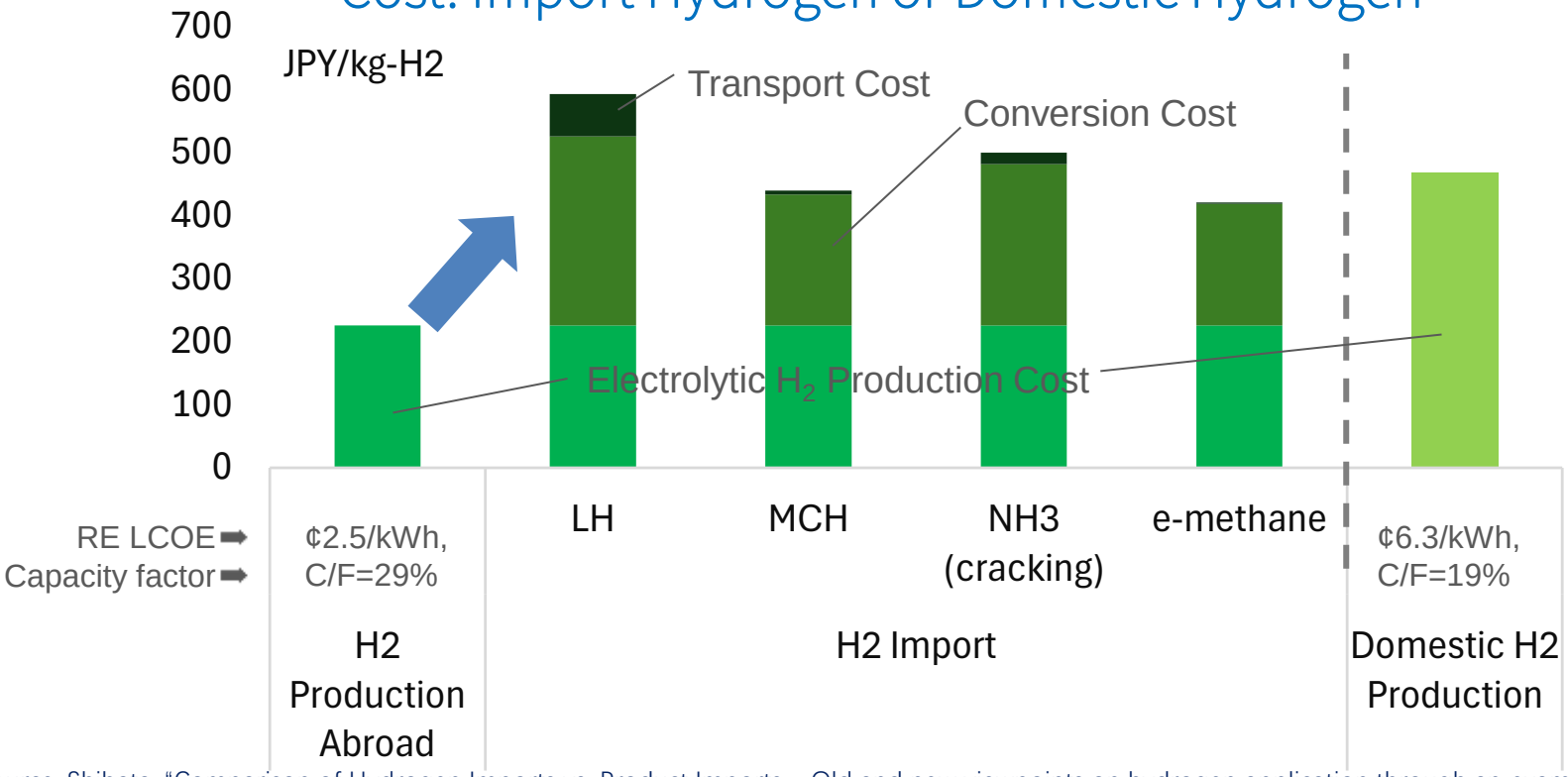
## $CO_2$ attribution

- ✓ *To whom the $CO_2$ emissions at consumption point of e-gas/fuel are attributed.*

# Energy is getting “Hard-to-Transport”

- Cost of conversion from hydrogen to carriers are extremely high. Domestic hydrogen can compete with imported hydrogen.
- Do you really transport hydrogen/renewables ?

## Cost: Import Hydrogen or Domestic Hydrogen



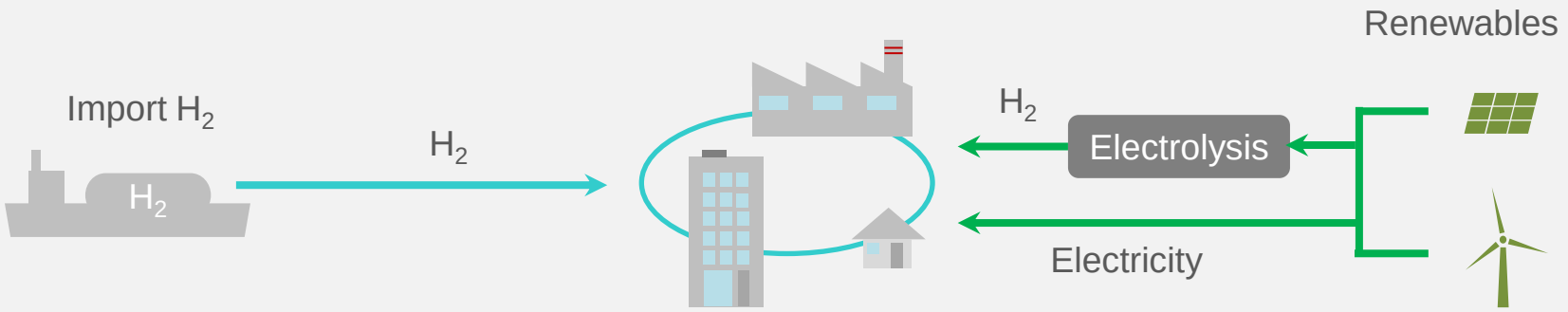

Source: Shibata, “Comparison of Hydrogen Imports vs. Product Imports - Old and new viewpoints on hydrogen application through an example of hydrogen-based direct reduction ironmaking -”, IEEJ, 2023

# “Special Zone” of Renewables and Hydrogen

- Hard-to-Transport. Then, why do not consumers move to the region where renewables are abundant and cheap.

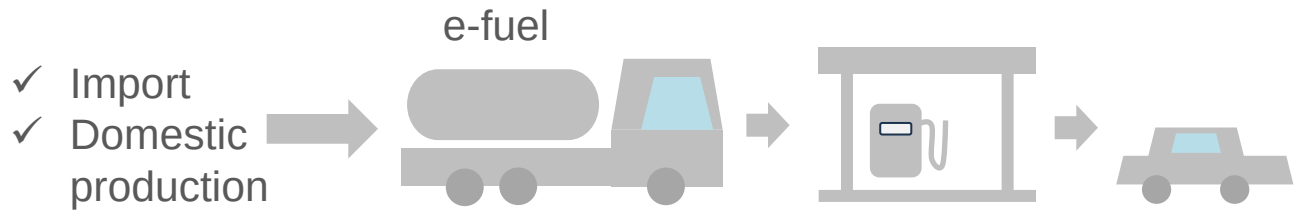
## “Special Zone” of Renewables and Hydrogen

- ✓ Regions with abundant renewables
- ✓ Large-scale Hard-to-Abate demand located, otherwise should be invited.
- ✓ Construct $H_2$ network from scratch.

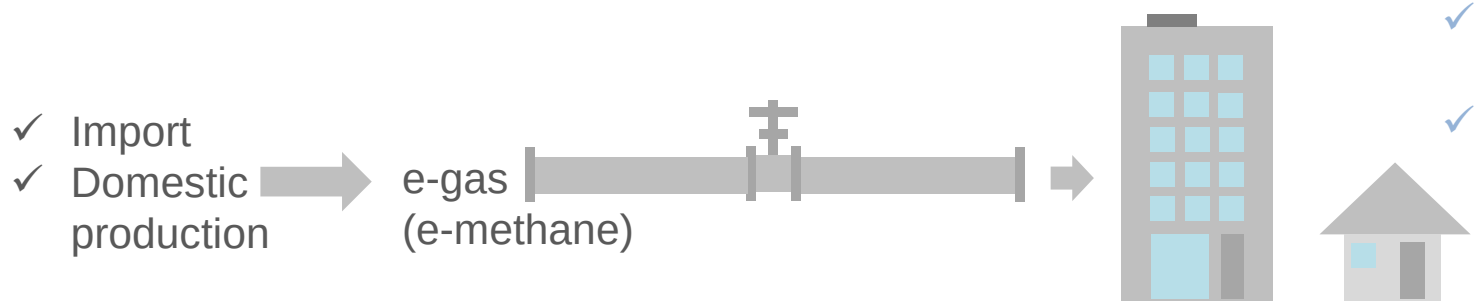


# $H_2$ or e-gas/fuel ? Infrastructure and Industry

- Consistency between abroad and domestic infrastructure
- Protect existing infrastructure and industry through e-gas/fuel ? Or develop new infrastructure and industry ?
- The “existing” does not last forever.
- Once started e-gas/fuel, when stops? Depends on $CO_2$ forever ?




- ✓ *Protect automobile industry pyramid ?*
- ✓ *Depends on world market*

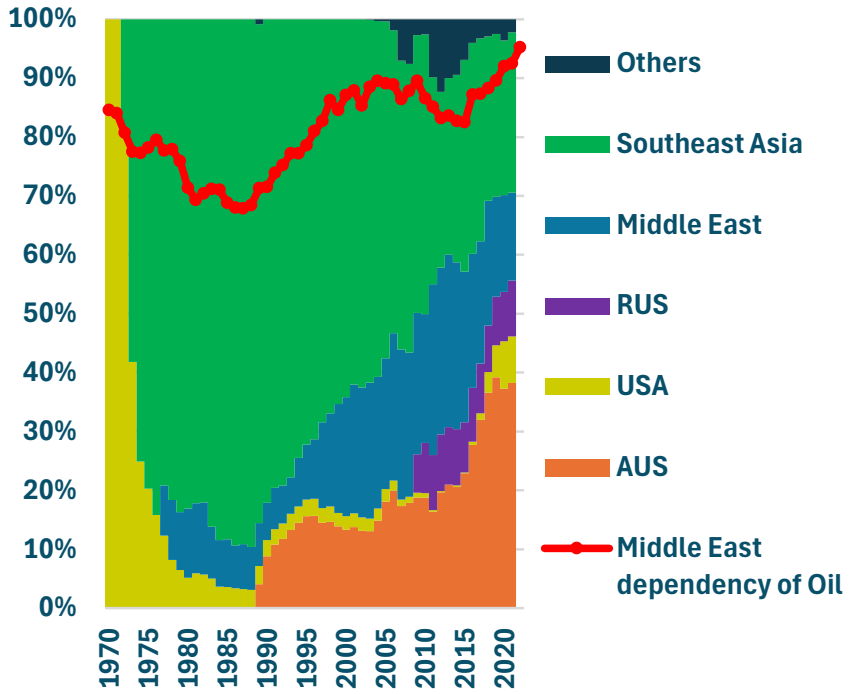



- ✓ *Buildings/houses have strong inertia*
- ✓ *Scrap & build or renovation to cope with new energy infrastructure*

# What lessons learnt from the past fuel import ?

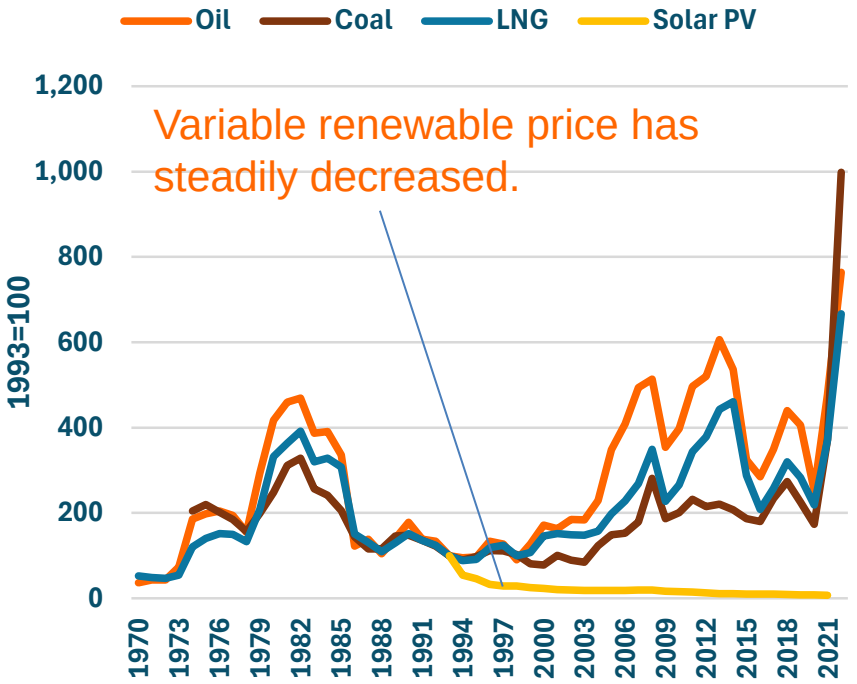
- LNG import has been diversified, while oil dependency on Middle East gets higher than that at the time of oil crisis.
- Volatility of fossil fuels are extremely larger than renewables.

## LNG and Oil Dependency




## Price of Fossils and Solar PV

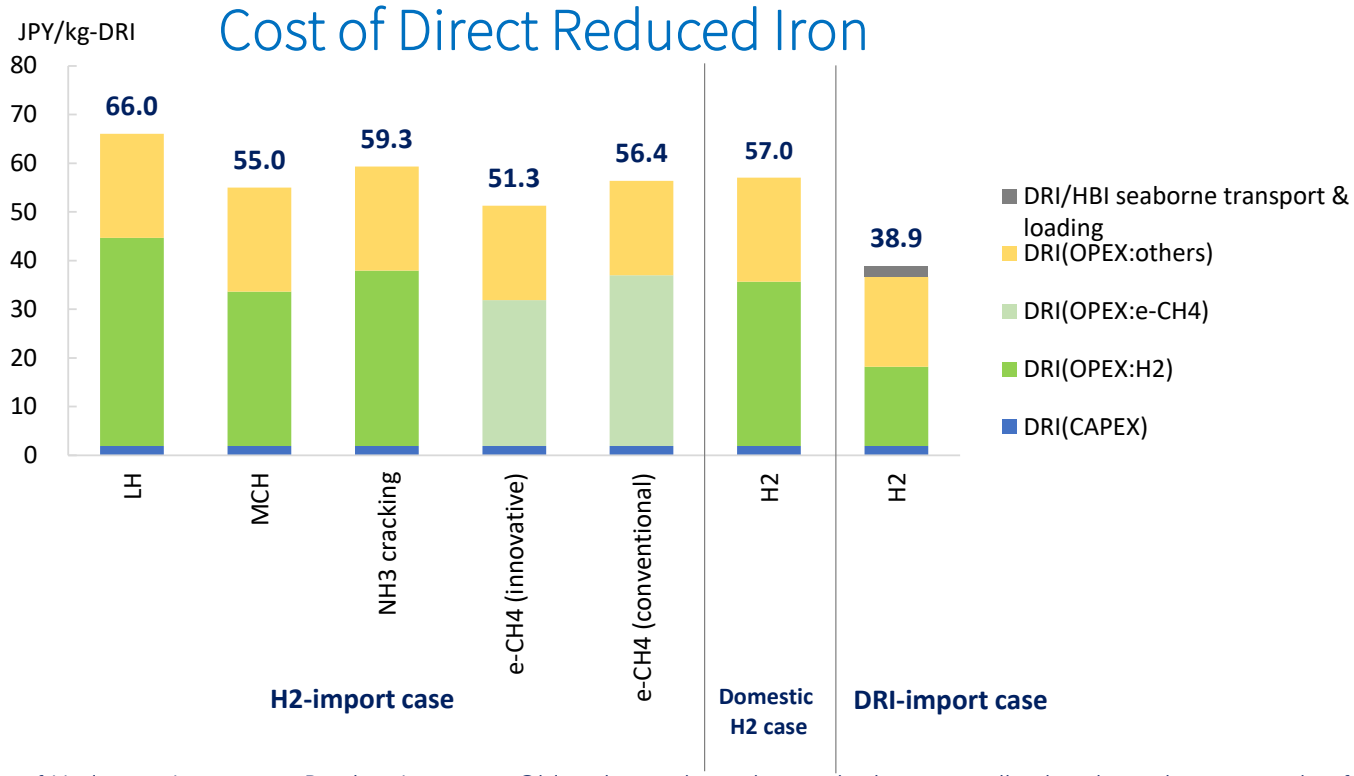
(Y1993 = 100)




Source: "Energy and Economy Statistics 2024" (IEEJ) and "Energy White Paper 2023" (METI)

# What do you import ?

- Import of DRI from abroad (manufactured in low-cost $H_2$ country) is much less expensive than domestic DRI by import $H_2$.
- Other option may be manufacturing in domestic region with cheaper $H_2$/renewables, avoiding $H_2$ transport.

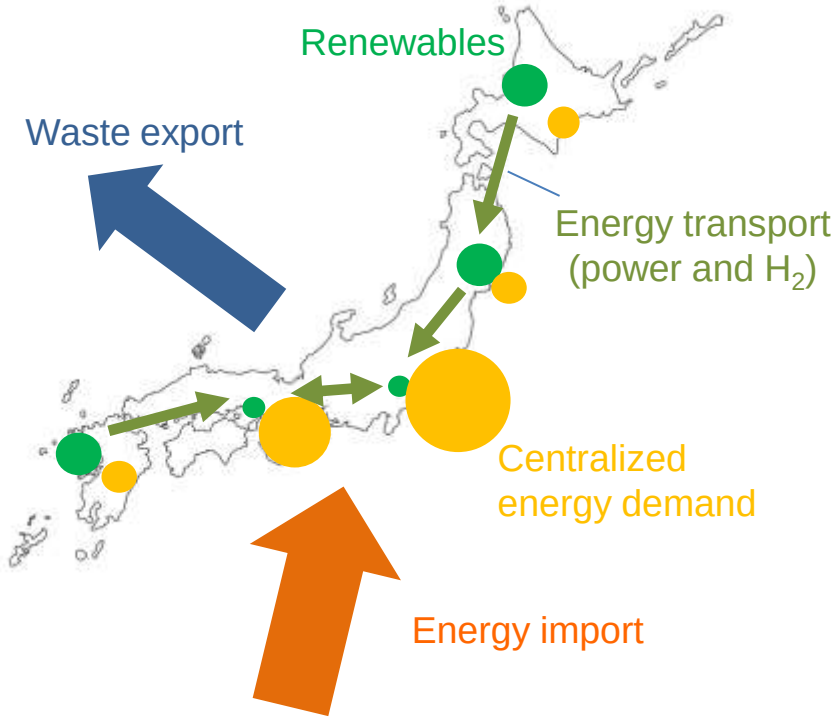



Source: Shibata, "Comparison of Hydrogen Imports vs. Product Imports - Old and new viewpoints on hydrogen application through an example of hydrogen-based direct reduction ironmaking -", IEEJ, 2023

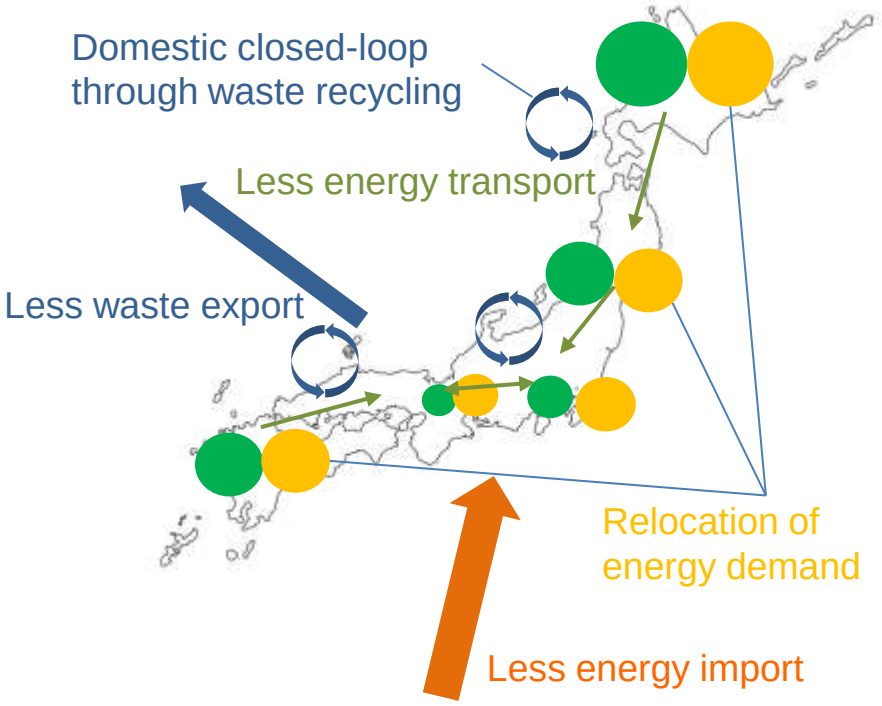
# Future Energy/Industry System

- What solution to protect domestic industry and to enhance energy and economic security ?
- Efficiency, recycling, resilience, and new industry

## National Power Decline & inefficiency




## Development through Industry Transformation & efficiency



# Summary

- Efficient, resilient and high-security energy system is required.
- Existing infrastructure should be employed, but new infrastructure should also be discussed.
- Choices among electricity, $H_2$ and e-gas/fuels should be based on deep discussions on future infrastructure and industry.
- Energy consumers may want to move to harness “hard-to-transport” energy.
- Clean fuels import are necessary. But should be careful of the potential risks.
- Addressing what can be done domestically to the maximum extent is important. Renewables, recycling, etc.
- Discussions based on existing infrastructure may face the limit.

Thank you

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