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2050 Climate neutrality and the role of green H2

A perspective from Japan

Yuko Nishida, Senior Manager
Renewable Energy Institute, TOKYO

Japan's Policy Landscape for 2050 Climate Neutrality

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1. Current Emission Status in Japan

- GHG emission; Decline since 2013
- Emissions by sector

2. Current Japanese INDC and long-term target

- Target for 2030: 26% reduction from 2013 (Current Strategic Energy Plan)
- Long term target: Proclaiming the goal "decarbonized society as early as possible in the second half of this century"
  Aiming to the reduction of GHGs emissions by 80% by 2050

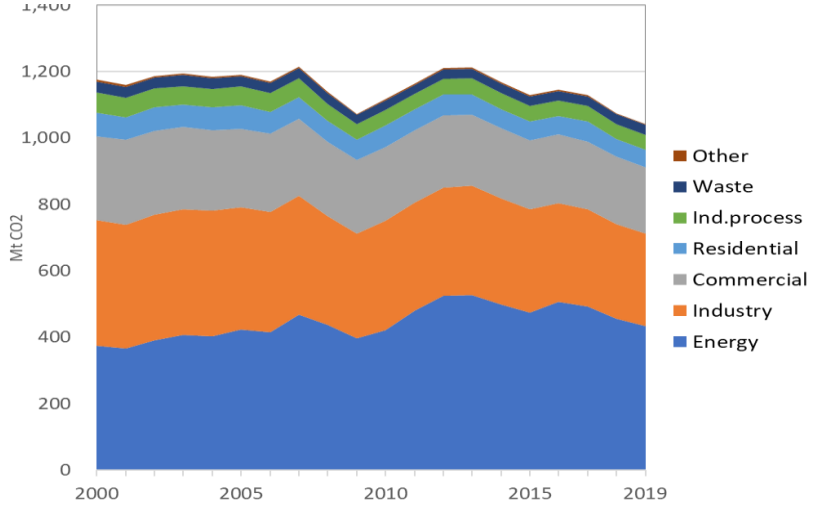
3. Declaration of climate neutral by 2050 by PM Suga (Oct. 2020)

- Accelerate its climate commitment --GHG net zero emission by 2050
- Started the discussion for the plans and measures; Two major plans
  the 6th Strategic Energy Plan
  Global warming countermeasure plan

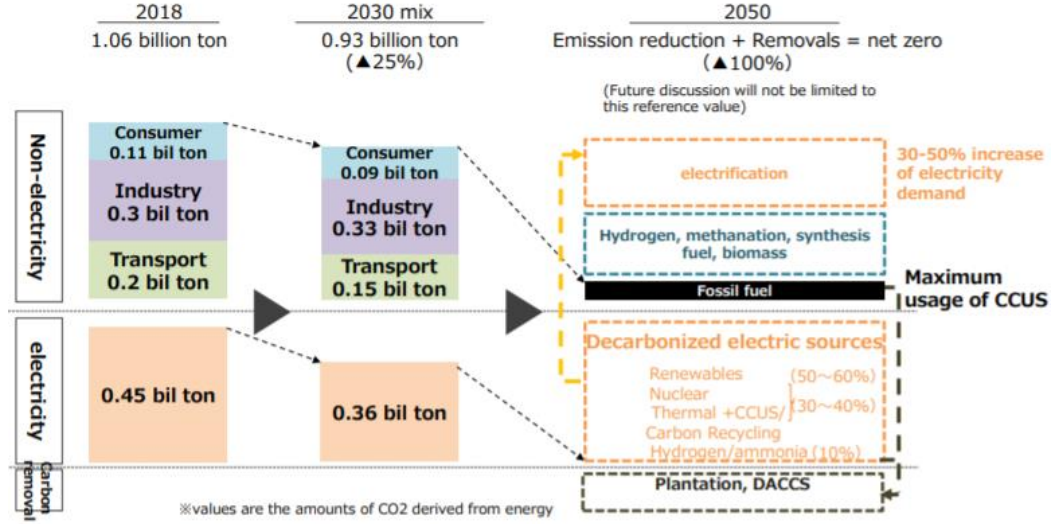
4. Green Growth Strategy towards 2050 Carbon Neutrality (Dec.2020)

- Industrial policy for achieving carbon neutrality by 2050 with a good cycle of economic growth and environmental protection
- Set ambitious goals for 14 priority fields spelling out current challenges and future actions
- Comprehensive policies for achieving goals (budget, tax, regulatory reform, standardization and international cooperation)

CO2 Emissions by sector NIES, Inventory Office



Green Growth Strategy through C Neutrality METI (2020)



Japan's Pathway to 2050 Climate Neutrality: REI Proposal

1. Net zero emission by 2050 based on 100% renewables energy system

- -45% GHG reduction in 2030 in line with IPCC 1.5 degree scenario
- By 2045 90% reduction, and 100% in 2050
- REI-Agora Energiewende-LUT collaboration study provide the tangible scientific base for this pathway*

2. Electricity decarbonization and electrification

- Large deployment of renewables in power generation based on the declining RE cost
- Fast electrification in heat (in buildings and industry) and transport sector is necessary to utilize decarbonizing power

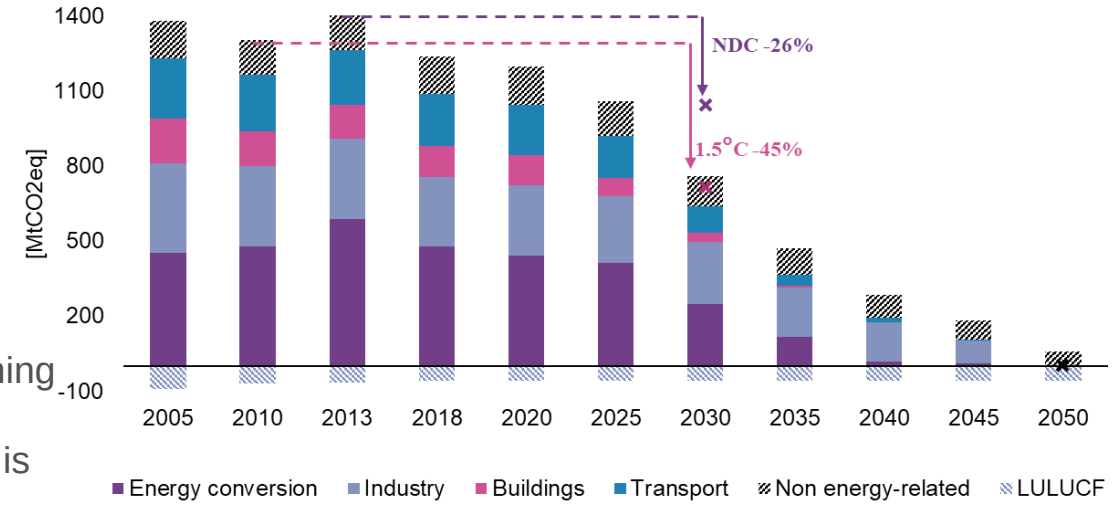
3. Energy efficiency and declining of demand

- Energy demand is projected to decrease due to the declining population
- Energy efficiency improvement in demand and supply side will be significant

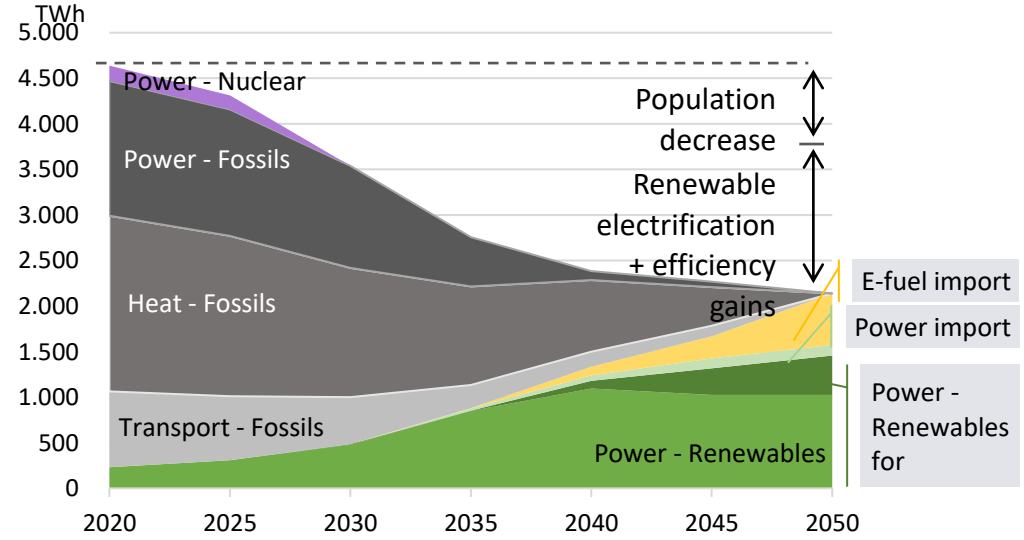
4. Green hydrogen for the area hard to be electrified

* Renewable pathways to climate-neutral Japan, REI-Agora-LUT, 2021,(link)

CO2 Emissions by sector, Inventory Office



Primary energy demand from 2020 to 2050



Japan's Pathway to 2050:
Key features of renewable-based energy system in 2050

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1. Power system stability in 100% renewables

- Very high share of PV and wind power generation requires more system flexibility
- Flexible demand activated when high RE feed in; storage, smart charging , Power to Heat, power to fuels
- Flexible energy sources available when low RE feed in; hydro dams, pumped-hydro storage, gas turbines and gas CHP running on biogas and e-fuels, biomass power plants and CHP, battery storage

2. Electricity trades among regions are fully utilized and crucial to keep the stability

- Interregional power trade will increase from 2020 to 2050 by 65% to balance the regional power demand-supply
- Better utilization of existing lines + grid expansion

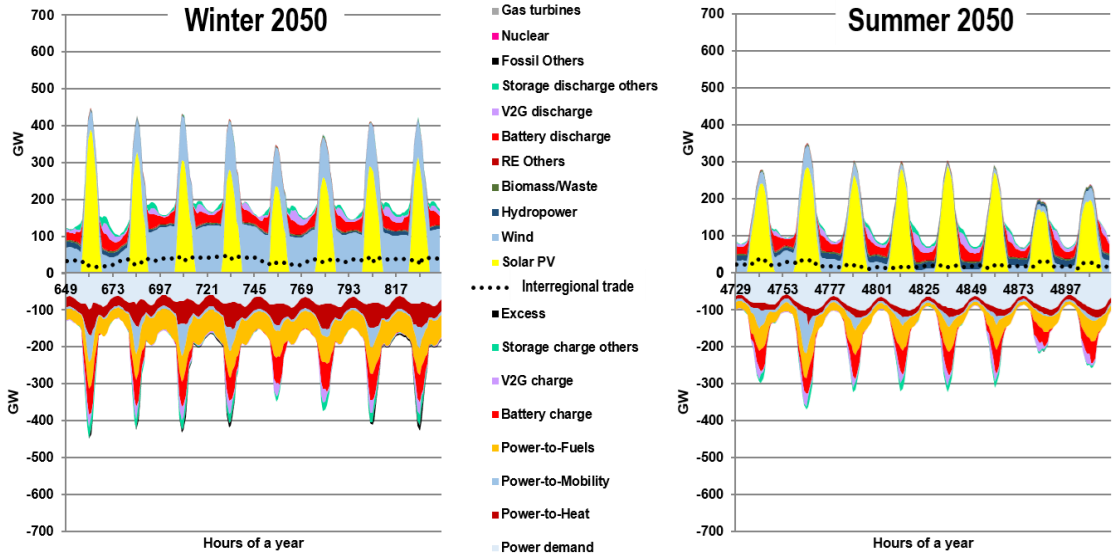
3. Cost for energy transformation

- Thanks to the demand decrease by half, total annual cost in 2050 is lower in 2030 by 30%

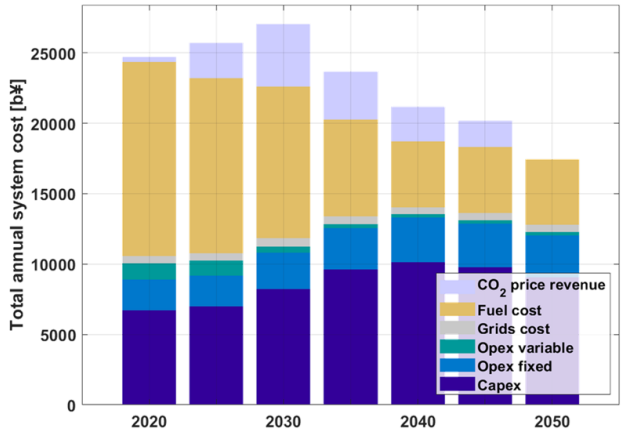
4. Nuclear and CCS

- Nuclear and CCS are not anymore economically viable options for power generation.
- Location of storage is another issue on CCS in Japan.

Typical weeks during winter and summer in 2050



In 2050 annual total system cost is lower than in 2030 by30%



REI Proposal for 2030: toward 2050 decarbonization

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1. 45% ~50% renewable share in electricity generation

- To achieve 2050 decarbonization and reduce GHG inline with 1.5 degree scenario, large renewable deployment in power generation is essential

2. Further examination of REI's proposed energy mix

- In the latest study on 2030 energy mix, detailed power balance and stability are examined.
- The proposed energy mix has performed fully without any deficit.
- LCOE is also projected and found it in the reasonable increase of even less.

3. Necessary measures for 2030

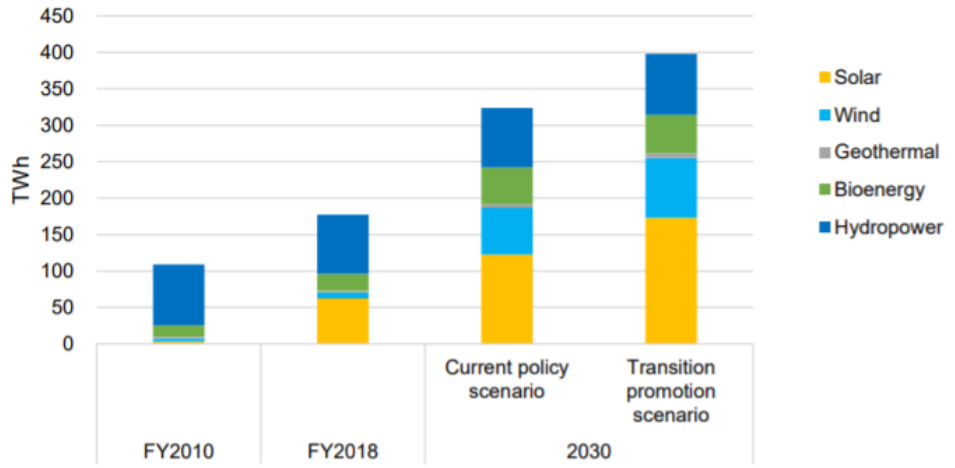
To realize high share of renewables, driving policy is necessary. Among those policy measures, most important ones are as follows

1) Power system reform
In Japan, still tremendous barriers to introduce renewables.
To create "fair" power system for renewables are necessary.

2) Carbon pricing
In the REI 2030 study, 500 USD/ton carbon price included. At least this level of carbon price is necessary

3) Land-use regulation
Re-consider existing land-use regulation for rational use for renewables, is also a crucial aspects of regulation reform.

Development of Renewable power, REI



Note: Electricity generated figures do not include output curtailment amounts.

Source: By Renewable Energy Institute with actual figures from the Ministry of Economy, Trade and Industry's "Comprehensive Energy Statistics of Japan"

Japan's Pathway to 2050: Role of Green Hydrogen

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1. Green Hydrogen and synthetic fuel demand needs large amount of energy

- Green hydrogen and syn fuels demand* accounts for more than 50% of total primary energy.
  *electricity to generate green hydrogen domestically + imported green hydrogen

2. Green hydrogen Use for area where direct electrification is not feasible

- As the last step to eliminate residual emissions
- High temperature heat use in industry >>green hydrogen and syn methane
- Aviation, marine, and heavy-duty truck in transportation >>FT fuel

3. Power system flexibility

1) Power to Fuel: Flexible hydrogen generation

- Use or electrolysers can be very promising flexible demand
- Syn methane generation can be also the flexible power demand

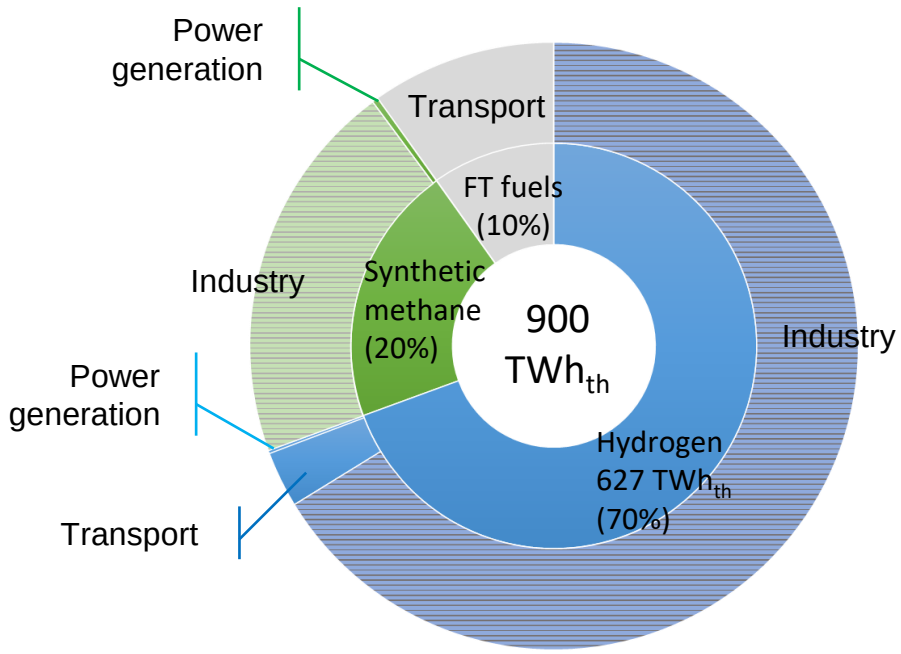
2) Gas storage

- Power to fuel especially syn methane can be used as gas storage, which is suitable for long-term seasonal storage

4. Minor role in power generation and building sector

- H2 cost will be inevitably higher than renewable electricity, green hydrogen should be used sparingly.
- To seek for electrification opportunity as much as possible

Increased use of green synthetic fuels



Key policies toward green hydrogen

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1. Reduce renewables cost in Japan

- Renewables cost is the key to make local production of green hydrogen competitive
- Expand renewable generation is also crucial

2. Limit the use of hydrogen in the segment that are hard to electrify

- Even including import H2, green hydrogen is still cost high compared with renewable power.
- Using hydrogen for electricity generation and for light passenger vehicles are not economically wise solution

3. Develop a dedicated international strategy for synthetic fuel imports

- Large scale of domestic green H2 production put high pressure on the Japanese power system
- LH2 oversea transport is technically and economically challenging. Affordable H2 carriers (such as NH3) may be a favorable option