Assessment of long-term low-emission pathways in Japan using AIM/Enduse [Japan]

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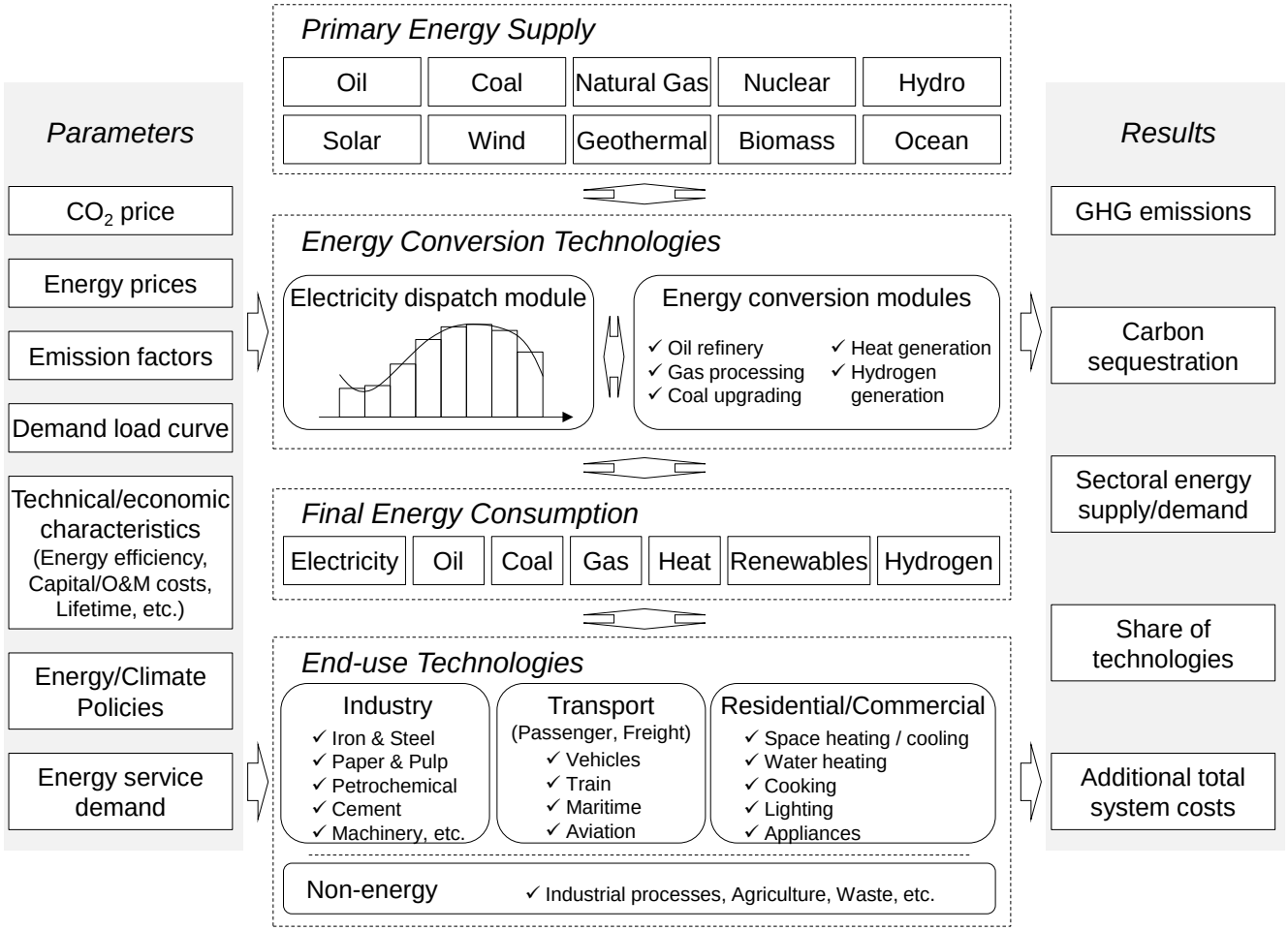
Backgrounds and objectives

- Japan submitted its INDC on July 2015, which is to reduce GHG emissions by 26.0% in 2030 below the 2013 level.
- According to the Plan for Global Warming Countermeasures published on May 2016, Japan aims to reduce greenhouse gas emissions by 80% by 2050 as its long-term goal.
- However, quantitative analysis regarding consistency between the 2030 and 2050 targets is not yet provided.
- This study assess emissions pathways by 2050 considering both the 2030 target (NDC) and the 2050 target (long-term goal) using AIM/Enduse [Japan].

Overview of AIM/Enduse [Japan]

- Bottom-up of end-use sectors, hard-linked with energy supply sectors
- Recursive dynamic model
- Minimizing total system costs; capital, O&M, and emission costs



Examples of measures in AIM/Enduse [Japan]

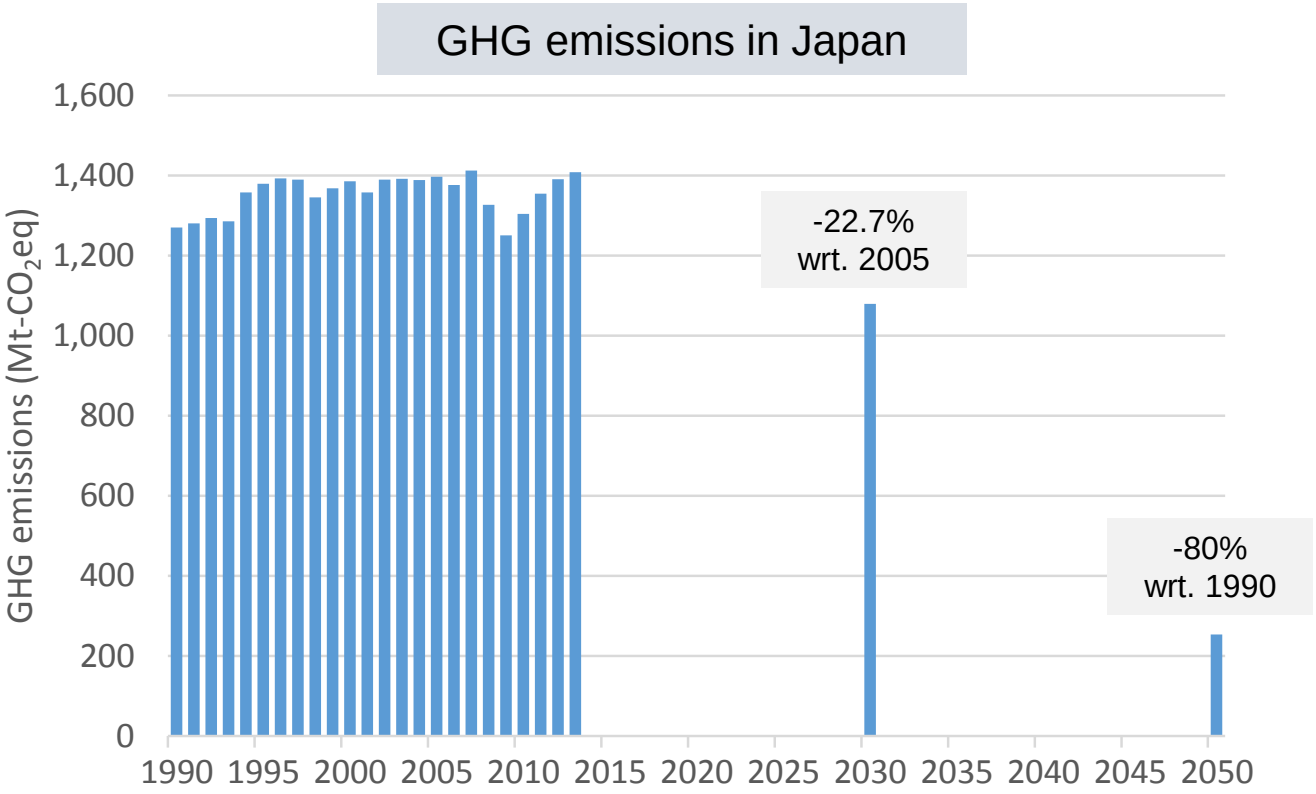
- Wide range of mitigation technologies are included.
- Unlike the NDC, most of measures for energy conservation are excluded. (e.g. behavioral change, modal shift to public transport)

Sector	Technologies
Energy conversion	efficiency improvements of power generation; coal and gas with CCS; nuclear power; hydropower; wind power; solar PV; geothermal; bioenergy; ocean; PHS; reinforcing electricity interconnection; Hydrogen generation (electrolysis)*
Transport	fuel economy improvement of ICE, train, maritime, and aviation; NGV; BEV*; PHEV; FCEV; biofuels; eco-driving
Residential/ commercial	Improvement of energy-efficiency performance of buildings (e.g. insulation); high-efficiency equipment and appliances; electric heat pump water heaters; electrification for heating, cooling, and cooking; energy-management systems
Industrial (incl. agriculture)	energy-efficiency improvements in industrial processes; CCS for iron making and cement lime; high-efficient boiler, furnace, and motor; industrial heat pump; fuel economy improvements of agricultural machines; bioenergy use; management of nitrogen fertilizer

* BEV, electric water heater, and electrolysis could act as flexible resources to integrate VREs in this version of AIM/Enduse

The 2030 and 2050 target in Japan

- 2030 target: 25.4% reduction wrt. 2005 based on the NDC
- 2050 target: 80% reduction based on the national goal that considers the global 2 degrees goal



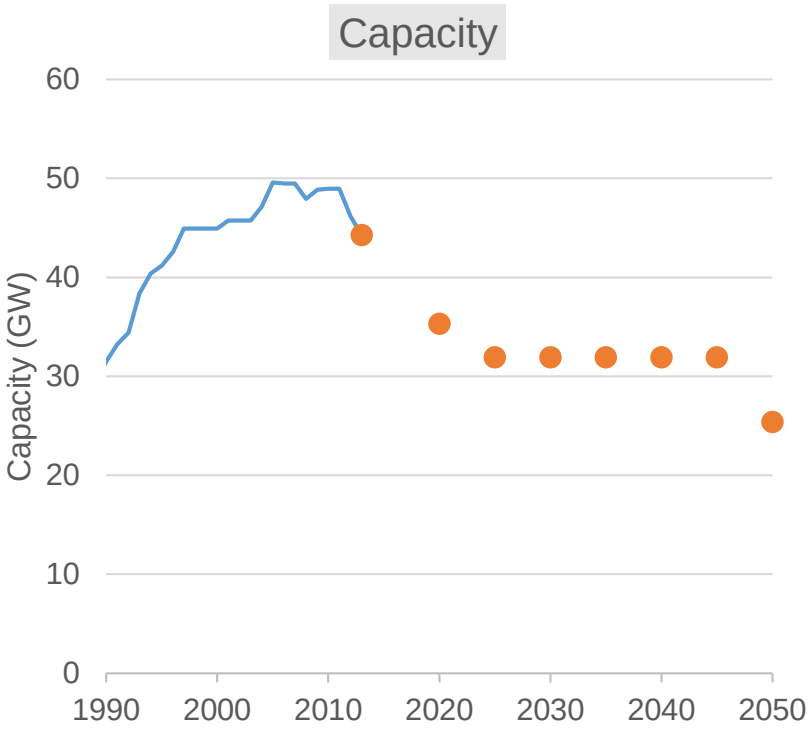
* Excluding LULUCF

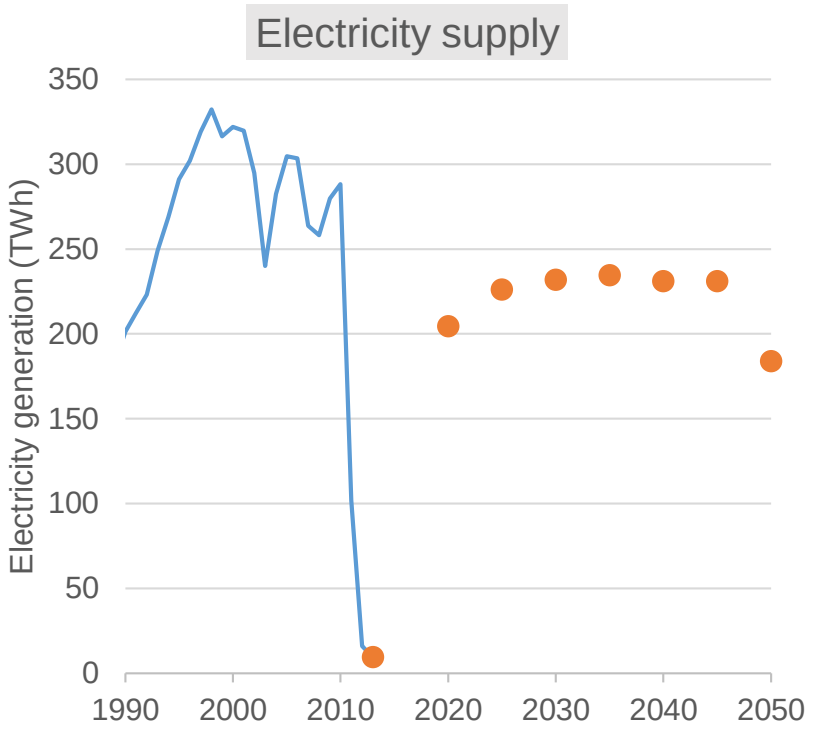
Cases

1. Reference
   No carbon price.
2. NDC-Extended
   Implicit carbon prices are implemented to meet the NDC by 2030. Between 2030 and 2050, carbon prices are constant.
3. NDC-80
   Implicit carbon prices are implemented to meet the NDC by 2030, and strengthened thereafter toward the 80% reduction by 2050.
4. Immediate-80
   Compared with NDC-80, higher carbon prices are implemented by 2030 to the level of around a half of 2050.
5. No nuclear
   Meeting both the 2030 and 2050 target without restart of nuclear power.

Assumptions on nuclear power

- Lifetime: Extension to 60 years for the plants built since mid-1980s, 40 years for all others (excluding No-Nuclear case)
- Electricity supply from nuclear power:
  - ➢ 232 TWh in 2030 (almost consistent with the assumption of NDC)
  - ➢ 184 TWh in 2050

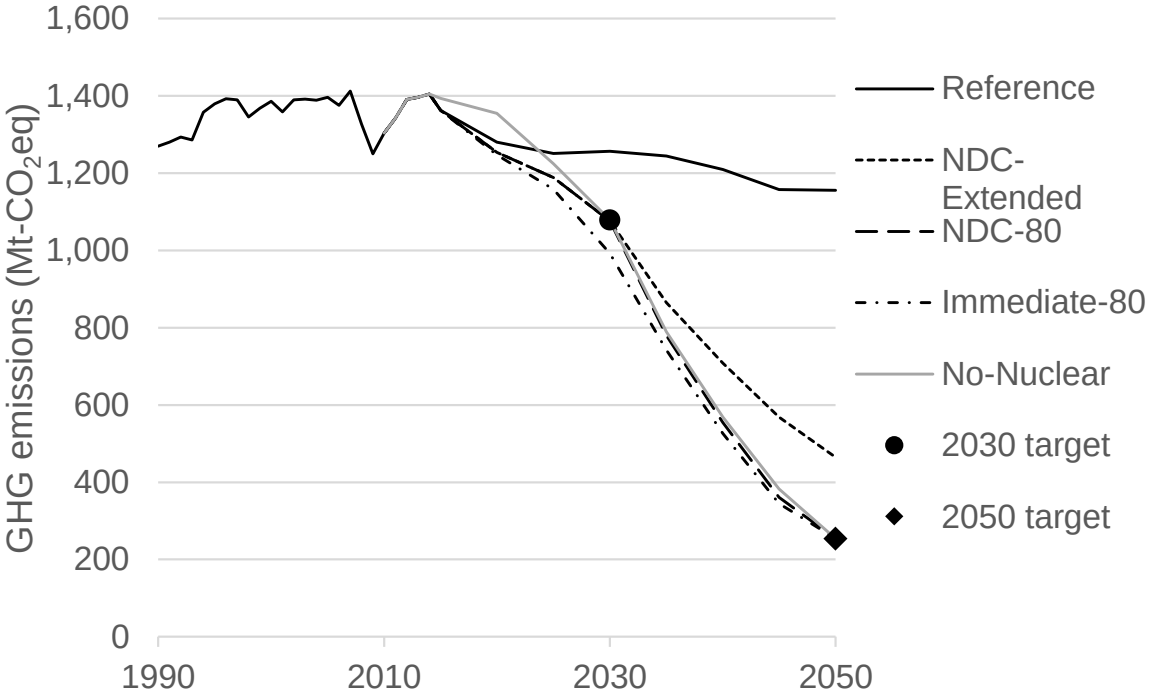




Results: GHG emissions

- Both 2030 and 2050 targets are technically feasible without nuclear power, however rapid reduction is required after 2030
- Immediate-80 case results 29% reduction in 2030 (wrt. 2005)
- Carbon prices range 600-740 US$/t-CO2 in 2050 to meet the 2050 target

GHG emissions pathways



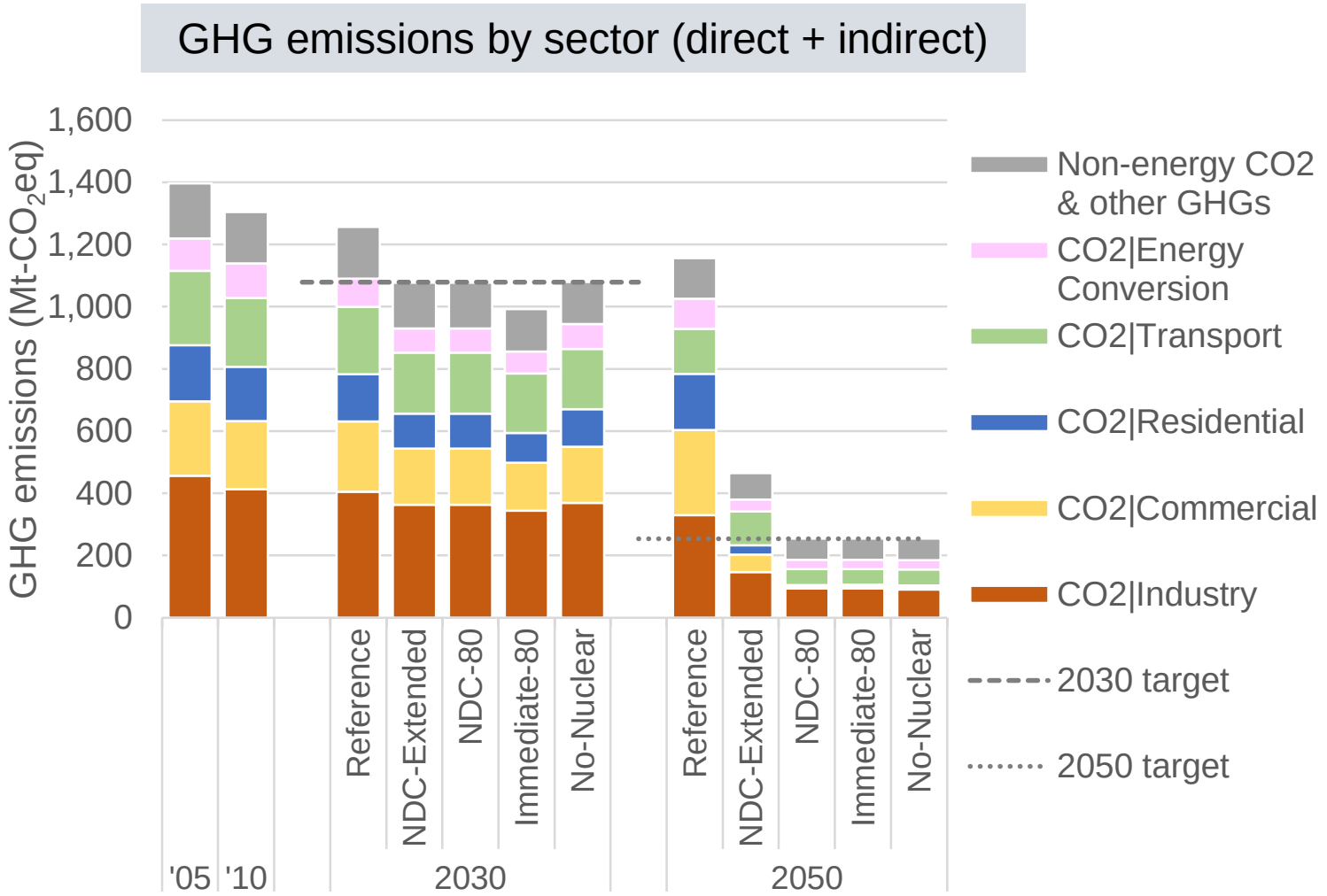
Carbon prices

Case	2030	2050
Reference	0	0
NDC-Extended	165	165
NDC-80	165	654
Immediate-80	260	607
No-Nuclear	454	736

Unit: (US$/t-$CO_2$)

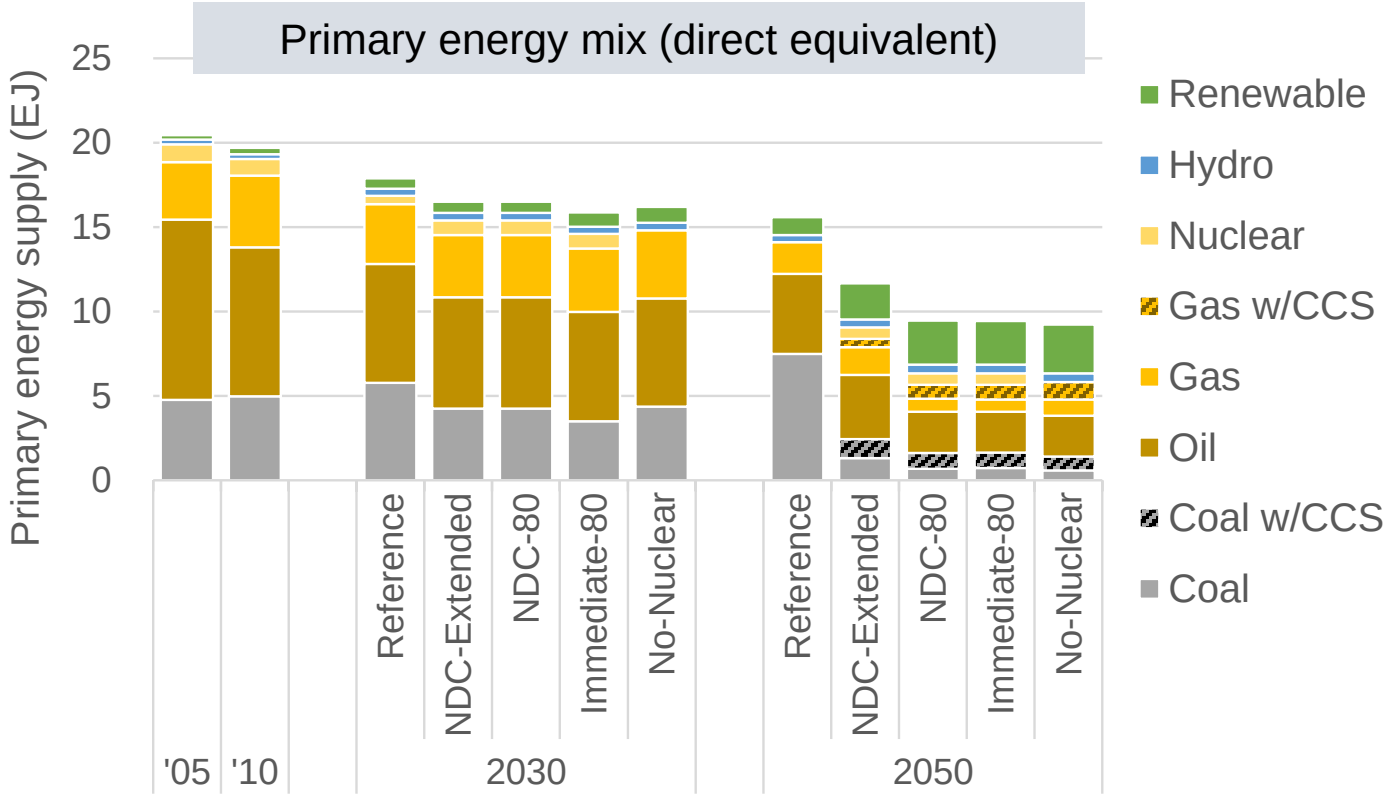
Results: GHG emissions by sector

- Residential and commercial sectors are almost decarbonized in 2050 to meet the 2050 target.



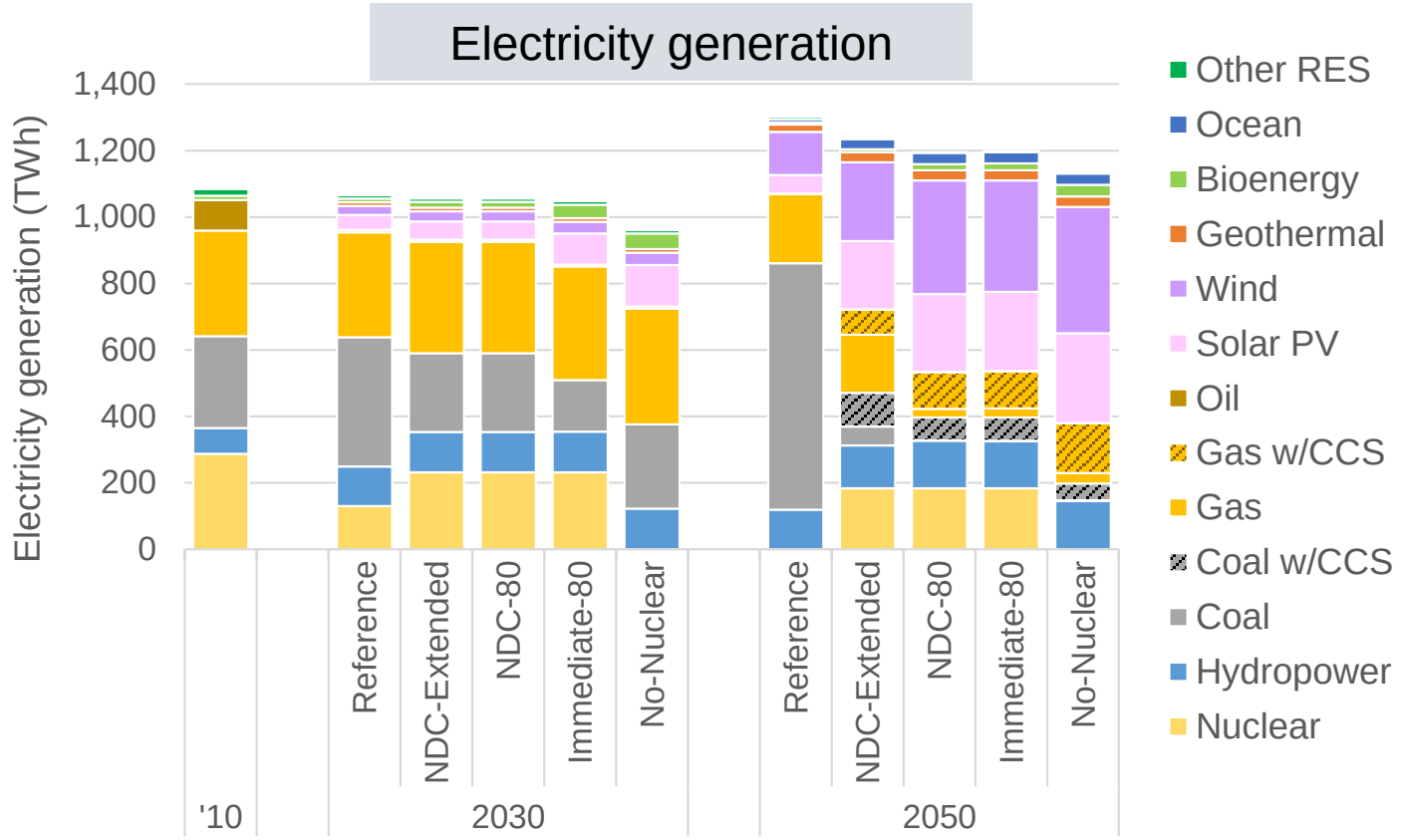
Results: Primary energy mix

- Energy efficiency and low-carbon energies are key options
- Share of low-carbon energies (NDC-80):
  - ➢ 12% in 2030, 59% in 2050
- Innovative technologies such as CCS could be important options by 2050



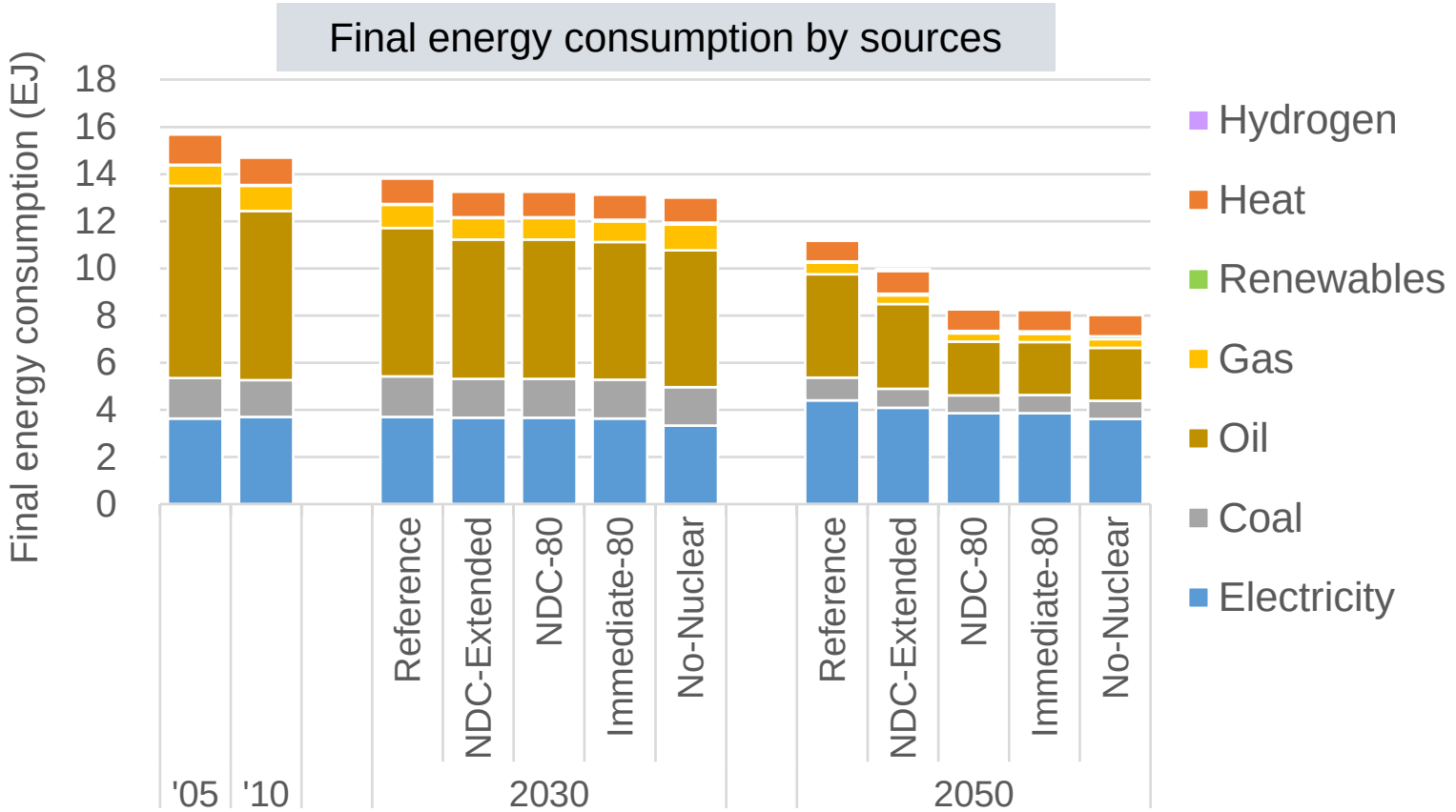
Results: Electricity supply

- Renewables account for 23% in NDC-80, 30% in Immediate-80 in 2030. In 2050, electricity is almost decarbonized.
- Integration of variable renewable energies (VREs) is challenge after 2030



Final energy consumption

- Energy efficiency continues to be a key option by 2050
  - ➢ Around 10-11% in 2030, 43% in 2050 (wrt. 2010)
- Electrification is another challenge, especially after 2030.
  - ➢ Around 28% in 2030, 46% in 2050



Conclusions

- Japan's NDC would be effective to consolidate a transition from the baseline trajectory, by improvement of energy efficiency and deployment of low-carbon electricity.

- The 80% target by 2050 requires significant electrification in end-use sectors as well as the acceleration of energy efficiency and decarbonization of electricity between 2030 and 2050.

- The implementation of NDC is meaningful, however, rapid transformation of energy systems would still be required to meet the national long-term goal.