Assessment of Japan's INDC Using AIM/Enduse[Japan]

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Emissions reduction target of Japan's INDC

- Japan's INDC was determined coupled with the Long-term Energy Supply and Demand Outlook, and was submitted on 17th July 2015 to the UNFCCC.
- GHG emissions reduction:
  26.0% wrt. 2013, 25.4% wrt 2005 (including LULUCF)

GHG emissions target in the government's INDC

	2005	2013	2030
Energy CO_2	1,219	1,235	927
Non-energy CO_2	85.4	75.9	70.8
CH_4	39.0	36.0	31.6
N_2O	25.5	22.5	21.1
HFCs	12.7	31.8	21.6
PFCs	8.6	3.3	4.2
SF_6	5.1	2.2	2.7
NF_3	1.2	1.4	0.5
Total	1,397	1,408	1,080

Source: Government of Japan (2015), Submission of Japan's Intended Nationally Determined Contribution (INDC)

* emissions/sink from LULUCF are excluded in the table

Example of Measures in INDC

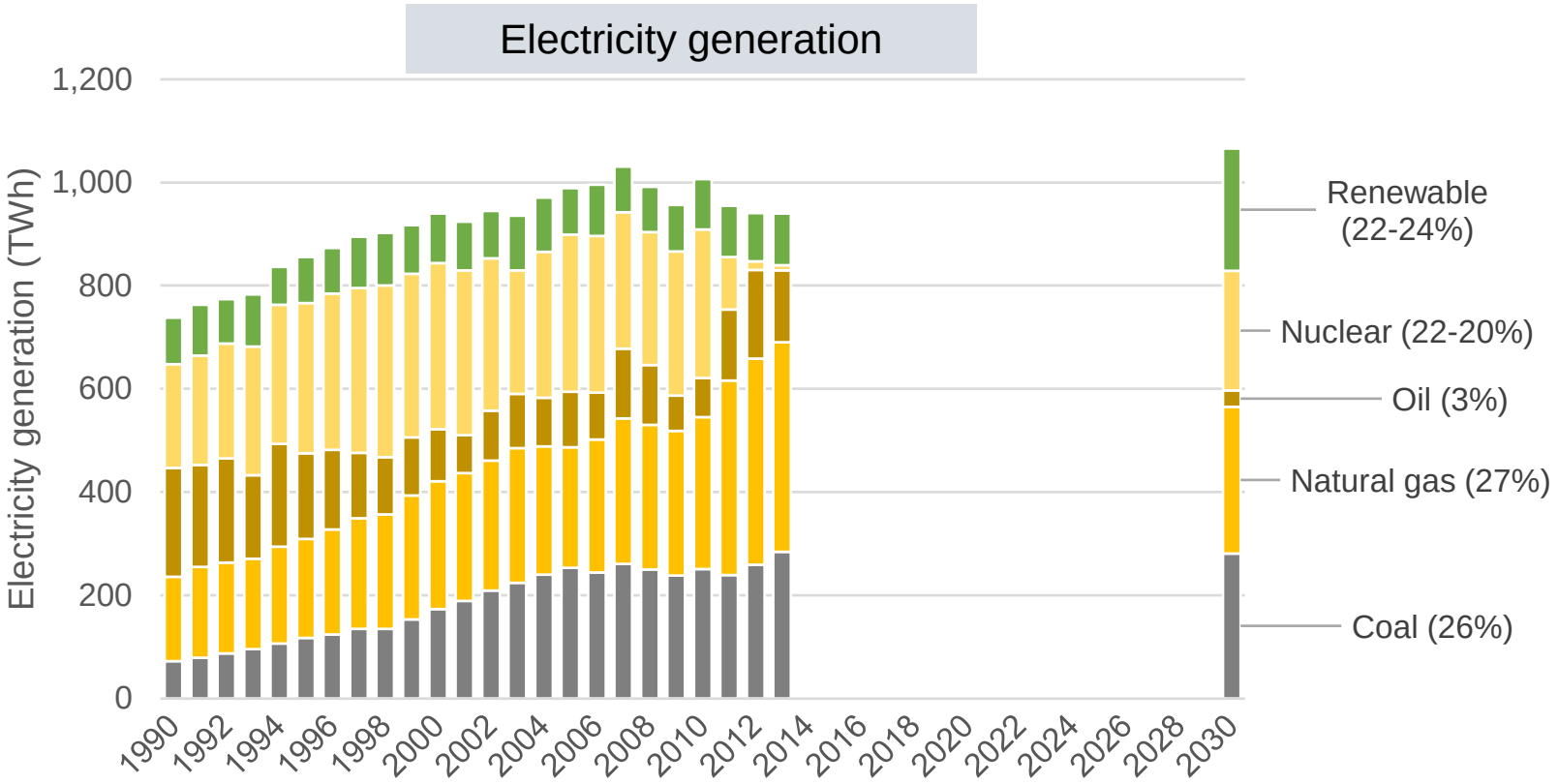
- Japan's INDC is based on bottom-up calculation formed by following measures.

Industry (ex. Iron & steel)	• Efficiency improvement of electricity-consuming facilities • More chemical recycling of waste plastic at steel plants • Introduction of next-generation coke making process (SCOPE21) • Improvement of power generation efficiency • Enhanced energy efficiency and conservation facilities • Introduction of innovative ironmaking process (Ferro Coke) • Introduction of environmentally harmonized steelmaking process (COURSE50)
Commercial /Residential	• Promotion of compliance of energy saving standards for newly constructed buildings • Energy efficiency and conservation buildings (remodeling) • Introduction of commercial-use water heater • Introduction of highly efficient light • Introduction of refrigerant control technology (F-gases) • Improvement of energy efficiency and conservation performance of equipment by the top runner program, etc. • Thorough implementation of energy management in commercial sector with BEMS and energy efficiency diagnosis • Promotion of nationwide campaigns (through promotion of Cool Biz/Warm Biz, repair of local government buildings) etc.
Transport	• Improvement of fuel efficiency • Promotion of next-generation automobiles • Other measures in transport sector (traffic flow improvement, promotion of public transport, etc.)
Energy conversion	• Expanding renewable energy introduction to the maximum extent possible • Utilizing nuclear power generations whose safety is confirmed • Pursuit of high efficiency in thermal power generation (USC, A-USC, IGCC, etc.)

Source: Government of Japan (2015), Submission of Japan's Intended Nationally Determined Contribution (INDC)

Electricity generation outlook in Japan

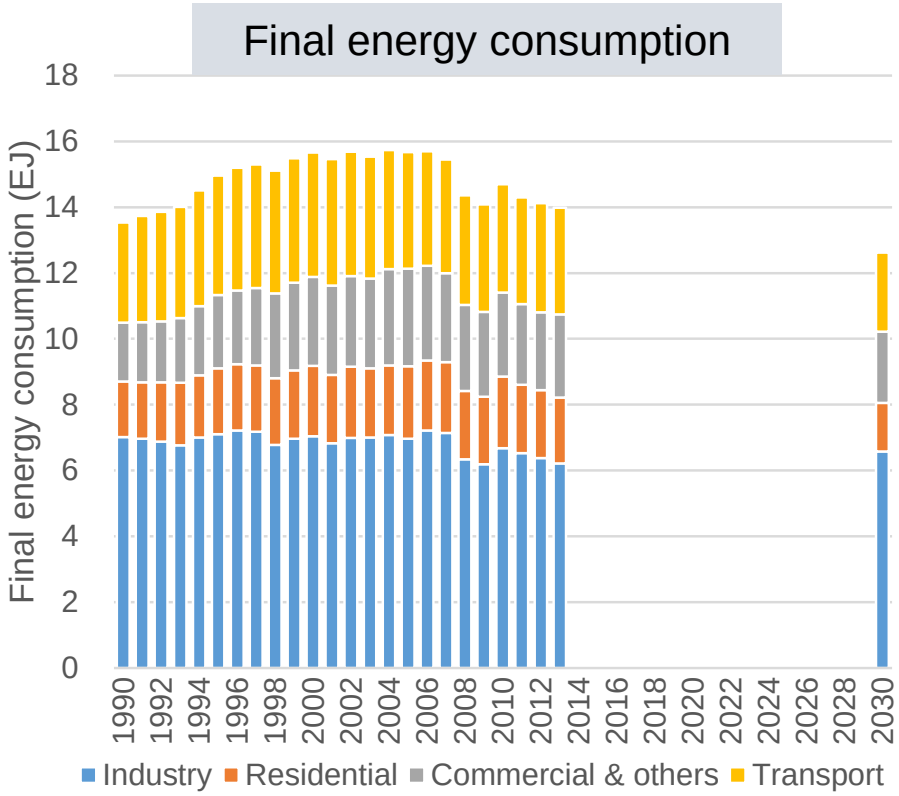
- In the Long-term Energy Supply and Demand Outlook:
  - ➢ Renewables : 22% - 24% in 2030
  - ➢ Nuclear : 20% - 22% in 2030

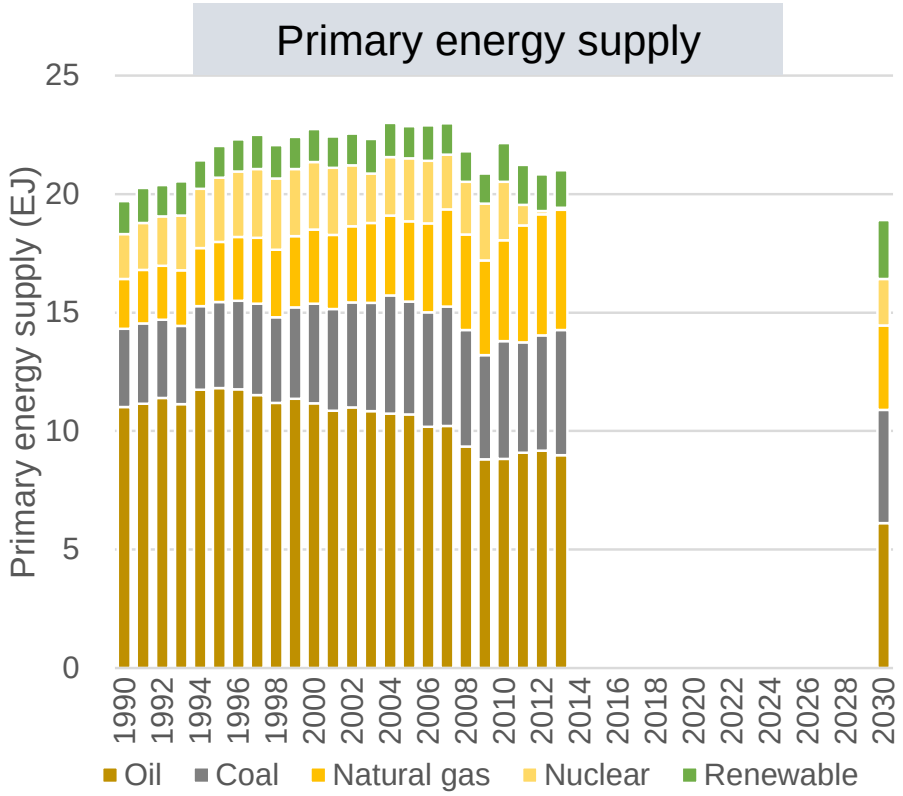


Source: Ministry of Economy, Trade and Industry (2015). Long-term Energy Supply and Demand Outlook

Energy supply and demand outlook in Japan

- In the Long-term Energy Supply and Demand Outlook:
  - ➢ FEC : 10% reduction wrt. 2013
  - ➢ Renewables : 13%-14% of TPES in 2030

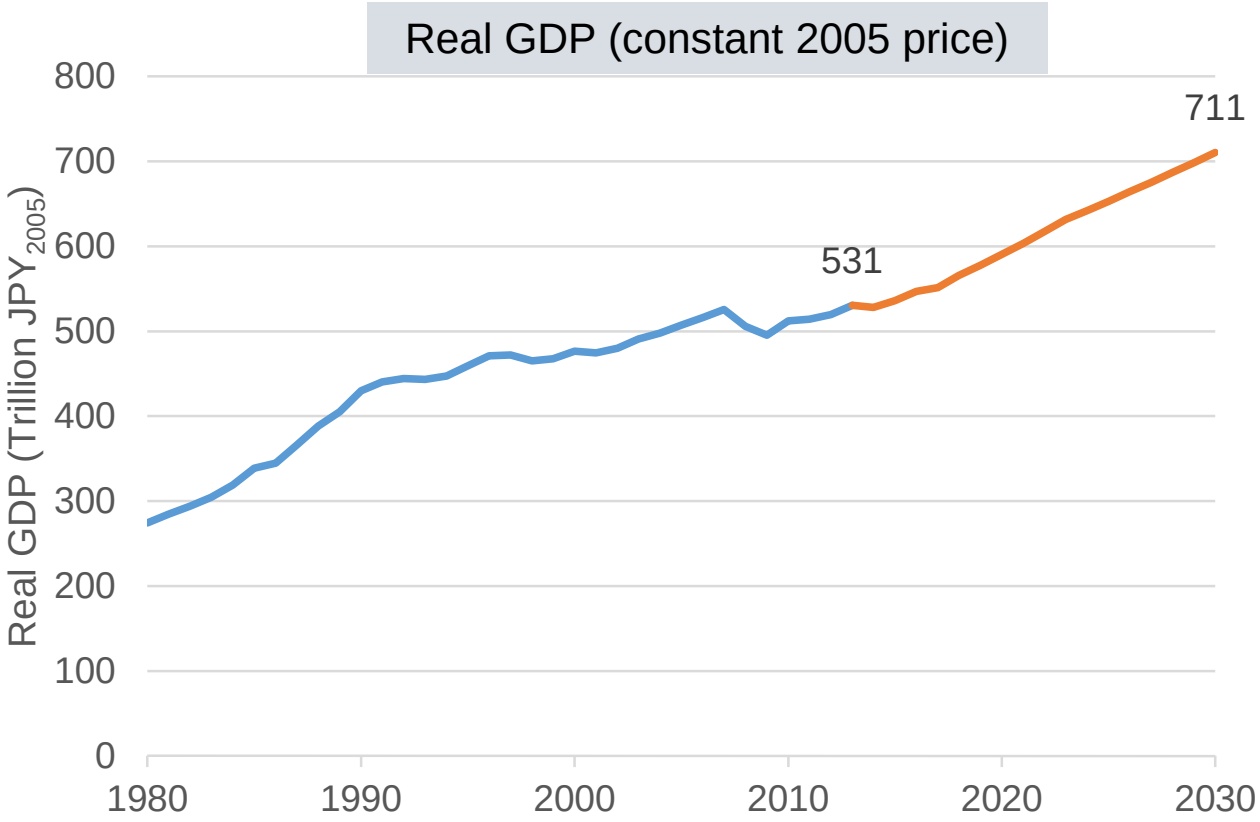




Source: Ministry of Economy, Trade and Industry (2015). Long-term Energy Supply and Demand Outlook

Economic growth outlook in Japan

- In the Long-term Energy Supply and Demand Outlook:
  - ➢ GDP growth: 1.7% from 2024 to 2030



Source: Ministry of Economy, Trade and Industry (2015). Long-term Energy Supply and Demand Outlook

Objectives

- Although Japan's INDC includes background information about the measures and energy mix, following aspects need to be clarified:

1) Feasibility and necessary effort to meet the INDC target
2) Robustness of INDC, especially in terms of the uncertainty of nuclear power
3) Consistency between INDC and 2050 target (80% reduction by 2050)

- This study aims to assess emissions pathways by 2050 using AIM/Enduse [Japan], especially focusing on the three key aspects.

MILES Project

- MILES (Modeling and Informing Low Emission Strategies) Project is convened by IDDRI (France) funded by EU

- The objective of this report is to understand the implication of INDC of the 6 regions (EU, Japan, US, Brazil, China, and India) at a national and global level.

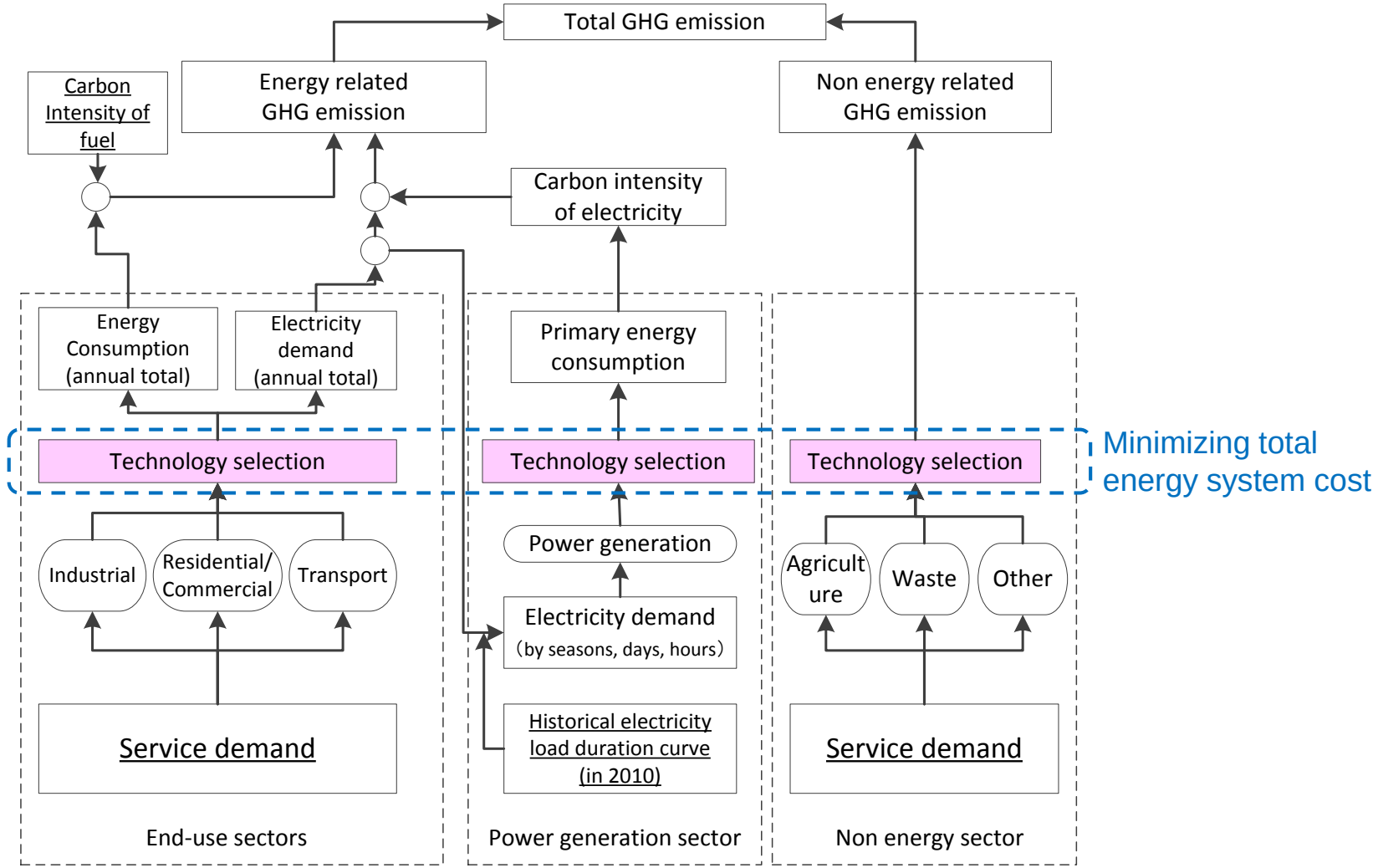
- Japan's analysis was conducted by NIES & RITE

- NIES team: Dr. Mikiko Kainuma, Dr. Toshihiko Masui, and Ken Oshiro

- The Synthesis Report is available online

http://www.iddri.org/Projets/MILES-(Modelling-and-Informing-Low-Emission-Strategies)

Multi-region AIM/Enduse [Japan]



For more details: *Oshiro, K., & Masui, T. (2015). Diffusion of low emission vehicles and their impact on CO2 emission reduction in Japan. Energy Policy, 81, 215-225. doi:10.1016/j.enpol.2014.09.010*

Examples of measures in AIM/Enduse [Japan]

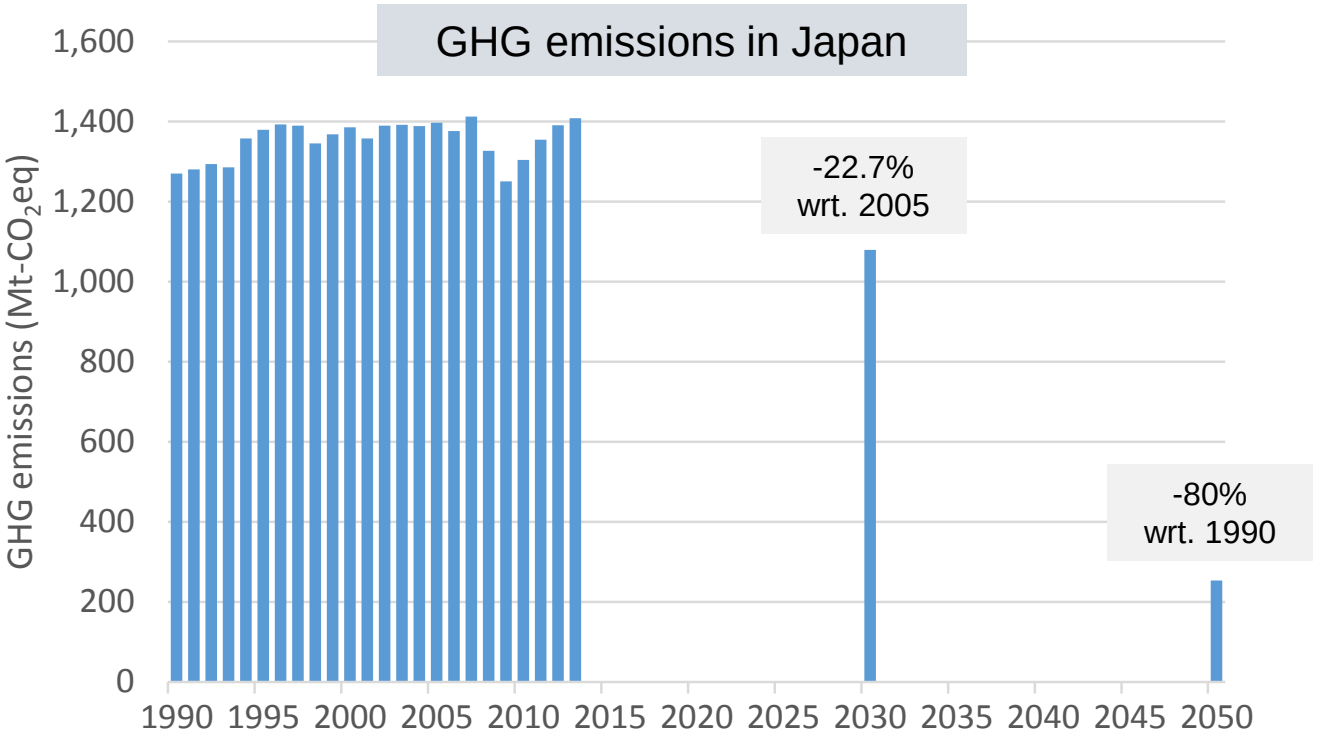
- Wide range of mitigation technologies are included.
- Unlike INDC, most of measures for energy conservation are excluded. (e.g. behavioral change, modal shift to public transport)

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

Methodology

- Implicit carbon prices are implemented to meet:
  - ➢ 2030 target: 25.4% reduction wrt. 2005 based on INDC
    -> 22.7% reduction excluding LULUCF
  - ➢ 2050 target: 80% reduction wrt. 1990



Source: Greenhouse Gas Inventory Office of Japan, The GHGs Emissions Data of Japan (1990-2013)
* Excluding LULUCF

Scenarios

INDC Scenario

Implicit carbon prices are implemented to meet the INDC target by 2030, and are strengthened thereafter toward the 80% reduction by 2050.

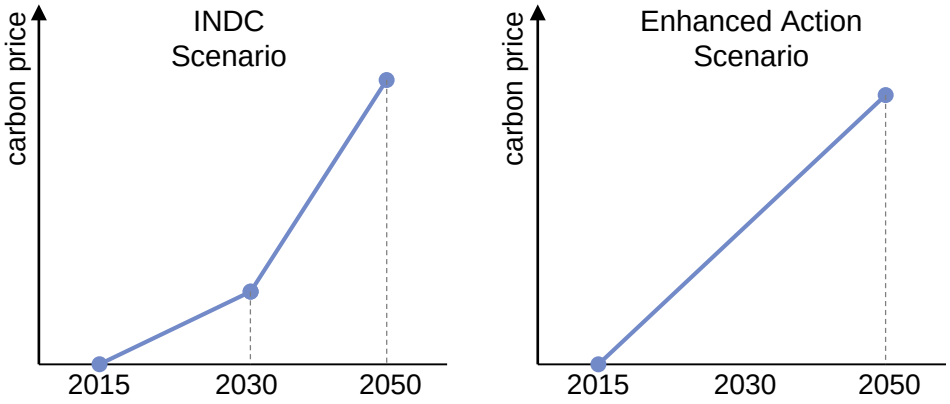
Enhanced Action Scenario

Compared to INDC Scenario, higher carbon prices are implemented by 2030 to the level of around a half of 2050.

Low-Nuclear Scenario

All nuclear power plants operate no more than 40 years, by contrast to other scenarios considering the extension to 60 years for several plants.

Assumptions of carbon price implementation



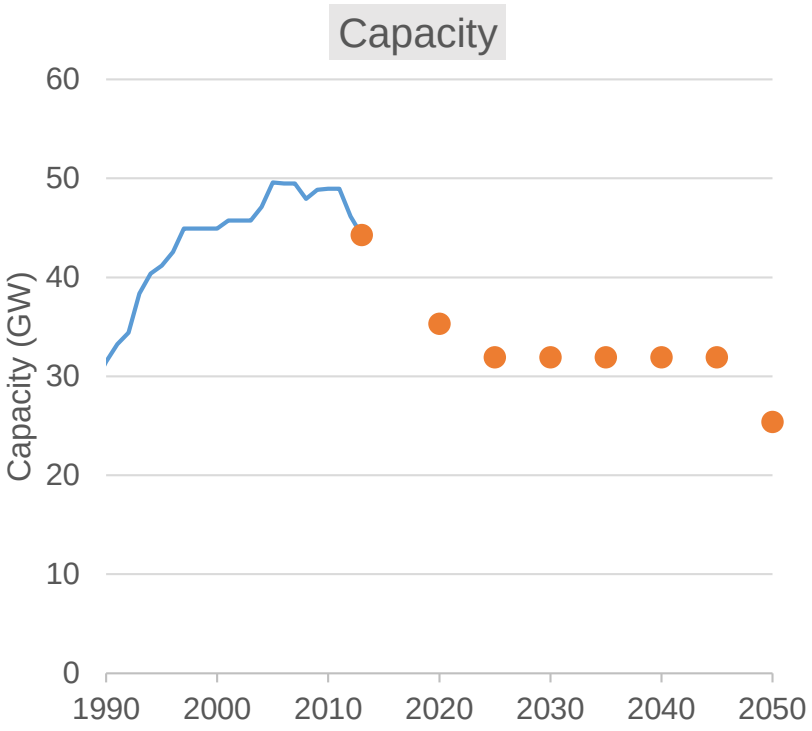
Assumptions of socio-economic indicators

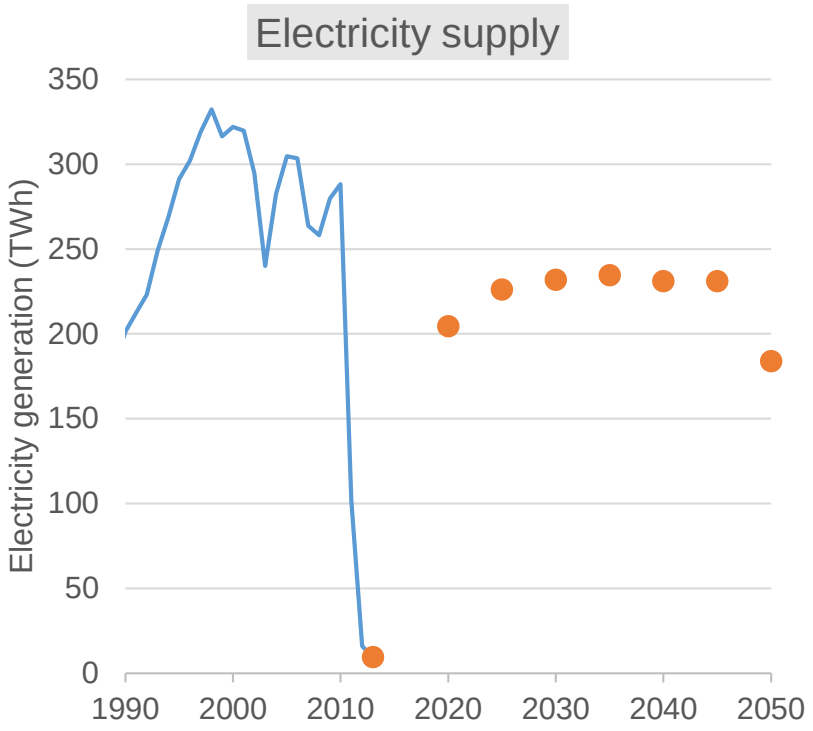
	2005	2010	2020	2030	2040	2050
Population (millions)	128	128	124	117	107	97
Real GDP (trillion US$$_{2005}$)	4.6	4.6	5.3	6.4	7.4	8.3

*Real GDP is taken from the government's INDC by 2030, and estimated using GDP per capita of SSP5 afterward

Electricity supply from nuclear power
(exogenous parameter)

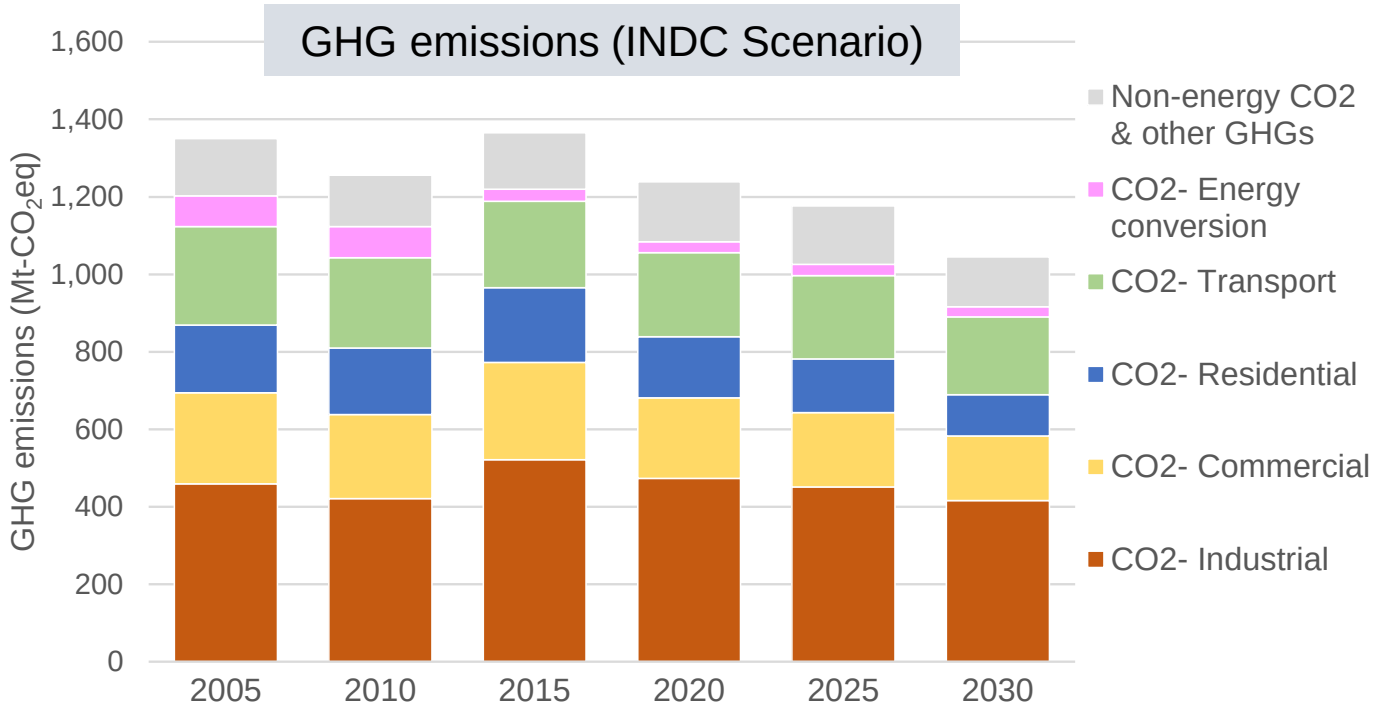
- Lifetime: Extension to 60 years for the plants built since mid-1980s, 40 years for all others (based on IEA WEO 2014)
- Electricity supply from nuclear power:
  232 TWh in 2030, 184 TWh in 2050





GHG emissions in INDC Scenario

- Japan's INDC target appeared technically feasible with energy efficiency improvement and low carbon energies.
- The implicit carbon price is estimated to rise to around 187 USD/t-CO_2 in 2030 to meet the INDC target.

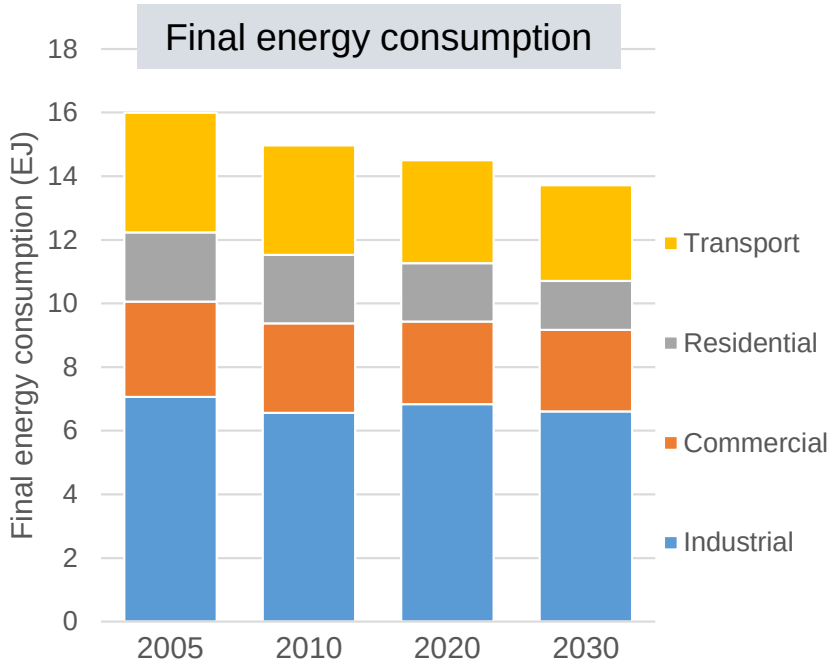


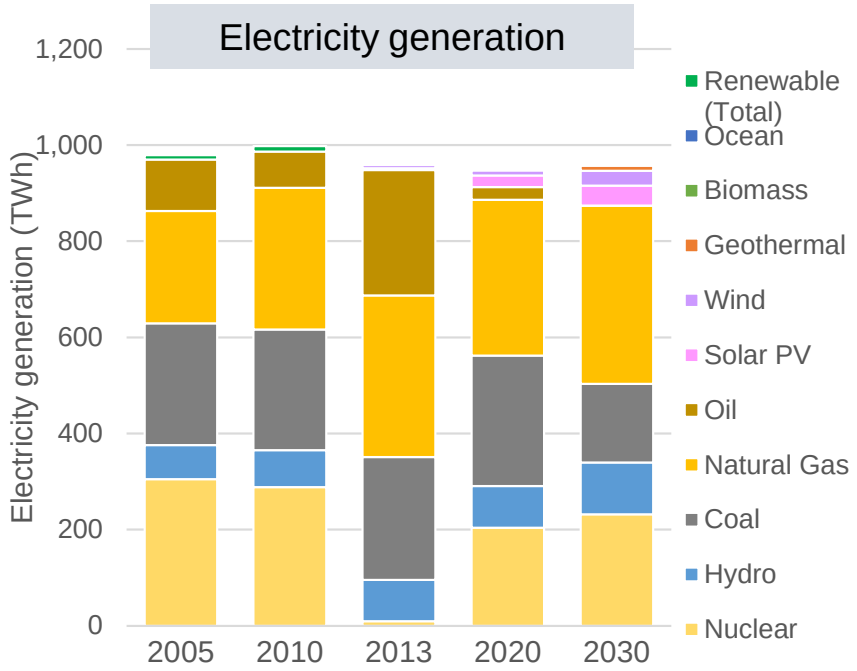
* NF_3 emission is excluded. GWP is taken from IPCC SAR

Result 1) Feasibility and necessary effort to meet the INDC target

EE and RE in INDC Scenario

- Considering high GDP growth by 2030, INDC Scenario requires substantial energy efficiency improvement.
- Unlike government's INDC (which focuses energy security as well as environment), switch from coal to natural gas power plant contributes to reducing CO_2 emissions by 2030.

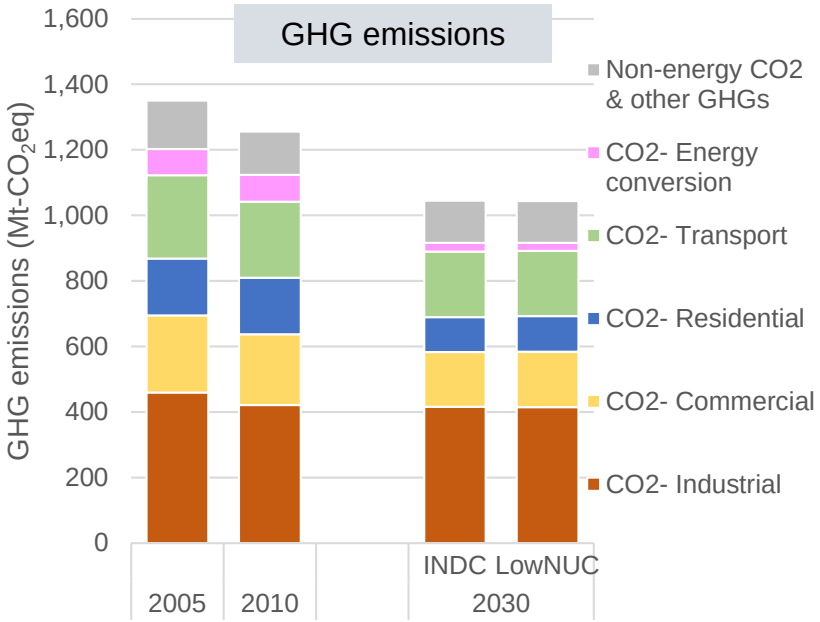


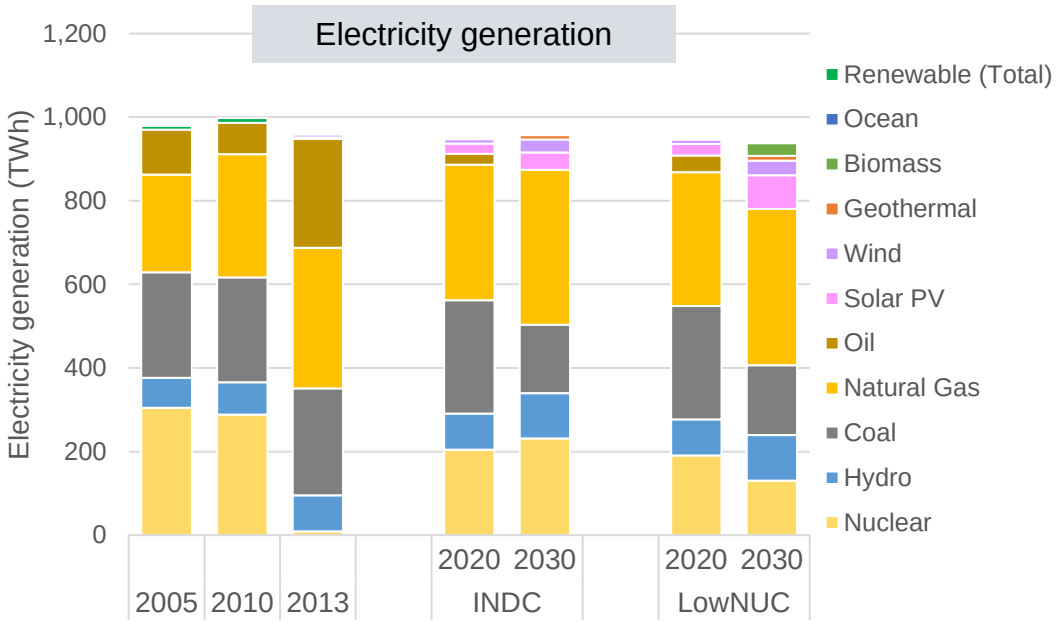


Result 2) Robustness of INDC in terms of the uncertainty of nuclear power

GHG emissions in Low-Nuclear Scenario

- The INDC target is still feasible with the alternative low-carbon options (renewable energies and gasification)
- Carbon price in 2030 : 236 USD/t-CO_2
  (approx. 26% higher than INDC Scenario)

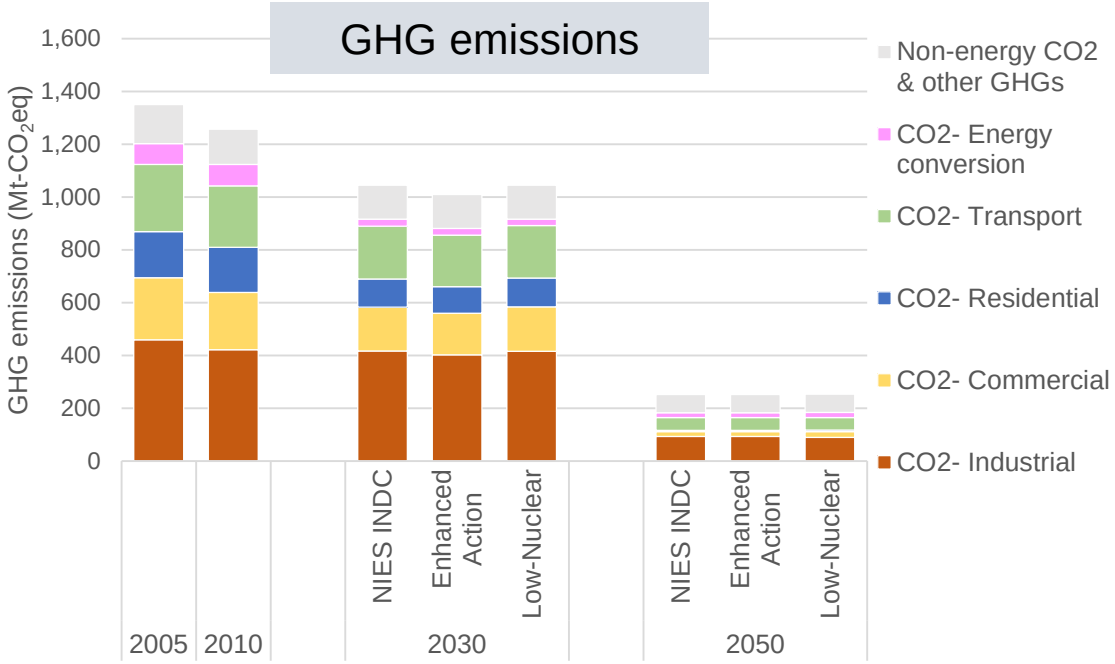




Result 3) Consistency between INDC and 2050 target

GHG emissions by 2050

- INDC-80% pathway by 2050 appears technically feasible with energy efficiency and low-carbon energies including CCS. However, rapid reduction is required in this period.
- In the Enhanced Action Scenario, carbon prices in 2030 is increased to 220 US$/t-$CO_2$, however, the effort to achieve 80% target could be reduced.

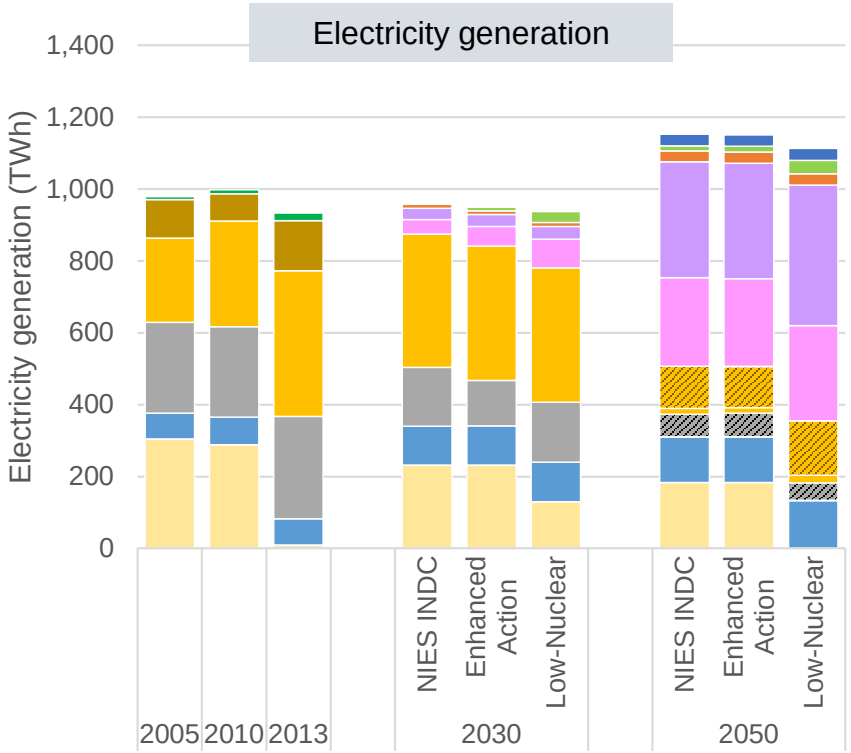


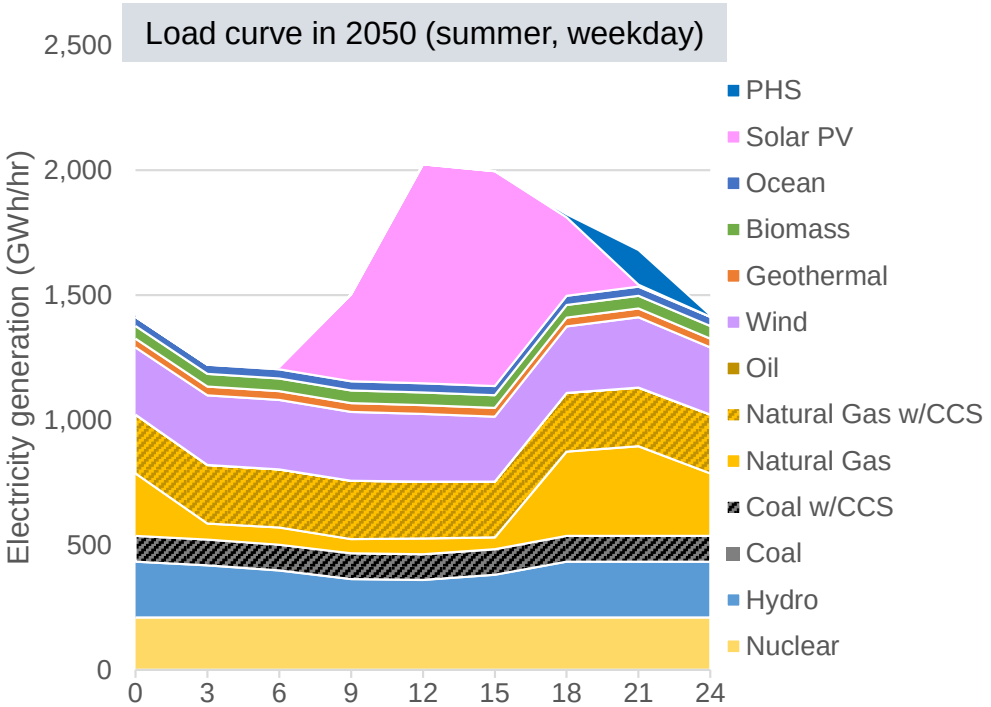
Carbon Prices (US$/t-$CO_2$)

Scenario	2030	2050
INDC Scenario	187	523
Enhanced Action Scenario	220	514
Low-Nuclear Scenario	236	631

Energy system transformation in supply side by 2050

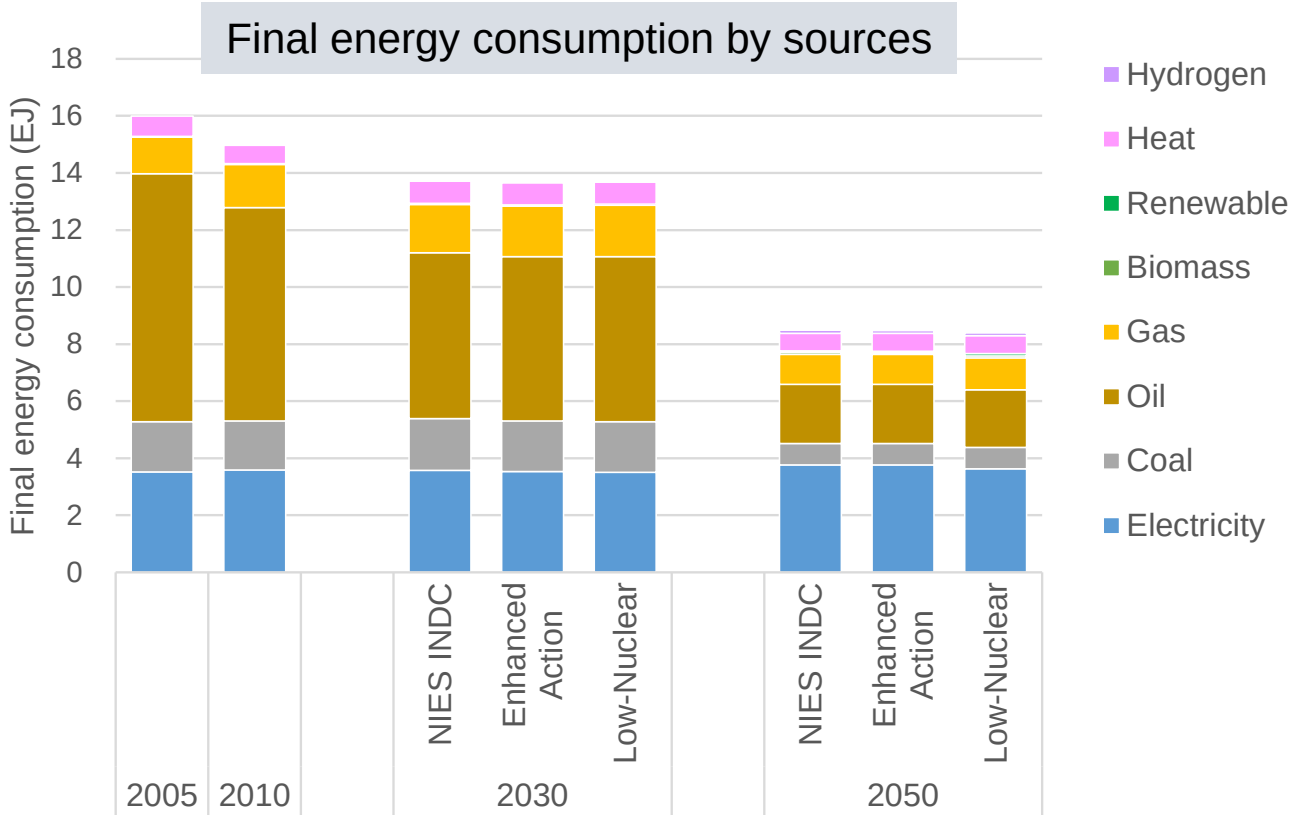
- INDC-80% pathways require substantial energy system transformation, especially challenges to decarbonize electricity by low carbon energies (renewable, nuclear, and CCS)
- Because of large scale diffusion of solar PV and wind power, additional efforts to integrate VREs are required





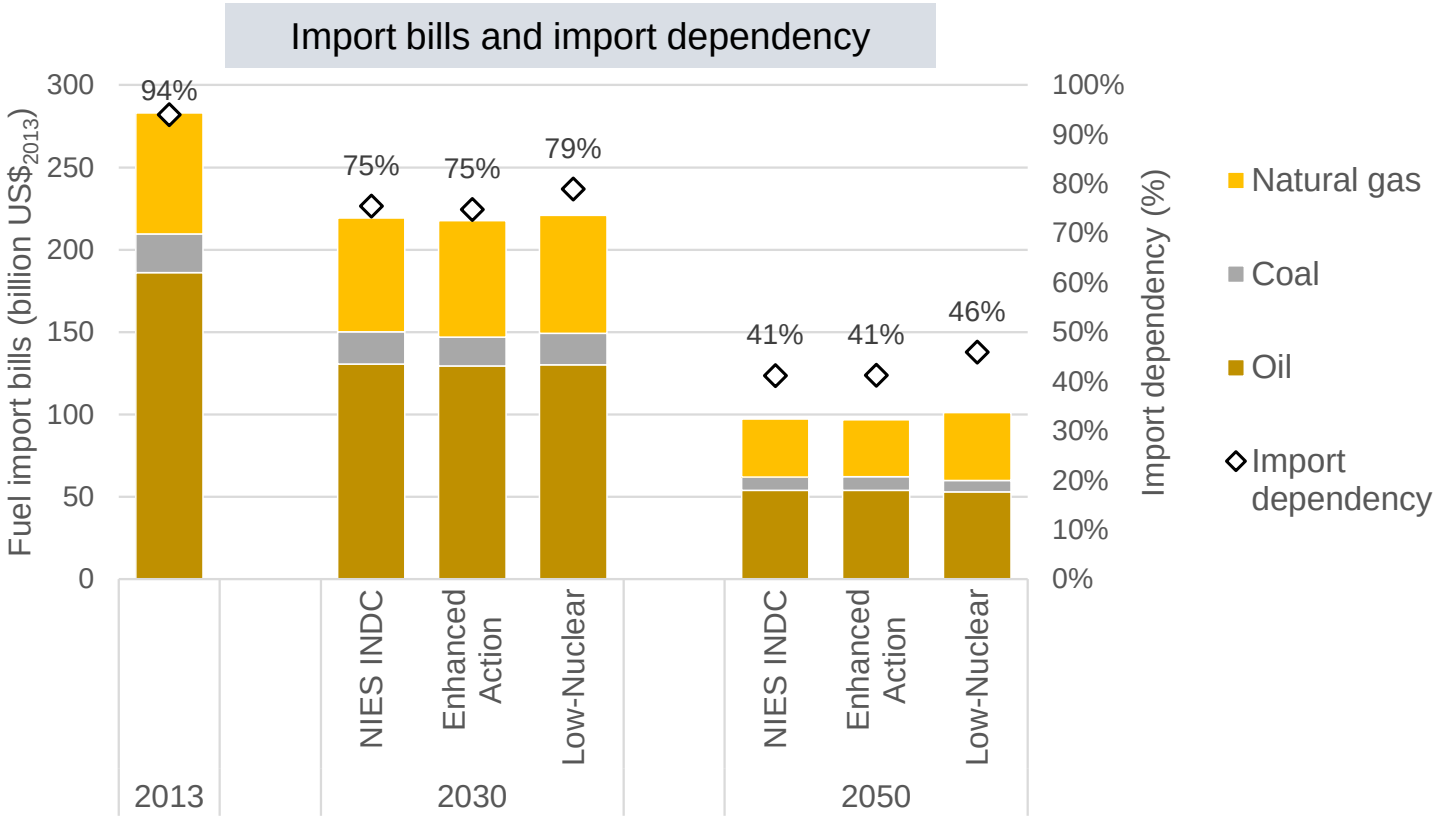
Energy system transformation in demand side by 2050

- Between 2030 and 2050, FEC is reduced by approx. 40%.
- Electrification in demand side contributes to reducing CO_2 emission largely, coupled with decarbonization of electricity.



Co-benefit: import dependency and import bills

- Due to energy system transformation by 2050:
  - ➢ Import dependency is reduced by a half of PES by 2050
  - ➢ Import bills falls to approx. 100 billion US$ by 2050



* Nuclear power is accounted as a domestic production complied with the IEA statistics

Conclusions

- Japan's INDC requires energy efficiency improvement and promotion of renewable energies.
  Carbon price in 2030 rises to 187 US$/t-$CO_2$.

- In Low-Nuclear Scenario, additional deployment of renewable and natural gas are required to meet the INDC target.
  In this case, carbon price in 2030 rises to 236 US$/t-$CO_2$.

- INDC-80% pathways are technically feasible, however, they require the challenges to transform energy systems between 2030 and 2050.

- Energy system transformation could contribute to enhancing energy security indicators, even with low dependency on nuclear power in the long-term.

Thank you for your attention

- MILES Project 2015 Synthesis Report

Spencer, T., Pierfederici, R. et al. (2015). Beyond the numbers: understanding the transformation induced by INDCs, Study N° 05/15, IDDRI – MILES Project Consortium, Paris, France, 80 p.
http://www.iddri.org/Projets/MILES-(Modelling-and-Informing-Low-Emission-Strategies)

- DDPP Japan 2015 Report

Kainuma, M. et al. (2015). Pathways to deep decarbonization in Japan, SDSN - IDDRI.
http://deepdecarbonization.org/wp-content/uploads/2015/09/DDPP_JPN.pdf