Scenario analysis on mid-century low emission pathways in Japan

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July 17, 2018. LCS-RNet 10th Annual Meeting, Yokohama

Japan's mid- to long-term mitigation targets

1997
- COP3, Kyoto: 6% reduction between 2008-2012 (wrt. 1990)

2007
- Former prime minister, Mr. Abe announced Cool Earth 50: 50% reduction by 2050 globally (May)

2008
- Mr. Fukuda: 60-80% reduction by 2050 (June)
- G8 Toyako Summit: at least 50% reduction by 2050 (July)

2009
- Mr. Aso: 15% reduction by 2020 (wrt. 2005) (June)

(2009.9 Change of administration)
- Mr. Hatoyama: 25% reduction by 2020 (wrt. 1990) (September)

2010

2011

(2011.3 the Great East Japan Earthquake)

2012
- The 4th Basic Environmental Plan (April)
- The Innovative Strategy for Energy and the Environment: about 20% reduction by 2030 (wrt. 1990) (September)

(2012.2 Change of administration)

2013
- Global Warming Countermeasures to implement Cancun Agreements: 3.8% reduction by 2020 (wrt. 2005) (November)

2014

2015
- INDC: 26.0% reduction by 2030 (wrt. 2013) (July)

2016
- The Plan for Global Warming Countermeasures: 80% reduction by 2050 (May)

20xx
- The Long-term Low Greenhouse Gas Emissions Development Strategies

Mid-term Target Committee (The Cabinet)

Task Force on Global Warming (The Cabinet)

Mid- and Long-Term Roadmap subcommittee (Central Environment Council)

Energy and Environment Council (Council on National Strategy and Policy)

Review Committee on measures and strategies adopted during or after 2013 (Central Environment Council)

Subcommittee on Fundamental Issues (Advisory Committee on Natural Resources and Energy)

Subcommittee on Global Warming Measurement after 2020 (Central Environment Council)

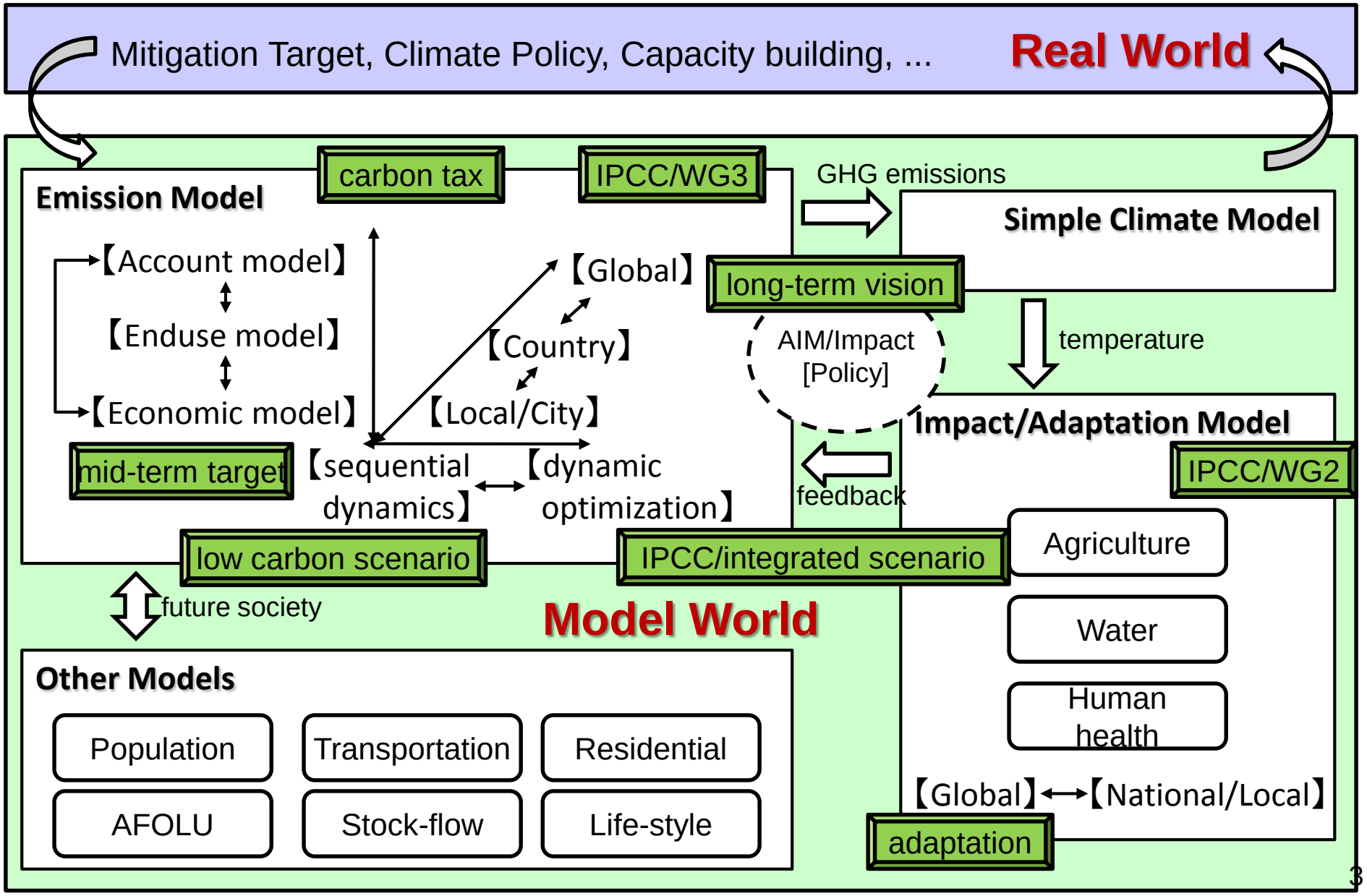
INDC WG (Industrial Structure Council)

Round Table on the Long-term Climate Change Strategy (Ministry of Environment)

Subcommittee on the Long-term Low Carbon Vision (Central Environment Council)

Platform on the Long-term Global Warming Countermeasures (Industrial Structure Council)

Overview of AIM



Decarbonization scenario analysis in Japan using AIM/Enduse

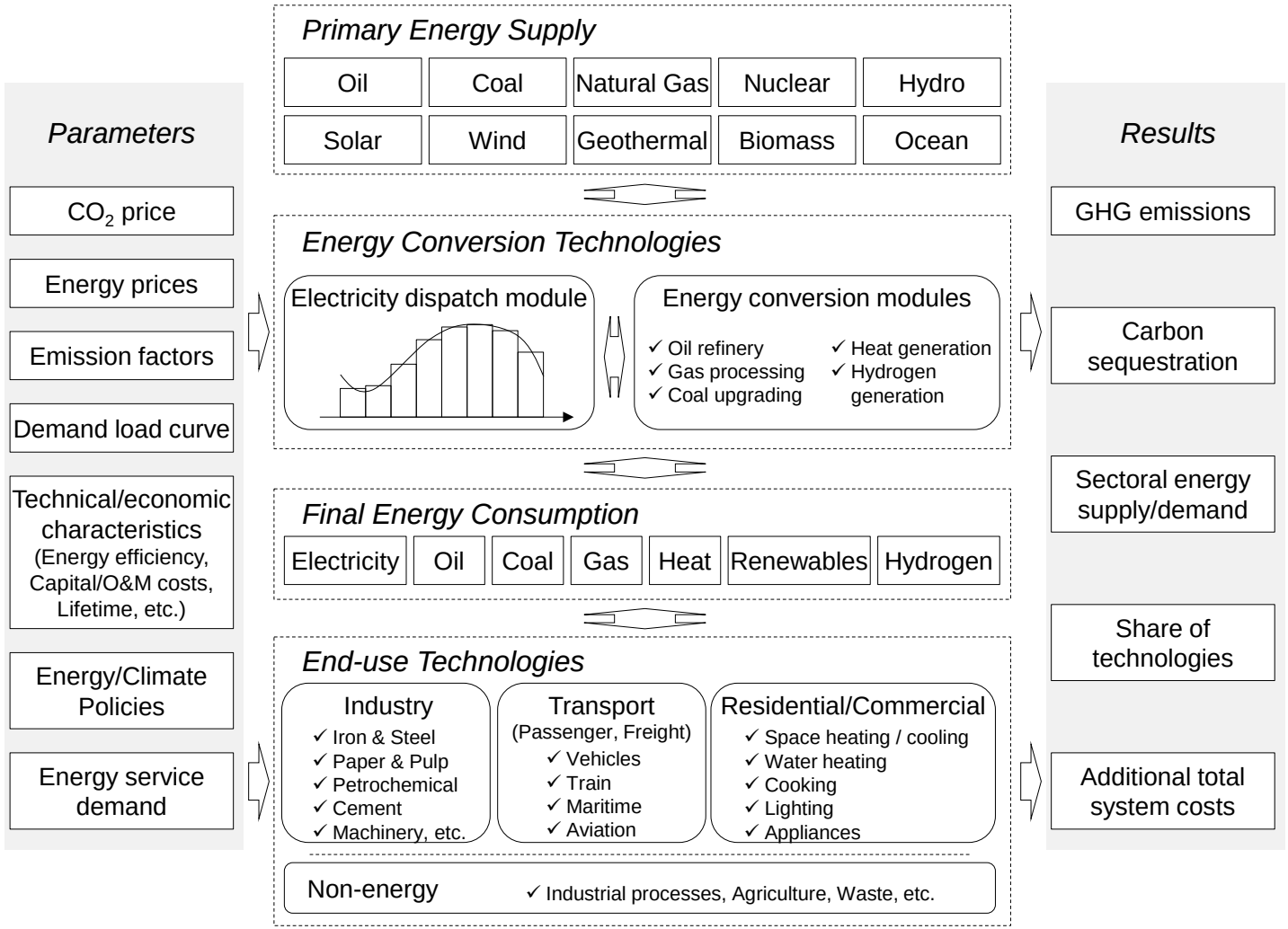
1. Scenario analysis on the NDC and 2050 goal in Japan
   - NDC (-26% in 2030) and the 2050 goal (-80% in 2050)

2. Assessment of net-zero emission pathways by 2050
   - Mid-century pathways corresponding to the 1.5^{o}C goal

3. Mid-century pathways consistent with the well-below 2^{o}C target
   - Multi-model analysis on national pathways under the WP3 of CD-LINKS

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



1. Scenario analysis on the NDC and 2050 goal

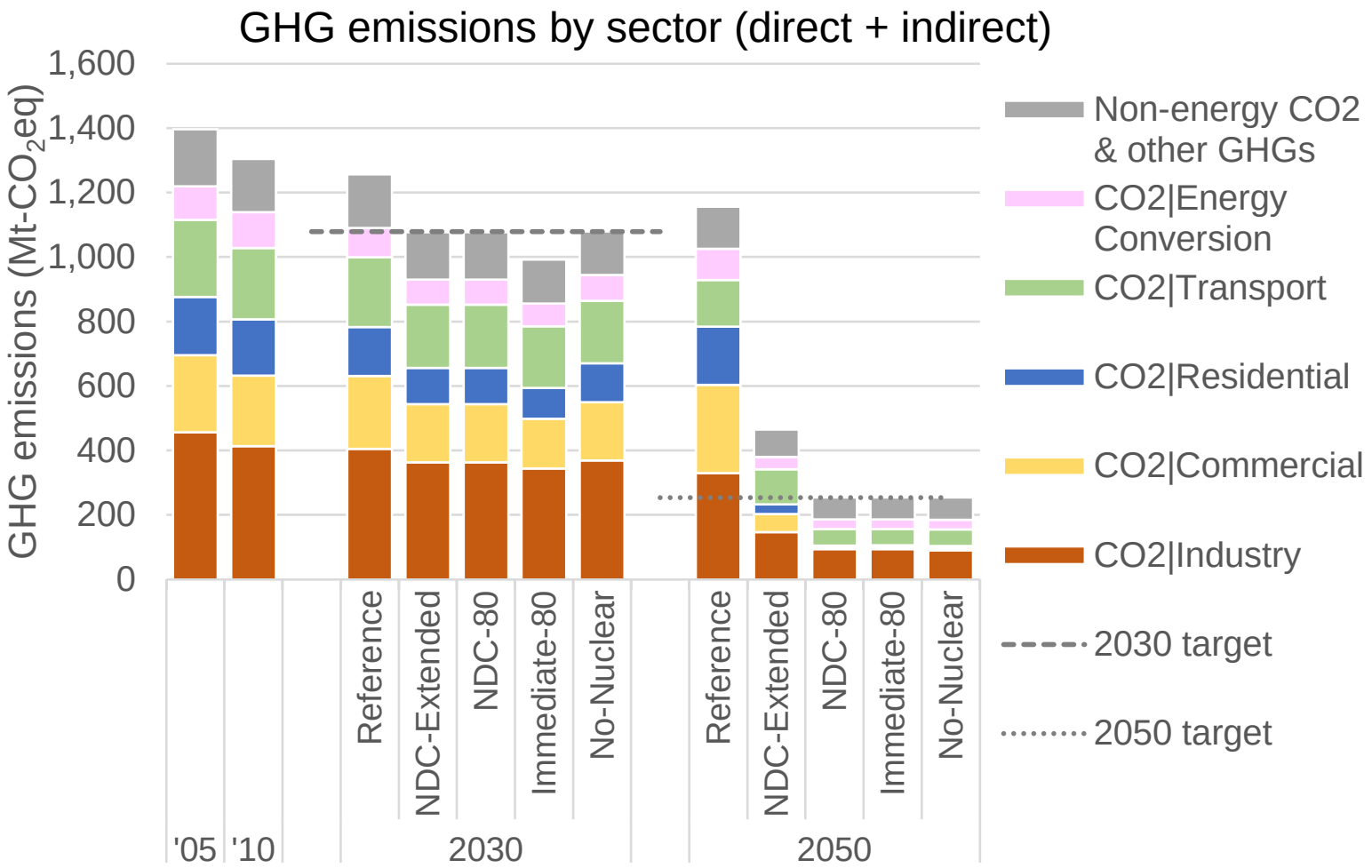
- Japan submitted its INDC on July 2015, which is to reduce GHG emissions by 26.0% in 2030 below the 2013 level.
- According to the Plan for Global Warming Countermeasures published on May 2016, Japan aims to reduce greenhouse gas emissions by 80% by 2050 as its long-term goal.
- However, quantitative 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].

Cases

1. Reference
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.

GHG emissions by sector

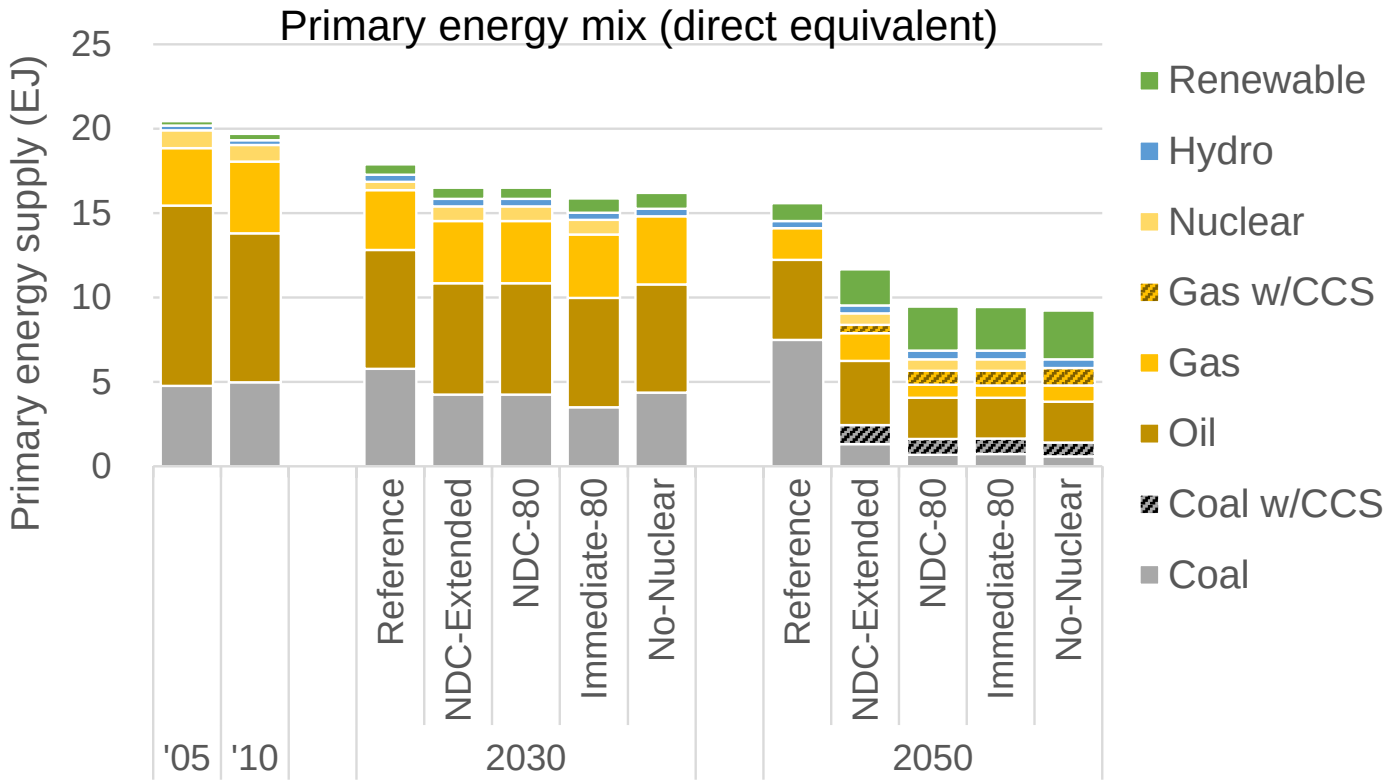
- Residential and commercial sectors are almost decarbonized in 2050 to meet the 2050 target.



Oshiro, K., Masui, T., Kainuma, M. (2017). Energy Policy.

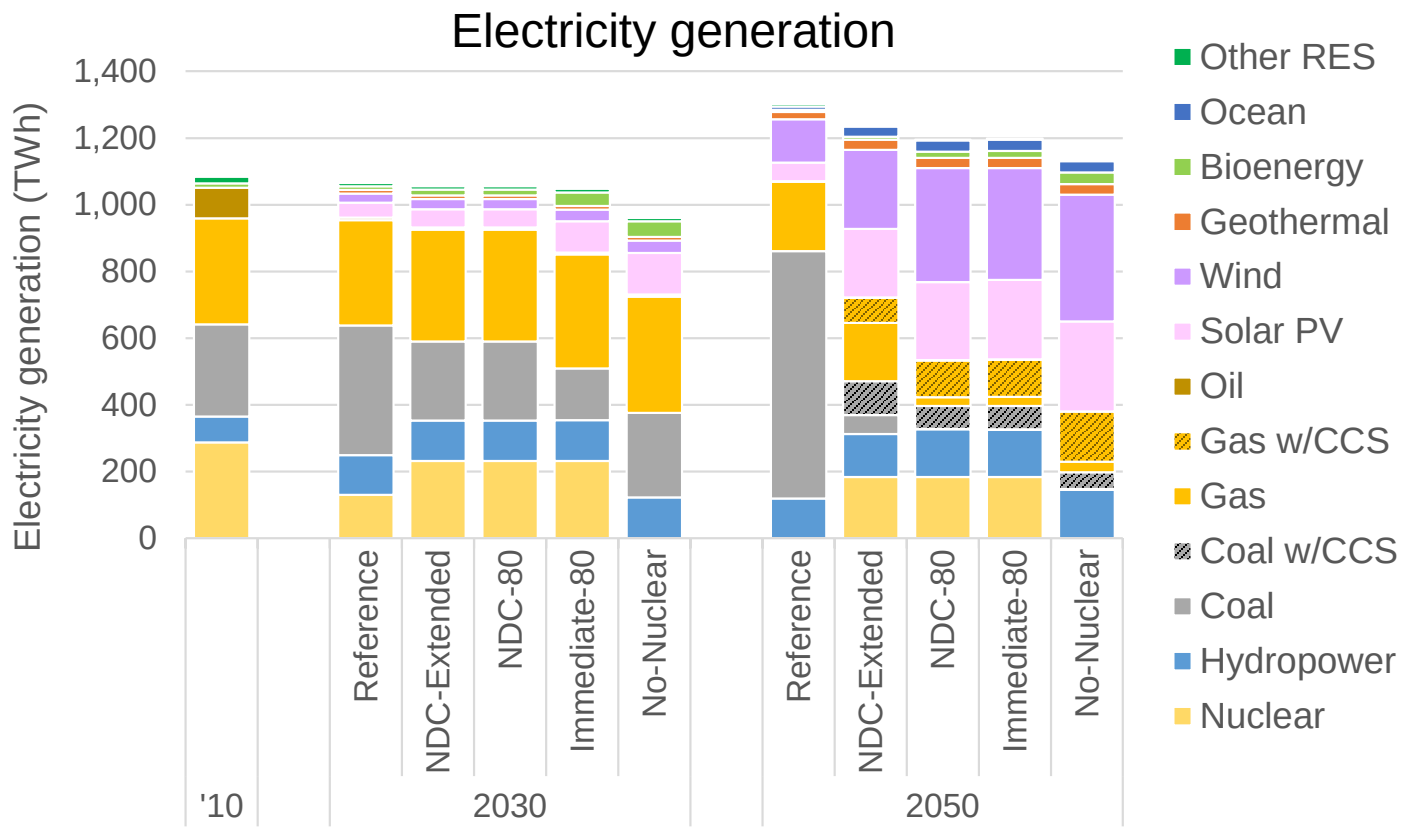
Primary energy mix

- 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



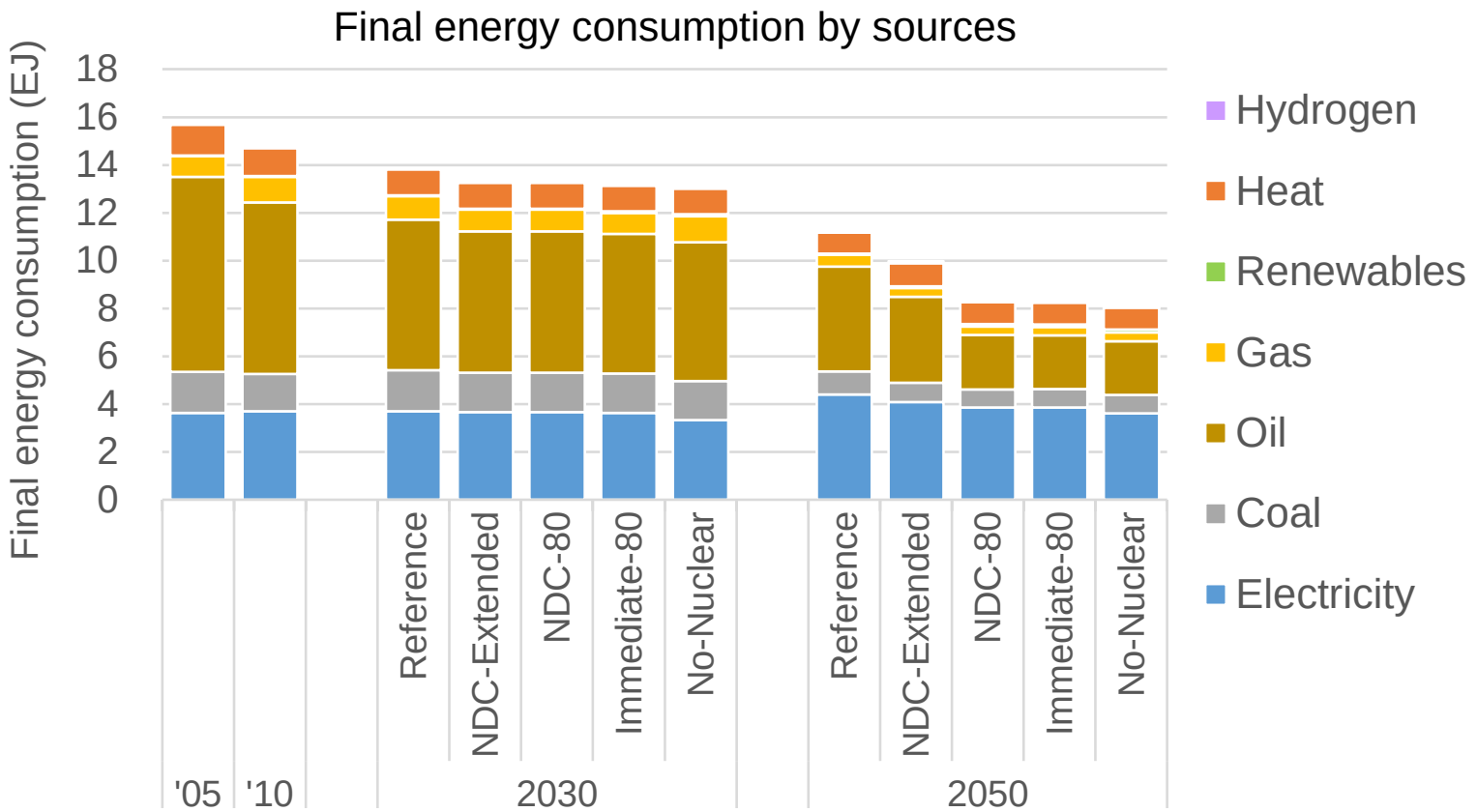
Electricity supply

- 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



Key insights from the NDC and 2050 goal assessments

- 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.

2. National zero-emission pathway by 2050 in Japan

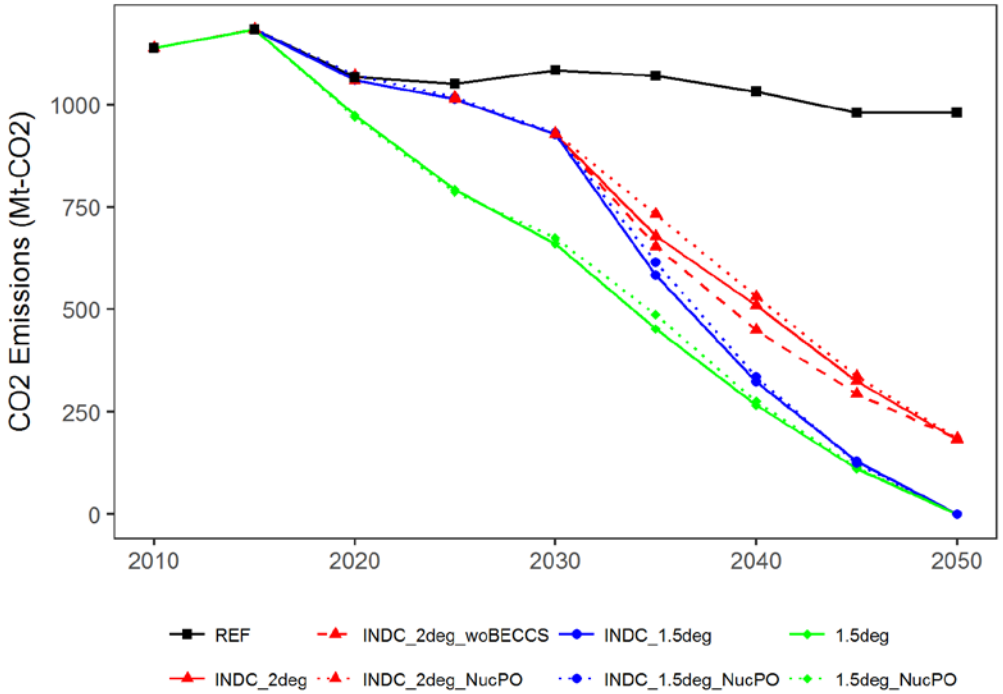
- According to the previous studies on global 1.5ºC pathways, CO_2 emissions needs to be net-zero around 2050 globally (Rogelj et al. (2015)).
- Assessing national net-zero emission pathways by 2050 using AIM/Enduse [Japan], mainly focusing on:
  - difference of energy system transformation with the 2ºC scenario (80% reduction by 2050)
  - the role of technologies, such as negative emission and nuclear
- BECCS was added to the technology options in AIM/Enduse[Japan]

Oshiro, K., Kainuma, M., & Masui, T. (2017). Transformation of Japan's energy system to attain net-zero emission by 2050. Carbon management, (in press)

Net-zero emission pathways in Japan

- BECCS is required in zero-emission. 80% reduction is achievable without BECCS
- Phase-out of nuclear power would not compromise zero-emission
- If following the NDC, drastic emission reduction is required after 2030
- Zero emission pathway results steep rise in CO_2 price, more than 2,000 US$/t-$CO_2$ in 2050

CO_2 emissions, energy

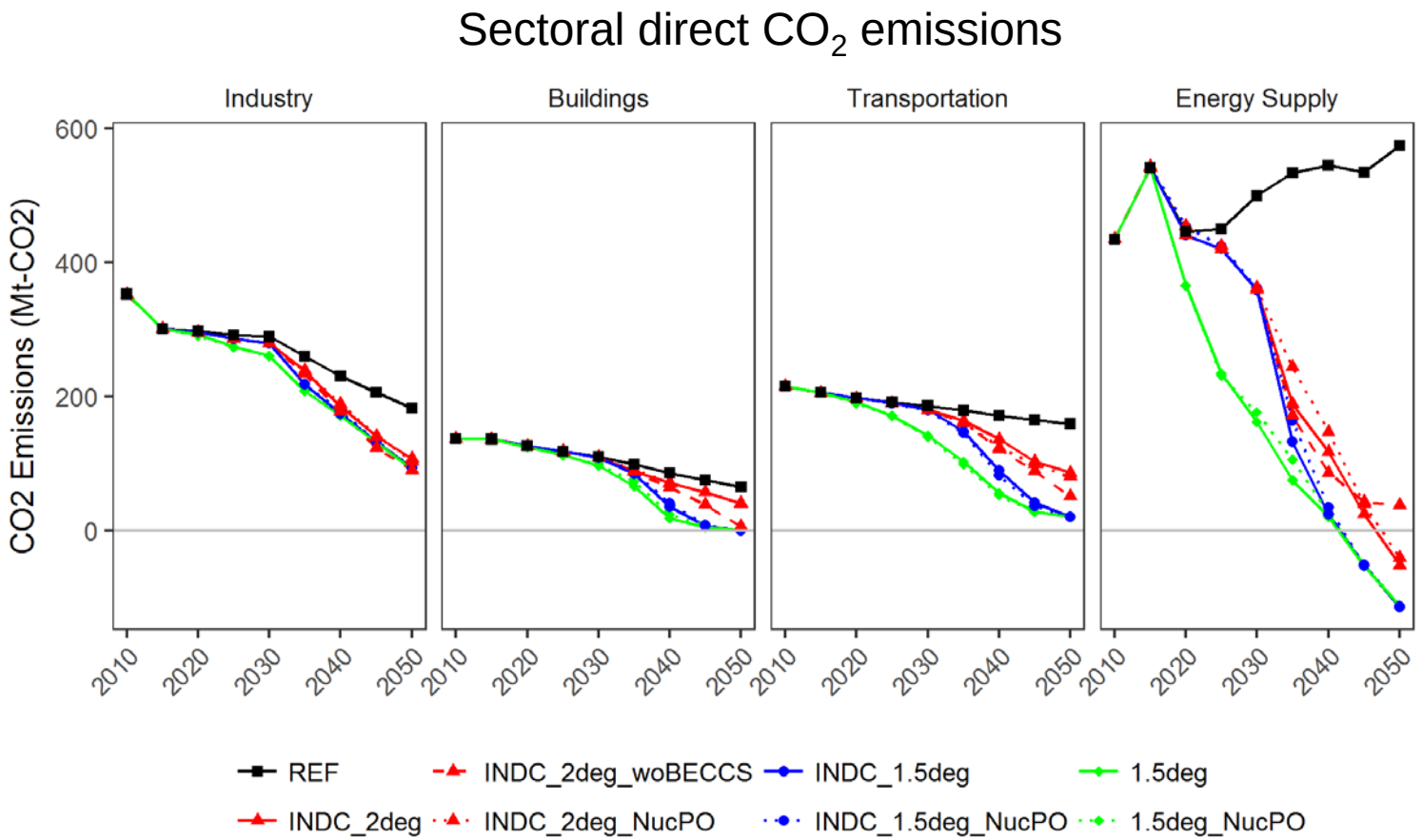


CO_2 price (US$/t-$CO_2$)

Emission constraint	Technology availability		
	Full	w/o BECCS	Nuclear phase-out
Ref	0		
INDC-2deg	520	860	570
INDC-1.5deg	2,490	-	3,150
1.5deg	2,200	-	2,640

Sectoral challenges to zero emission

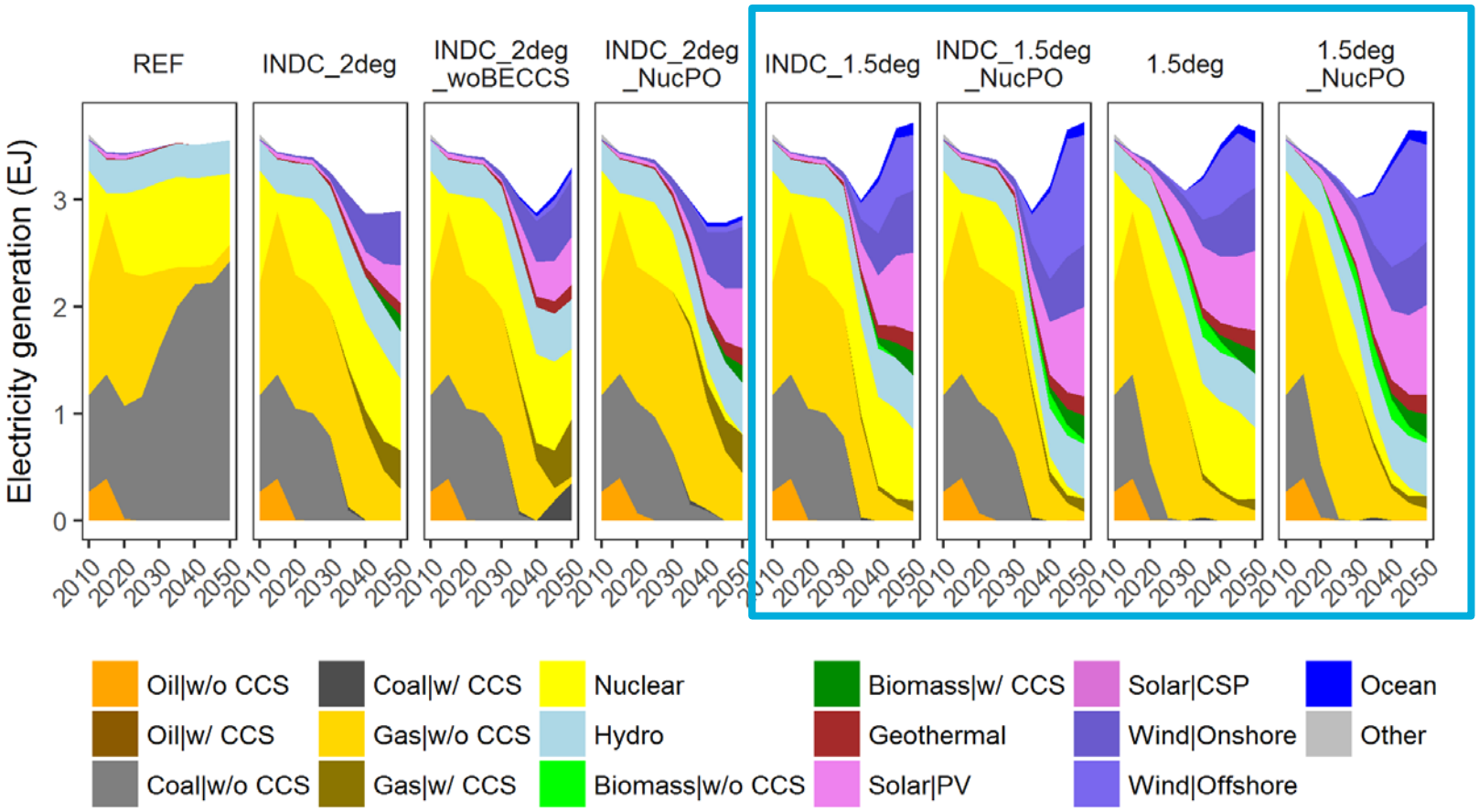
- Power sector requires large-scale transformation.
- Difference between net-zero and 80% reduction is moderate in the buildings and industry sector.
- Buildings sector needs to be almost decarbonized even in 80% reduction.



Energy system transformation in power sector

- Dependence on VREs, such as solar and wind, as well as BECCS.
- Given phase-out of nuclear, challenges to integrate VREs are exacerbated.

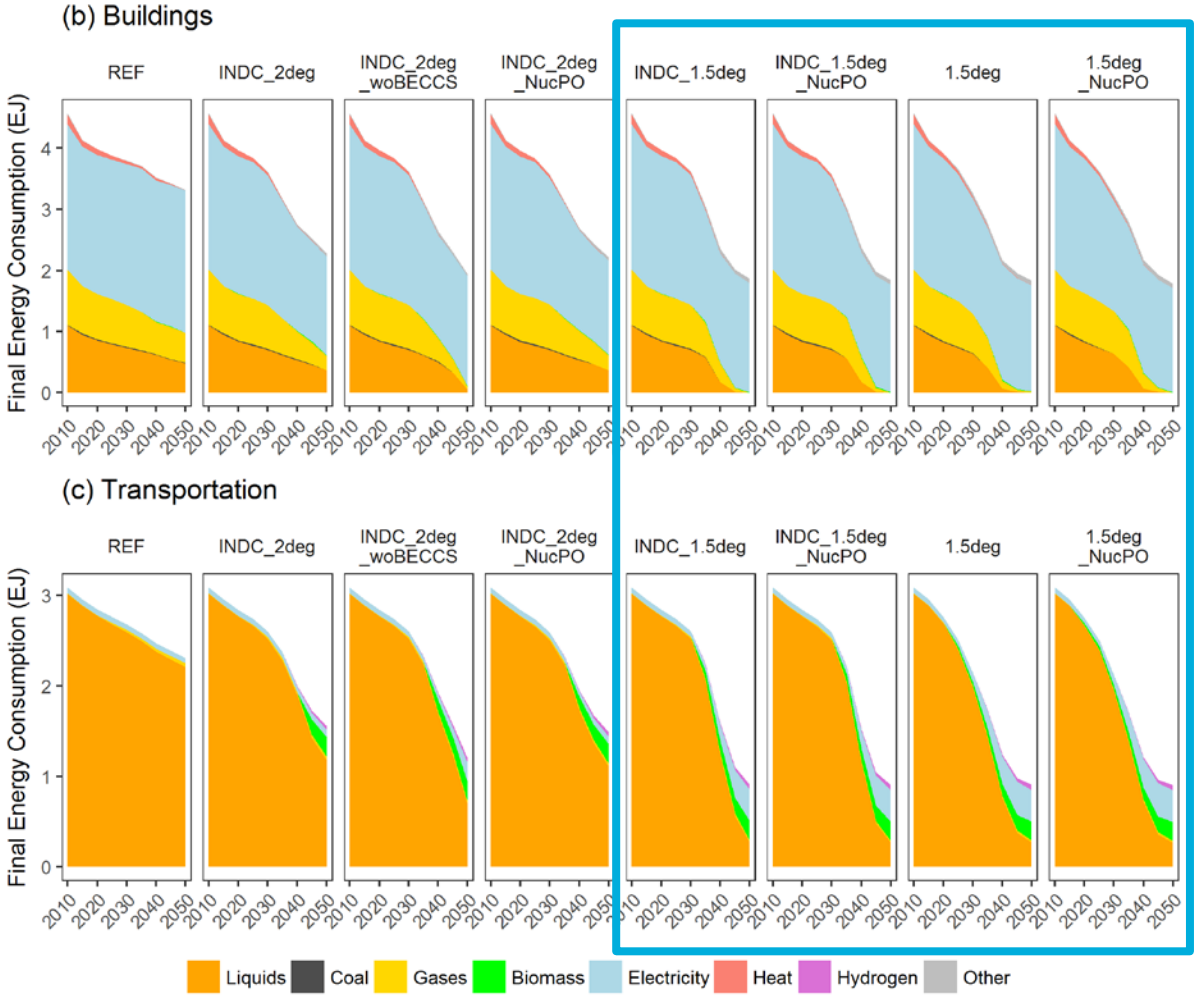
Electricity generation



Energy system transformation in energy demand sectors

- Buildings sector: completely electrified by 2050 even in the 80% reduction
- Transport sector: switch to BEV and FCEV

Final energy demand by sources in the buildings and transportation sectors



Conclusions

- Three pillars of decarbonization are confirmed both in the 2^{o}C and 1.5^{o}C scenarios; energy efficiency, decarbonizing electricity, and switch to low-carbon carriers.

- National mitigation pathways corresponding to the 1.5^{o}C goal require to enhance mitigation efforts, especially in the energy supply sectors.

- These key pillars are robust across different models, however there is wide variation in the options for energy system transformation.

Acknowledgements: This research was supported by the Environment Research and Technology Development Fund (2-1702) of the Environmental Restoration and Conservation Agency.