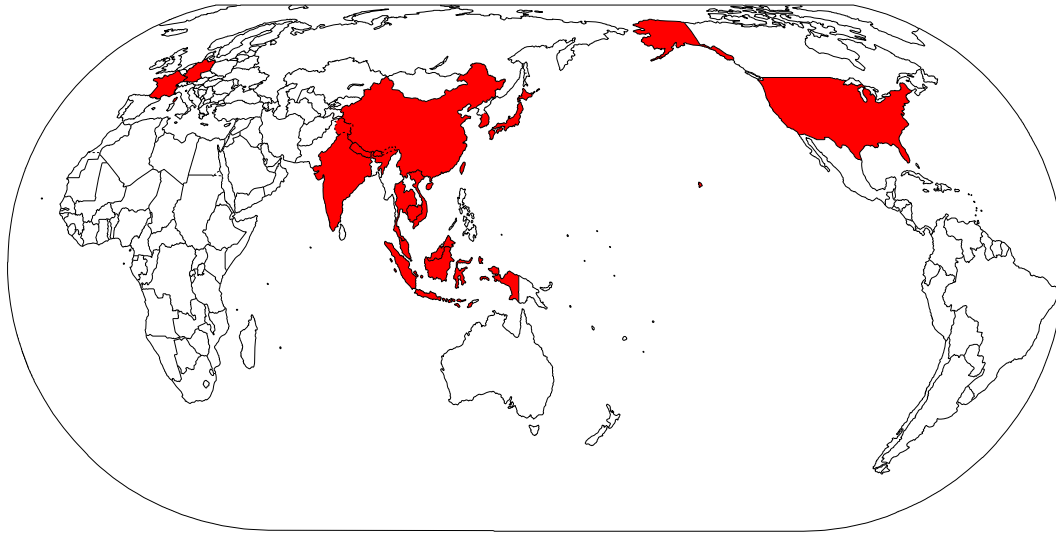# Net-zero emission pathways in Japan assessed by AIM/Enduse

Toshihiko Masui (National Institute for Environmental Studies)
Ken Oshiro (Kyoto Univ.)

Session 2: Net-zero emissions pathways
APERC Annual Conference 2019
Grand Prince Hotel New Takanawa, Tokyo, Japan
15 May 2019

Asia-Pacific Integrated Model
http://www-iam.nies.go.jp/aim/index.html

AIM
ASIA-PACIFIC INTEGRATED MODEL

NIES *JAPAN*

International Network of AIM (Asia-Pacific Integrated Model)

The 24th AIM International Workshop @NIES, Japan, Nov 5-6, 2018

- Asian economies will update their mitigation target and roadmap to achieve the 2/1.5 degree target reflecting their issues to be solved and the resources to be endowed.

- Model can be a collaboration tool between science and decision making process. From the long-term viewpoint, each economy will need the capacities to develop model and scenarios by itself.

- AIM (Asia-Pacific Integrated Model) has supported Asian economies to develop the integrated assessment model and their long-term low carbon scenarios.

- In detail, please visit our website; http://www-iam.nies.go.jp/aim/index.html

In addition to AIM International Workshop, activities on capacity building in Asia are our important works.

Provision of AIM/CGE at Workshop on carbon neutral development in Bhutan on May 17 & 18, 2018

Training workshop on AIM/Enduse at SIIT, Thammasat Univ. from June 11 to 15, 2018 (10 Participants from 2 economies)

Training workshop on AIM/CGE at SIIT, Thammasat Univ. from June 26 to July 5, 2018 (7 participants from 3 economies)
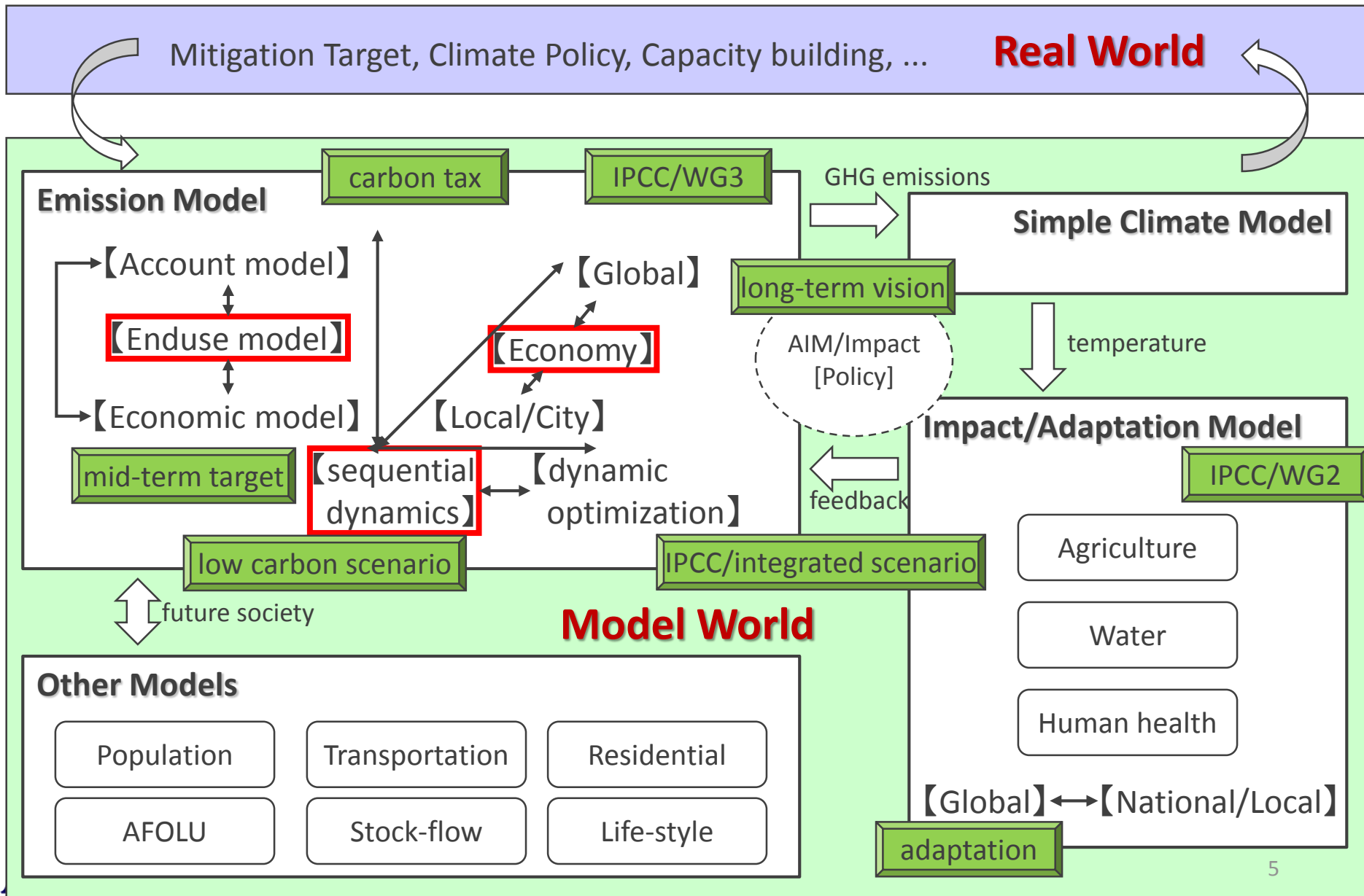
Toward low carbon society, AIM team contributes to several international activities such as DDPP, CD-Links and other international model comparisons

Overview of AIM (Asia-Pacific Integrated Model)

Mitigation Target, Climate Policy, Capacity building, ... **Real World**

Emission Model

carbon tax   IPCC/WG3   GHG emissions

【Account model】   【Global】

【Enduse model】   【Economy】

Simple Climate Model

long-term vision

AIM/Impact [Policy]

temperature

【Economic model】   【Local/City】

Impact/Adaptation Model

mid-term target   【sequential dynamics】 ⟷ 【dynamic optimization】

IPCC/WG2

feedback

low carbon scenario   IPCC/integrated scenario

Agriculture

future society

Model World

Water

Other Models

| Population | Transportation | Residential |
| AFOLU | Stock-flow | Life-style |

Human health

【Global】⟷【National/Local】

adaptation

5

Overview of AIM/Enduse

Energy	Energy Technology	Energy Service
• Coal • Oil • Gas • Renewables • Electricity	• Blast furnace • Power generation • Air conditioner • Fluorescent • Automobile	• Crude steel production • Electricity demand • Demand for heating and cooling • Lighting • Passenger, freight transport

Flow of real world →

← **Flow of simulation**

Energy Consumption CO_2 emission	←	Technology Selection	←	Energy Service Demand

Energy Database	Technology Database	Socio-economic scenarios
• Energy type • Energy price • Energy constratins • CO_2 emission factor	• Technology cost (Initial cost, running cost) • Energy consumption • Service supply • Diffusion rate • Lifetime	• Population growth • Economic growth • Industrial structure • Employment • Lifestyle

AIM
ASIA-PACIFIC INTEGRATED MODEL

6

GHG emissions in Japan; trend and future targets

Source: GIO, NIES   http://www-gio.nies.go.jp/aboutghg/nir/nir-j.html
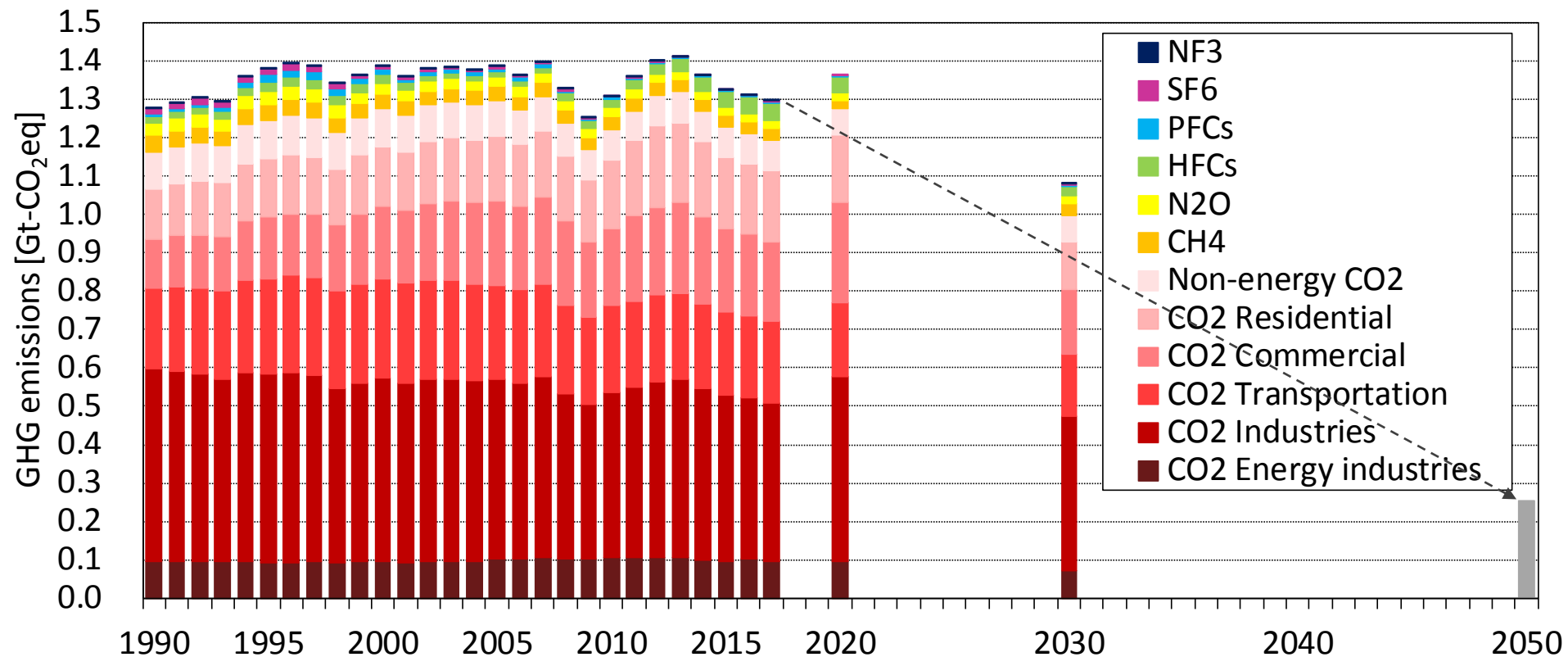
Zero-emission pathway by 2050 in Japan

- According to the previous studies on global 1.5^{o}C 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 2°C scenario (80% reduction by 2050)
  - the role of technologies, such as negative emission and nuclear

- BECCS is added to the technology options in AIM/Enduse[Japan]

- Oshiro, K., Kainuma, M., & Masui, T. (2018). Transformation of Japan's energy system to attain net-zero emission by 2050. Carbon management 9(5), https://doi.org/10.1080/17583004.2017.1396842,

Taylor & Francis

Carbon Management

ISSN: 1758-3004 (Print) 1758-3012 (Online) Journal homepage: http://www.tandfonline.com/loi/tcmt20

Transformation of Japan's energy system to attain net-zero emission by 2050

Ken Oshiro, Toshihiko Masui & Mikiko Kainuma

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

CO_2 emissions, energy
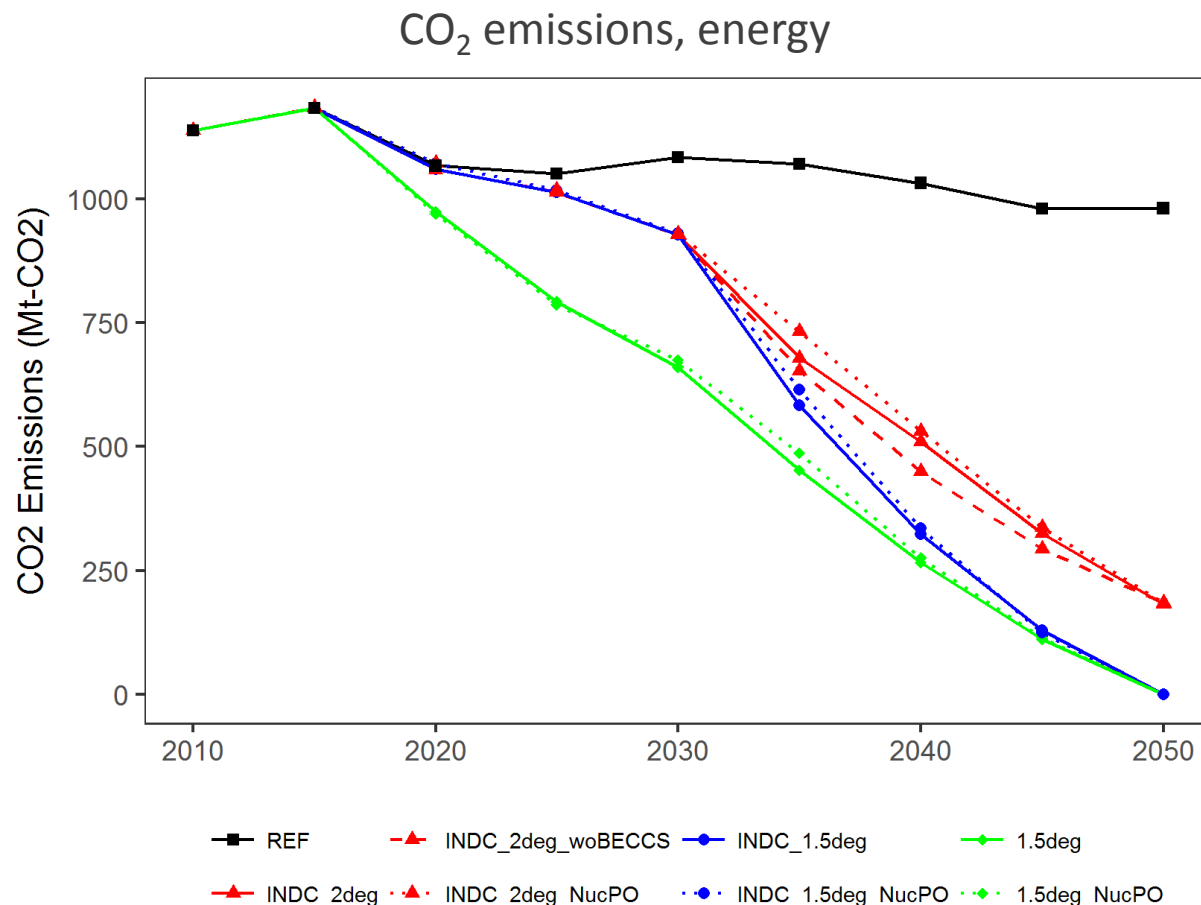
Sectoral strategies to zero emission in Japan

- Power sector needs to be largely transformed, including net-negative.
- Difference between net-zero and 80% reduction is moderate in the buildings and industry sector.
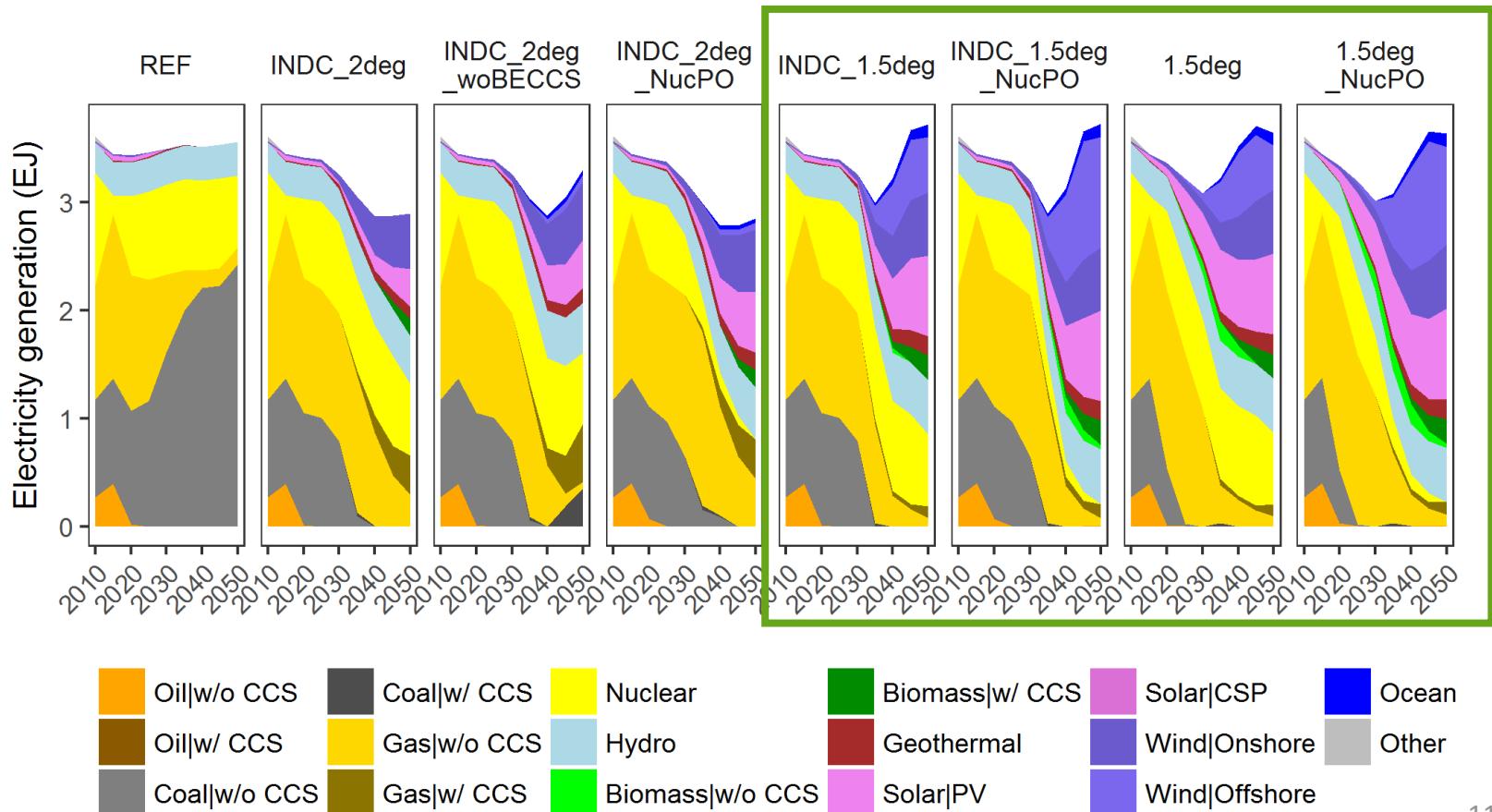- Buildings sector needs to be almost decarbonized even in 80% reduction.

Sectoral direct CO_2 emissions
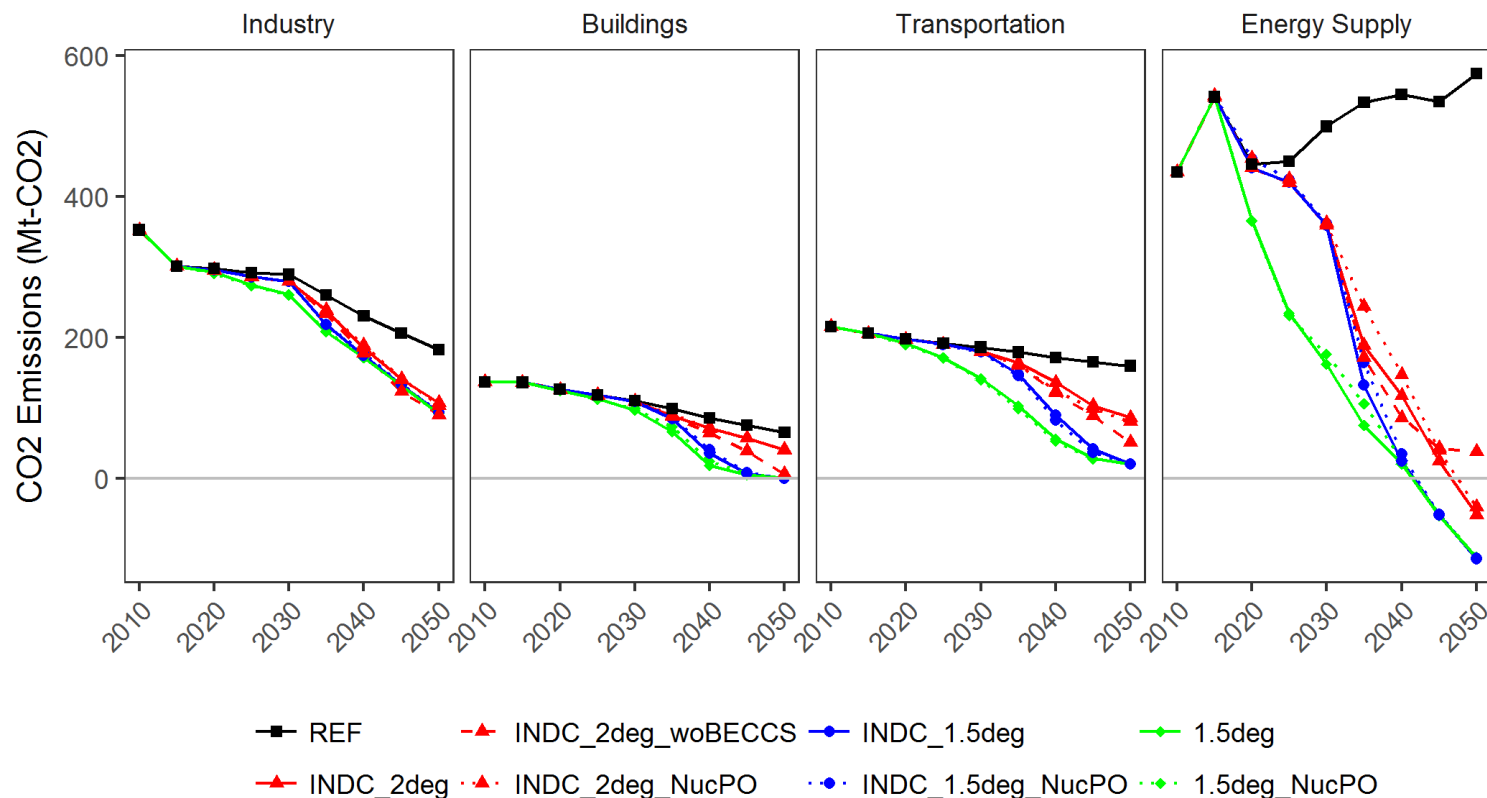
Energy system transformation in power sector

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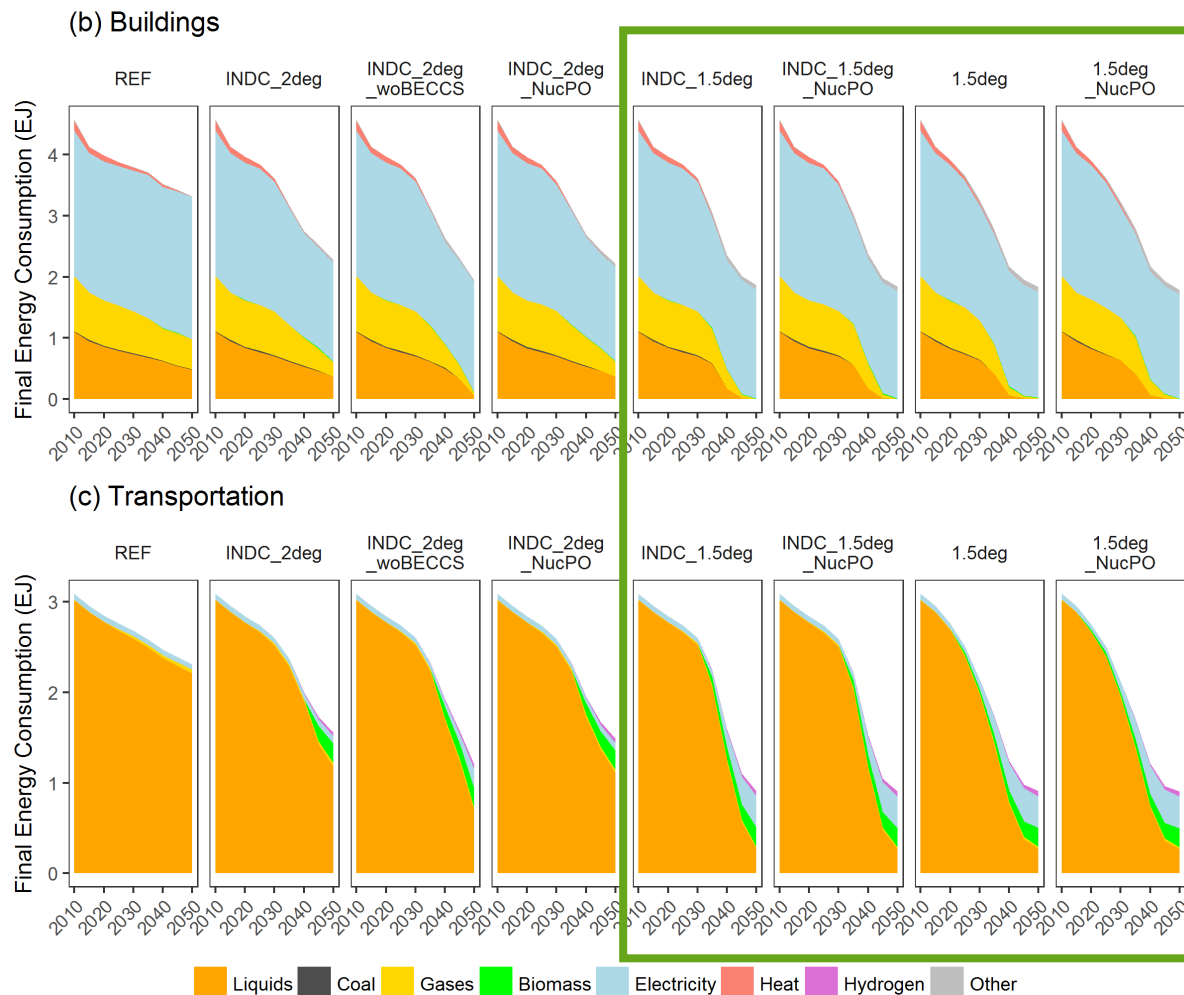

Electricity generation

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

Compared with EU net-zero emission scenarios

|	Electrification (ELEC)	Hydrogen (H2)	Power-to-X (P2X)	Energy Efficiency (EE)	Circular Economy (CIRC)	Combination (COMBO)	1.5°C Technical (1.5TECH)	1.5°C Sustainable Lifestyles (1.5LIFE)
Main Drivers	Electrification in all sectors	Hydrogen in industry, transport and buildings	E-fuels in industry, transport and buildings	Pursuing deep energy efficiency in all sectors	Increased resource and material efficiency	Cost-efficient combination of options from 2°C scenarios	Based on COMBO with more BECCS, CCS	Based on COMBO and CIRC with lifestyle changes
GHG target in 2050	-80% GHG (excluding sinks) ["well below 2°C" ambition]					-90% GHG (incl. sinks)	-100% GHG (incl. sinks) ["1.5°C" ambition]	
Major Common Assumptions	• Higher energy efficiency post 2030 • Deployment of sustainable, advanced biofuels • Moderate circular economy measures • Digitilisation				• Market coordination for infrastructure deployment • BECCS present only post-2050 in 2°C scenarios • Significant learning by doing for low carbon technologies • Significant improvements in the efficiency of the transport system.			
Power sector	Power is nearly decarbonised by 2050. Strong penetration of RES facilitated by system optimization (demand-side response, storage, interconnections, role of prosumers). Nuclear still plays a role in the power sector and CCS deployment faces limitations.							
Industry	Electrification of processes	Use of H2 in targeted applications	Use of e-gas in targeted applications	Reducing energy demand via Energy Efficiency	Higher recycling rates, material substitution, circular measures	Combination of most Cost-efficient options from "well below 2°C" scenarios with targeted application (excluding CIRC)	COMBO but stronger	CIRC+COMBO but stronger
Buildings	Increased deployment of heat pumps	Deployment of H2 for heating	Deployment of e-gas for heating	Increased renovation rates and depth	Sustainable buildings			CIRC+COMBO but stronger
Transport sector	Faster electrification for all transport modes	H2 deployment for HDVs and some for LDVs	E-fuels deployment for all modes	Increased modal shift	Mobility as a service			• CIRC+COMBO but stronger • Alternatives to air travel
Other Drivers		H2 in gas distribution grid	E-gas in gas distribution grid				Limited enhancement natural sink	• Dietary changes • Enhancement natural sink

Source: Table 1: Overview of main scenario building blocks
European Commission (2018) A Clean Planet for all; A European long-term strategic vision for a prosperous, modern, competitive and climate neutral economy
https://ec.europa.eu/clima/sites/clima/files/docs/pages/com_2018_733_analysis_in_support_en.pdf

Compared with EU net-zero emission scenarios
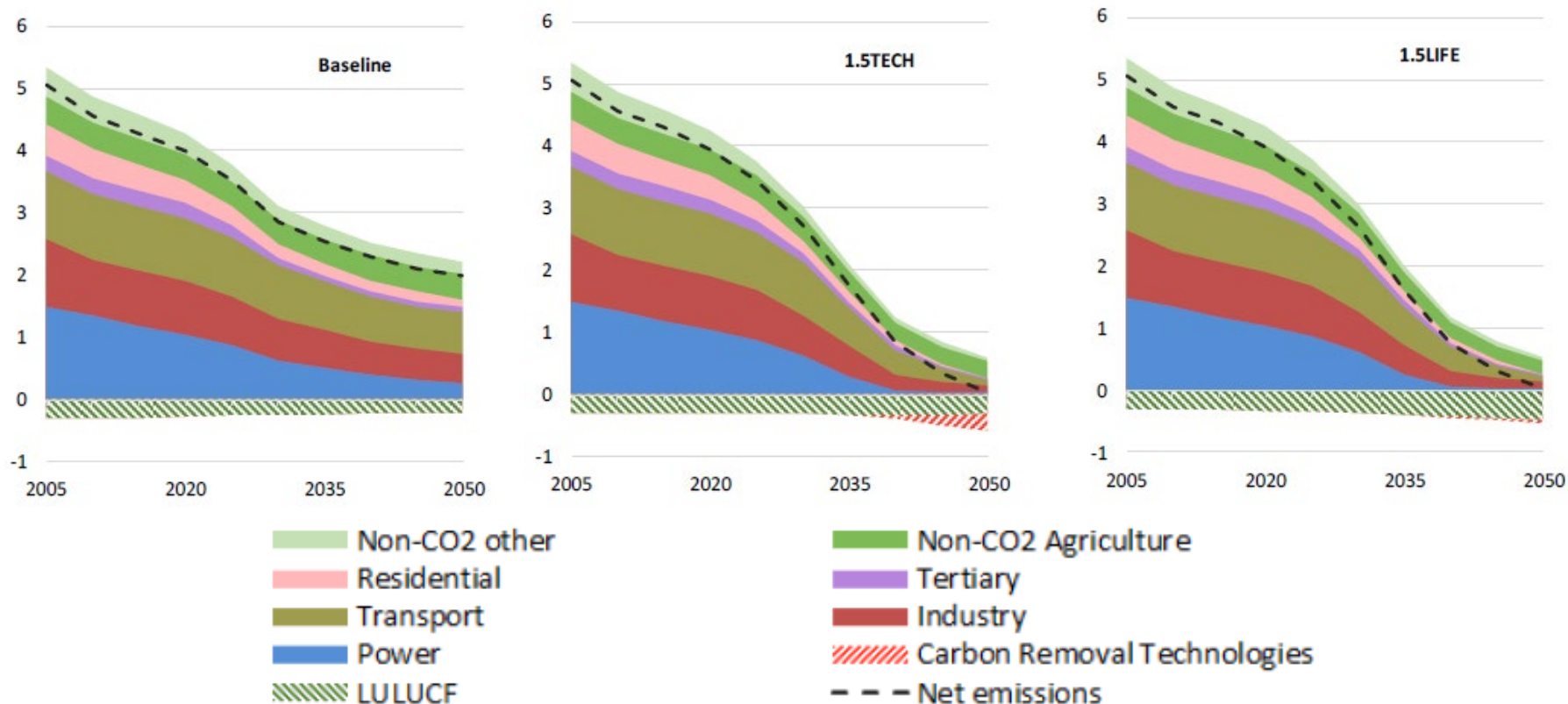
Compared to results from AIM/Enduse [Japan], EU scenarios show
- emissions from transportation will be larger, and
- emissions from industry will be smaller.

Source: 7.7 GHG Pathways towards 2050 (GtCO2eq)
European Commission (2018) A Clean Planet for all; A European long-term strategic vision for a prosperous, modern, competitive and climate neutral economy
https://ec.europa.eu/clima/sites/clima/files/docs/pages/com_2018_733_analysis_in_support_en.pdf

14

Toward net zero emission in 2050

- Among the regions/models, the roadmaps to achieve the net zero emission in 2050 are different. More detailed analysis will be needed using integrated assessment model.

- Rapid diffusion of technologies on energy efficiency improvement and renewable energy supply will be absolutely imperative.

- Not only technologies but also socio-economic condition and lifestyle will have to be changed drastically.
  -> Necessity of "Transition"

- Concrete narrative stories to realize vision and goal will be needed.
  -> Share of vision and goal with all stakeholders

- Integrated assessment model will check consistency and reality of narratives.
  -> Identification of issues