This research was performed under the Environment Research and Technology Development Fund JPMEERF20192008, JPMEERF20221002 and JPMEERF20231002 of the Environmental Restoration and Conservation Agency of Japan.

Results and Roles of Research on Decarbonization Scenario Development in Asia
アジアにおける脱炭素シナリオ開発研究の成果と役割

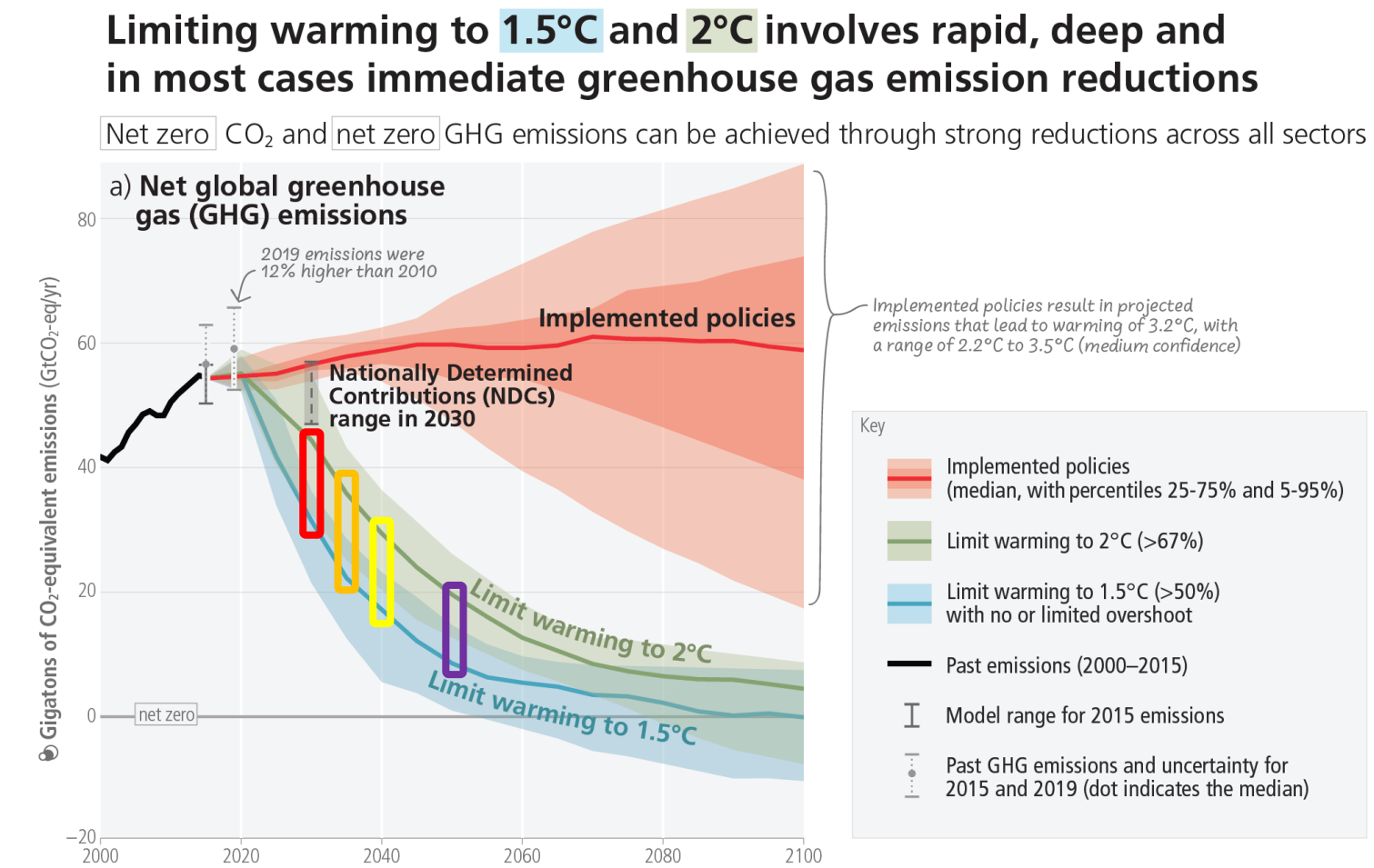
Toshihiko Masui / 増井利彦
National Institute for Environmental Studies / 国立環境研究所

To Realise "Net Zero" in Asia
～Methodologies of Support for Implementing Climate Change Mitigation Plans～
International Forum on Sustainable Asia and the Pacific (ISAP) 2024 TT-3
Online / November 27, 2024
アジアにおけるネット・ゼロの実現に向けて
～気候変動緩和策の実装化に向けた支援の方法論～
ISAP2024 持続可能なアジア太平洋に関する国際フォーラム TT-3
オンライン / 2024年11月27日

AIM ASIA-PACIFIC INTEGRATED MODEL
Asia-Pacific Integrated Model
https://www-iam.nies.go.jp/aim/index.html

NIES JAPAN

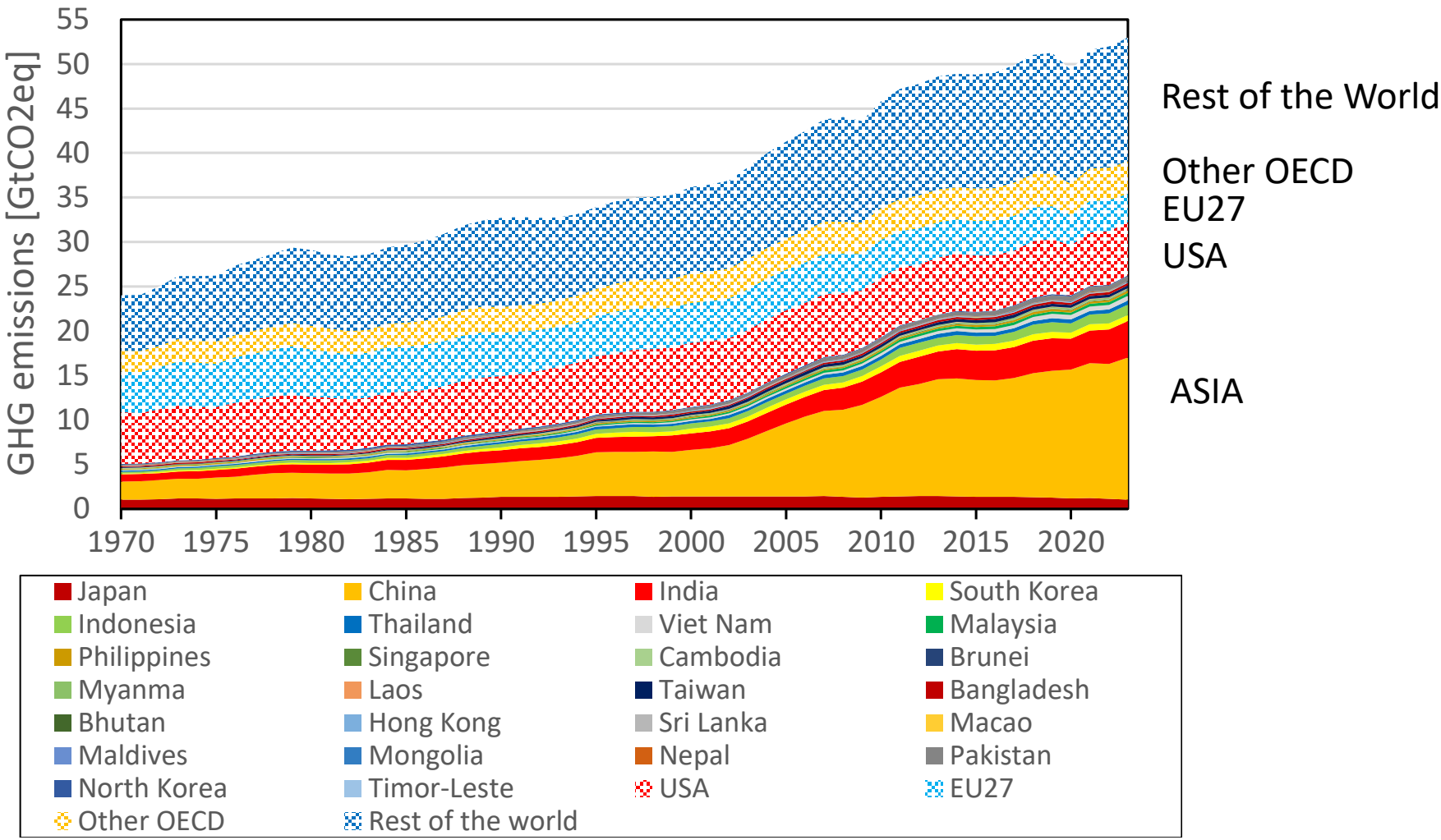
Necessary GHG reduction to achieve 1.5℃ and 2℃ targets



Reduction rate to 2019 level		2030	2035	2040	2050
Limit warming to **1.5°C** (>50%) with no or limited overshoot	**GHG**	**43 [34-60]**	**60 [49-77]**	**69 [58-90]**	**84 [73-98]**
	CO2	48 [36-69]	65 [50-96]	80 [61-109]	99 [79-119]
Limit warming to 2°C (>67%)	GHG	21 [1-42]	35 [22-55]	46 [34-63]	64 [53-77]
	CO2	22 [1-44]	37 [21-59]	51 [36-70]	73 [55-90]

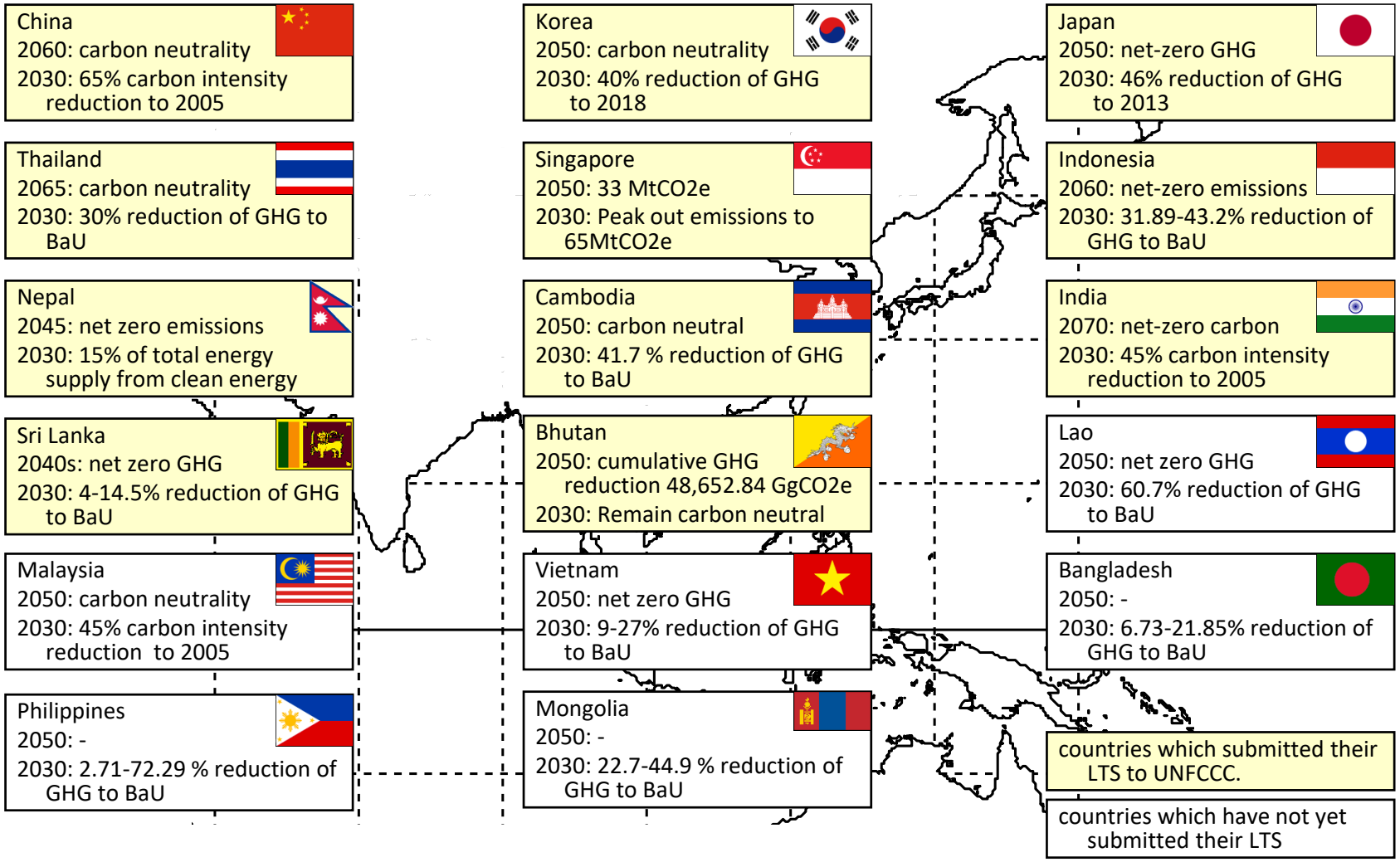
Source: IPCC (2023) Summary for Policymakers. In: Climate Change 2023: Synthesis Report. Contribution of WGI, II and III to AR6 of IPCC; Figure SPM.5 & Table 1

GHG emissions from Asia

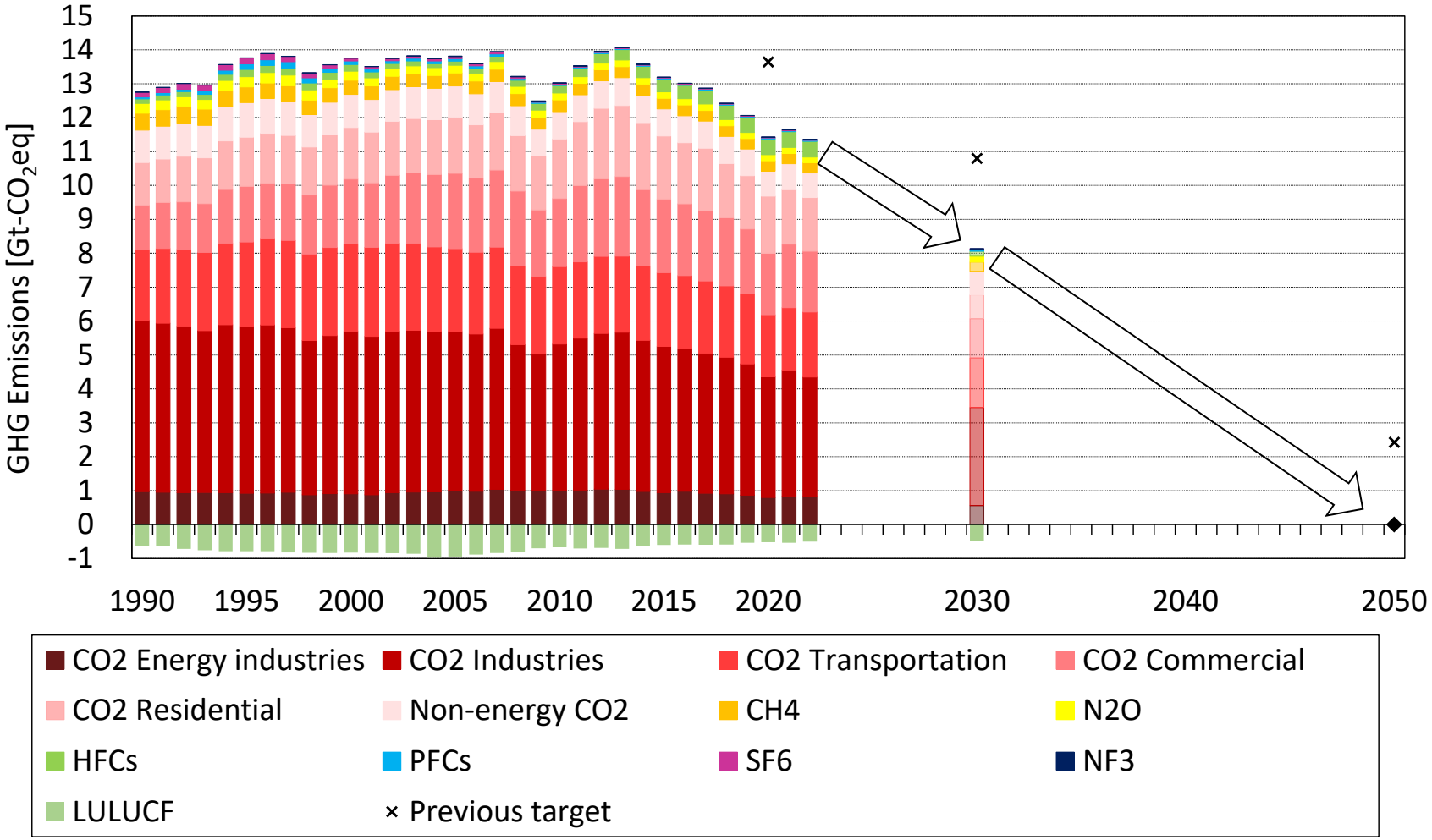


Source: European Commission, Joint Research Centre et al., GHG emissions of all world countries, Publications Office of the European Union, Luxembourg, 2024, https://data.europa.eu/doi/10.2760/4002897, JRC138862.
https://edgar.jrc.ec.europa.eu/booklet/EDGAR_2024_GHG_booklet_2024.xlsx

To achieve 1.5 degree target, not only developed countries but also developing countries will need net-zero



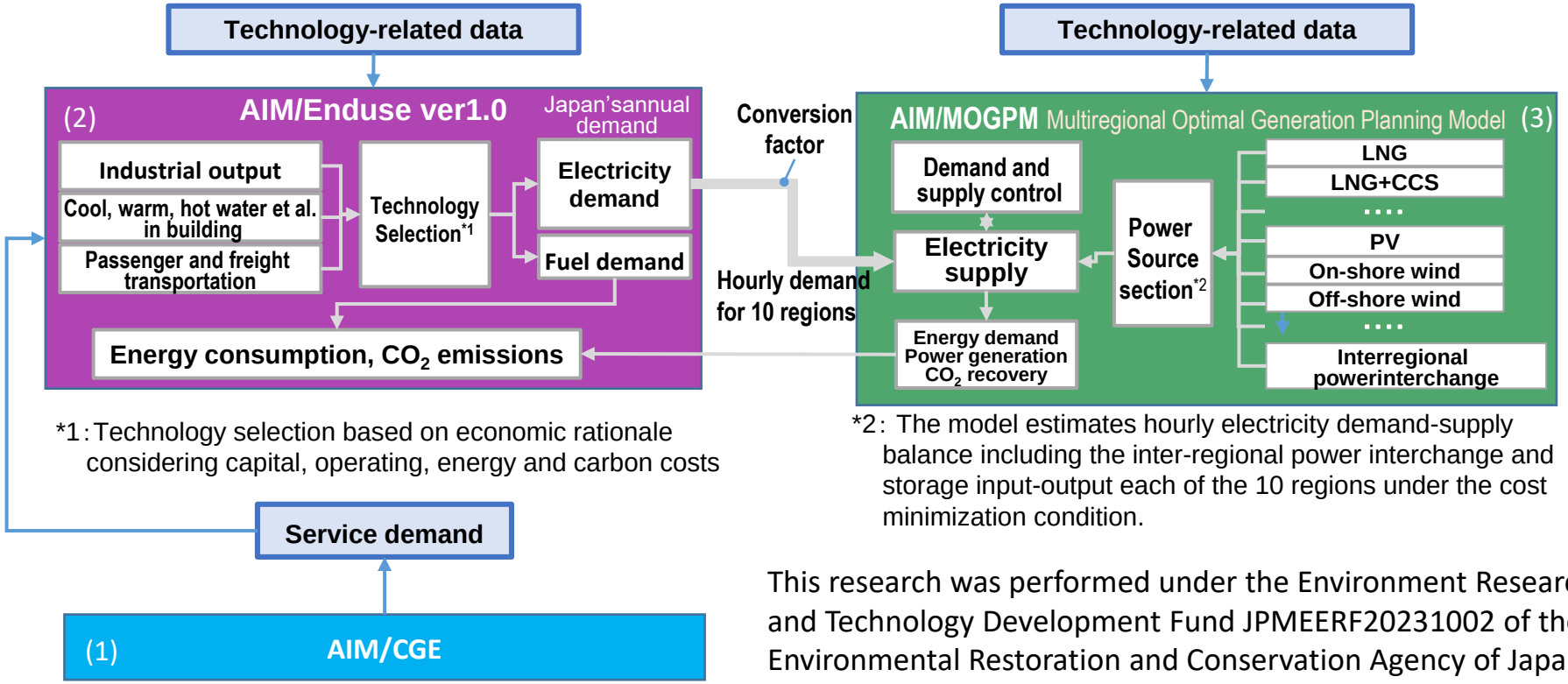
Past trend and future targets of GHG emissions in Japan



Source:
Historical data: Greenhouse Gas Inventory Office of Japan, Japan's National Greenhouse Gas Emissions
Target: Japan's Nationally Determined Contribution (NDC) and Long-Term Strategy under the Paris Agreement

AIM (Asia-Pasific Integrated Model) to assess net-zero GHG in Japan

- An applied general equilibrium model is used to establish a macro-frame for the future, given the economic growth rate and population assumptions (1). Next, future energy demand is estimated using an energy demand model (2). The annual electricity demand estimated in (2) is expanded to hourly demand by region, and the generation facility configuration and supply configuration are estimated using a cost-optimized power supply model that can take into account coincidence constraints and inter-regional interconnection line constraints (3). The results are fed back into the energy demand model to calculate Japan's overall energy supply and demand and CO_2 emissions.



*1 : Technology selection based on economic rationale considering capital, operating, energy and carbon costs

*2 : The model estimates hourly electricity demand-supply balance including the inter-regional power interchange and storage input-output each of the 10 regions under the cost minimization condition.

This research was performed under the Environment Research and Technology Development Fund JPMEERF20231002 of the Environmental Restoration and Conservation Agency of Japan.

https://www.nies.go.jp/social/publications/dp/pdf/2024-03.pdf

Scenario | Three scenarios in this analysis

- In this analysis, we assumed three scenarios and estimated emission pathways to 2050 for each: A) the "Decarbonization Technology Progress Scenario", which assumes that although efficiency improvements and renewable energy deployment will continue, the implementation of innovative technologies will not fully develop after 2030; B) In addition to A), "Innovative Technology Deployment Scenario," which assumes that large-scale deployment of innovative decarbonization technologies will progress after 2030; and C) In addition to B), a "Social Transformation Scenario," which incorporates reduced demand for goods and transportation due to social transformation.

A) "Decarbonization Technology Progress Scenario" (Technology Progress)

Energy efficiency and renewable energy technologies are deployed as planned until 2030, and continue to deploy at the same rate after 2030. On the other hand, innovative decarbonization technologies that are expected to be deployed at an accelerated pace and on a large scale after 2030 are assumed to be deployed at a slower pace.

<GHG net-zero scenario>

B) "Innovative Technology Deployment Scenario" (Innovative Technology)

A scenario in which innovative decarbonization technologies that are expected to be deployed at an accelerated pace and on a large scale after 2030 are fully deployed, and net zero GHG emissions are achieved in 2050.

C) "Social Transformation Scenario" (Social Transformation)

In addition to B, this scenario incorporates a reduction in demand for goods and transportation while maintaining or improving people's utility, etc., as a result of social transformation, such as the development of digitalization and the circular economy. Net zero GHG emissions in 2050.

Innovative decarbonization technologies for large-scale deployment beyond 2030

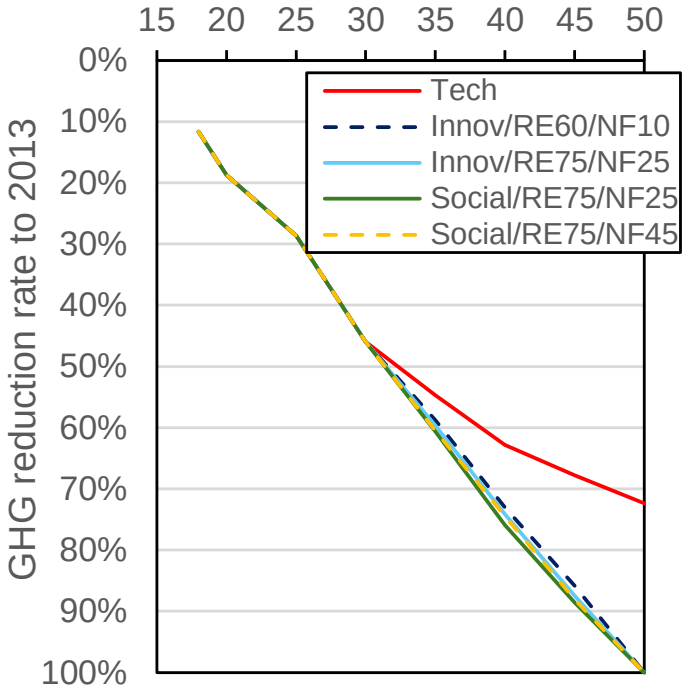
- Expanded use of synfuels (hydrogen, synthetic fuels, ammonia) and biofuels
- Further deployment of PV and offshore wind power
- Further electrification of freight vehicles
- Further proliferation of HP equipment
- CCUS implementation in power generation and industry
- Negative emission technologies

Assumed social transformation

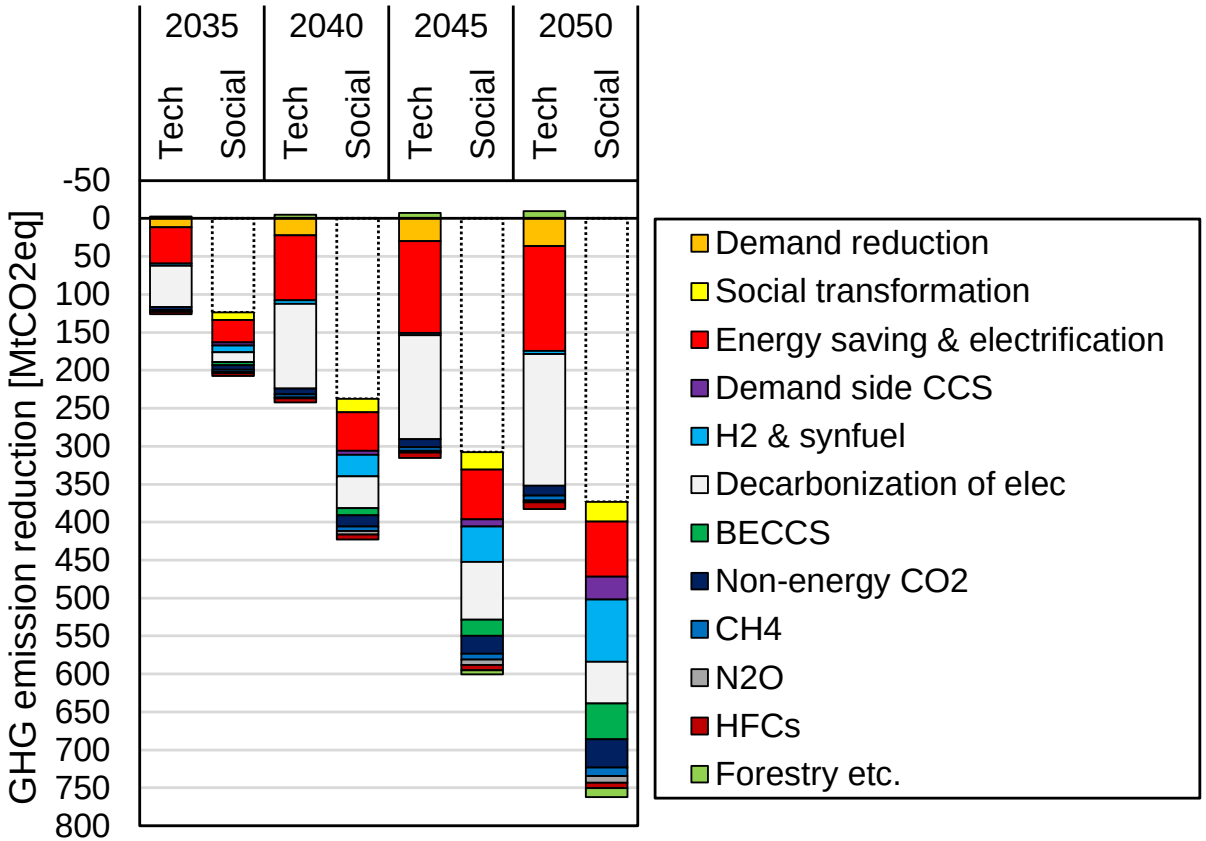
- Efficient use of materials: Sharing, long life, recycling, resource-saving design, etc.
- Reduction of business and commuting travel: ICT to substitute for travel demand, etc.
- Reduction of freight transportation: Efficient use of materials to reduce freight transportation, etc.

Mitigation pathways | GHG emission reduction to achieve the net-zero

- In Technology Progress Scenario, GHG emissions in 2050 is around 70% reduction compared to those in 2013. Decarbonization of electricity and energy saving and electrification of the end-use sectors account for a large share of the total GHG reduction.
- From Technology Progress Scenario to Social Transformation Scenario, not only the decarbonization of electricity and energy efficiency and electrification in end-use sectors, but also various measures such as new fuels, BECCS, demand-side CCS, and social transformation contribute to emission reductions, and achieve the net zero GHG emissions by 2050.



<GHG emission reduction trajectories>



<GHG emission reduction from 2030 level>

Tech: Technology progress scenario
Social: Social transformation scenario (case: RE75 and NF25)

As a tool for cooperation with Asian countries toward net-zero society

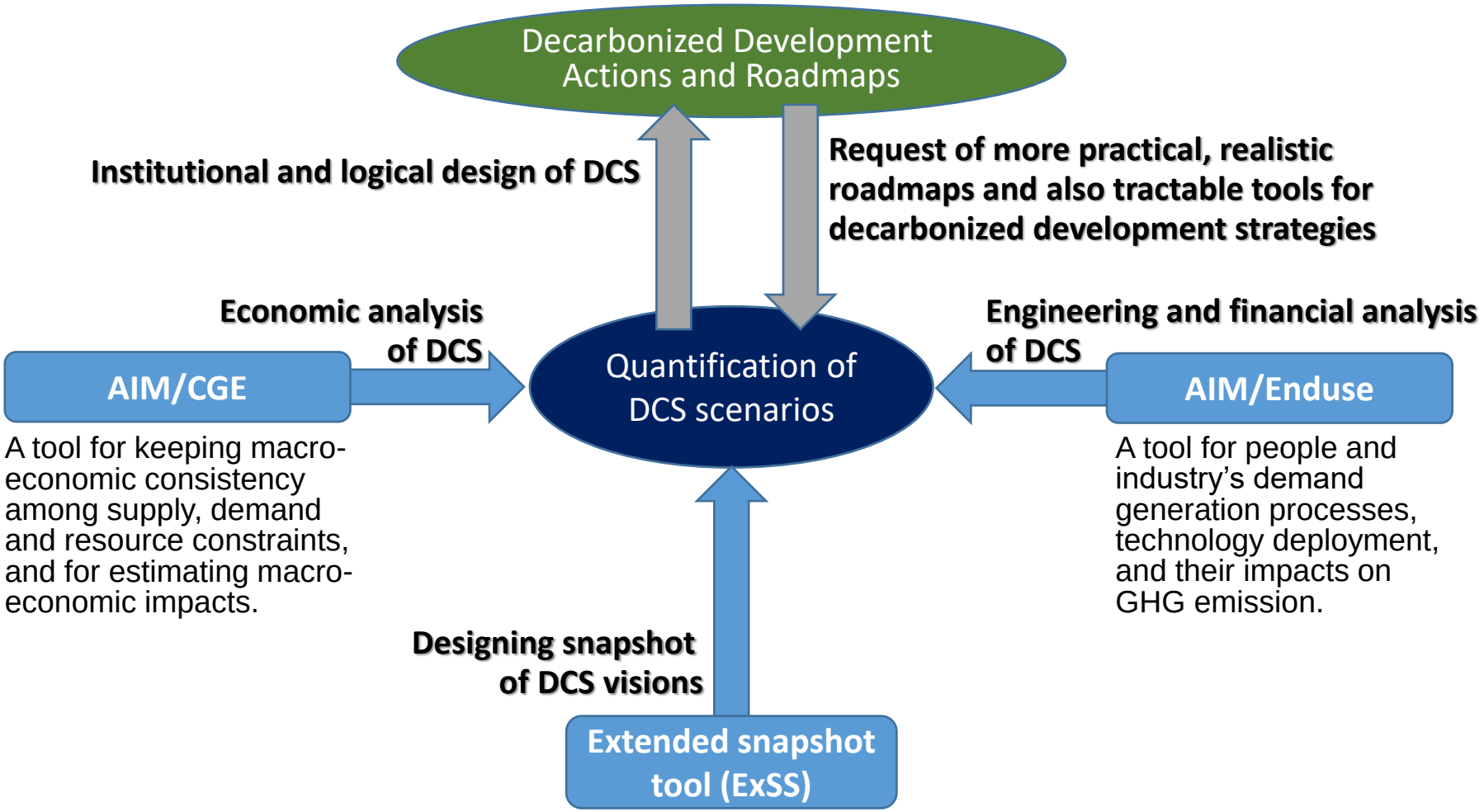
2021.10: Plan for Global Warming Countermeasures

- ✓ In addition to providing policy recommendations to partner countries, Japan will strengthen its engagement with them, support the formulation of long-term strategies and the revision of NDCs, and help the private sector build institutions and improve their implementation capacity, through the Asia-Pacific Integrated Model (AIM), thereby contributing to increasing the ambition of partner countries and strengthening their efforts toward decarbonization.

2023.12: Assistance Package to Promote Investments for Global Actions Toward the Achievement of the Paris Agreement Goals

- ✓ Thus, the Government of Japan will expand the scope of technical support provided for the formulation of net-zero targets with feasible measures using a simulation model (Asia-Pacific Integrated Assessment Model, or AIM) to 10 countries, while considering the timeline of the next round of NDCs submission by 2025.

Assessment of decarbonization scenarios in Asia



Thailand

Prof. Bundit Limmeechokchai
(Sirindhorn International Institute of Technology, Thammasat University)

Mid-century, Long-term Low Greenhouse Gas Emission Development Strategy (Revised Version)

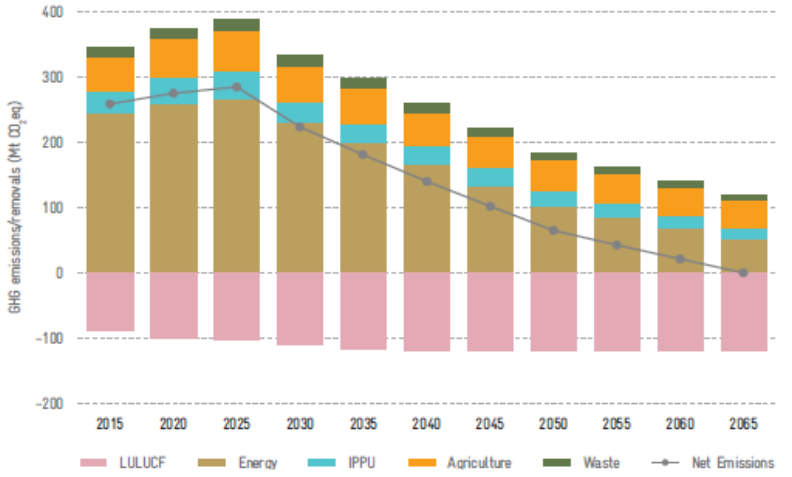


Figure 3-3 Thailand's 2065 Net Zero GHG Emission Pathway

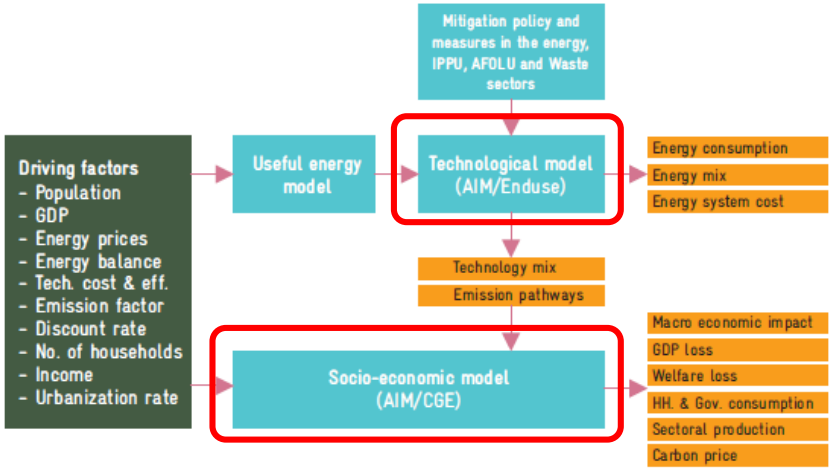


Figure 3-1 Framework of Thailand's LT-LEDS

https://unfccc.int/sites/default/files/resource/Thailand%20LT-LEDS%20%28Revised%20Version%29_08Nov2022.pdf

Indonesia

Long-term strategy for Low Carbon and Climate Resilience 2050

Prof. Rizaldi Boer
(Bogor Agricultural University)
Prof. Retno Gumilang Dewi and
Dr. Ucok WR. Siagian
(Bandung Institute of Technology)

4.1. Scenario Development

4.1.1. Models for Mitigation Pathways

Indonesia used a set of models in developing the emission pathways with two stages of analysis. In the first stage, separate models were developed for modelling agriculture, forestry and other land uses (AFOLU), and energy. The AFOLU sector used AFOLU Dashboard (a spreadsheet model), meanwhile energy sector used AIM-EndUse and the AIM-ExSS (Extended Snapshoot). In both models, economic and population growth are the key drivers for changes in food and energy demand. In the second stage, the economic and economic impact of both AFOLU and energy sector mitigation are analysed by utilizing the Asia Pacific Integrated Model/Computable General Equilibrium (AIM/CGE)-Indonesia (see Figure 3).

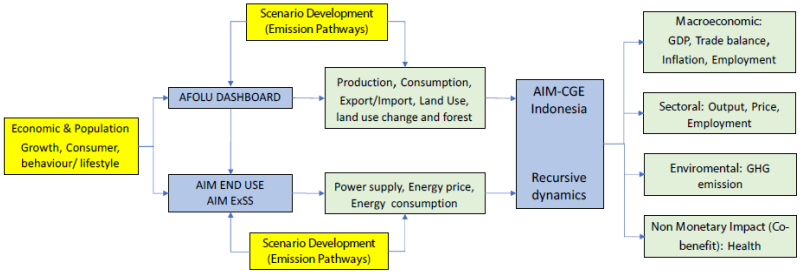
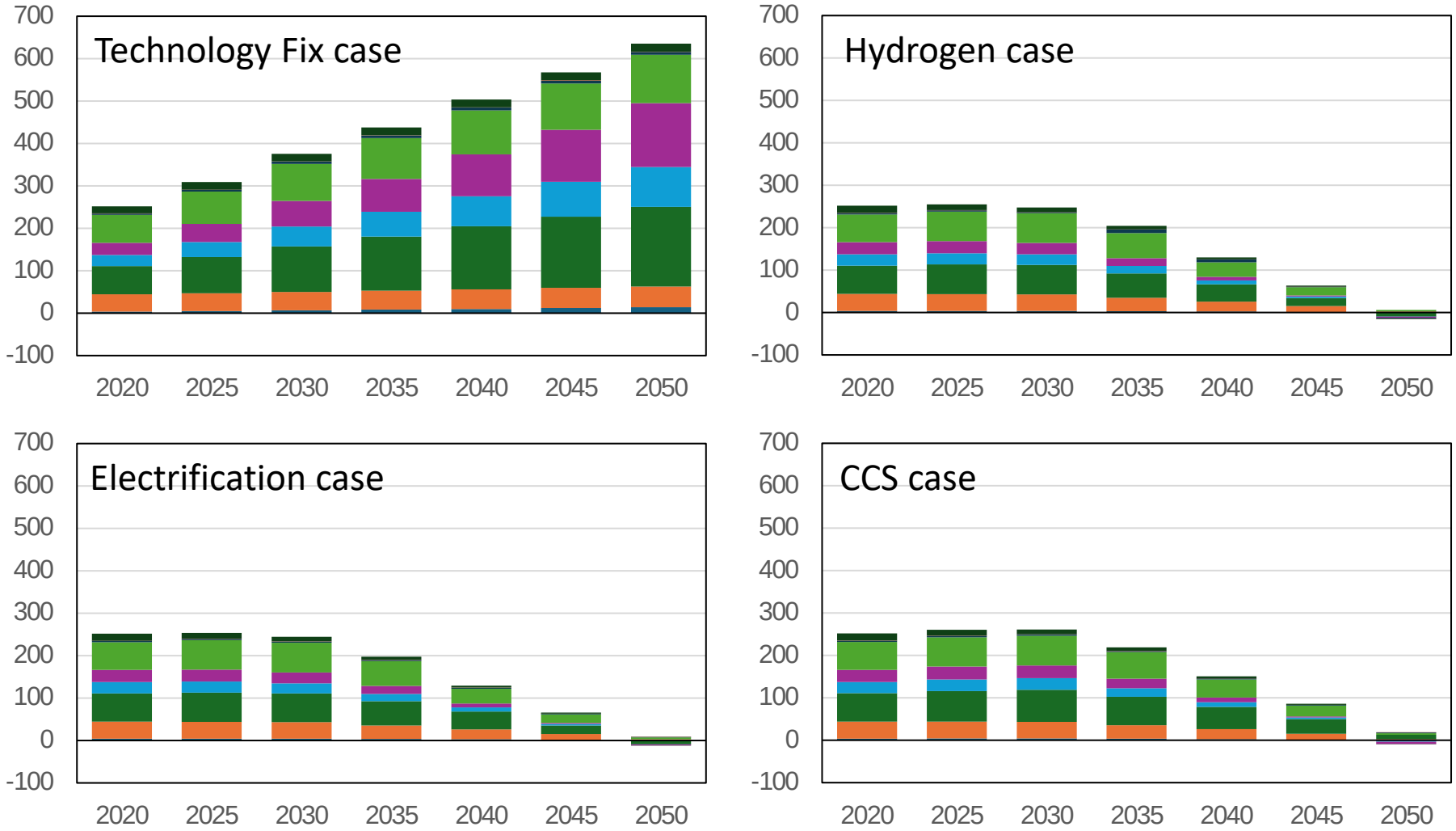


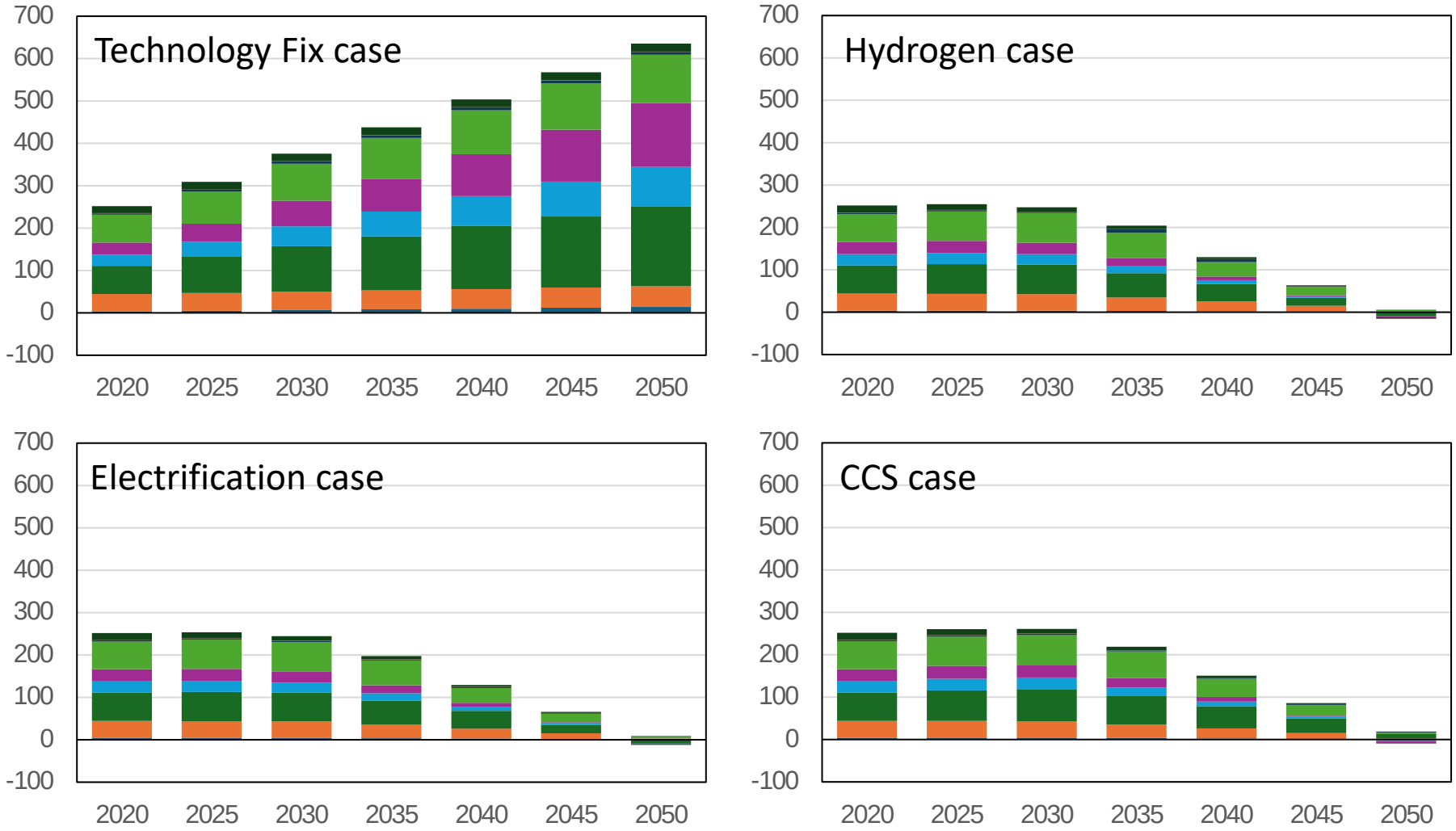
Figure 3. Models for developing emission pathways in Indonesia

https://unfccc.int/sites/default/files/resource/Indonesia_LTS-LCCR_2021.pdf

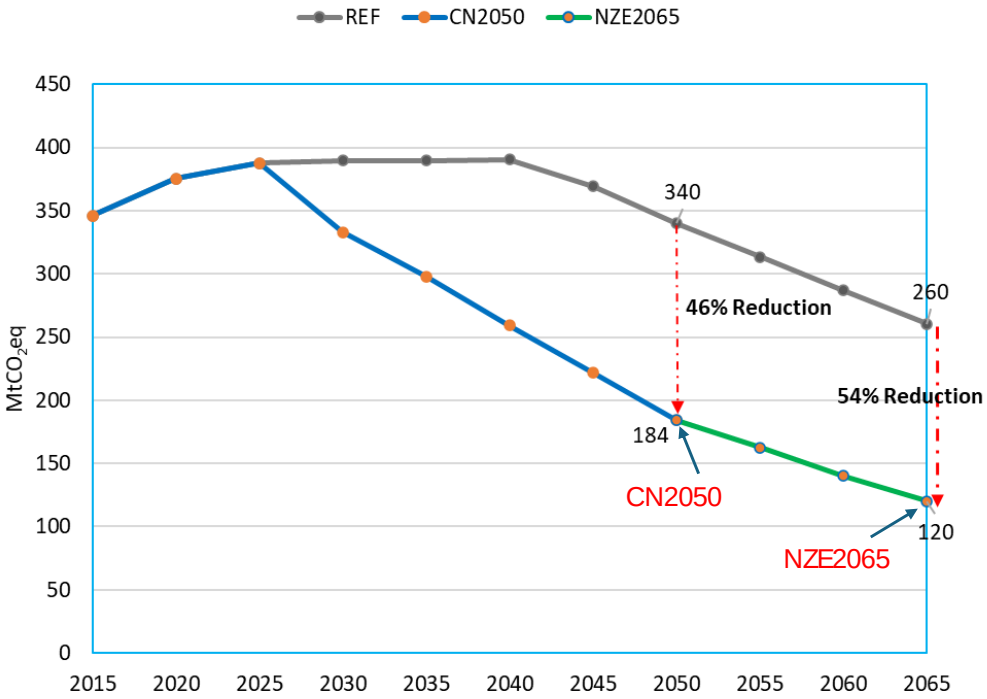
CO2 emission pathways in Thailand using AIM/Enduse unit: MtCO2



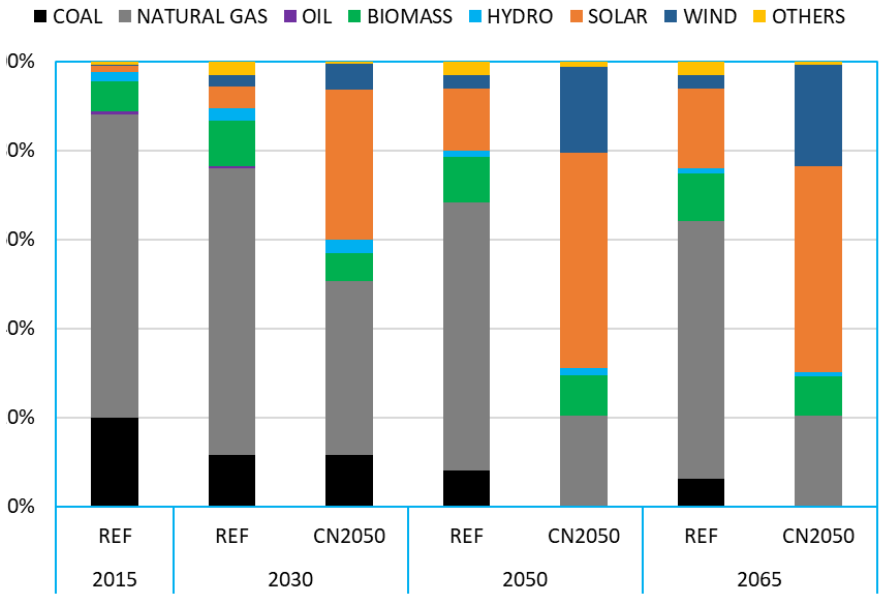
CO2 emission pathways in Indonesia using AIM/Enduse unit: MtCO2



Assessment of GHG emissions pathways in Thailand using AIM/CGE



GHG Emission Trajectories in REF & CN2050 Scenarios (includes emissions from Waste, Agriculture, Energy & IPPU Sectors)

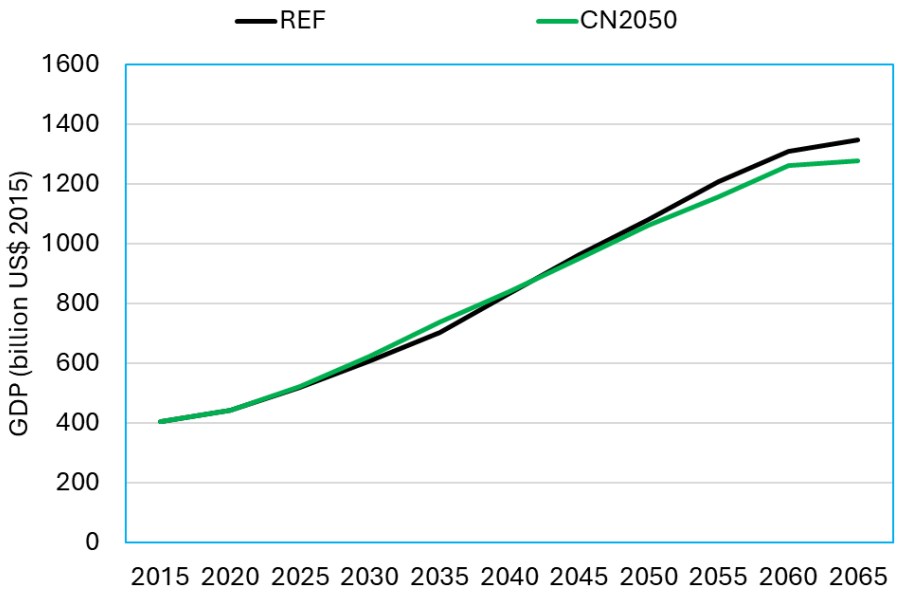


Technology share of power supply

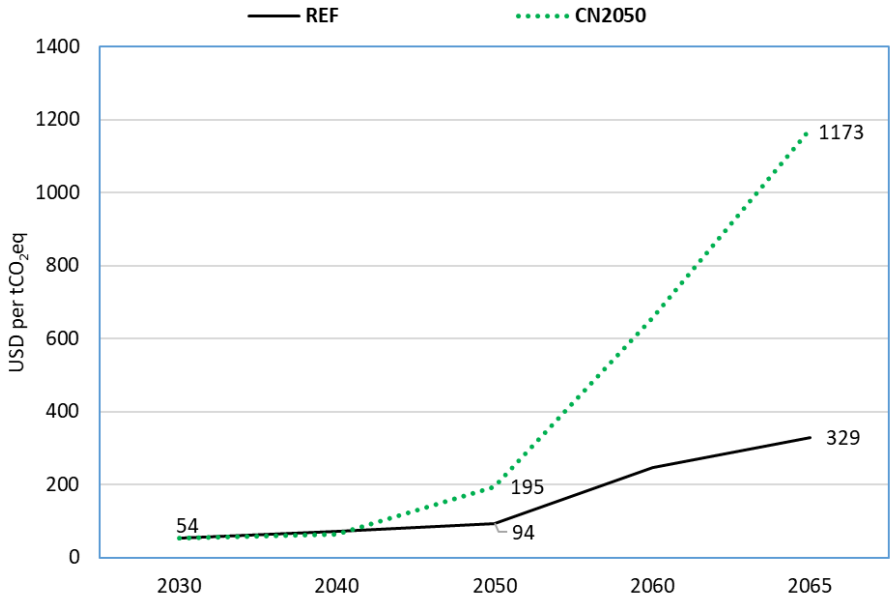
Note: Net GHG emissions are expected to reach 220 $MtCO_2eq$ in 2050 & 140 $MtCO_2eq$ in 2065 in REF scenario, with the LULUCF sector contributing to a constant removal of 120 $MtCO_2$ from 2037 onwards.

Salony Rajbhandari et al. (2024)
Decarbonization of Power Sector in Thailand to Achieve Carbon Neutrality by 2050
International Conference on Sustainable Energy (ICUE2024), Pattaya City, Thailand

Assessment of GHG emissions pathways in Thailand using AIM/CGE



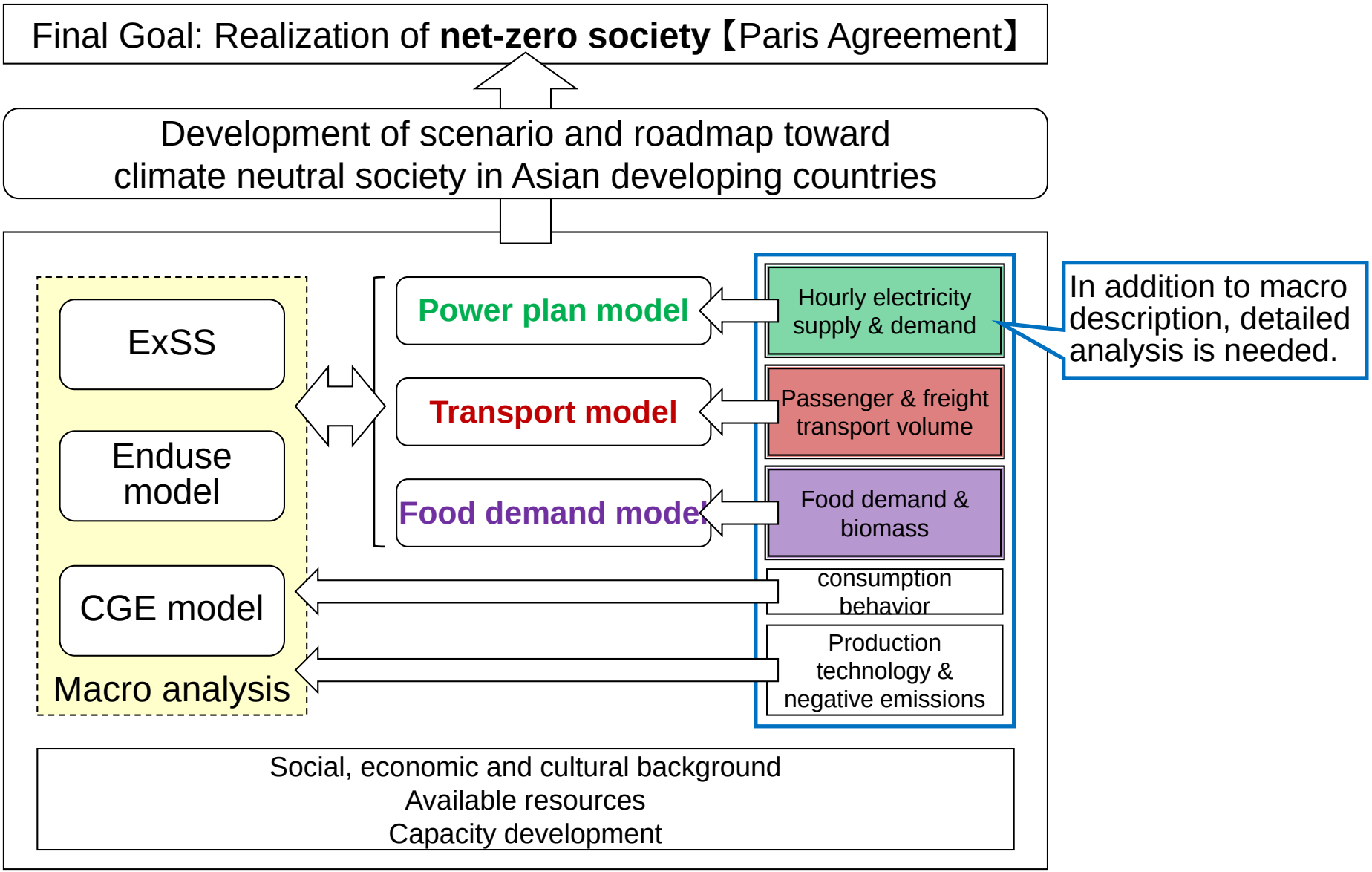
GDP



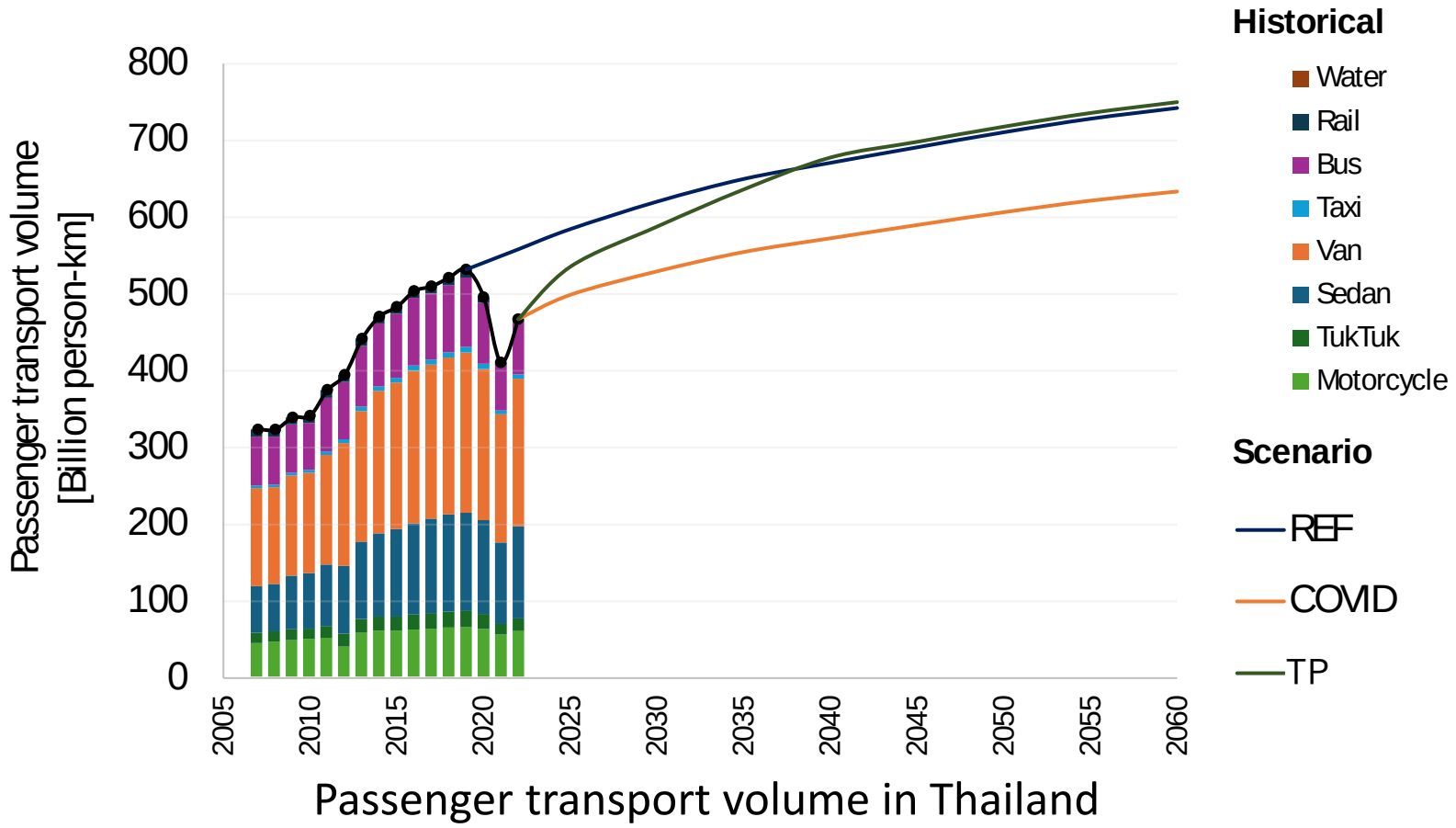
Carbon price

Salony Rajbhandari et al. (2024)
Decarbonization of Power Sector in Thailand to Achieve Carbon Neutrality by 2050
International Conference on Sustainable Energy (ICUE2024), Pattaya City, Thailand

From macro scenarios to detailed scenarios in ERTDF1-2202



Analysis on GHG from passenger transport in Thailand



REF: Reference scenario
COVID: COVID impact scenario
TP: Transport modal shift policy scenario

Achiraya Chaichaloempreecha et al. (2024)
Changes in Transport Demand and Modal Shift on GHG Emissions in Thailand
International Conference on Sustainable Energy (ICUE2024), Pattaya City, Thailand

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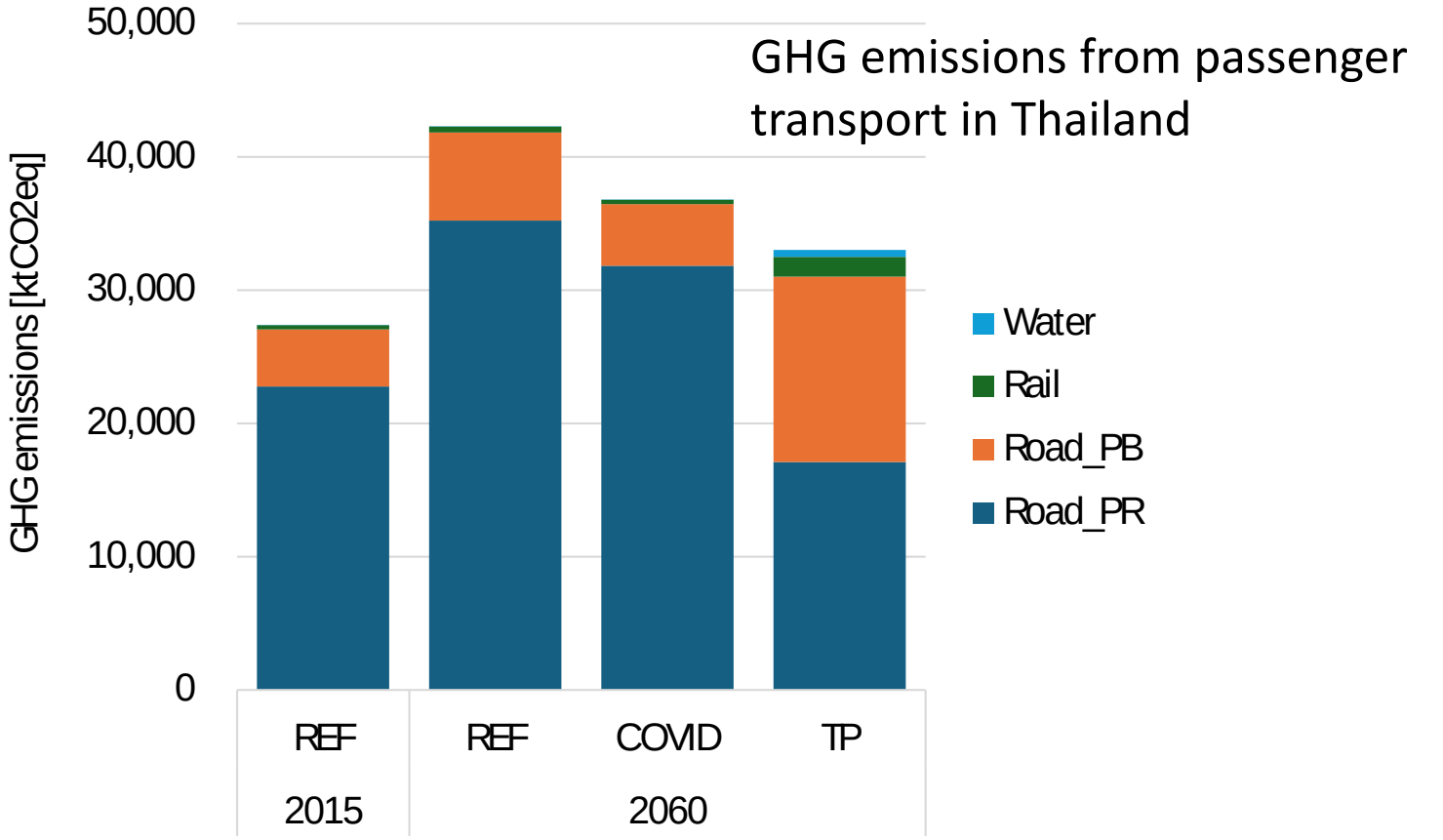

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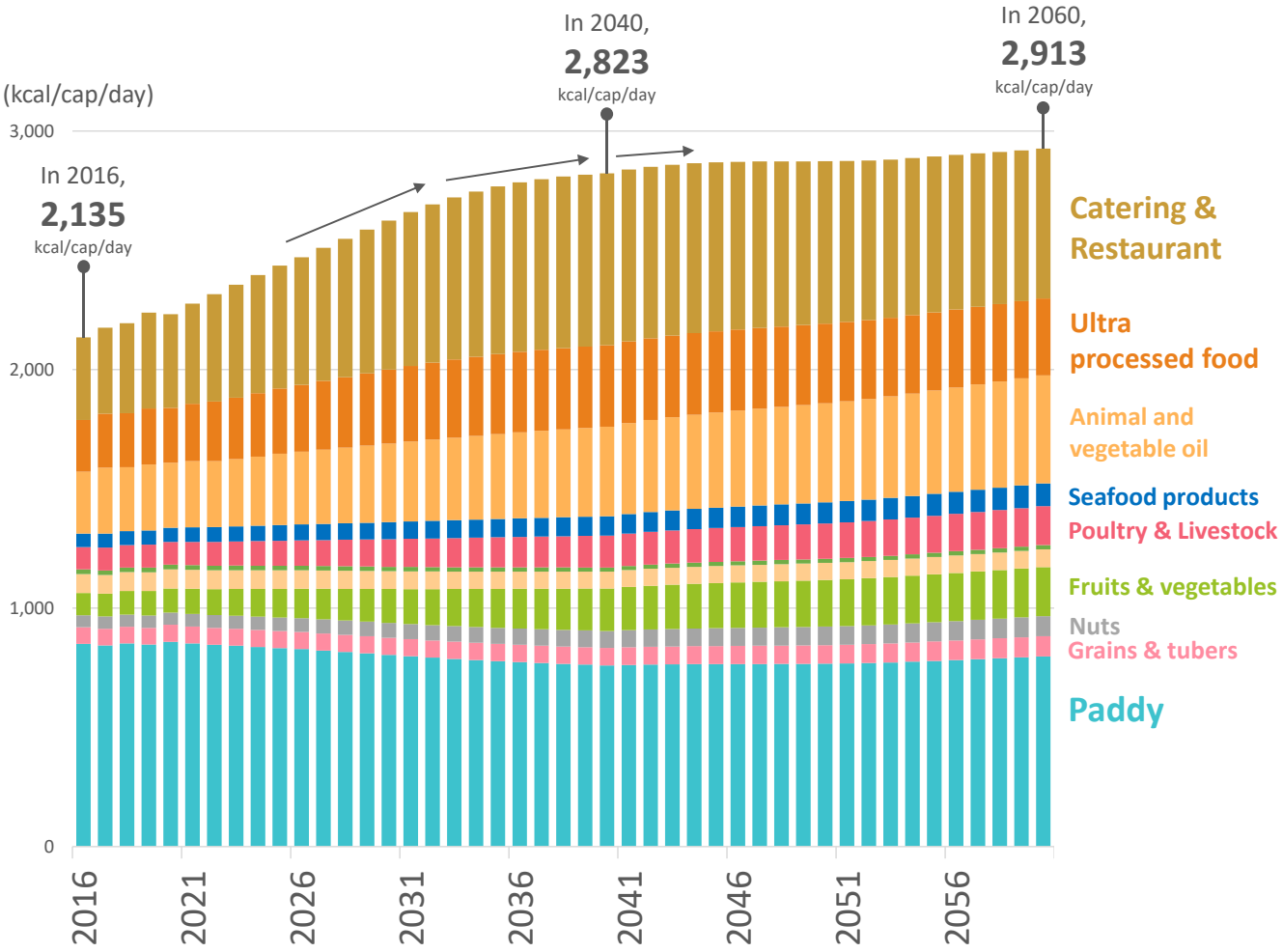
International Conference on Sustainable Energy (ICUE2024), Pattaya City, Thailand

Food demand & GHG emissions in Indonesia



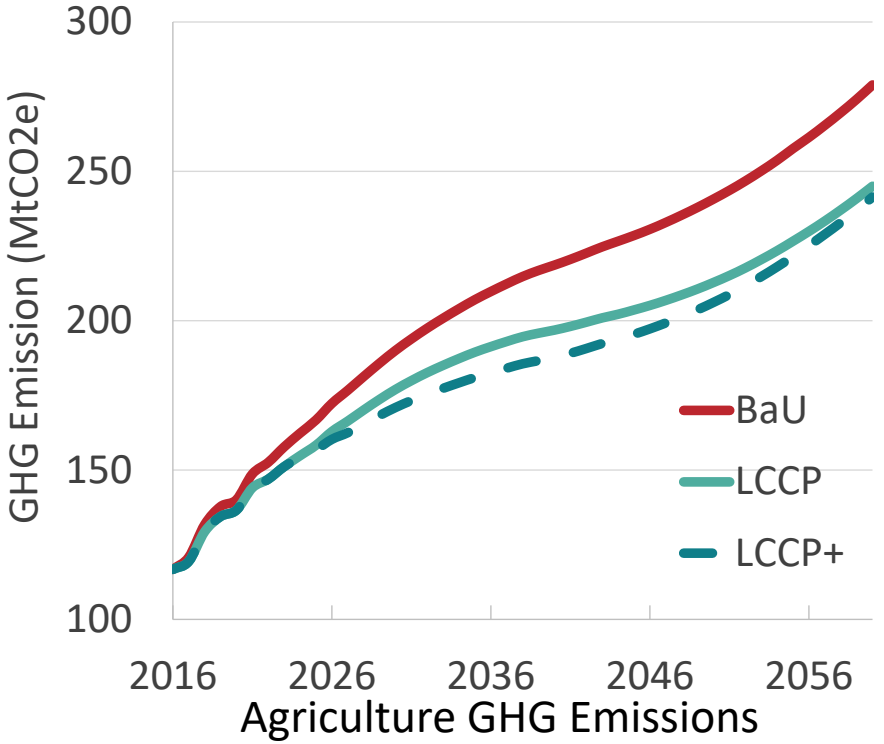
Food demand under Business-as-Usual (BaU)

Food demand & GHG emissions in Indonesia

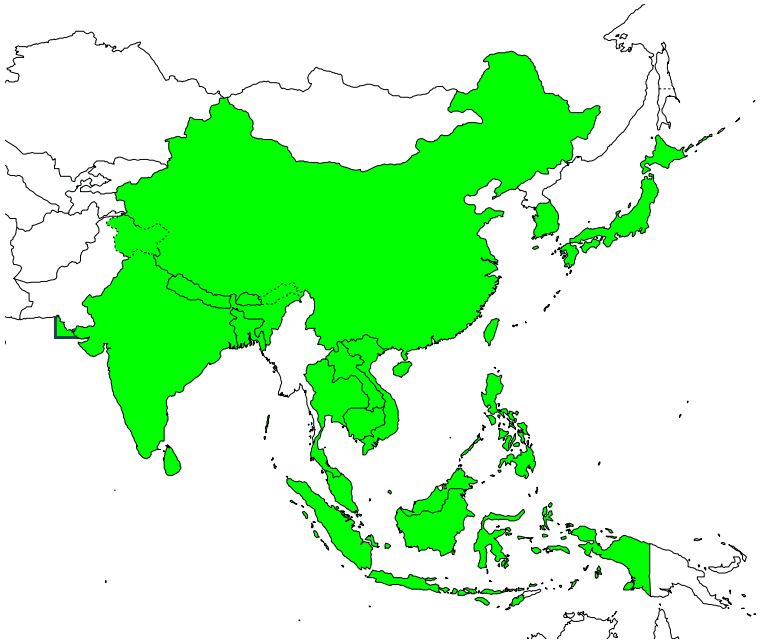
Scenario	Business as Usual (BaU)	Low Carbon Compatible with Paris Target (LCCP)	LCCP + Sustainable and Healthy Diet
Mitigation activities	No mitigation	Agriculture sector mitigation activity following Indonesia Long-Term Strategy (LTS)	
Food demand	Conventional trajectory		Sustainable healthy consumption

Mitigation actions in Agriculture sector:
- Rice field
  a. Adoption of low-emission variety
  b. Improved water use efficiency
- Livestock feed supplement
- Reduction of fertilizer use

Sustainable healthy consumption:
- Increasing high-nutrient food
- The diet is mainly sourced from whole food, slower growth of processed food and non-home cook.
- Smaller share of animal-source food



Annuri Rossita & Toshihiko Masui (2024)
Socioeconomic Impacts from Shifting to Sustainable Food Consumption towards Indonesia's Net Zero Emission
International Conference on Low Carbon Asia, Dalian, China



NIES: National Institute for Environmental Studies
IGES: Institute for Global Environmental Strategies
MHRT: Mizuho Research & Technologies

NDC and LTS

Agreement between countries/regions

Government

MOEJ, Embassy, JICA

Provision of numerical results
Policy support

Research collaboration, Provision of AIM, Analysis support, Capacity development

【Asian country/region】

Policy needs & requests

【Japan】

Research requests

Other stake-holders

Research institute (AIM members)

AIM team (NIES, IGES, MHRT, E-konzal, ...)

Other stake-holders

AIM ASIA-PACIFIC INTEGRATED MODEL

Training Workshop to introduce AIM for young researchers

Jan. 30-Feb. 1 2017, SIIT-TU, Thailand

Support of policy dialogue

October 30, 2019, Bangkok, Thailand

In place of my presentation's summary

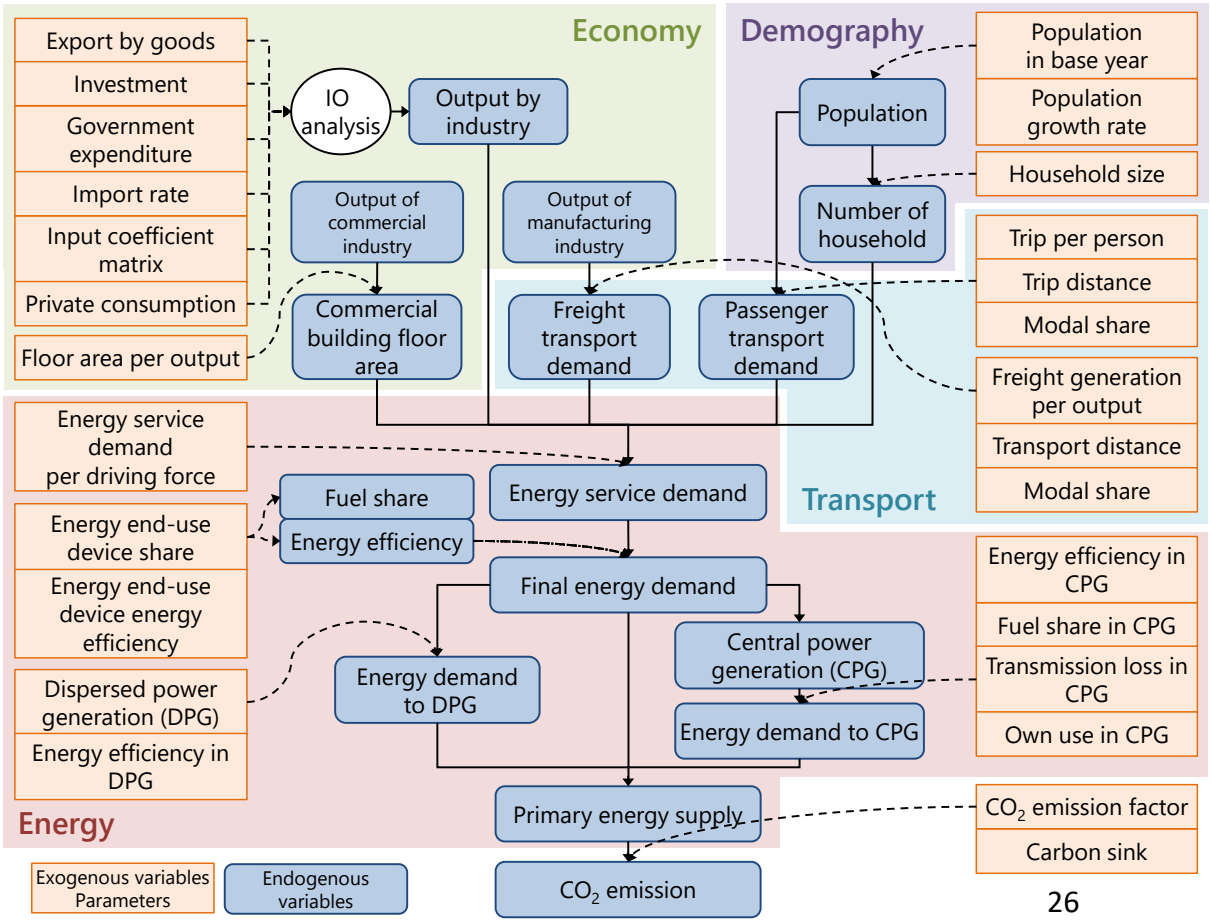
- Asian developing countries are also requested to show pathways to achieve net-zero society.
  - ✓ There is still a gap between the net-zero pathway and the current actions.
  - ✓ Academic researches need to show
    - significance and benefits of introducing more ambitious measures,
    - how to introduce more ambitions measures into the real society, and
    - consistency among countries' net-zero pathways in Asia and the world.

- Japan's emission reduction targets and efforts are also important to serve as a model for Asian developing countries.

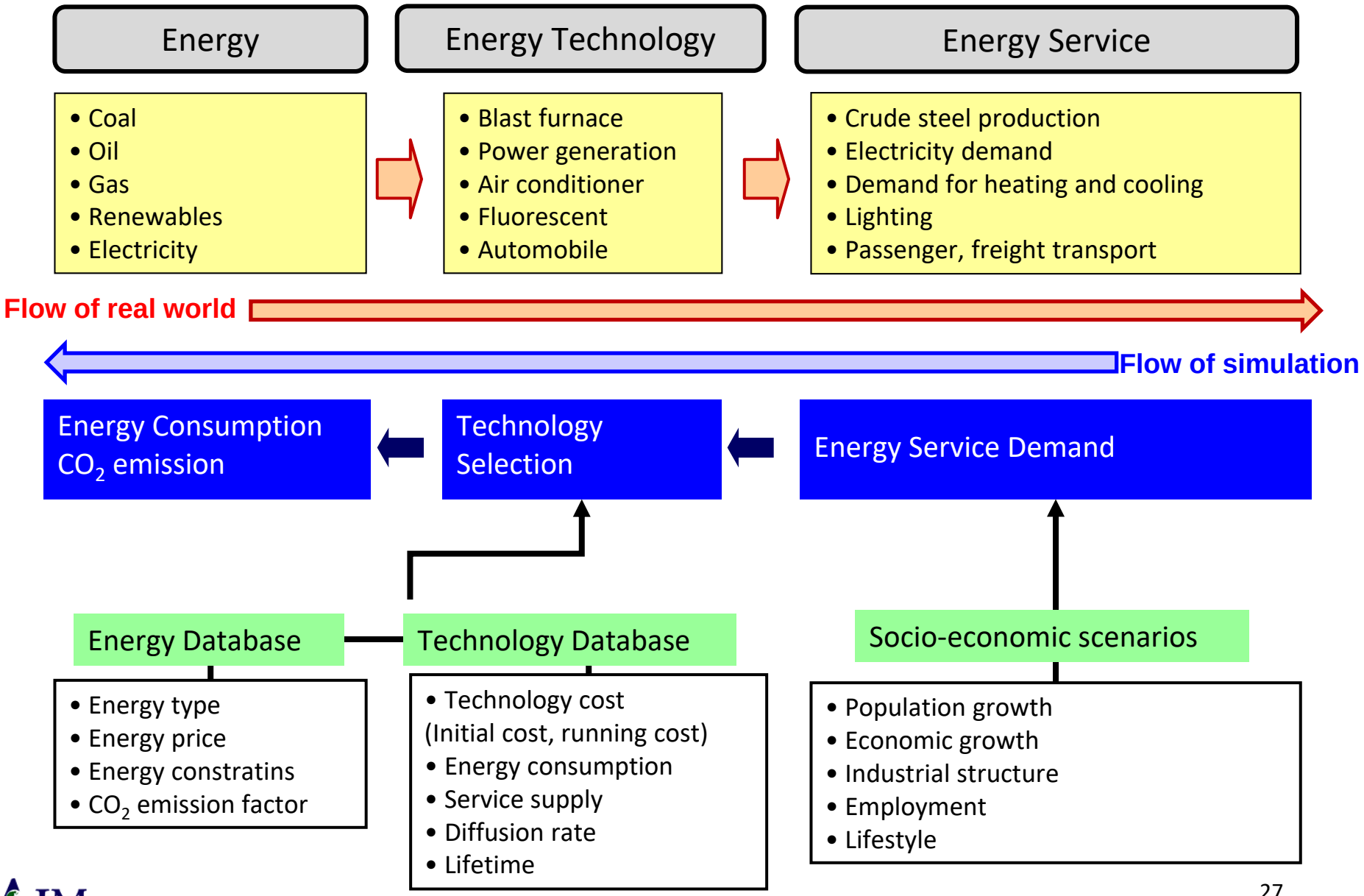
Appendix

Extended Snapshot Tool (ExSS)

- Extended Snapshot Tool (ExSS) is an accounting type, static model consisting of simultaneous equations with about 6000 variables.
- It describes socio-economic activity, energy consumption, power generation, technology diffusion and GHG emissions in a future year.
- Coupled with waste and AFOLU model, it can show a comprehensive vision of a country or a region as a low-carbon society.
- Data requirement: Input-output table, energy balance table, demography, and transport data in a base year.



Overview of AIM/Enduse model

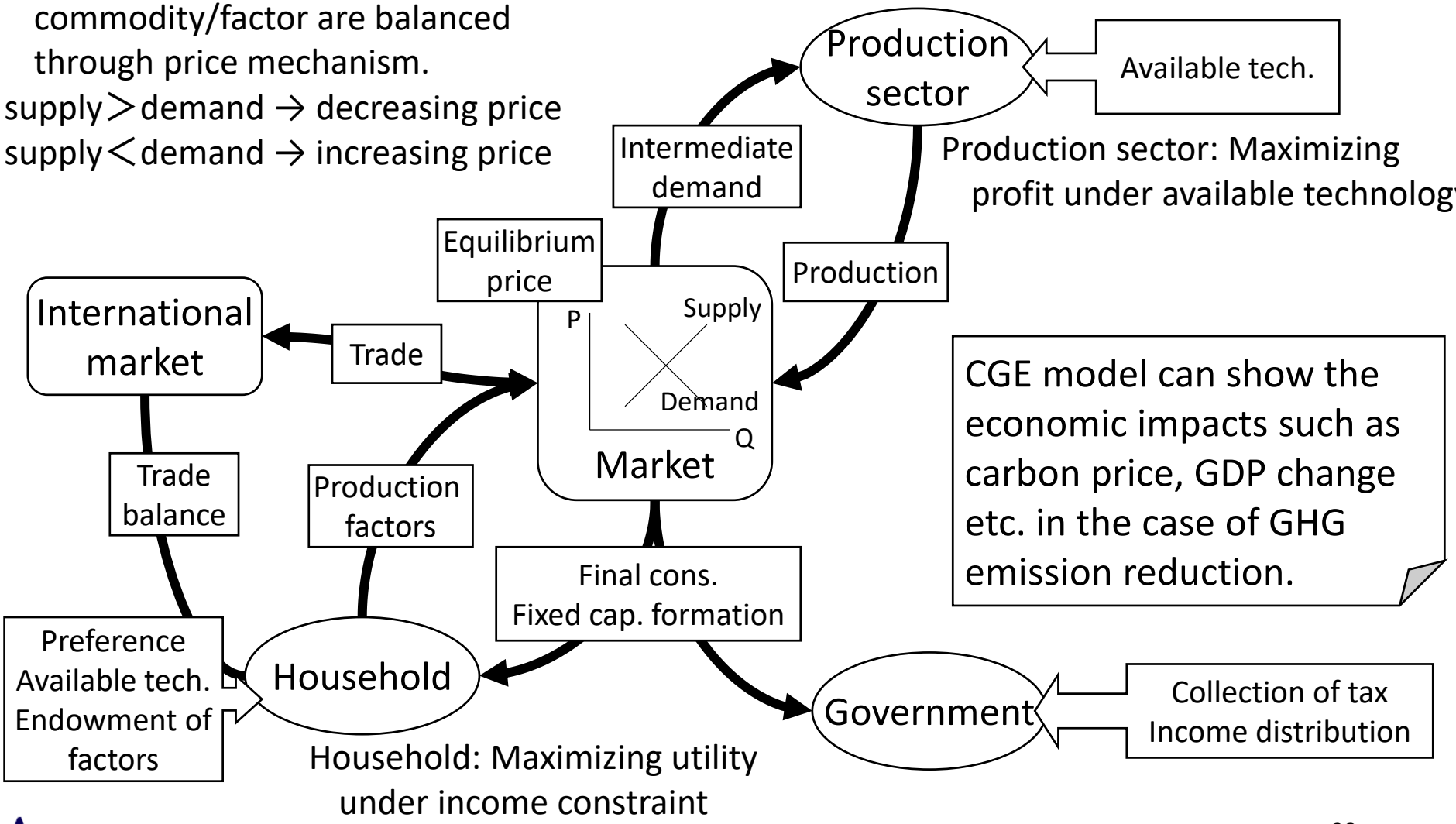


Concept of AIM/CGE (Computable General Equilibrium)

Market: supply and demand of every commodity/factor are balanced through price mechanism.

supply＞demand → decreasing price

supply＜demand → increasing price



CGE model can show the economic impacts such as carbon price, GDP change etc. in the case of GHG emission reduction.