Extension of National Decarbonization Studies in AIM

- Toward an integrated analysis of decarbonization and other issues -

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Impact of changes in socio-economic activity and consumption behavior on realization of decarbonized society in Japan (FY2020-2022, NIES, Mizuho Research & Technologies, NTT, Center for Environmental Science in Saitama, Kyoto university)

Goals on Climate Change Issues

Global:
Holding the increase in the global average temperature to well below 2℃ above pre-industrial levels

Paris agreement

In model pathways with no or limited overshoot of 1.5℃, global net anthropogenic CO_2 emissions decline reaching net zero around 2050

IPCC Global warming of 1.5℃"

Japan: 46% reduction in 2030
Net zero in 2050

Social Issues Facing Japan

- **Declining birthrate and aging population**
  →Labor shortage, Issues specific to the elderly
- **Slowing economic growth**
- **Population concentration in urban areas**
  →Progressive depopulation of rural areas

Achieving Climate Goals and Solving Social Issues

Society5.0

A society that uses IoT and AI to achieve both economic development and solutions to social issues

Regional Circular and Ecological Sphere

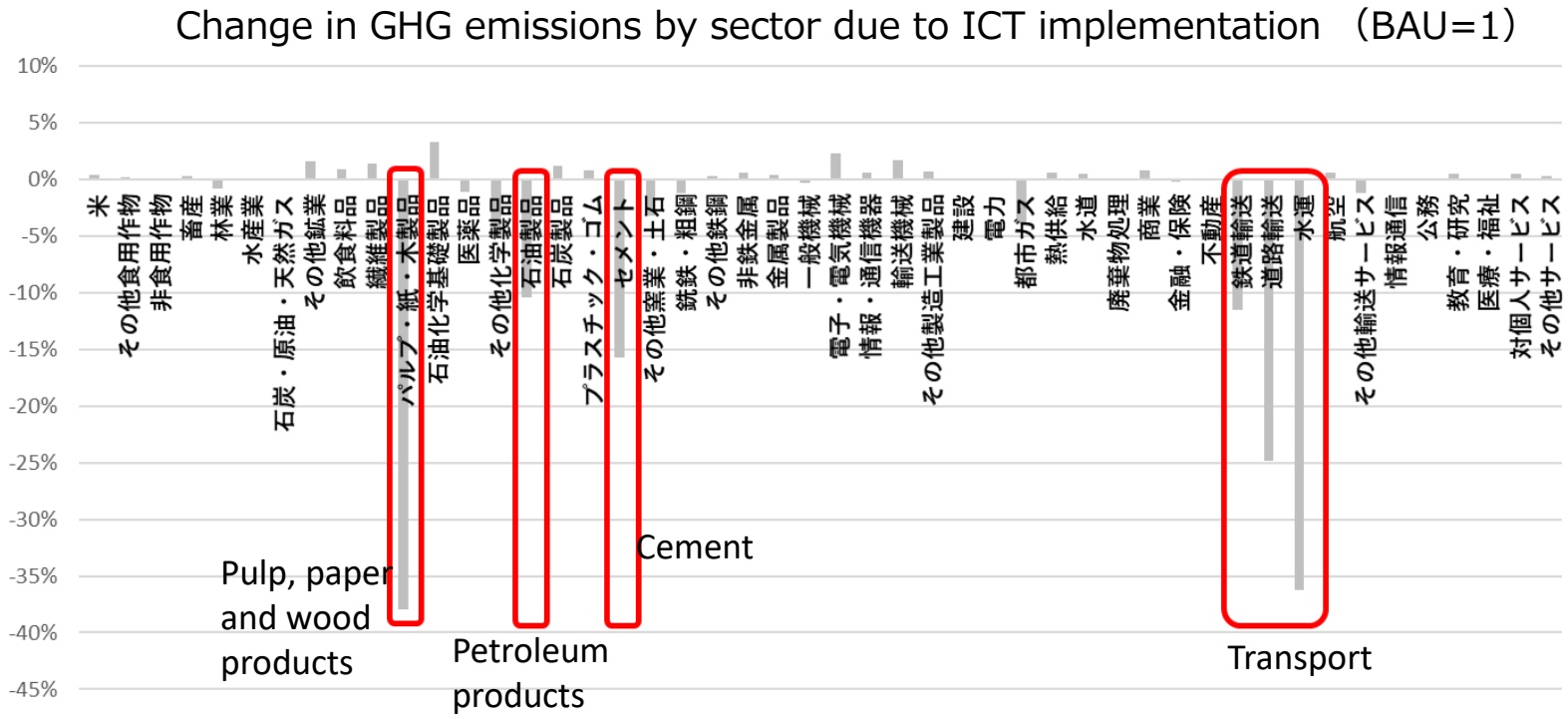
Integrated solutions to environmental, social, and economic issues by maximizing the use of local resources

- **What social changes and changes in consumer behavior are needed?**
- **How will changes in social and consumption behavior affect the achievement of climate goals?**

AIM ASIA-PACIFIC INTEGRATED MODEL

Long-term projections of ICT diffusion effects

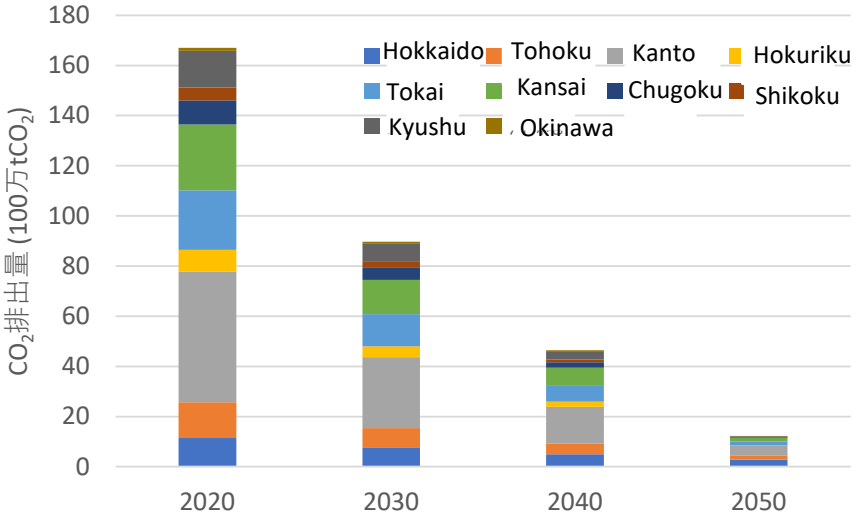
- The direct effects of the diffusion of ICT services/technologies that are expected to be diffused in the future in more than a dozen fields, including agriculture, manufacturing, transportation, education, social infrastructure, and daily life, are quantified and input into AIM/CGE to estimate the environmental and economic impact of ICT diffusion by 2050.
- Compared to the BAU in 2050, GHG emissions reduce by about 6% and GDP increase by less than 1% in ICT scenario.
- Regarding GHG emission reductions by sector, the emission reduction rates in the transportation sector and the petroleum products, cement, and pulp products sectors are particularly large. It was suggested that accelerated diffusion of ICT connected to demand reduction in these sectors will play an important role in the future decarbonization of Japan as a whole.



What are the key measures to achieve decarbonization in the household sector?

- Energy service demand and CO2 emissions were estimated for the household sector up to 2050 based on climatic and socioeconomic conditions and device information for each of the 10 regions.
- In cold regions Hokkaido and Tohoku, emission reductions were smaller than in other regions.
- Electrification has become the most important contributor to reducing CO2 emissions in the household sector by 2050. Reducing energy service demand is also an important factor in achieving a decarbonized society, and people will need to rethink their lifestyles so that service demand can be reduced.

【CO2 emission by region in household sector】



In cold regions (e.g. Hokkaido), many houses are dependent on kerosene, which is unique to the region, making it difficult to switch from kerosene to electricity by 2050.

【 CO2 emissions when key changes (equipment share, device energy efficiency, energy service demand) are fixed at 2015 】

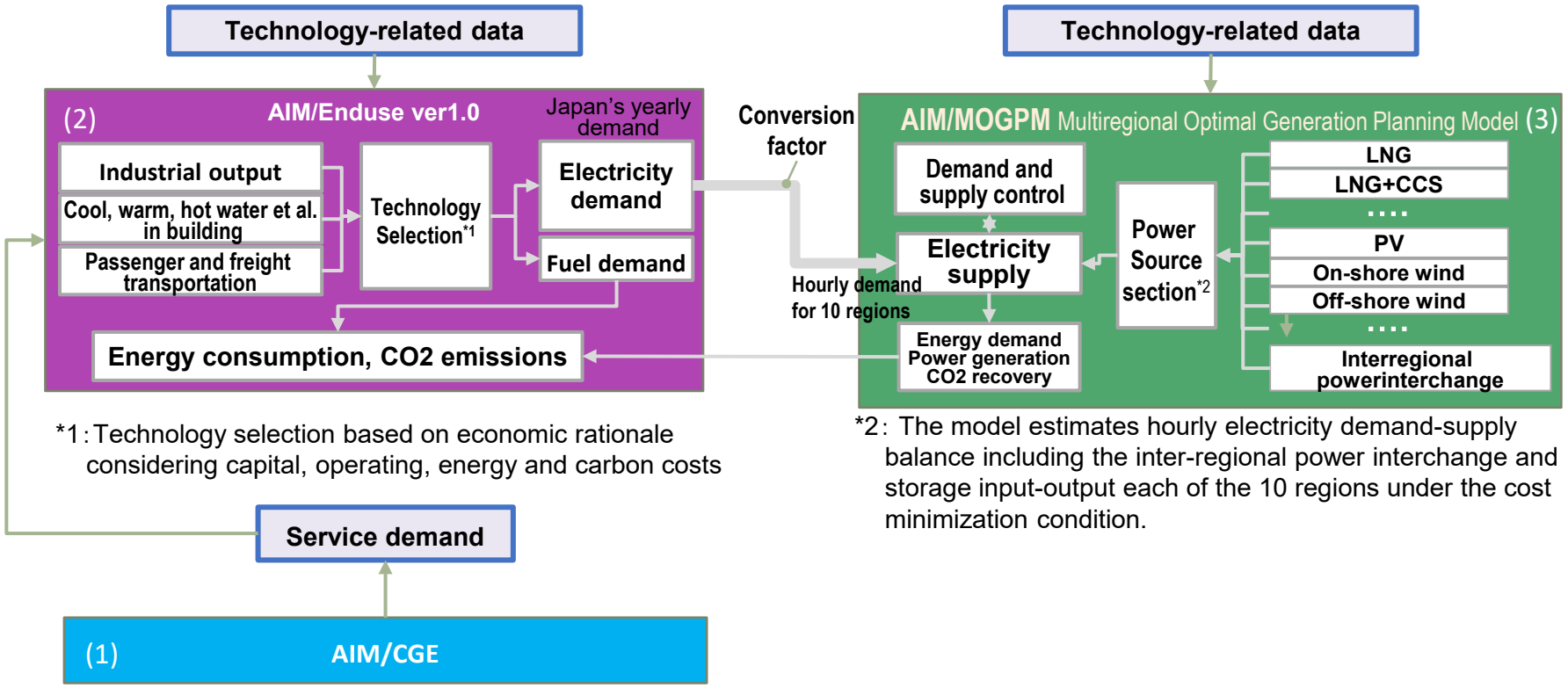
Unit: MtCO2		Device share 2015 fix	Device share 2015 fix	Energy service 2015 fix
2020	167	173 (104%)	175 (105%)	160 (96%)
2025	130	143 (110%)	145 (111%)	128 (98%)
2030	92	114 (124%)	108 (118%)	95 (103%)
2035	69	95 (138%)	83 (121%)	74 (108%)
2040	47	77 (162%)	59 (124%)	54 (114%)
2045	28	61 (218%)	35 (127%)	34 (121%)
2050	10	46 (473%)	13 (130%)	13 (138%)

※( )内の数字は、基準ケースとの比較を表す.

Kanamori (2022) Analysis of achievement of GHG reduction target for 2030 and 2050 of Japan's household sector. Journal of JSCE G(Environment), 78 (6), II_215-II_224 (in Japanese)

Quantitative analysis of Japan's decarbonized society : Model

- 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, demand, and CO2 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.

Quantitative analysis of Japan's decarbonized society : Scenario

- 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**

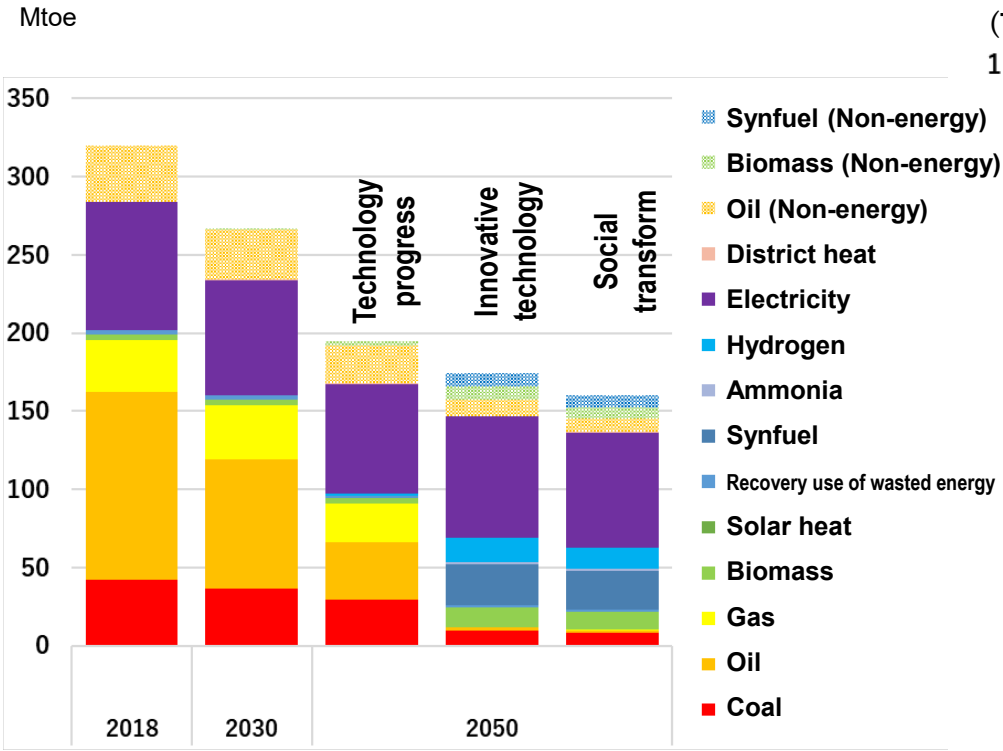
- Efficient use of materials: Sharing, long life, recycling, resource-saving design, etc.
- Reduction of business and commuting travel: ICT to substitute for travel demand, etc.
- Reduction of freight transportation: Efficient use of materials to reduce freight transportation, etc.

AIM ASIA-PACIFIC INTEGRATED MODEL

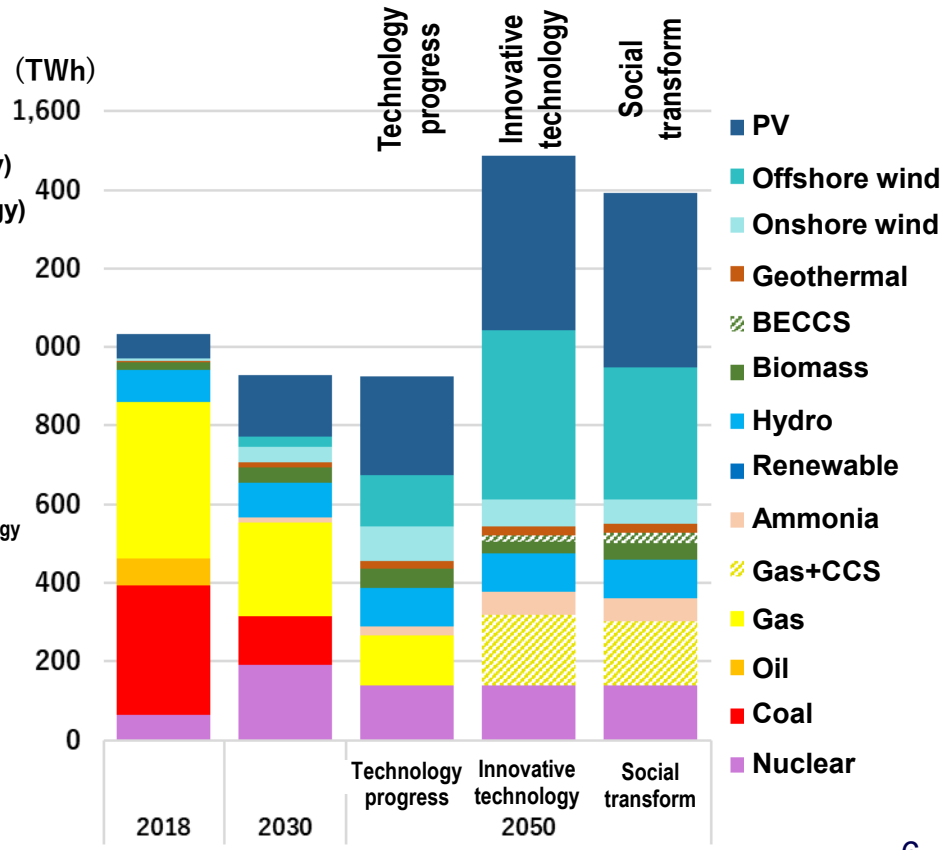
Quantitative analysis of Japan's decarbonized society: Energy consumption, Generation mix

- Final energy consumption has been reduced by 40% to 50% from the current level due to economic and social structure changes and energy efficiency improvement. The two net-zero scenarios expand the share of electricity and hydrogen-based fuel use.
- In the two net-zero scenarios, electricity demand increases significantly for the production of hydrogen-based fuels. To meet that electricity demand, there is a significant increase in the amount of electricity generated by solar PV and offshore wind power.

<Final energy consumption>



<Power generation mix>

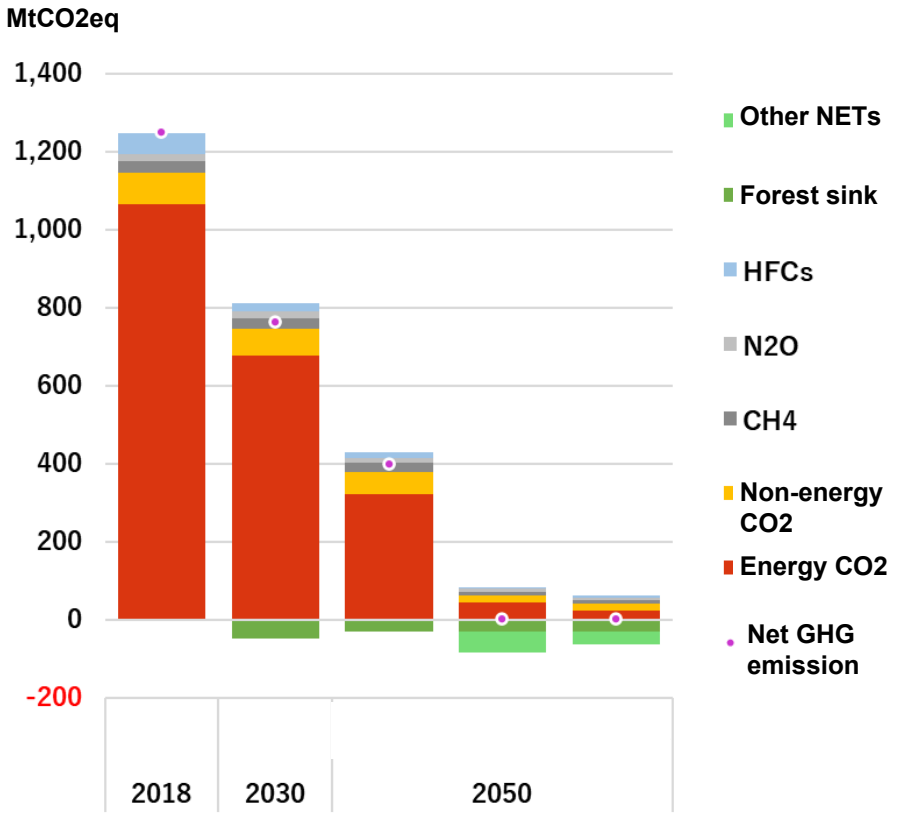


AIM ASIA-PACIFIC INTEGRATED MODEL

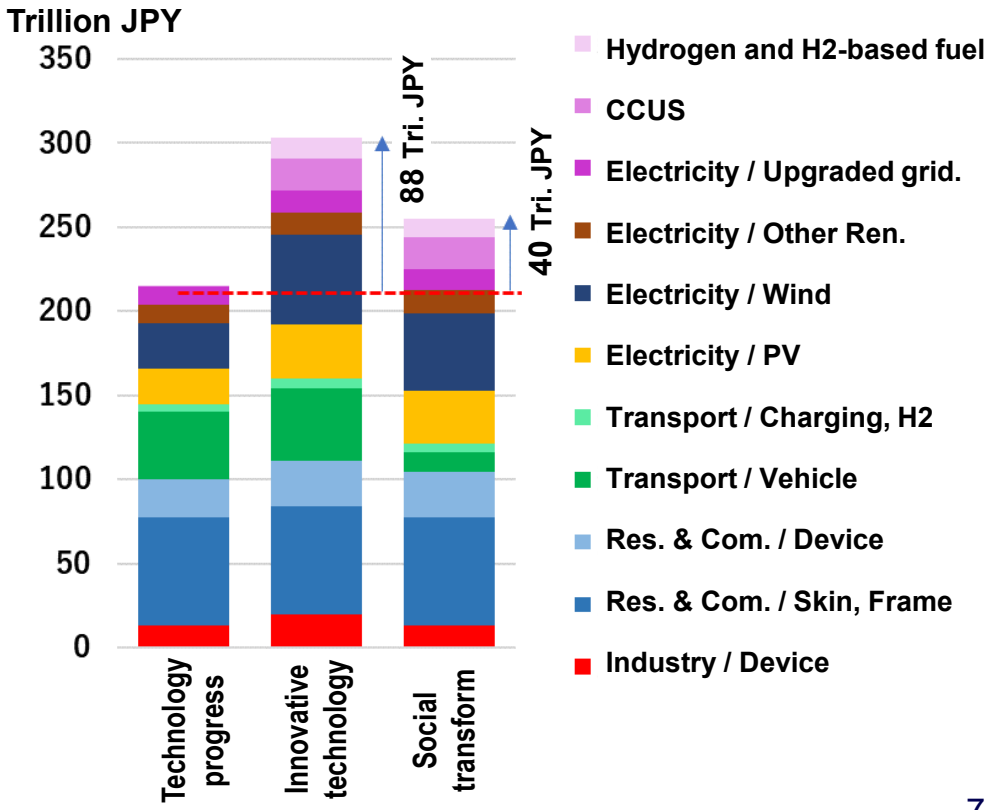
Quantitative analysis of Japan's decarbonized society: GHG emissions, Investment

- In the technological progress scenario, emissions exceed 400 MtCO2eq in 2050. In the two net-zero scenarios, GHG emissions remain at a certain level. However, negative emission measures such as forest absorption offset GHG emissions, resulting in net-zero emissions.
- Social transformation has the effect not only of reducing GHG but also of reducing the amount of investment in energy systems. Therefore, realizing social transformation will increase the feasibility of GHG net zero.

<GHG emissions>



<Total amount of investment (2021-2050)>



Analysis of Japan's Decarbonization Scenarios Considering Prefecture Level Measures

（FY2023-FY2025 NIES, Tokyo Metropolitan Research Institute for Environmental Protection(TMRIEP), Lake Biwa Environmental Research Institute(LBERI)）

How can prefectures decarbonize consistent with Japan's vision of a decarbonized society?

【Issue 1】Decarbonization analysis of 47 prefectures (NIES)

- Study on the amount of actions and measures introduced based on social and economic structure by prefecture
- Development of local resources such as renewable energy and forests consistent with Japan's decarbonization plan

Resources Energy

ICER (Inter-regional Carbon Emission and Removal model)

Characteristics by prefecture

Snapshot tool for hybrid (top-down and bottom-up) regional decarbonization society analysis

【Issue 2】Decabonization analysis in Japan（NIES）

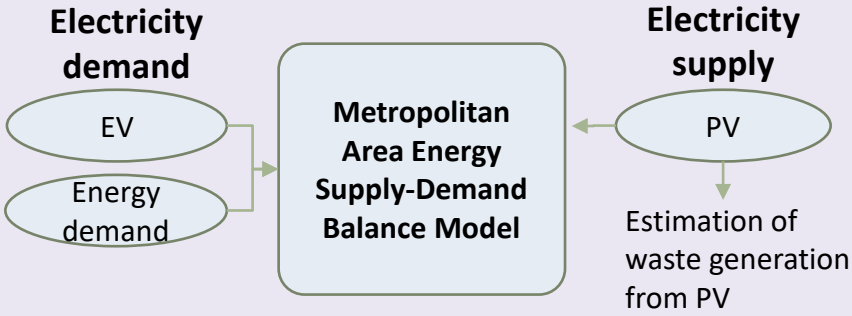
AIM/CGE	AIM/Enduse	AIM/MOGPM
Macro flame Economic impact	Technology choice	Power supply structure

✓ Set appropriate analysis segments

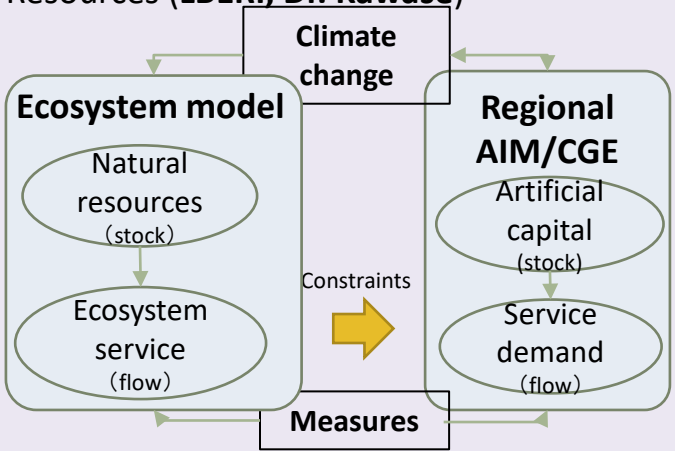
✓ Roadmap to a decarbonized society based on latest plans

【Issue 3】Integrated analysis of local decarbonization and other issues

① Analysis of the mass introduction of PV and EVs and the resulting electricity supply-demand balance for the Tokyo metropolitan area **(TMRIEP)**



② Reconciling a Nature-Symbiotic Society with a Decarbonized Society in Shiga Prefecture Focusing on Local Resources (**LBERI, Dr. Kawase**)



What will be the state of the region's natural resources when decarbonization is achieved?