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Hitachi-UTokyo Lab. 5th Industry-Academia Collaboration Forum
Toward Realizing Energy Systems to Support Society 5.0

Simulation of Linkage between Energy and Cities Aiming for Carbon Neutrality

Naoki Yoshimoto

R&D Group, Hitachi, Ltd.

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1. Research Objectives

How should we carry out urban development to aim for carbon neutrality?

What kind of measures and transitions should be taken to achieve the city’s ideal state while achieving carbon neutrality?

Trial to link simulations for separately comprehending the "city’s ideal state" and the "energy supply and demand."

2. Achieving Carbon Neutrality with the Participation of All Stakeholders

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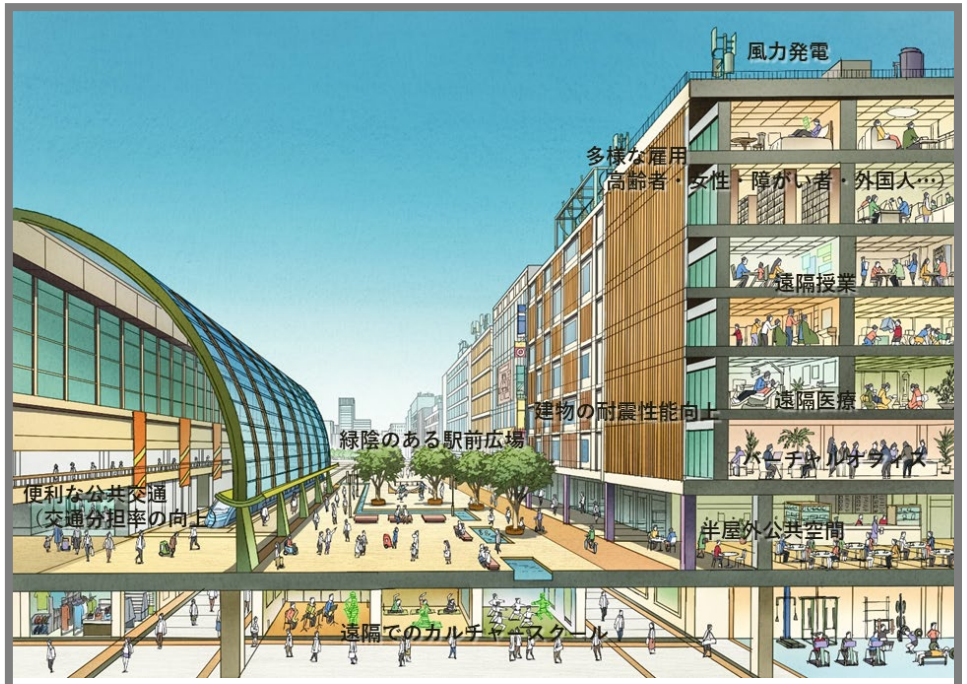
Carbon neutrality cannot be achieved through the efforts of a single person or institution; it requires changes in the behavior of all members of society. There is a need to explore the path to transition that matches the changes in individual lifestyles and the city's ideal state.



City's ideal state

Can get around on foot: Walkable city
No need to wait to get a ride: Demand-based transportation
Comfortable: Extension of stay.

Achieving carbon neutrality

Will people be forced to put up with limitations in the supply of renewable energy?

There are lingering concerns about fuel prices and supply shortages.

There should be a balance between realizing the city's ideal and achieving carbon neutrality.

■ Behavior of society as a whole must be changed.

■ Explore the path to transition to find a balance between both.

Trial to link a policy recommendation AI that can visualize the turning points for the city's ideal state and an energy supply-demand simulator that can quantify carbon neutrality.

3. Policy Recommendation AI -> Technology Selection Model: Overview of Coupled Simulation

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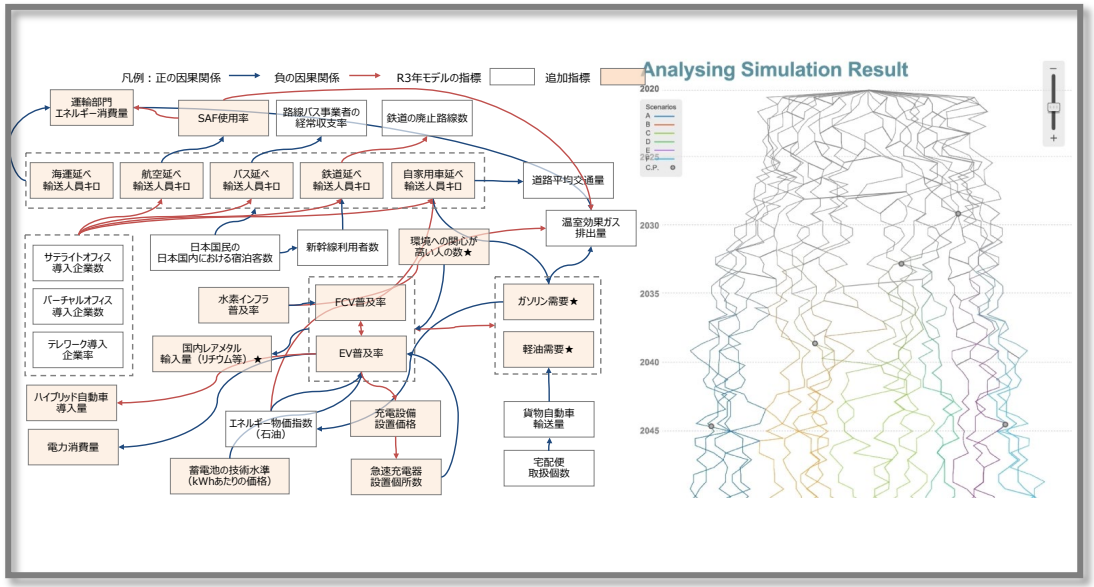
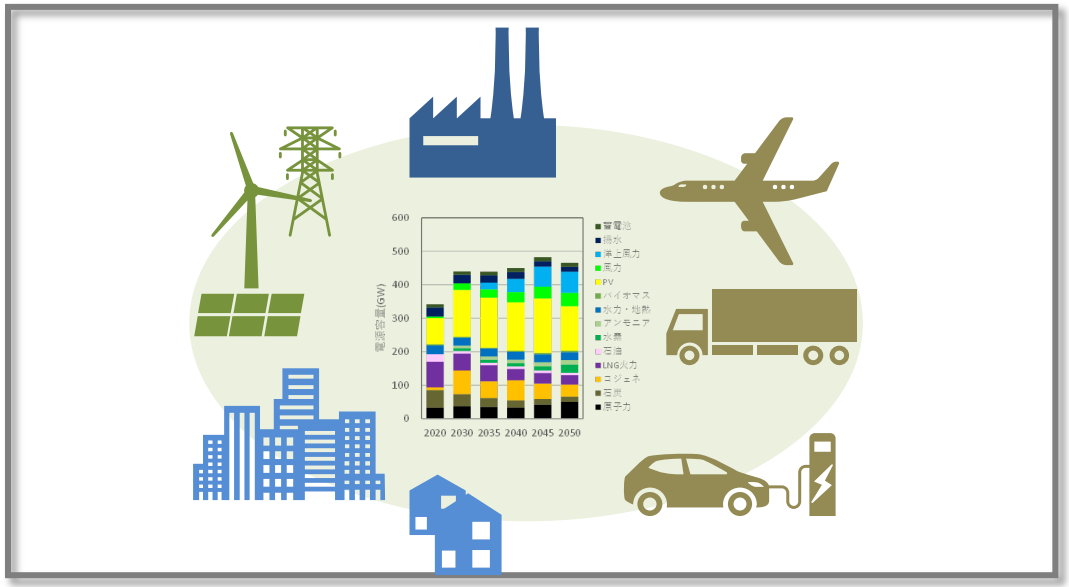
To evaluate the fusion of the city's ideal state and energy, link the tool for visualizing social impact assessment and scenario turning points (policy recommendation AI) and the energy supply-demand simulator. Derive proposal that balances people's happiness and CN.

Policy Recommendation AI (Cyber PoC)



Energy supply and demand simulation



Advantages	■ Ability to describe social trends other than energy supply and demand. ■ Ability to visualize the turning points for realization.	■ Takes into account the supply-demand balance for 24 hours x 365 days = 8760 hours. ■ Possible to reflect policies on power supply configuration, etc.
Disadvantages	■ Inability to take power supply and demand balance into account. ■ Difficult to reflect electricity system policies.	■ Need for including EV and other technology costs as given data. ■ Flexible reflection of demand data.

4. Improvement of Policy Recommendation AI

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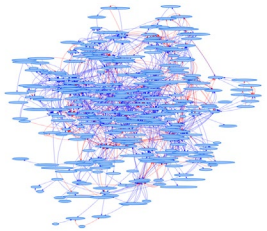
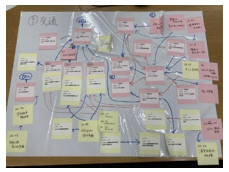
Addition of energy-related indicators and correlations to the policy recommendation AI that shows the turning points for the city's ideal state. Enabled coupled analysis with energy supply and demand simulation.

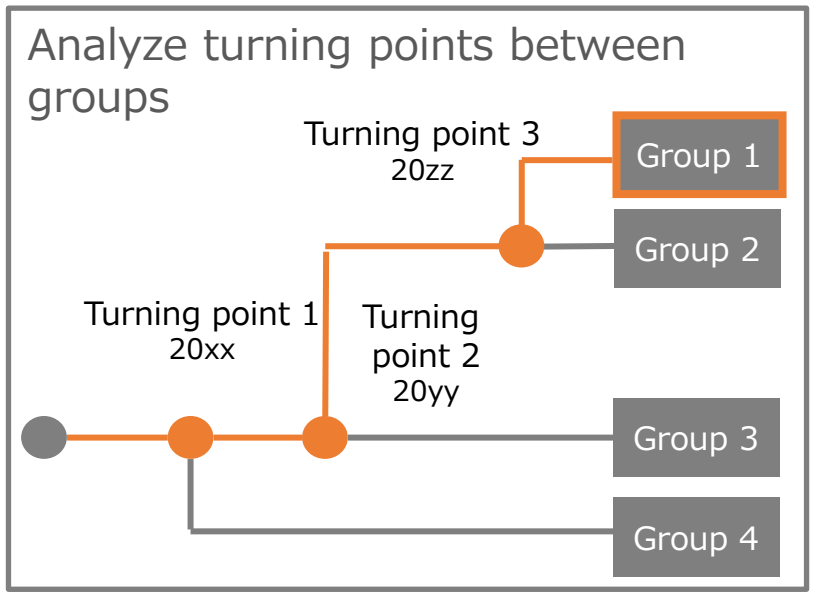
Policy Recommendation AI (Cyber PoC)

- 684 correlations were generated for a total of 230 indicators in 14 sectors

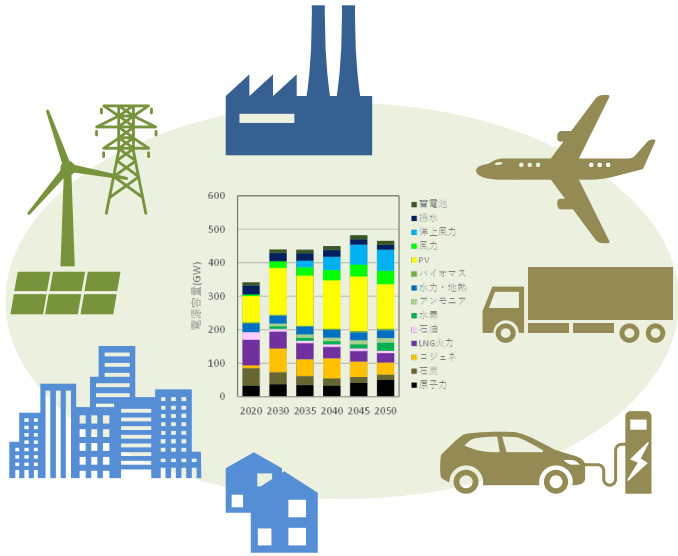
1. Population
2. Finance
3. Nature and environment
4. Employment and working style
5. Parenting
6. Healthcare and welfare
7. Community and lifestyle
8. Education
9. Social infrastructure
10. Transportation
11. Industry
12. Tourism
13. Inequality
14. Happiness







Energy Supply-Demand Simulation



Improvement 1

Addition of energy-related indicators and correlations to the indicators and correlations for future urban development.

Improvement 2

When and what kind of innovation is needed Analysis of energy trends related to each turning point.

Improvement 3

Reflect the timing and scale of innovation expansion.

5. Results of Assessment (Scenario Comparison)

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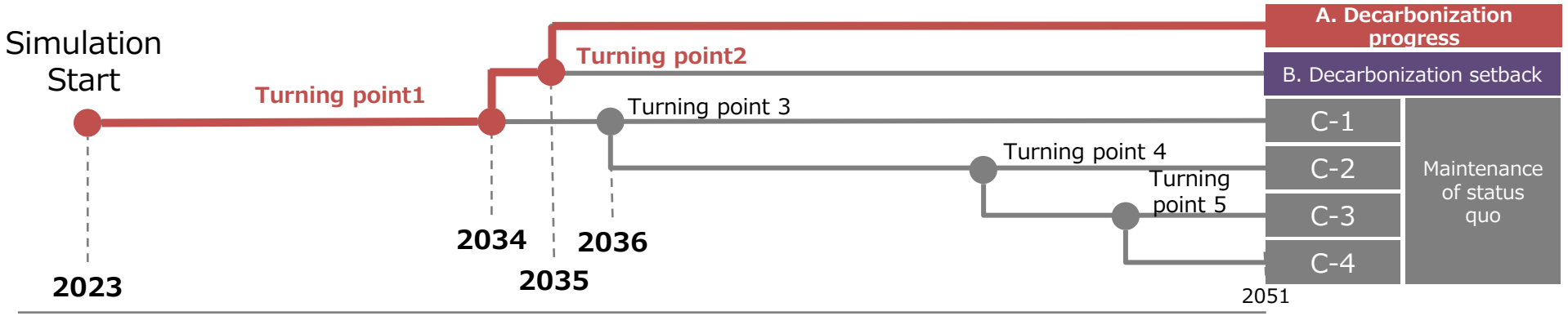
Extract scenarios for achieving carbon neutrality. After two turning points, the population and tourism sectors will be improved.



	① Population	② Finance	③ Community and lifestyle	④ Nature and environment	⑤ Employment and working style	⑥ Parenting	⑦ Education	⑧ Industry	⑨ Transportation	⑩ Social infrastructure	⑪ Healthcare and welfare	⑫ Tourism	⑬ Inequality	⑭ Happiness	Greenhouse gas emissions (Rate of change)
A. Decarbonization progress	○	△	-	○	-	-	△	-	-	-	-	○	△	-	**-0.121**
B. Decarbonization setback	-	○	-	-	△	-	-	-	-	-	-	○	△	-	0.184
C-1. Maintenance of status quo	-	-	-	△	-	-	△	△	-	-	-	△	△	△	-0.034
C-2. Maintenance of status quo	△	△	-	△	-	-	-	○	△	-	-	-	○	△	0.002
C-3. Maintenance of status quo	△	△	-	-	△	-	○	-	-	-	-	-	○	△	-0.059
C-4. Maintenance of status quo	○	△	-	-	-	-	△	-	○	-	-	○	○	○	0.028

Appropriate improvements on depopulation and urbanization control zones, leading to improvement of household population. Progress in improvements in nature and the environment centered on decarbonization, leading to growth of the tourism industry that takes advantage of regional characteristics, including decarbonization.

6. Consideration of the Characteristics of Turning Points and Necessary Measures in the Energy Sector

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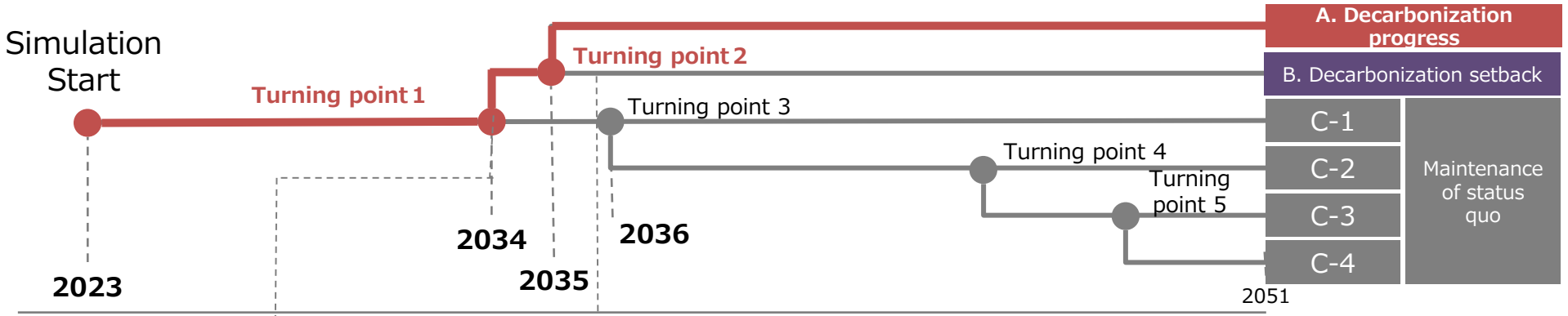
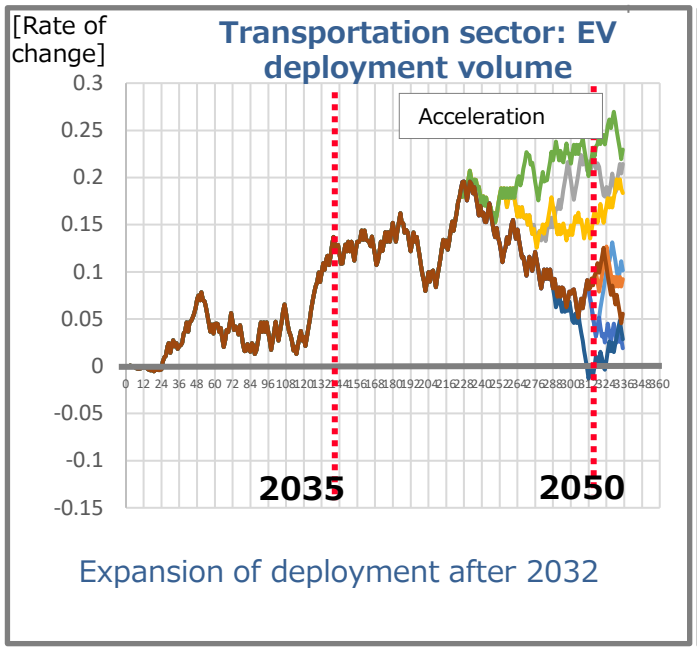
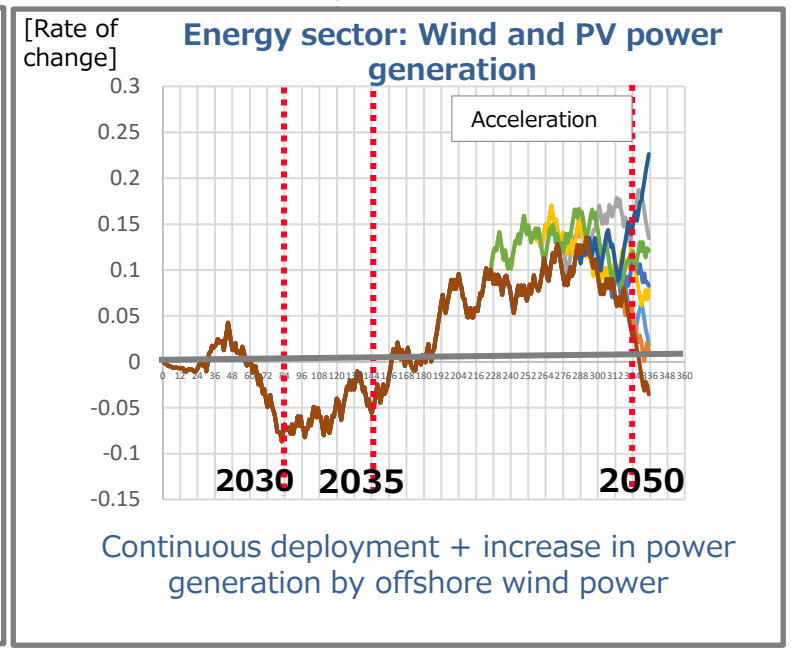
Full-scale acceleration of the introduction of renewable energy, full-scale introduction of EVs, corporate investment, and monetization cycle.

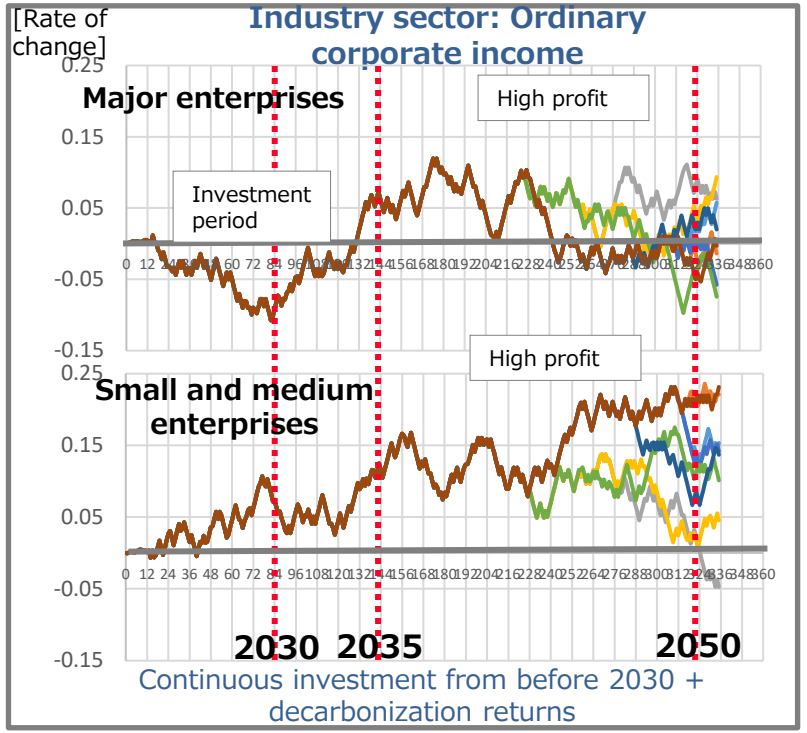




Expansion of deployment after 2032



Continuous deployment + increase in power generation by offshore wind power



Continuous investment from before 2030 + decarbonization returns

7. Energy Supply and Demand Linked with the Results of Policy Recommendation AI

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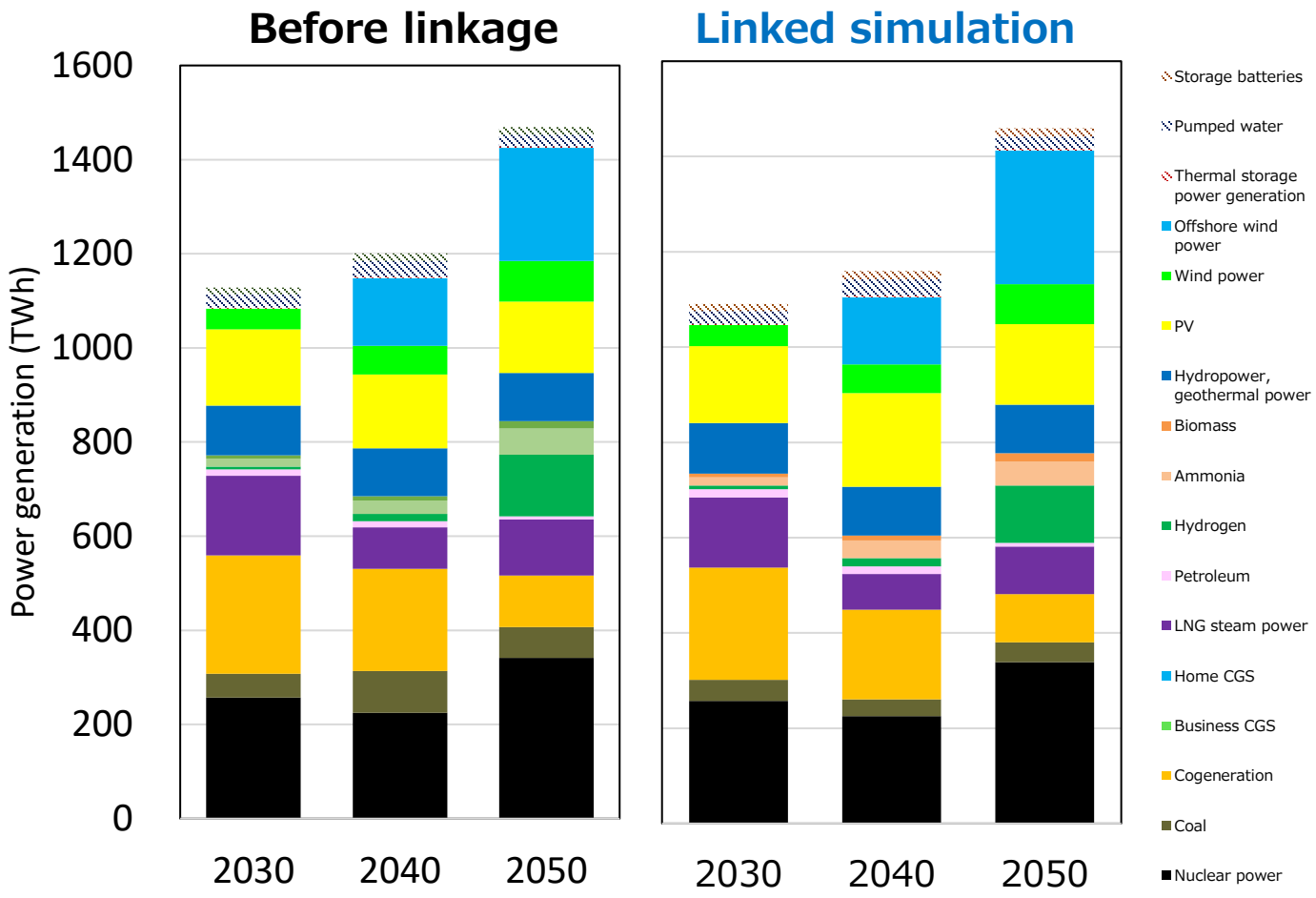
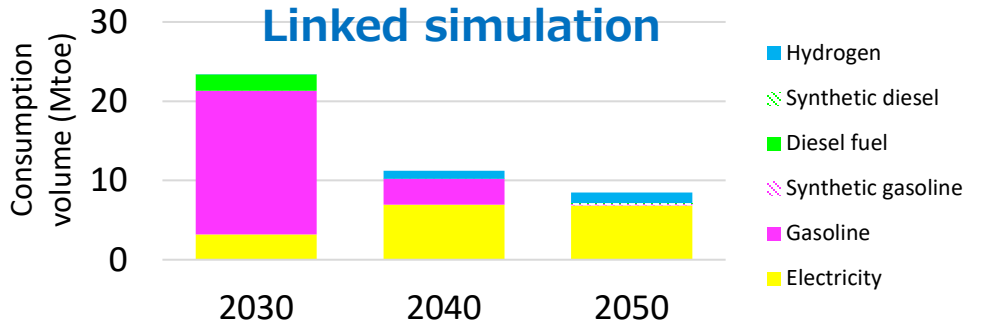
Although the change in total electricity consumption is small, the electrification of private cars has increased significantly, pointing to a trend towards reduction of CO_2 emissions, mainly in the electricity sector, against the backdrop of energy conservation and electrification by companies.

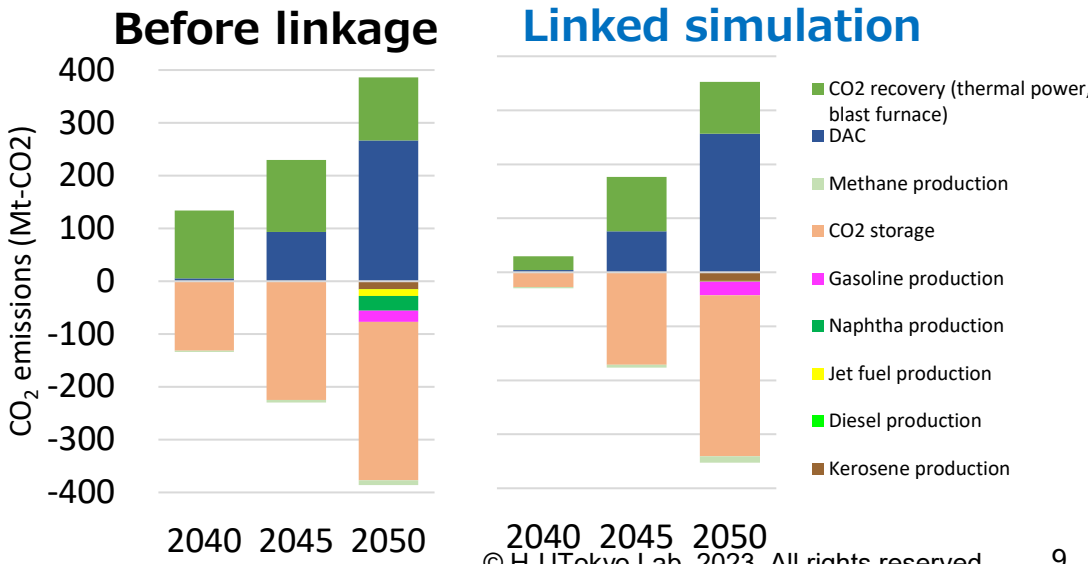
Power generation (TWh)



Energy consumption of private vehicles



CO_2 emissions



8. Influence on Turning Points other than Energy and Points to Keep in Mind

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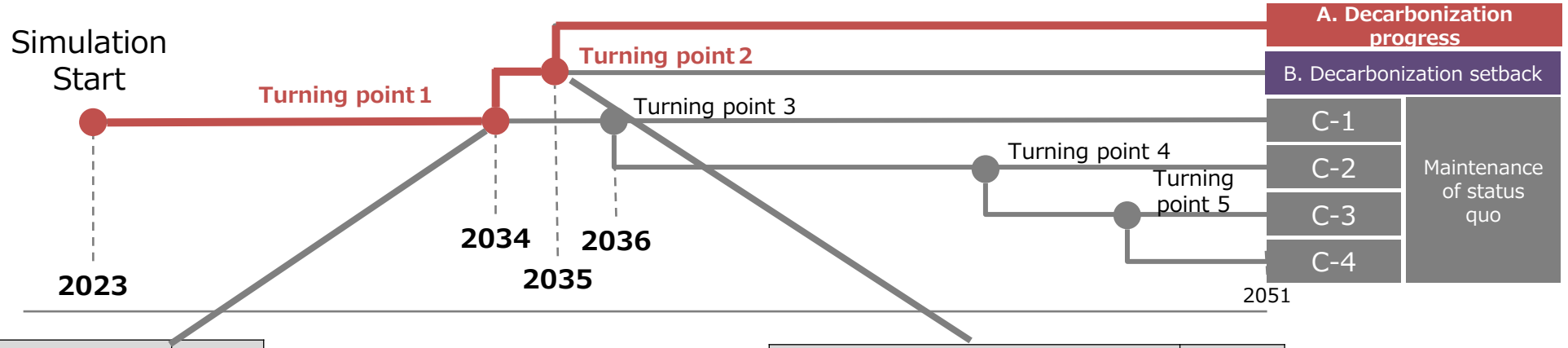
Decarbonization progresses and setbacks require measures for ① smart city implementation in response to population decline, ② securing employment, including nursing care, and ③ improving the efficiency of lifestyles and corporate activities using information.



Indicator	Impact
No. of foreign tourists visiting Japan	1.241
Ratio of depopulated areas (no. of depopulated municipalities)	1.105
No. of Shinkansen users	0.849
Population outside the urban planning area	0.815
Public road maintenance rate	0.802
No. of employees leaving jobs for care-giving and nursing	0.791
Blackout period per household in Japan	0.739
No. of households	0.719
No. of employees (SMEs)	0.665
No. of small settlements	0.630
No. of employees (major enterprises)	0.592
No. of patents registered	0.587
No. of full-time employees in the workforce	0.532
National healthcare costs	0.529

Sparsely populated areas
Development of non-urban-planning areas
Improvement of no. of small settlements

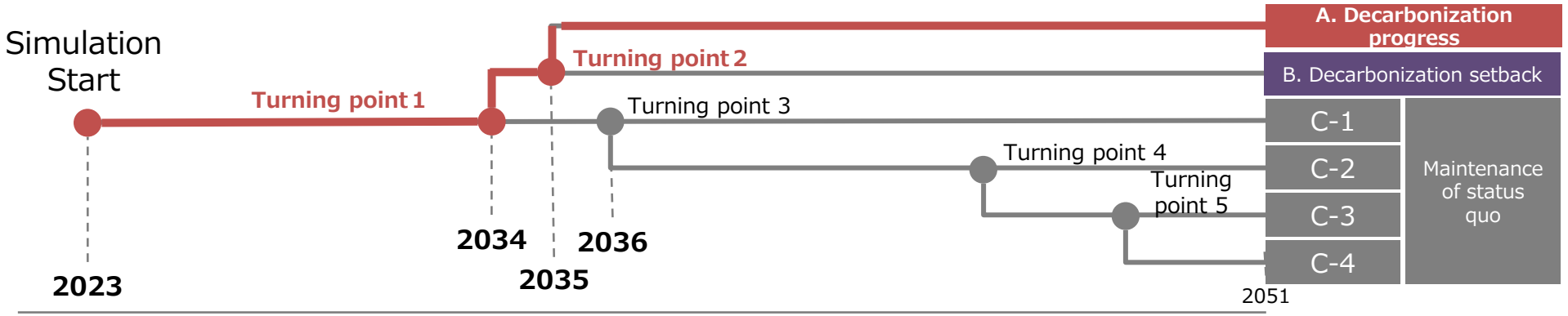
Securing employment, including nursing care

Indicator	Impact
Heat pump shipments	3.385
Ratio of companies adopting telework	2.347
No. of single households	2.274
Ratio of households that order online	2.018
No. of recipients of nursing care services	1.696
No. of factories in Japan	1.495
No. of small bases formed	1.261
Internet usage time	1.248
No. of certified NPOs	1.186
Marital birth rate	1.153
Average household size	1.152
No. of administrative consultations received (complaints from residents)	1.142

Improvement of efficiency of daily life and corporate activities by leveraging the information sector

9. Towards the Next Action

Full-scale acceleration of the introduction of renewable energy, full-scale introduction of EVs, corporate investment, and monetization cycle. In-charge of these measures: national government, local governments, and local companies.



Energy measures: Full-scale participation of consumers

① EV: Motivation of purchase by residents and expansion of deployment

Smart introduction and use based on energy supply.

② Corporate investment: Expansion of environmental investment content

Energy conservation, promotion of electrification, industrial relocation and consolidation.

Response based on energy supply and regional revitalization.

Non-energy measures: Creation of smart cities

① National land measures: Linkage with national policies and decarbonization measures

Long-term measures for national land and decarbonization.

② Utilization and efficiency of the information sector: Balance between the government and the private sector

In the regions, the private sector must foster permanent measures, with the government acting as an intermediary.

10. Conclusions

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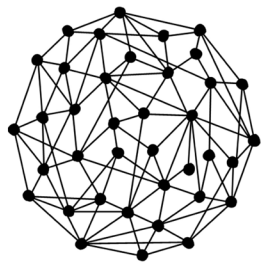
1. **Linkage of policy recommendation AI and energy supply-demand simulation**
   (a) In addition to carbon neutrality, urban development accompanied by growth of population and tourism.
   (b) Energy measures: ① Expansion of introduction of renewable energy ② Expansion of deployment of EVs ③ Proactive corporate investments.
   (c) Non-energy measures: ① Creation of smart cities ② Lifestyle and corporate activities utilizing the information sector.

2. **Energy supply and demand simulation awareness**
   (d) Progress in electrification and reduction of energy consumption in the transportation sector.
   (e) Progress in reduction of greenhouse gas emissions reflecting energy conservation and transition, including corporate initiatives.

3. **Future initiatives**
   Further consideration of model integration, coupling methods, etc.
   Relevance and comparison with other social models.



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