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TITLE: A decade of progress and challenges of the Japan Model Intercomparison Project (JMIP)

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ABSTRACT:

This presentation reviews the progress and challenges of the Japan Model Intercomparison Project, or JMIP. JMIP was inspired by the Stanford Energy Modeling Forum and aims at understanding robust pathways for Japan's mitigation and uncertainties associated with them. Since its project launch in 2016 and first publication in 2019, it has made significant progress and contributed to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change, among other achievements. Many features of Japan's mitigation pathways are similar to other global or national studies, but a few differences emerge because of Japan's unique situation. First, the marginal cost of abatement tends to similar to, or higher than, in North America or Europe. Second, because of the high population density, Japan may need to rely on electricity supply options other than solar and wind power. Despite significant progress, JMIP has been facing challenges. A relatively low level of "futuring capacity" of Japan's policy system has led to a limited influence of JMIP on the policy process. Future research agendas include how Japan can contribute to mitigation beyond 2050 and how to better bridge research and policymaking.

BACKGROUND:

This paper reviews the progress of the Japan Model Intercomparison Project (JMIP), drawing on multiple past studies, and discusses challenges ahead based on recent analyses and trends. JMIP has examined pathways for Japan to achieve deep decarbonization, including net-zero emissions by 2050 and beyond. The project began with its first publication in 2019 (JMIP 0) (Sugiyama et al., 2019). Inspired by the Stanford Energy Modeling Forum (EMF) and other model intercomparison efforts such as the Asia Modeling Exercise, JMIP has conducted a series of model comparisons, initially focused on an 80% emissions reduction target (EMF 35 JMIP 1) (Sugiyama, Fujimori, Wada, Oshiro, et al., 2021; Sugiyama, Fujimori, Wada, & Weyant, 2021) and more recently on net-zero emissions by 2050 (JMIP 2) (Sugiyama et al., 2025) (Figure 1) and post-2050 net-negative emissions in the most recent, ongoing phase (JMIP 3).

PROGRESS OF JMIP

Despite some initial skepticism, JMIP has made significant progress through multiple phases. JMIP has brought together multiple modeling teams and contributed to the evidence base assessed by the Intergovernmental Panel on Climate Change (IPCC) Sixth Assessment Report. Participating models cover a wide range of modeling approaches in terms of economic representation (computable general equilibrium versus partial equilibrium), regional breakdown (Japan as one country versus 10 system operator regions), and other dimensions. This has enabled us to identify robust mitigation strategies as well as areas of uncertainty.

JMIP has highlighted several Japan-specific features affecting decarbonization pathways. These include relatively smaller penetration of variable renewable energy, reflecting Japan's high population density. Another feature is that implied carbon prices are similar to, or higher than, in similar studies conducted in the United States and Europe (Figure 2), in light of the currently higher costs of renewables and various mitigation technologies. This finding of high carbon prices is interesting, as Japan's final energy demand is expected to decline because of a shrinking population. There is major uncertainty surrounding imported hydrogen and related fuels such as ammonia; the government is exploring clean fuel imports but it remains an area of significant innovation and geopolitical uncertainty. Nonetheless, across scenarios, economy-wide energy efficiency, deep decarbonization of the power sector, end-use electrification, and carbon dioxide removal (CDR) emerge as robust strategies to achieve deep emissions reduction in Japan. Our recent analysis also demonstrates that Japan's goal of net-zero emissions in 2050 would require CDR on the scale of 10 to 20% of current emissions to offset residual emissions. Our findings on robust strategies are broadly consistent with other national and regional model intercomparison studies.

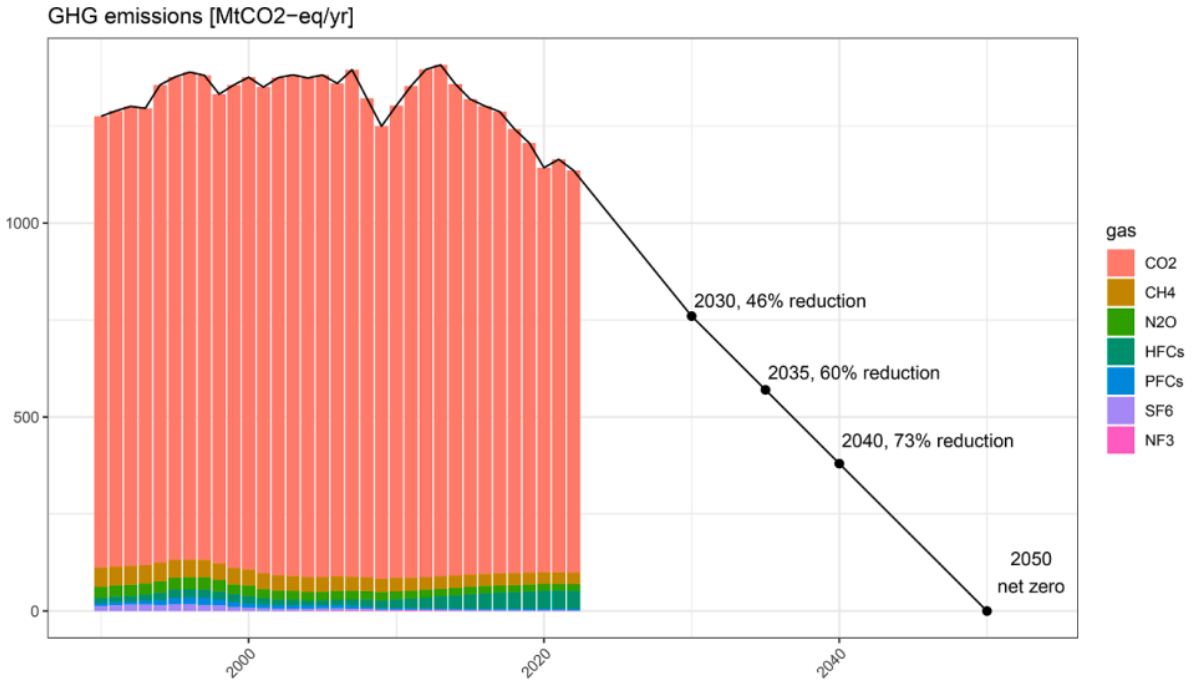


Figure 1. Past emissions and future goals. Adapted from Figure 1 of Sugiyama et al. (2025).

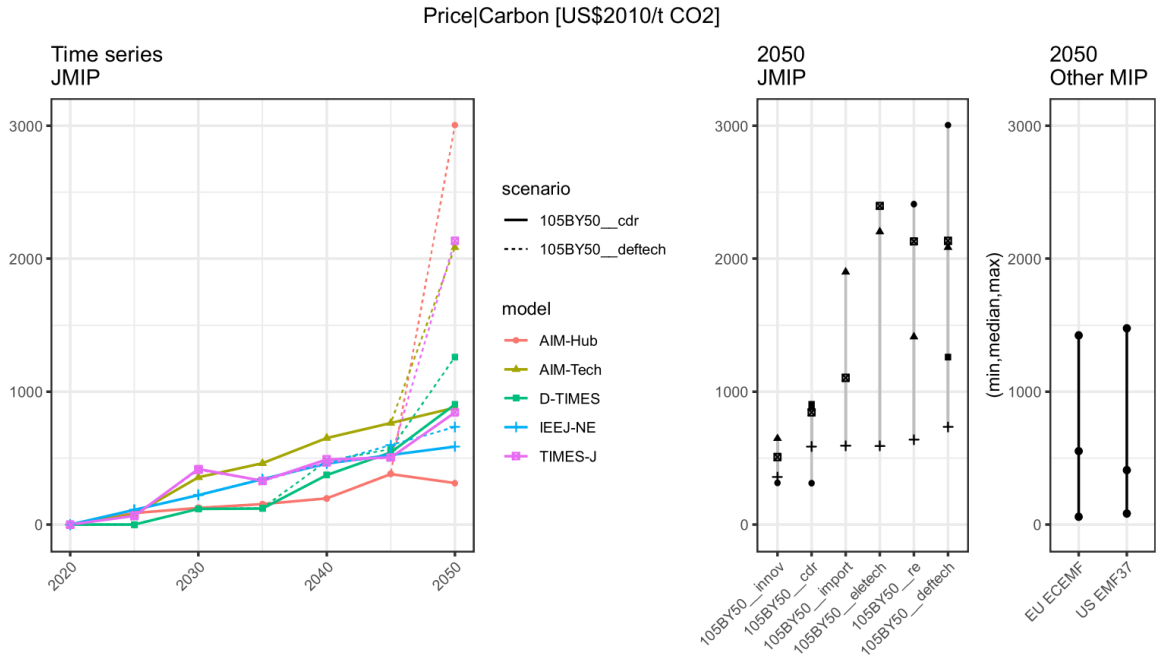


Figure 2. Adapted from Figure 12 of Sugiyama et al. (2025). Carbon price for the five JMIP 2 models . (Left) time series, (middle) the 2050 values by technology scenario, and (right) the comparison with American and European studies. Note that the target of the EU ECEMF emissions reduction was net-zero GHG emissions whereas that for the US EMF 37 was net-zero CO_2 emissions. In the middle panel, the technology scenario is sorted by the maximum of carbon price.

JMIP 3 is now proposing to examine emissions mitigation pathways post-2050. The historical responsibility and Japan's capability for mitigation as well as the equity consideration all suggest net-negative emissions target for post-2050. We have designed stylized emission pathways for 2050 and beyond, which is shown in Figure 3. As shown in the figure, an expected scale of CDR in 2100 can reach as large as 100% of the current emissions. Various considerations would make it hard for Japan to achieve this CDR scale, including social acceptability of geological CO_2 storage and availability of land-based CDR. Our analysis will highlight the implications of Japan's CDR and international emissions trading under Article 6 of the Paris Agreement.

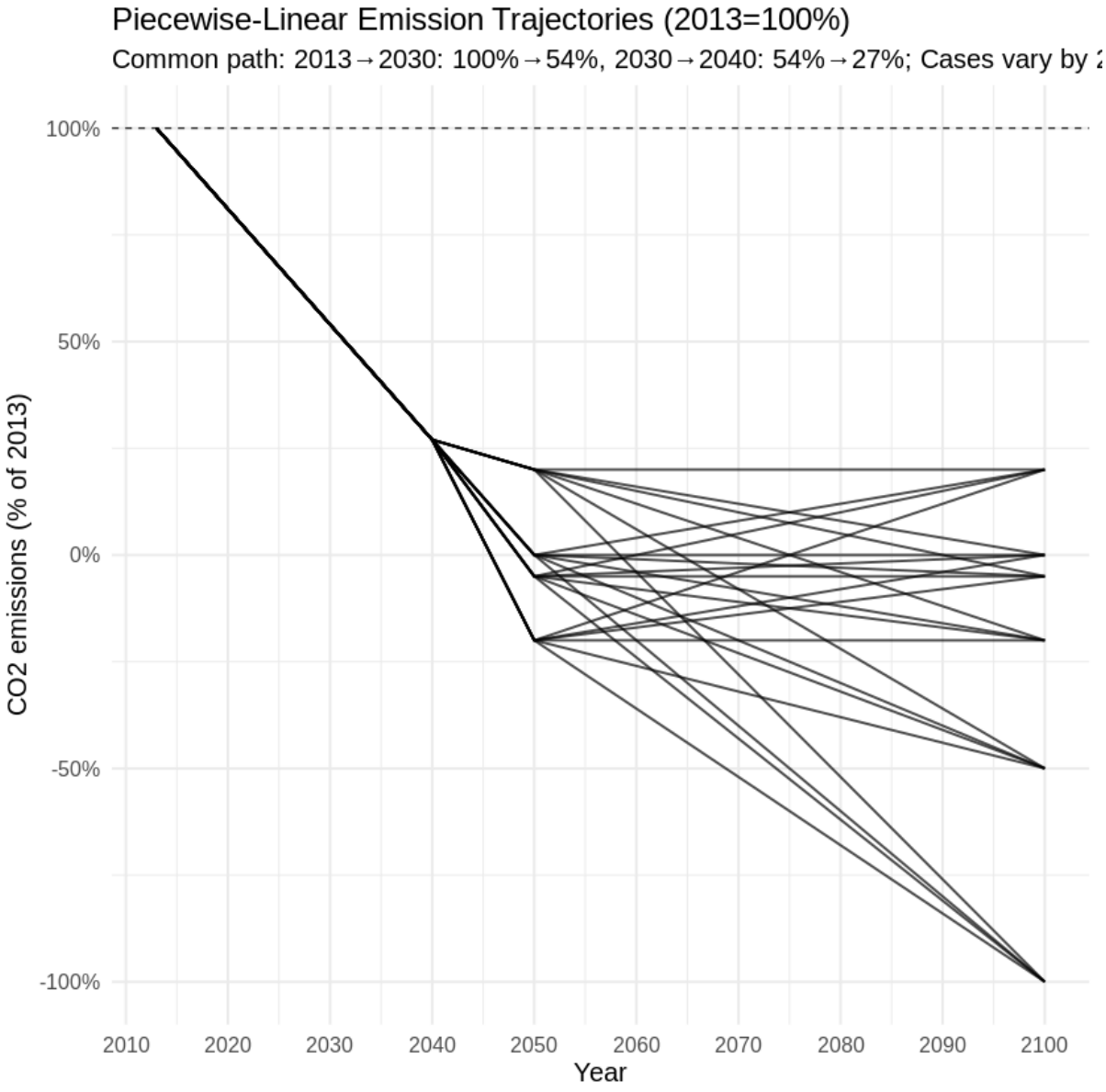


Figure 3. JMIP 3 Scenario design proposal for post-2050 analysis.

CHALLENGES AHEAD

JMIP also faces two key challenges. One is limited diversity in participating models, with relatively few general equilibrium type models compared with some international exercises. Because of the shift in policy context from environmental regulation toward green industrial policy, there is an increasing need for analyzing economic implications of climate, technology, and industrial policies in greater detail. A further challenge is integration with policymaking. While Japan's government has conducted smaller internal model comparison activities during their policymaking processes, JMIP has historically maintained some distance from policy processes, although its inputs can still be improved. Japan's policy system as a whole may have a low level of futuring capacity, a form of policy capacity for using futures and scenarios in policymaking. Improving the translation of JMIP insights into policy design and deliberation in this context, and receiving feedback on scenario design from the policy community, remains an important area for future work.

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REFERENCES:

Sugiyama, M., Fujimori, S., Wada, K., Endo, S., Fujii, Y., Komiyama, R., Kato, E., Kurosawa, A., Matsuo, Y., Oshiro, K., Sano, F., & Shiraki, H. (2019). Japan's long-term climate mitigation policy: Multi-model assessment and sectoral challenges. *Energy*, *167*, 1120–1131. https://doi.org/10.1016/j.energy.2018.10.091

Sugiyama, M., Fujimori, S., Wada, K., Oshiro, K., Kato, E., Komiyama, R., Silva Herran, D., Matsuo, Y., Shiraki, H., & Ju, Y. (2021). EMF 35 JMIP study for Japan's long-term climate and energy policy: Scenario designs and key findings. *Sustainability Science*, *16*(2), 355–374. https://doi.org/10.1007/s11625-021-00913-2

Sugiyama, M., Fujimori, S., Wada, K., & Weyant, J. (2021). Introduction to the special feature on energy scenarios for long-term climate change mitigation in Japan. *Sustainability Science*, *16*(2), 347–353. https://doi.org/10.1007/s11625-021-00931-0

Sugiyama, M., Shiraki, H., Fujimori, S., Wada, K., Cao, T., Frazer, E., Hamasaki, H., Kato, E., Matsuo, Y., Nishiura, O., Okubo, T., Oshiro, K., Otsuki, T., Sano, F., & Yoshida, H. (2025). JMIP 2 Part 1: Technology uncertainty and robustness in Japan's net-zero pathways. *Energy and Climate Change*, *6*, 100210. https://doi.org/10.1016/j.egycc.2025.100210