Industry's Role in Energy Transition: Soft-Linking IAM and IO with extended electricity supply sectors

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１． Introduction

Energy transition towards ambitious climate goals (1.5 degree) requires a shift from fossil fuel energy to renewables on the energy supply side. However, the renewable power generation technologies themselves are highly material- and energy-insensitive. They require higher initial investments in infrastructure than fossil-based power systems (Hertwich et al., 2015). Moreover, the expansion of renewable energy capacities also drives the expansion of infrastructure and electricity transmission/storage capacity (Deetman et al., 2021). The upstream industry sectors of such infrastructure construction are extremely difficult to decarbonize (due to the need for high temperatures, the existence of process emissions, the time it takes to update industry facilities, etc.).

To capture such part, we estimated the industrial energy consumption induced by the introduction and replacement of RE capacities by soft-linking IAM and IO with dynamic iterations, so that it is still feasible to achieve long-term climate goals such as carbon neutrality.

２． Methodology

To capture the industrial energy consumption in response to the changes in the power generation mix, we conducted the soft-linking between the integrated assessment model GCAM (Global Change Analysis Model) and a national input-output framework with extended electricity supply sectors IONGES (Input-Output table for analysis of Next-Generation Energy System). The overview of the linking is shown in Figure 1.

On the IAM side, in each period, the model solves the optimal combination of energy supply technologies subject to a given level of energy service demand. Such energy service demand is usually aggregated from energy end-use sectors (agriculture, industry, transportation, and buildings), among which the industrial energy service demand projection can be highly coupled with the GDP growth. To capture the industry's response to the changes in the energy supply structure, the investment in new capacity in IAM will be mapped to an IO framework to calculate the energy consumption induced by energy transition on the supply side and further linked back to the IAM as additional industrial energy demand. In each period, the iteration between the IAM and IO model will continue

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until the changes in the linking variable are smaller than a stop parameter. The inter-period iteration (iteration between year t and year t+5) will still be conducted in the IAM.

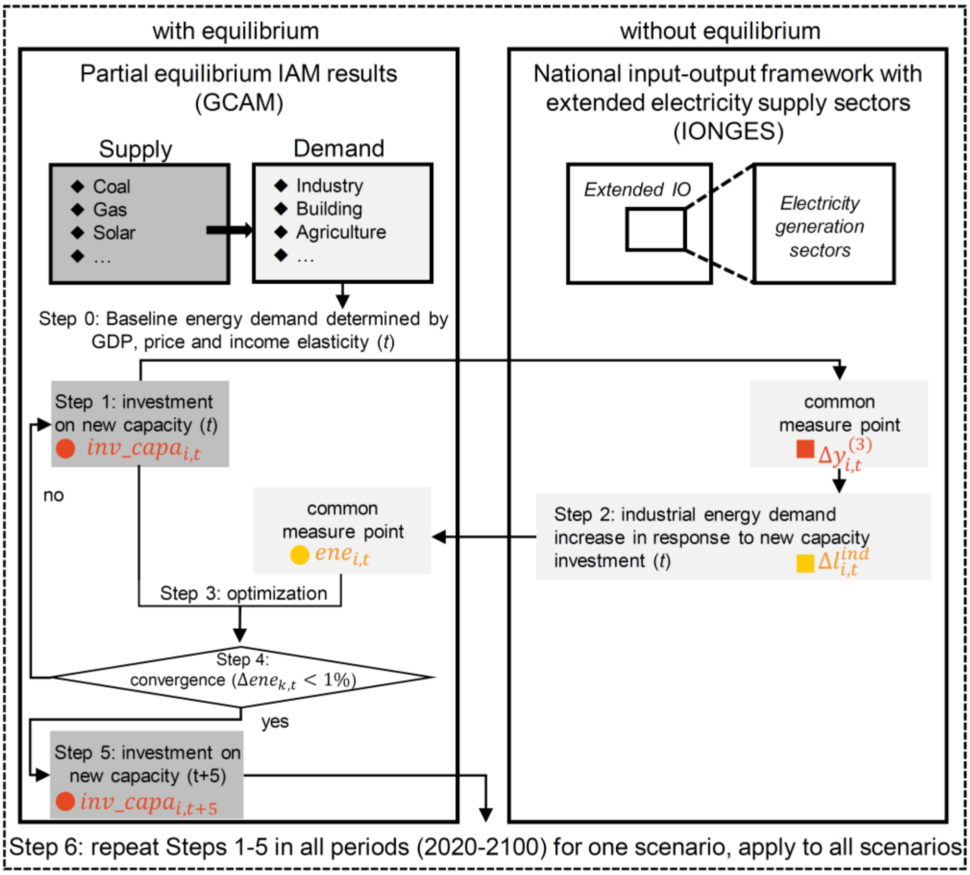

Figure 1. Overview of the methodology

3. Results and Conclusions

The results show that: i) the industrial final energy under the carbon neutrality scenario would be 0.2-0.7EJ more after linking, which is almost the gap between the carbon neutrality and the reference scenario; ii) to achieve carbon neutrality by 2050, more power generation capacities would be introduced in the near-term periods (2020-2030), bringing additional growth afterward. Our soft-linking approach emphasized the role of industries in the energy transition and explored how industries can benefit from an increasingly low-carbon energy supply.

Reference

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