ASSESSMENT OF JAPAN'S NET ZERO TARGET BY 2050 USING DYNAMIC MULTI-SECTOR ENERGY ECONOMIC MODEL

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Overview

Japan announced its net-zero emissions target by 2050 and become carbon neutral in 30 years. The pathway to become a decarbonized society is not very smooth and there are many socio-economic effects which needs to be dealt carefully. As a highly energy intensive economy that mostly relies on import for primary energy supply, Japan needs to shift carefully to renewables and other clean energy technologies like nuclear power and hydrogen. In addition, appropriate carbon pricing and promotion of carbon-capture technologies like CCS and DAC have become essential in coming days. In this study, we analysed the overall energy economic effect in order to materialize the net-zero policy and obtained the optimum pathway to achieve the goal in a sustainable manner. Several scenarios have been analysed with key focus on the electricity, material and automobile sectors.

Methods

The Dynamic Multi-Sector Energy Economic (DMSEE) model developed for this analysis, uses linear programming approach to quantitatively analyse the interrelationship among Top-Down (TD) economic sectors and thus elaborate the Bottom-Up (BU) electricity sector in term of different power generation technologies considering techno-economic and environmental constraints. We used the TD information obtained from Global Trade Analysis Project (GTAP) 10 database that represents the world economy through bilateral trade information. For the BU electricity sectors, eight power generation technologies were considered: nuclear, coal-fired, gas-fired, oil-fired, biomass, hydro, solar PV and wind power generation. The objective function of the model is to maximize utility for consumptions. The constraints include supply-demand balance, resource balance, capital investment limit, labour availability from TD perspective and other technical limitations from the BU electricity sector. Different carbon-emission limits are imposed to obtain optimal electricity generation mix for different scenarios.

Results

Our model computes results for 6 time points starting from 2025 to 2050 at 5 years interval. Hourly electricity generation from different technologies is obtained to generate optimal power generation mix for a particular year. Carbon emission limit was introduced in a step by step manner so that carbon neutrality could be achieved by 2050. The GDP over the years, import, and export of particular goods of interest were also calculated. The impact on productivity for the material and automobile sedctors were analysed under the emission restricted scenario with alternate energy technologies. The results of this analysis provides critical information regarding optimum pathway to net zero through timely deployment of useful technologies.

Conclusions

196 countries adopted the historic Paris Agreement to reduce global warming and build resilience to climate change. Environmental measures are no longer considered as constraints on economic growth. Rather, they create opportunities to transform the industrial structure and increased productivity through changes in economy and society promoting investments. In this analysis, we re-evaluate the justification of net-zero concept from Japan’s energy-economic perspective which could be equally applicable to other countries of the world.

References

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Acknowledgement: This work was supported by JSPS KAKENHI Grant Number JP20H02679 and by the Environment Research and Technology Development Fund 2-2104 of the Environmental Restoration and Conservation Agency.