Abstract for Hydrogen Reduction Steel Production and its Impact on the Economies of Japan: A Simulation with E3ME-FTT:Steel

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1. Objectives

For achieving Net-carbon steel and carbon neutral in Japan, it is necessary to transmit to green steel. The purpose of this study is to follow up on the latest steel technologies and explore the possibility of decarbonized steel production in the future.

2. Introduction, Method and Data

E3ME-FTT:Steel model is used to simulate technology diffusion in the iron and steel sector of Japan. The policies which support decarbonized and low-carbon steelmaking technologies are set up in the decarbonization scenarios. By simulating E3ME-FTT and comparing decarbonization scenarios with baseline, the environmental impact can be analyzed. The subsidy for supporting the Hydrogen Direct Reduction and other steelmaking technologies by 2050 can be estimated. Decarbonization in the iron and steel sector is tried to be realized through maximizing the Hydrogen Direct Reduction by 2050, the impact on the Japanese economy can be also measured. Moreover, whether carbon neutrality can be achieved in the whole country of Japan by 2050 will be estimated. The data in the E3ME model covers 59 regions, 42 industries, 12 fuels, 24 power generations. In the E3ME data, there are 26 technologies in the iron and steel sector.

3. Assumption

This study follows the steelmaking technologies schedule which was published by METI. How to use subsidies and the emphasis of subsidies in line with the announcement of the Japanese government. There are assumptions used in this study. There are goals of hydrogen supply and cost announced by METI. This study uses the goal of hydrogen supply as the supply and the goal of hydrogen cost as the price. From setting up the hydrogen supply and price, hydrogen demand can be simulated by E3ME-FTT model. When domestic hydrogen supply cannot cover the demand, hydrogen will be imported. The import price is assumed to be 25.5 JPY/Nm3. Compared with the domestic hydrogen cost target of 100 JPY/Nm3 recently and 30 JPY/Nm3 by 2030, the import price would be greater than the domestic price. By 2044, import price will meet domestic price, which means that there will be no more imports. The technology is assumed to innovate on the importer's side and import price slightly declines to 22 JPY/Nm3. After 2045, domestic price declines to 20 JPY/Nm3 until 2050, which is lower than the import price (see Figure 1).

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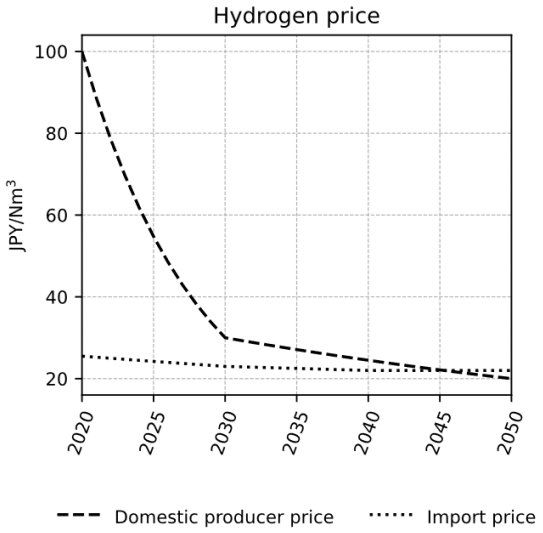

Figure 1. hydrogen domestic price and import price

4. Main Results

This study shows that the economic effects by decarbonization scenarios are positive. Due to lifespan, 77% of Blast Furnaces need to be renovated by 2030. The simulations showed that it is possible to promote decarbonized and low-carbon steelmaking processes through policies by the diffusion of Hydrogen Direct Reduction steelmaking, steel recycling, add CCS and renewing Blast Furnace to the Top Gas Recycling Blast Furnace. The policy packages which are set up in the decarbonization scenarios help to transmit the energy system from fossil fuel to renewable energies, and help to achieve green steel. The total final energy consumption also decreases due to uptake of more efficient steelmaking processes. Though maximizing the Hydrogen Direct Reduction, large scale decarbonization in the iron and steel sector can be achieved but not the whole country of Japan. The results imply that decarbonization in other sectors is indispensable, such as the power sector. However, it is a big step towards the hydrogen economy. The trade balance (net export) benefits Japan. Due to the carbon tax and other increased fiscal rates, price increases and leads to a negative impact on consumption. However, the uptake of low carbon technologies induces investments on new buildings and equipment. The investments create jobs which increase disposable income and at the end augment consumption. The combined effect stimulates economic activity and has a positive effect on GDP.

5. Conclusions

There is an extensive transition from carbon-intensive to low-carbon steelmaking technologies. The results have shown that transmitting to low-carbon steelmaking technologies and focusing on Hydrogen Direct Reduction is important for Net-carbon steel and carbon neutral in Japan. The results have further elucidated that Japan has a gain from decarbonized steelmaking, such as positive economic effect.