THE ROLE OF CARBON CAPTURE AND UTILIZATION IN INDUSTRIAL SECTOR DECARBONIZATION: A CASE STUDY OF JAPAN

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Although the Japanese government announced an ambitious CO_2 reduction target of 80 percent of its 2013 levels by 2050, Japan's economy is highly dependent on its energy-intensive exports that it currently produces by importing nearly all its fossil fuels. Furthermore, the industrial sector is the most difficult and expensive sector to decarbonize using currently available technologies.

As such, Carbon Capture and Utilization (CCU), which converts captured CO_2 into other substances using chemical reactions with hydrogen, is considered the ultimate carbon neutral technology. Therefore, comprehensive model-based studies of CCU's economic viability have been expected. Such an approach can help us understand the potential roles of CCU technology under different assumptions and using different strategies to decarbonize the petrochemical industry. Specifically, this study aims to investigate 1) the roles that CCU could play in Japan's decarbonization pathways to 2050; 2) the factors that influence CCU deployment; and 3) how the market penetration of Zero-Emission Vehicles (ZEVs) could affect CCU deployment.

To this end, the MARKet ALlocation (MARKAL) model is extended to add CCU technologies and to represent chemical production processes in greater detail, including basic petrochemical products. Furthermore, the total optimal (minimized) system cost, given climate policies and technological assumptions, is examined to include the role of CCU by testing scenarios based on various parameters, such as CO_2 emission constraints; CAPEX and OPEX of the CCU technology; primary energy import prices; hydrogen prices; and the different maximum allowable market penetration rate of ZEVs.

Under a climate policy that reduces total Japanese CO_2 emissions by 80% by 2050, the optimal decarbonization pathway applies CCU technology to 17.8% of energy use in the relevant petrochemical industries in 2050. However, the implicit carbon price at this point is a very high value of \$662/tonnes-CO_2 in a scenario.

Given the scenarios analyzed, this study shows (1) Petrochemical processes remain some of the most challenging and costly parts of the economy to decarbonize and (2) Further CCU technology improvements leading to reduced costs are required for it to play a significant role in near future decarbonization efforts.

Benjamin Leibowicz (Have your advisor sign here; electronic signatures with pdf authentication are OK. If you are co-advised, then copy and paste these lines again and have them both sign.)

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