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Assessment of Potential and Breakeven Prices of Fusion Power Plants under Low-Carbon Development Scenarios

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Climate change has become one of the most important issues to be tackled in the world. Deep emission reduction of greenhouse gas must be achieved in this century. In the COP21 of United Nations Framework Convention on Climate Change (UNFCCC) on December 2015 in Paris, a new mechanism of CO2 emission reduction (Paris Agreement) was adopted based on the pledge-and-review approach. Fusion energy has outstanding characteristics of plentiful resources, no nuclear runaway, and zero-carbon emission. DEMO plant projects have begun in the participating parties of the ITER project. They aim at demonstration of not only electricity generation but also economy and social acceptability of commercial fusion power plants.
Roles and breakeven prices of nuclear fusion have been analyzed by using energy system models in the previous studies. However, their assumptions for fusion energy assessment are out of date, because new scenarios reflecting the latest data and storylines have been developed for the long-term energy system assessment. In this study, we assessed a role of fusion energy by using state-of-the-art model and scenarios.
We studied breakeven prices and potential capacity of fusion power plants under five low-carbon development scenarios using a state-of-the-art global energy system model: DNE21+. The DNE21+ model is a linear programming model which minimizes the world energy system cost. The model represents regional differences dividing world into 54 regions, and assesses energy technologies which are bottom-up modelled in detail.
A wide range of breakeven prices of capital costs per unit of 1 ˜ 8 $/W in the United States, EU, Japan, China, Korea, India, and Russ and/or enhancement of the plant availability are desired in the DEMO project. Fusion can play a significant role in the low-carbon development if it secures the economy, substituting fission and fossil fuel power plants with carbon dioxide capture and storage (CCS). Fusion energy development could be justified in economic meaning alone if their research and development (R&D) costs ($) are less than the total installed capacity (W) to the power of 1.5, which correspond to the total energy system cost reduction in the world.

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