Contribution ID: **46** Type: **Poster**

Contribution of fusion energy to low-carbon development under the Paris Agreement and accompanying uncertainties

Wednesday, 24 October 2018 08:30 (4 hours)

The Paris Agreement requires deep reduction of greenhouse gas emissions. The world is toward rapid transition not only for climate change mitigation but also for sustainable development. Fusion energy has outstanding characteristics of plentiful resources, no nuclear runaway and zero-carbon emission, and its development has made a remarkable progress thanks to large investment for more than 50 years. However, long-term strategies for fusion energy development will become critically important in order to promote future DEMO projects by another large-scale investment and gain social acceptance. In this study, we assessed potential contribution of fusion energy to low-carbon development which is prescribed in the Paris Agreement under the combination of uncertainties of future socioeconomic development, the 2℃ target and future commercial fusion power plants.

We analyzed global energy systems up to 2100 in consideration of uncertainties by combining socioeconomic scenarios, global CO2 emission pathways, and fusion power plants by using a global energy systems model: DNE21+. We used three Shared Socioeconomic Pathways (SSPs) to express the uncertainty of future socioeconomic development. Assumptions and parameters for DNE21+ were harmonized with the SSP narratives. Four global CO2 emission pathways were used to simulate the uncertainty of the long-term targets of the Paris Agreement. For the uncertainty of fusion energy development, we set three scenarios, i.e., No Fusion, Conventional R&D and Advanced R&D which have different assumptions on parameters of fusion power plants. The parameters were set by considering potential and achievable cost reduction and performance improvement on the extension of DEMO concept design.

Global negative CO2 emission in 2100 by drastic decarbonization of energy systems is required in order to achieve the 2℃ target, and fusion power plants will be installed in the latter half of the 21st century mainly in the countries which have limited potentials of zero-emission energy sources such as Japan, Korea and Turkey. If inexpensive power plants could be developed by enhanced R&D and advanced design in DEMO projects, fusion power plants will also be deployed in the EU28, India and China. This study could be implicated in long-term strategy planning for fusion energy development.

Country or International Organization

Japan

Paper Number

FIP/P3-2

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Session Classification: P3 Posters

Track Classification: FIP - Fusion Engineering, Integration and Power Plant Design