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Future Electric Market and Fusion Deployment Strategy with Electricity Storage Systems

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This paper points out one of the critical issue overlooked for fusion to become a viable energy source in the future, quantitatively analyzes the requirements, and suggests a possible solution. Future grids in possible markets and the impact of fusion introduction was analyzed with numerical model, and the limitation and requirements of the generation capacity of fusion plant is shown as the function of grid capacity, composition and stability. There are very limited opportunity of 1GW or above for fusion in most of the emerging grids, and fusion will need smaller capacity, or better ancillary service including innovative storage.

Almost all the fusion reactor designs assume large and stable electricity grids to connect and expect unlimited large pulsed power supply for starting plants. Unlike in the grids in the countries where fusion research is currently pursued, majority of the future grids where fusion would be deployed are anticipated to be significantly different. Even in the large grids in advanced countries, future system will be rather unstable because of the larger renewable fraction and trends to free electricity markets. Majority of the electric grids in the world will be still far smaller than 50GW at the middle of this century, where introduction of fusion electricity over 1GW would be difficult.

This paper analyzes the impact of fusion electricity on small size grids. Fusion plants requires large electricity for startup, and in the case of disruption or other unexpected shut down, loss of electricity in a short time would disturb the stability of the grids .

The authors established a simplified Heffron–Philips model constructed in Matlab/Simulink®. This model analyzes quantitative impacts of fusion on a given grid size and composition, and provides limits and requirements for fusion to be installed.

This concept suggests the possibility of faster and easier introduction of fusion energy in the future, with reduced difficulty and with larger and more attractive market possibility. Majority of sales of fusion, if it would be viable, is in the developing countries rather than the mature markets where growth is not expected, and thus encompassing such a business model could justify the investment for fusion development.

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