

Impact of Fusion Reactor on Electricity Grids

Yasushi Yamamoto and Satoshi Konishi

Institute of Advanced Energy, Kyoto University, Gokasho, Uji, Kyoto 611-0011, Japan

A fusion power reactor will require a few times larger recirculating power compared with other power stations, and when it starts, all this power will be received from the electricity grid. But there are restrictions in the maximum power and rate of variability which fusion power station can be received, depending on the system scale and the composition for the stable operation of the electricity grid. Large generation capacity is one of the major drawbacks of fusion as an energy plant. Particularly in the developing countries with small scale grids where deployment of fusion is expected to take place in the future global energy market, such an impact could be a major constraint.

In the future fusion power station, the plasma operation should become steady-state, and the plasma start-up is expected to be occurred a few times per a year. Mitigation measures such as fly-wheel motor generator or other energy storage may be unreasonable from technical and economical aspects. This study intends to analyze the impact of fusion reactor on the electricity grid to identify the possible window for introduction of fusion as the function of grid capacity, plant scale, and startup scenario.

For this purpose, we have been studying influences of these power demands on a small grid for grids with capacity of 5GW-25GW, and the dynamic response of the electric power system with a power demand of the ITER class reactor ($\sim 300\text{MW}$ and regulation 200MW/s) is analyzed. Results are as follows,

- (1) The rate of change of active power requirement for additional heating is faster than the response time of electric grid.
- (2) For a Fusion reactor with 1GWe output, the grid capacity of $10\sim 20\text{GWe}$ is required for safely supplying startup power.
- (3) By develop the slower increase of additional heating power (NBI, ECH, ICRF) and L-H transition scenario, which matches the response time of electric grids, fusion reactor can be introduced into smaller grids.

Considering above results, the general characteristics of the electric power system for mature grid, developing country, and future energy mix with significant renewable electricity are reviewed and evaluated from the aspect of introduction of fusion power in the global market.