

Economic Performance of Fusion Power Plant on Future Deregulated Electricity Market

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The economic performance of steady-state fusion power plants on future deregulated electricity markets was quantitatively analyzed for the first time with a newly constructed Simplified PJM Market Model. The results showed that (i) discussions based on simple levelised cost of electricity are insufficient for deregulated markets and (ii) the unplanned outage frequency target should be lowered to 0.3 times/year on deregulated market to achieve economic rationality of fusion power plants.

Conventionally, the development strategies for fusion power plants came from extrapolation of past fission plant installation trends. However, due to the rapid transformations of the markets around the world, the future electricity markets will be significantly different from that of half a century ago. The fusion development strategies shall be revised accordingly: conventional measures such as levelised cost of electricity (LCOE) may no longer be applicable to future fusion power plants.

To quantitatively analyze the economic performance of steady-state fusion power plants on future deregulated electricity markets, Simplified PJM Market Model that incorporates three Energy Market, Imbalance Fee and Ancillary Service Market was constructed. A steady-state fusion power plant with 1,200 MW electrical output (2,801 MW fusion) was assumed. The net present values (NPVs) of 40 years of plant operation were calculated with the discount rate of 1.7%. A sensitivity analyses were conducted for the unplanned outage frequency from 0.001 to 0.00001 times/hours.

The economic performance of fusion power plant showed higher sensitivity to the unplanned outage frequency on deregulated market. The NPV of fusion plant on deregulated market would be devaluated from +368 million USD to -741 million USD when the unplanned outage frequency rises from 10⁻⁵ per hour to 10⁻⁴ per hour, while on conventional market, the devaluation would be only from 370 to 285 million USD.

This study pioneered a vital new area for the economic assessment of fusion power plant: the economic performance on the deregulated electricity market. Results show that discussions based on simple LCOE would be inapplicable to deregulated markets, and the unplanned outage frequency target should be lowered on deregulated market.

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