Format 3

Abstract

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Water electrolyzers to balance supply and demand of electric power for implementation of renewable energy on a large scale

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Abstract

In Japan, implementation of renewable energy has been progressing, but the intermittent nature of renewable energy supply could lead to a disruption in the balance between supply and demand of electric power. Such a disruption poses a risk of large-scale power outages, making it imperative to keep the amount of supply and demand same. Japan has been establishing a market for supply and demand adjustment, and trading of electricity for each component of power fluctuations has been underway since 2024. However, the number of bids has remained low, and the power supplies that won in another markets (e.g., capacity markets) have been taking care of supply and demand adjustment. In this context, further expanded implementation of renewable energy requires an increase of the number of equipment that can operate to adopt to electricity demand/supply balancing. Characterized by high load-following capabilities, the water electrolysis, particularly polymer-electrolyte membrane (PEM) water electrolysis, has been considered suitable for such a purpose among the various types of water electrolysis .

Herein, we report our investigation on the PEM water electrolyzer as the power adjustment equipment with testing its load-following characteristics. Our testing proved that the PEM water electrolyzer was indeed suitable as “a tertiary adjustment power”, but was found not suitable as “a primary adjustment power” under the conditions tested. Two factors were identified for the PEM to be able to meet the requirement of load-following for the primary adjustment; improvements in equipment performance, and optimizations of the operating conditions of the auxiliary equipment. Our future work includes continued investigation of the operating conditions that can fulfill the requirement for “a primary adjustment power”. Our investigation was extended to the feasibility study of the business by calculating the annual revenue from trading in the electricity market using the PEM water electrolysis. Quantitatively, the revenue from trading in the electricity market was determined, highlighting the profitability of the business itself.

Lastly, the anion exchange membrane (AEM) water electrolyzer, a next-generation water electrolyzer, was investigated as a future alternative of the PEM, whose equipment and operating costs were expected to be smaller than the PEM counterpart. Our preliminary testing unveiled that the AEM water electrolyzer could achieve higher performances than the PEM, motivating us to investigate further the potential of the AEM water electrolyzer as a power adjustment equipment by testing the load-following characteristics of the AEM water electrolysis in the future.

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