

Effects of transactions on balancing market on hydrogen production cost in Japan

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Keywords: hydrogen production, wholesale market, balancing market, PEM

Abstract

1. Background

In Japan, the public and private sectors are working together to develop the hydrogen production and utilization technology because it is one of the innovative technologies which will contribute to the decarbonization of energy sources toward achieving carbon neutrality in 2050. For the early social implementation of hydrogen, an urgent issue is to supply of hydrogen inexpensively, in large quantities, and in a stable manner. In this study, we will discuss the potential of reducing the hydrogen cost by optimizing the cost of electricity used for hydrogen production, using transactions in the Japanese electricity market.

Due to the Japanese government's electricity market reforms, the electricity market, including the wholesale market and the balancing market, has been developed as of 2022. In this estimation, to optimize the cost of electricity used for hydrogen production, we assume that we will procure inexpensive electricity from the wholesale market and obtain revenue from the balancing market. And we assume that we will bid on the replacement reserve-for-FIT (RR-FIT) with load reduction of hydrogen production equipment though there are five types of transactions in the balancing market. The requirements for the RR-FIT are shown in the table.

Major requirements in balancing market

	Frequency Containment Reserves (FCR)	Synchronized Frequency Containment Reserves (S-FCR)	Frequency Restoration Reserves (FRR)	Replacement Reserves (RR)	Replacement Reserves for FIT (RR-FIT)
Open of Markets	2024	2024	2024	2022	2021
Response time	10 Sec.	5 Min.	5 Min.	15 Min.	45 Min.
Duration time	5 Min. or more	30 Min. or more	30 Min. or more	3 hours	3 hours
Minimum Capacity	5MW (1MW Of line)	5MW	5MW	5MW	5MW

2. Approach to economic evaluation

We measured the hydrogen production efficiency and time response of solid polymer electrolyte membrane (PEM, output capacity: 5 Nm³-H₂/h) type hydrogen production equipment which has high efficiency and high load-following capability among several kinds of a hydrogen production equipment. As a results, we evaluated that the PEM type equipment we measured is adaptable to the RR-FIT.

Using the obtained PEM data and the transactions data of the wholesale markets and the balancing market, we simulated a few models to estimate the balance of income and expenses. As a result, we confirmed a certain effect in reducing hydrogen cost by obtaining income from the balancing market. On the other hand, we confirmed that active participation in the balancing market may conversely increase the hydrogen cost, such as under strong constraints on the supply of hydrogen. Therefore, how to optimize the operation is one of the challenges for commercialization.