The 2024 IERE-SwRI San Antonio Energy Transition Workshop
May 13–16, 2024

Cost reduction of green hydrogen production by optimizing the capacity of electrolyzer

Mina NISHI
Senior Researcher
Energy Transformation Research Laboratory,
Central Research Institute of Electric Power Industry,
Yokosuka, Japan

Keywords: *Renewable energy storage, Power to Gas, Cost analysis of hydrogen, Water electrolysis, Output curtailment, Optimization of capacity of electrolyzer*

Abstract

Hydrogen is one of the most promising elements to accelerate the realization of low carbon society as well as for a sector coupling. Generally, hydrogen produced from renewable energy using water or steam electrolysis (green hydrogen) is costly as renewable energy is more expensive compared to it produced from fossil fuels. However, the more the renewable energy is introduced, the less the electricity costs thus the price of green hydrogen can be significantly lowered. First, the present study is focused to analyze the green hydrogen cost based on the recent price estimation of renewable electricity in near future. For the analysis, levelized cost of hydrogen (LCOH) is calculated for producing hydrogen in Japan as well as in Australia. When hydrogen is produced in Australia, it is necessary to carry it to Japan by some means. One of the ways of transporting hydrogen is to liquefy it and transport it by a tanker. Thus, it is chosen in this study to analyze the cost of green hydrogen transportation by liquefied hydrogen in the case of the production in Australia. As a result, the cost of hydrogen production is more than twice in Japan compared to Australia because the electricity cost of Japan is more than the twice (wind 8.5 Yen/kWh, solar photovoltaic 7.0 Yen/kWh) compared to it of Australia (onshore wind 3.3Yen/kWh and solar photovoltaic 2.2 Yen/kWh). However, LCOH in Japan is about the same as around 50 to 60 Yen/Nm^3 for both cases since the transportation cost of hydrogen from abroad to Japan is quite costly.

Second, a kind of case study is shown in which the actual data of solar photovoltaic generation in Tokyo area in 2018 was assessed to obtain the relationship between LCOH and the load factor of electrolysis as well as the output curtailment. When the installed capacity of the water or steam electrolysis is reduced, its load factor is increased and thus the cost of electrolysis is reduced. However, the cost of electricity is increased according to the curtailed output. It is shown that LCOH reaches the minimum value of 45.6 Yen/Nm^3 that is about 7.3 Yen/Nm^3 lower than the value without any electricity curtailment, when the relative capacity of electrolysis to solar photovoltaic is 0.58 and the output of solar photovoltaic is curtailed about 5.2% at that time.