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A two-stage stochastic framework for hydrogen pricing in green hydrogen stations including high penetration of hydrogen storage systems

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Abstract-

The key role of hydrogen stations (HSs) is to produce hydrogen and deliver it to hydrogen demands. Offering too high prices by HSs decreases their demand and profit; while offering too low prices decreases their revenue and thereby their profit. In literature, optimal pricing of hydrogen has not been done for HSs. In this research, a risk-averse two-stage stochastic mixed-integer linear model is proposed for optimal pricing of hydrogen for hydrogen consumers in hydrogen stations including hydrogen storage systems. Hydrogen storage capability enables HS operator to purchase more electricity at times with cheaper electricity and offer lower prices for consumers. HS operator sets the prices for demands and procures the required electricity in a way that both its expected profit and risk metric are optimised. The studied HS includes an electrolyzer, a hydrogen storage tank, a transformer and a rectifier, while it is able to procure electricity through a day-ahead electricity market, a photovoltaic (PV) unit and a fuel cell (FC). The pricing is done for residential, industrial and transportation-based demands with different price-quota curves. Hydrogen pricing is done for flat and real-time pricing (RTP) tariffs and the effect of pricing type on HS profit, risk and prices is assessed. The effect of price-quota curves, PV and FC on HS profit, risk and prices are investigated. The results approve the efficiency of the proposed model for hydrogen pricing in HSs. The significant impact of hydrogen storage system on the developed model is verified.

Index Terms- Green hydrogen; Hydrogen storage; Hydrogen pricing; Hydrogen station; Electricity market; Uncertainty

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