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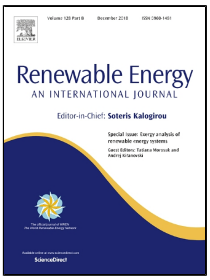

The effect of electricity markets, and renewable electricity penetration, on the levelised cost of energy of an advanced electro-fuel system incorporating carbon capture and utilisation

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The effect of electricity markets, and renewable electricity penetration, on the levelised cost of energy of an advanced electro-fuel system incorporating carbon capture and utilisation

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Abstract

Power-to-Gas (P2G) is a technology that converts electricity to gas and is termed gaseous fuel from non-biological origin. It has been mooted as a means of utilising low-cost or otherwise curtailed electricity to produce an advanced transport fuel, whilst facilitating intermittent renewable electricity through grid balancing measures and decentralised storage of electricity. This paper investigates the interaction of a 10MW_e P2G facility with an island electricity grid with limited interconnection, through modelling electricity purchase. Three models are tested; 2016 at 25% renewable electricity penetration and 2030 at both 40% and 60% penetration levels. The relationships between electricity bid price, average cost of electricity and run hours were established whilst the levelised cost of energy (LCOE) was evaluated for the gaseous fuel produced. Bidding for electricity above the average marginal cost of generation in the system (€35-50/MW_eh) was found to minimise the LCOE in all three scenarios. The frequency of low-cost and high-costs hours, analogous to balancing issues, increased with increasing shares of variable renewable electricity generation. However, basing P2G systems on low-cost (less than €10/MW_eh) hours alone (999 hours in 2030 at 60% renewable penetration) is not the path to financial optimisation; it is preferential to increase the run hours to a level that amortises the capital expenditure.

Keywords:

Power-to-gas (P2G); Levelised cost of energy (LCOE); Renewable Energy Storage; Electricity Market; Electrofuel; Optimisation.

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