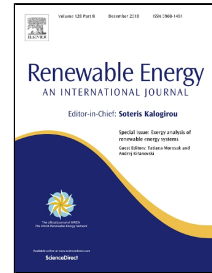


# Accepted Manuscript

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

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9

10 **Abstract**

11 Power-to-Gas (P2G) is a technology that converts electricity to gas and is termed gaseous fuel from  
12 non-biological origin. It has been mooted as a means of utilising low-cost or otherwise curtailed  
13 electricity to produce an advanced transport fuel, whilst facilitating intermittent renewable  
14 electricity through grid balancing measures and decentralised storage of electricity. This paper  
15 investigates the interaction of a 10MW<sub>e</sub> P2G facility with an island electricity grid with limited  
16 interconnection, through modelling electricity purchase. Three models are tested; 2016 at 25%  
17 renewable electricity penetration and 2030 at both 40% and 60% penetration levels. The  
18 relationships between electricity bid price, average cost of electricity and run hours were established  
19 whilst the levelised cost of energy (LCOE) was evaluated for the gaseous fuel produced. Bidding for  
20 electricity above the average marginal cost of generation in the system (€35-50/MW<sub>e</sub>h) was found to  
21 minimise the LCOE in all three scenarios. The frequency of low-cost and high-costs hours, analogous  
22 to balancing issues, increased with increasing shares of variable renewable electricity generation.  
23 However, basing P2G systems on low-cost (less than €10/MW<sub>e</sub>h) hours alone (999 hours in 2030 at  
24 60% renewable penetration) is not the path to financial optimisation; it is preferential to increase  
25 the run hours to a level that amortises the capital expenditure.

26

27 **Keywords:**

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

30

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