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System-Level Cost of Green Hydrogen as Flexible Demand in a Fully Renewable Power System: A Scenario-Based Assessment for New Zealand 2050

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Extended Abstract

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Abstract Summary

This paper evaluates the system-level role of green hydrogen in a fully renewable electricity system by modelling electrolysis as a one-directional flexible load rather than bidirectional storage. Using New Zealand's projected 2050 system as a case study, we simulate 3,744 scenarios across wind, solar, and electrolyser capacities based on 21 years of historical data. The results show that, under an electricity-only objective, electrolysers are systematically dominated by additional renewable capacity and do not appear in the cost-optimal solution. The cost of surplus absorption increases nonlinearly with electrolyser scale due to declining utilisation. While higher renewable penetration expands the range of economically viable hydrogen deployment, it does not uniformly reduce costs across all scales. The findings highlight that hydrogen viability depends on renewable overbuild and external demand, offering policy-relevant insights for integrating hydrogen into high-renewable power systems.