

# Green hydrogen from hydropower: A non-cooperative modeling approach assessing the profitability gap and future business cases

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## Abstract

This paper investigates a possible future business case for green hydrogen production from hydropower. The main research question is to find the trade-offs for a run-of-river hydropower plant owner between the currently prevailing business model of wholesale electricity trading and, alternatively, production of green hydrogen. Hence, a bi-level optimization framework between a hydropower plant owner ( $H_2$  producer and price setter) and a transportation firm ( $H_2$  consumer) is developed. The empirical scaling of the numerical example describes Central Western European wholesale electricity market settings. Results indicate that the current market environment and price setup do not allow for profitable green hydrogen production as yet. However, an increasing  $CO_2$  price as the key determining parameter leads to improved competitiveness and expected profitability of the business case studied in this work. In the numerical example examined, a  $CO_2$  price above 245 EUR/t triggers profitability, when green hydrogen production is competing with a future electricity contract price of 45 EUR/MWh.

**Keywords:** Green hydrogen, Hydropower, Non-cooperative game, Resource allocation, Profitability,  $CO_2$  price

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