

# **The impact of contracts on hydrogen and electricity markets under a joint Cournot equilibrium**

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## **Abstract-**

**Volatility in energy prices, alongside the European Commission's decarbonization strategy, has led to reforming the European electricity market and the creation of a hydrogen strategy. Hydrogen and electricity have a symbiotic relationship: hydrogen production through electrolysis relies on electricity, while its production provides flexibility to the power system utilizing renewable energy surpluses. This research provides a joint electricity and hydrogen market model based on Cournot equilibrium, solved with an equivalent optimization problem, incorporating contracts for both goods. Results for the MIBEL show that contracts increase market competition, reduce prices, and enhance renewable energy utilization. Wholesale electricity and hydrogen prices decrease by 10 % and 8 %, respectively, while electrolytic hydrogen production rises by 10 %. Profits increase by over 20 %, with the hydrogen sector doubling its gains. The model also identifies contract prices that ensure profitability and emissions reduction. These findings highlight the potential of PPAs and HPAs to support energy transition goals.**

**Index Terms-** Electricity market; Hydrogen market; Hydrogen purchase agreement; Power purchase agreement; Game theory

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