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# Comparing hydrogen fuel cost of production from various sources - a competitive analysis

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ABSTRACT

The world's fossil fuel supplies are being depleted at an accelerated rate, and the demand for these resources is only growing. In addition, fossil fuels which provide 80% of the world's basic energy have detrimental effects on the ecosystem, mostly through the emission of greenhouse gases that exacerbate climate change. The urgency of swiftly shifting from conventional energy sources to sustainable or renewable alternatives that can meet present and future global energy demands is highlighted by the environmental crisis that is worsening. As an energy carrier, hydrogen emerges as a strong contender in this transition, and the cost of production of hydrogen is also associated. Thus, to provide a competitive analysis of the cost of hydrogen production, a thorough literature review was conducted. This literature review looks into both basic and advanced hydrogen production technologies, evaluating their cost-efficiency profiles. Comparing the cost of hydrogen production from various sources becomes critical in the pursuit of sustainable energy generation. It can quantify production costs by using powerful data analytics techniques. This entails meticulously collecting and preparing relevant cost data, identifying critical metrics, and employing statistical methodologies. Cost dynamics analysis includes descriptive analysis, data visualization, and rigorous statistical testing. According to the findings of this analysis, steam methane reforming technology has an impressive efficiency rate of 85% and a production cost of 2.27 USD/unit of hydrogen. Notably, while electrolysis produces cleaner hydrogen, its high energy consumption makes it more expensive than the less expensive SMR technology. Furthermore, regression analysis allows us to thoroughly examine potential influencing factors. Through rigorous data analysis, for example, a clearer image of the cost-effectiveness of different hydrogen sources might be created, enabling more informed decision-making in the field of sustainable energy generation.

## 1. Introduction

The most frequently mentioned important challenges in the 21st century [1] are the increased worldwide demand for energy production [2] and environmental concerns [3]. By the middle of the century, at least 10 terawatts [4] of carbon-free energy must be generated to meet the world's expanding energy needs [5] while safeguarding the environment [6]. The COVID-19 epidemic has had a significant impact on international economies during the past two years [7]. In addition, there has been an imbalance between supply and demand in the food and

*Abbreviations:* AEL, Alkaline electrolyzers; DOE, Department of Energy; CC, Carbon capture; CCS, Carbon capture and storage; CCU, Carbon capture, and utilization; CO, Carbon monoxide; $CO_2$, Carbon dioxide; $CO_4$, Carbon tetroxide; DCFA, Discounted cash flow analysis; DTR, Decision tree regression; EU, European Union; GHG, Greenhouse gas; GWP, Global warming potential; HHV, Higher heating value; HTSE, High-temperature steam electrolysis; HTTR, High-temperature engineering test reactor; IAHE, International Association for Hydrogen Energy; IC, Indirect cost; KNN, K nearest neighbours; LR, Linear regression; LSTM, Long short-term memory; MHR, Modular helium reactor; ML, Machine learning; PEM, Polymer electrolyte membrane; PNS, Purple non-sulfur; RSM, Response surface methodology; SOE, Solid oxide electrolyzes; SSMR-MS, Solar steam methane reforming with molten salt; SVR, Support vector regression; SWCR, Supercritical water-cooled reactor; TAC, Total annualized cost; TDIC, Total indirect cost; THEME, Hydrogen Economy Miami Energy; TIC, Total installed cost; TPEC, Total bought equipment cost; VHTR, Very high-temperature reactor.

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