Chapter 25
Unfolding Artificial Intelligence (AI) in Green Hydrogen Production:
Towards an Intelligent Energy Transition Fostering Sustainability

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ABSTRACT

Artificial intelligence (AI) is increasingly being integrated with green hydrogen production, so as to enable a seamless transition from conventionally suffocating energy sources. Water electrolysis, using renewable energies such as solar and wind energy as a power source, is the key technology of green hydrogen with considerable advantages towards decarbonizing energy-intensive industries and promoting global sustainability. Innovative application of AI is changing the way green hydrogen operates for efficiency and scalability by improving production processes saving energy in electrolysis making it cost effective. The AI and green hydrogen production benefits not only energy efficiency, but also serves to further the cause of climate action by weaning society off fossil fuels. And this clever, foresighted investment clears a path for a cleaner future which also adds one more way out of many possible ways that the world can reach its sustainability goals and move off carbon-neutral energy.

1. INTRODUCTION

AI-driven applications like machine learning models are now beginning to change the way electrolysis systems function, scheduling maintenance operations before it's too late, improving local conditions for proper hydrogen generation and much more (Boretti, 2024). AI is also heavily relied on to help manage

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the storage and transportation of hydrogen to make the supply chain process efficient and less energy wasteful (Singh & Kaunert, 2024). This way industries are able to effectively manage and integrate renewable energy sources within their hydrogen production process using predictive forecasting, artificial intelligence based data analysis and real-time optimization towards a more modestly cleaner energy ecosystem (Singh et al., 2024).

With the world facing a two-front challenge fighting climate change and moving to renewable resources, the importance of renewable energy sources has grown phenomenally (Singh & Kaunert, 2024). One of the most exciting renewable energy replacements is green hydrogen, which has been hailed as a game-changer in our quest to be carbon neutral and promote energy independence. Made from water electrolysis powered by 100% renewable energies such as solar, wind and hydroelectric power, green hydrogen is an easy and efficient solution for industries and sectors where fossil fuels are traditionally used (Singh et al., 2024). The positioning as a solution for decarbonizing heavier-polluting, higher-growth sectors like transportation and manufacturing (also known as hard-to-abate industrial carbon sourcing) or heavy industry makes blue hydrogen sound like Corri-doors but also ultimately vital.

The large-scale deployment and manufacture of green hydrogen encounter numerous technological and economic difficulties. Hydrogen production via electrolysis is inefficient and energy-intensive, and it also faces challenges with regard to storage and distribution that must be overcome if green hydrogen is ever to become a viable global energy source (Singh et al., 2024). And this is where the role of Artificial Intelligence (AI) com into picture. The AI includes machine learning, deep learning, and data analytics that is helping sectors like healthcare to finance. The electricity sector uses Artificial Intelligence for renewable energy production, grid management, and demand predictions (Singh & Kaunert, 2024). The use of AI in green hydrogen production is still early, but holds potential to eliminate key bottlenecks, decrease costs, and offer scalability. AI-based solutions can help to optimize hydrogen production pathways -including improving the energy efficiency of less efficient modes like SMR or easing the deployment increase in renewable energy into the value chain. In addition, A.I. can be instrumental in storing, transferring, and utilizing green hydrogen to help take it from theoretical potential to real-world application (Raghav et al., 2024).

It undertake this study to investigate the potential of AI for green hydrogen production, assess and predict how machine learning can accelerate an intelligent energy transition, particularly in light of sustainability efforts. It, provides a look into the massive unlocked potential in green hydrogen by prospecting four powerful facets of AI and their role within this sustainability domain: an example being AI-powered electrolysis enhancement where researchers are exploring efficiency improvements to leverage further savings (Kaushik et al., 2024).

1.1 Significance of the Study

The importance of this study of the confluence, AI and green hydrogen creation is set in the context of nations around the world being on a war-footing to address the rapid advance of climate change. Green hydrogen is set to be important for decarbonizing hard-to-electrify sectors, as the world transitions to a net-zero emissions economy. Green hydrogen can offer an alternative for industries like steel manufacturing, aviation and shipping that may find direct electrification technologically challenging or economically infeasible but are facing pressure to meet decarbonization targets. But to realize this