Chapter 15
Green Hydrogen Next Frontier in Clean Energy:
Future of Energy Innovation With AI and Industry 6.0

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ABSTRACT

As the next frontier in clean energy, green hydrogen is seen as a key lever for decarbonizing industries and transforming balance across an energy system. Made from renewable power such as wind and solar via electrolysis, green hydrogen can replace fossil fuels, helping to meet the need for cleaner energy worldwide. Unfortunately, high costs and difficulties in production make the technology difficult to implement more than widely. These two major hurdles can be overcome with the clever use of artificial intelligence (AI) and Industry 6.0 technologies, leading to innovations in green hydrogen production. Through the combination of both, AI and Industry 6.0 are quickly making green hydrogen into a practical solution for energy needs which could unlock a future where clean energy is able to provide us with planet wide longevity as well as another century of industrial growth.

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1. INTRODUCTION

Green hydrogen is the new horizon of clean energy that can present a powerful and versatile solution to global energy problems. Integrating with AI and Industry 6.0-specific technologies is key to unleashing its full potential, innovation and large-scale adoption. Green hydrogen has the potential to enable a fully decarbonized future that can help transform industries, increase energy security and combat climate change once its technical, economic and policy barriers are overcome (Yang et al., 2021). The transition to green hydrogen economy is going to be challenging, but it can revolutionize the energy innovation and sustainability, through collective efforts and technical advancements. Industry 6.0 takes this a step further with smart factories and IoT-enabled automation that will now have greater scalability and cost efficiency associated with hydrogen production. Real-time data is analyzed to optimize energy use in electrolysis and thereby increase efficiency, as well predictive algorithms used to stabilize the grid and enable deployment of renewable energy sources (White et al., 2018).

With challenges facing energy generation and the climate, this marks a critical first step in decarbonizing energy across the globe. Of the many renewable energy carriers, green hydrogen is a game changer that not only can decarbonize transportation and industry but also power generation. Green hydrogen which is produced from water by renewable electricity via electrolysis contributes no carbon emission across its life cycle and will serve as a backbone for the energy transformation. In conjunction with the technological competencies of Artificial Intelligence (AI) and the principles of Industry 6.0, green hydrogen offers unmatched potential to fuel energy innovation, enhance efficiency, and deploy sustainable solutions across the globe. What makes green hydrogen so attractive is that it can fill the gaps left by irregular renewable sources such as solar and wind (Nastasi et al., 2022). When excess renewable energy is turned to hydrogen via electrolysis, it is a form of stored energy which can provide consistent and reliable electricity. Hydrogen is storable over longer periods of time, easily transportable and convertible back into electricity or heat when needed or used directly as a fuel. Yet various hurdles like high-cost production, energy inefficiencies and poor infrastructure need to be overcome to unlock the true potential of green hydrogen. Now, this is where the impact of AI and Industry 6.0 comes to life as it transforms each step in the hydrogen value chain.

Artificial intelligence (AI) provides effective support for optimizing green hydrogen production. Perhaps the only method that comes close is electrolysis, which takes energy to split water into hydrogen and oxygen, but AI-driven solutions can really help boost the effectiveness of such systems. These machine learning algorithms can model the operating regime of electrolyzers and find optimal conditions that produce highest hydrogen production with least energy consumption. AI can also allow you to predict equipment failures, allowing predictive maintenance of the electrolyzers and less down time. AI can process large sets of data to find possible patterns and trends which potentially leads to higher informed decision-making capabilities in the hydrogen production, storage and distribution phases (Danish & Senjyu, 2023).

The speed at which data is gathered and calculated within the framework of hydrogen systems powered by AI can be further multiplied based on the interaction with previously only connected nominated devices called Internet of Things (IoT) devices, which are slowly entering in to the market. Real-time monitoring of hydrogen production units using IoT sensors can provide measurement data such as the temperature, pressure, and energy consumed. The AI algorithms are fed this data to optimize performance, ensure safety, and minimize operational costs. IoT devices provide predictive maintenance systems to