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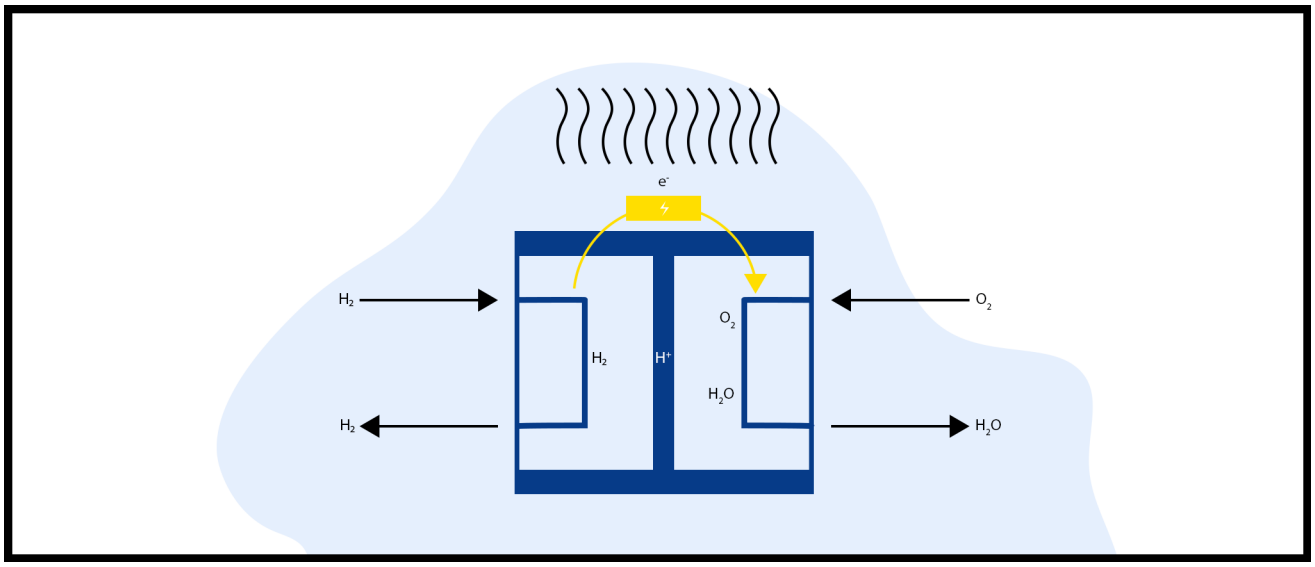

The Proliferation of the Hydrogen Economy

By Cameron Armstrong

State of the Hydrogen Economy

Hydrogen is a potential clean energy solution that has been garnering more attention as the world looks for diversified energy sources. Hydrogen shows incredible potential when addressing energy transitions as it is readily available, energy dense, and fast to refuel. Also, it has zero noise, visual, or greenhouse gas pollution resulting from its use. The global hydrogen economy is expanding amid surging environmental concerns, increasing government initiatives for developing cleantech infrastructure, and technological advancements heightening hydrogen's future potential. Around the world, governments are increasing monetary commitments to hydrogen infrastructure. In 2020, Germany adopted a national hydrogen strategy committing $7.9BN USD to new hydrogen businesses and research, Australia committed $207MM USD to finance projects growing its hydrogen economy, and the US increased its annual spend on hydrogen research, development, and deployment to $150MM USD (Dolan, 2020). In Alberta, the provincial government released a Hydrogen Roadmap in November of 2021, outlining goals for the near, medium, and long term. In the near term (2021-23), the action plan lists goals of blending hydrogen into natural gas distribution systems, increasing access to capital to support hydrogen infrastructure developments, and developing clean hydrogen hubs and partnerships across the province. The roadmap sets ambitious goals for 2030, citing $30BN CAD in new capital investment planned for clean hydrogen production and development in the province. By 2030, benchmarks for success include hydrogen integrated energy systems, global clean hydrogen exports, tens of thousands of jobs and billions of dollars of economic activity being created, and 14 metric tons of annual greenhouse gas emission reductions (Government of Alberta, 2021). As provinces across Canada and nations around the world diversify their energy infrastructures, developers of hydrogen fuel cells and fuel cell

vehicles will see continuing expansion.

Standard and Innovative Technologies

Hydrogen fuel cells are like the engine of the hydrogen economy and membrane electrode assemblies are the engine blocks of these machines. These membranes act as catalysts for generating electricity within a fuel cell. Currently, only carbon powders are commercially available for this purpose and they require arduous preparation steps and produce variable results (Atwa, 2021, p.1). Powder membranes are now threatened by a carbon film replacement. A carbon film filling this need was developed at the University of Calgary by the Birss Group. The technology has been patented and is being commercialized by an Alberta startup, Momentum Materials Solutions, founded by two of the developers, Chengying Ai and Viola Birss (Ai, 2021). When looking ahead, experts projected in July 2021 that "membranes are expected to continue to play a dominant role for the next 5–10 years, and continuous improvements are expected to contribute 10–20% to the improvement of power density... Improving power densities, reducing costs, and increasing the durability of fuel cells will directly promote large-scale commercialization" (Jiao, 2021, pp. 365/367). While hydrogen vehicles are in the early stages of adoption, there is clear potential for applying this technology toward cleaner transportation. The Royal Society of Chemistry published research outlining the paradigm-shifting nature of carbon film membranes, stating that carbon film, compared to powders, demonstrated higher levels of conductivity, durability, and uniformity. This uniformity enabled more predictable and repeatable test results and demonstrated the potential for exceptional scalability (Atwa 2021). Carbon film membranes will increase the performance, reduce the cost, and progress the adoption of hydrogen vehicles as the world continues pursuing cleantech.

Conclusion and Recommendations

In 2021, we are at a tipping point in hydrogen adoption. Innovations such as carbon film membranes are increasing the performance and durability of hydrogen fuel cells and, in turn, hydrogen vehicles. Renewable energies are becoming increasingly prevalent and affordable, bringing down the environmental cost of hydrogen production. Governments around the globe are investing in hydrogen fueling infrastructure, funding R&D, and incentivizing business development. All these converging factors validate the valuable future of hydrogen in the growing cleantech economy.

For the hydrogen economy to continue progressing, there are multiple measures that should be pursued. First, governments should continue supporting the hydrogen economy through tax incentives for early adopters of hydrogen vehicles, grant funding for innovative technology startups, and subsidies for the expansion of fueling infrastructure. Second, corporations should continue funding cleantech innovation, driving down the cost of renewable energy sources as they proliferate. Third, international cooperation will be critical in the hydrogen economy's success. Bilateral and multilateral agreements and initiatives will help supply meet demand so that markets with high concentrations of hydrogen vehicles are able to meet their demand through partnerships with hydrogen suppliers around the world. Along with international cooperation comes international regulation; regulatory frameworks will need to be developed to accurately define the carbon footprint of hydrogen production and consumption.

Canada is doing an excellent job of progressing the

hydrogen transition, with Alberta acting as a leader. Continued government investment for startups and SMEs pursuing hydrogen technologies will enable the faster progression of these technologies' commercial readiness. Once the economic viability of hydrogen as an energy source is established, government support will be less critical as these innovative startups grow into major corporations that are able to export hydrogen and fuel cell components around the world, bringing exponential GDP growth and economic benefit to Canada.

As of September 2021, 13 countries and the European Union have published national hydrogen strategies with 10 being published in the last year, including Canada. There are reportedly 19 other countries drafting strategies with the aim of publishing them in 2021 (World Energy Council, 2021). While increasing numbers of countries publishing hydrogen strategies is a sign of progression, a lack of action from energy superpowers mitigates this potential. The world is still waiting on official hydrogen strategies to be published by China, Russia, Venezuela, and Saudi Arabia. Should these countries commit to the transition, the world will see a new energy ecosystem emerge and the hydrogen economy will swell.

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