Renewable Hydrogen and Fuel Cells: The Future of Energy

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Presently, the global energy sector is in transition; there is a common goal to implement more renewable energy (RE) sources and decrease dependence on non-renewable sources/fossil fuels. However, this transition is far from simple and many complications arise particularly in grid balancing. The unique capabilities of reversible hydrogen fuel cells were explored to increase reliability and efficiency of RE production systems, in transition and beyond. This project investigated the relationship between the efficiency of the reversible fuel cell in electrolyzer mode and water temperature. The voltage across the electrolyzer was recorded at various current intervals at each water temperature using a single cell electrolyzer and a 100-cell stack electrolyzer. The Nernst equation was utilized to calculate the ideal voltage, and hence the efficiency. The experimental results supported the hypothesis that there would be a direct relationship between the water temperature and the efficiency of the electrolyzer. Following experimentation, calculations were made to determine if reversible fuel cells possess the capability to solve the aforementioned RE issues at the large scale. The city of Boulder was used as an example, and it was found that the entire city could be powered completely by stored renewable hydrogen during a peak energy demand day (24 hours) using only 0.2% of the annual energy produced by wind turbines in Colorado. This project demonstrated that reversible hydrogen fuel cells have the potential to solve the problems that accompany RE integration and can be made more efficient by using higher water temperatures in the electrolyzer.

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