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Assessment of Hydropower Generation and Green Hydrogen Production Potential in Jebba Dam, Nigeria, West Africa

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Hydropower can play a significant role in advancing the production of green hydrogen. However, hydro-climatic variability impacts hydropower production and thus the hydrogen potential. In this study, we developed novel analytics to understand how hydropower inter-annual variability translates to hydrogen production. We address this by; (i) analyzing Jebba dam hydro-climatic variables and associated hydropower generation (ii) translating the annual and quarterly hydropower production into hydrogen using five assumed scenarios; (iii) estimating the re-electrification potential and (iv) determining the quantity of petrol (or gasoline) that would be replaced and the amount of CO_2 and CO that would be avoided. We find that hydropower energy generation has increased significantly at the station. The estimated annual and quarterly green hydrogen potentials indicated that the highest potentials were 59,111 tons and 18,744 tons and have a re-electrification potential of 1,182 GWh and 374 GWh, which can replace 0.224 million liters and 0.071 million liters of petrol (or gasoline) in the year 2021 and the fourth quarter of 2021–04, respectively. This would prevent 0.52 million kg of CO_2, 0.92 thousand kg of CO in the year 2021, and 0.163 million kg of CO_2, 0.293 thousand kg of CO emissions in the fourth quarter of 2021–04. The study concludes that the impact of hydro-climatic variation on hydropower generation affects green hydrogen production potential. Nevertheless, using a percentage of hydropower energy can present a unique opportunity to move the nation toward the production of green hydrogen energy as a long-storage solution for rural areas' re-electrification and to meet electricity demand when the hydropower dam’s water storage is low. Furthermore, the adoption of a green hydrogen energy solution can contribute to the nation's and global climate change mitigation efforts.