

Analisis Tekno-Ekonomi Produksi Green Hydrogen Melalui Integrasi Panel Surya Terapung pada Waduk Saguling = Techno-Economic Analysis of Green Hydrogen Production Through the Integration of Floating Solar Photovoltaic at Saguling Hydropower Plant

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Abstrak

Krisis iklim global mendorong pengembangan hidrogen hijau sebagai sumber energi berkelanjutan. Penelitian ini mengkaji potensi teknis dan keekonomian produksi hidrogen hijau melalui integrasi panel surya terapung (floating PV) di Waduk Saguling. Perhitungan dilakukan berdasarkan data iradiasi matahari, karakteristik lokasi, dan parameter teknis-ekonomis dari teknologi Proton Exchange Membrane (PEM) electrolyzer. Estimasi biaya produksi menggunakan pendekatan Levelized Cost of Hydrogen (LCOH), sedangkan kelayakan finansial dianalisis dengan indikator Net Present Value (NPV), Internal Rate of Return (IRR), Payback Period (PBP), dan Profitability Index (PI). Hasil studi menunjukkan bahwa dengan kapasitas produksi sebesar 3.000 kg/hari dan total pasokan listrik tahunan sebesar 165,16 GWh (81,7% dari PLTS dan 18,3% dari jaringan PLN), diperoleh LCOH sebesar 12,43 USD/kg dan harga jual hidrogen diasumsikan sebesar 15 USD/kg. Evaluasi keekonomian menghasilkan NPV sebesar USD 6.771.567, IRR sebesar 8,29%, PBP selama 10,6 tahun, dan PI sebesar 1,27, yang menandakan kelayakan investasi. Simulasi Monte Carlo mengonfirmasi bahwa harga jual hidrogen merupakan variabel paling sensitif terhadap profitabilitas. Temuan ini menunjukkan bahwa produksi hidrogen hijau berbasis PV di Indonesia berpotensi kompetitif dan mendukung transisi energi rendah karbon.

.....The global climate crisis has accelerated the development of green hydrogen as a sustainable energy source. This study examines the technical and economic feasibility of producing green hydrogen through the integration of floating solar panels at the Saguling Reservoir. Calculations were based on solar irradiation data, site characteristics, and techno-economic parameters of Proton Exchange Membrane (PEM) electrolyzer technology. The Levelized Cost of Hydrogen (LCOH) was estimated, while financial viability was evaluated using Net Present Value (NPV), Internal Rate of Return (IRR), Payback Period (PBP), and Profitability Index (PI). The results show that with a production capacity of 3,000 kg/day and a total annual electricity supply of 165.16 GWh (81.7% from solar PV and 18.3% from the PLN grid), the LCOH is calculated at 12.43 USD/kg with a hydrogen selling price assumed at 15 USD/kg. Economic evaluation yields an NPV of USD 6,771,567, IRR of 8.29%, PBP of 10.6 years, and a PI of 1.27—indicating a financially viable project. A Monte Carlo simulation confirms that hydrogen selling price is the most sensitive variable influencing profitability. These findings suggest that PV-based green hydrogen production in Indonesia has the potential to be competitive and to support the transition toward a low-carbon energy system.