

OPTIMASI PERHITUNGAN LEVELIZED COST OF HYDROGEN MELALUI METODE DISKONTO BINER PADA TEKNOLOGI POWER-TO-GAS: STUDI KASUS HYDROGEN HUB PLN PUSLITBANG

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ABSTRAK

Transisi energi global menuju sistem rendah emisi karbon menempatkan hidrogen hijau sebagai solusi strategis untuk mengatasi intermitensi energi terbarukan dan mendekarbonisasi sektor sulit dielektrifikasi. Namun, perhitungan Levelized Cost of Hydrogen (LCOH) konvensional menggunakan metode diskonto tunggal mengandung kelemahan metodologis karena mengabaikan asimetri risiko antara arus kas masuk dan keluar. Penelitian ini mengoptimalkan perhitungan LCOH melalui metode diskonto biner pada teknologi Power-to-Gas (P2G) di Hydrogen Hub PLN Puslitbang sebagai studi kasus. Pendekatan kuantitatif deskriptif diterapkan dengan membandingkan hasil LCOH antara metode konvensional dan diskonto biner, dilengkapi analisis sensitivitas terhadap enam variabel kunci. Hasil menunjukkan bahwa metode diskonto biner menghasilkan rentang LCOH \$4,60–\$4,71/kg H₂, lebih rendah 0,6–3,0% dibandingkan metode konvensional (\$4,74/kg H₂). Harga listrik teridentifikasi sebagai faktor dominan (kontribusi 60–70% terhadap LCOH), diikuti oleh efisiensi sistem dan utilisasi kapasitas. Metode diskonto biner memberikan representasi risiko yang lebih akurat melalui penyajian rentang nilai LCOH yang mencerminkan ketidakpastian proyek. Rekomendasi kebijakan strategis meliputi implementasi kebijakan Net Metering with Compensation for Surplus Generation (NM-CSG), pengembangan kuota hijau, transisi ke mekanisme harga karbon, serta harmonisasi regulasi nasional. Penelitian ini membuktikan bahwa optimasi metodologis perhitungan LCOH merupakan elemen kritis dalam mengurangi kesenjangan implementasi antara ambisi kebijakan dan realisasi proyek hidrogen hijau di Indonesia.

Kata Kunci: Levelized Cost of Hydrogen (LCOH), Diskonto Biner, Power-to-Gas, Kebijakan Energi, Transisi Energi

OPTIMIZATION OF LEVELIZED COST OF HYDROGEN CALCULATIONS VIA BINARY DISCOUNTING METHOD IN POWER- TO-GAS TECHNOLOGY: A CASE STUDY OF PLN PUSLITBANG HYDROGEN HUB

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ABSTRACT

The global energy transition toward low-carbon systems positions green hydrogen as a strategic solution to address renewable energy intermittency and decarbonize hard-to-abate sectors. However, conventional Levelized Cost of Hydrogen (LCOH) calculations using single discount rate methodology contain methodological flaws by ignoring risk asymmetry between cash inflows and outflows. This research optimizes LCOH calculation through binary discounting method for Power-to-Gas (P2G) technology at PLN Puslitbang Hydrogen Hub as a case study. A quantitative descriptive approach was employed by comparing LCOH results between conventional and binary discounting methods, complemented by sensitivity analysis of six key variables. Results demonstrate that the binary discounting method yields an LCOH range of \$4.60–\$4.71/kg H₂, 0.6–3.0% lower than the conventional method (\$4.74/kg H₂). Electricity price was identified as the dominant factor (contributing 60–70% to LCOH), followed by system efficiency and capacity utilization. The binary discounting method provides more accurate risk representation through an LCOH range that reflects project uncertainty. Strategic policy recommendations include implementing Net Metering with Compensation for Surplus Generation (NM-CSG) policy, developing green quotas, transitioning to carbon pricing mechanisms, and harmonizing national regulations. This research proves that methodological optimization of LCOH calculation is a critical element in reducing the implementation gap between policy ambition and actual realization of green hydrogen projects in Indonesia.

Keywords: Levelized Cost of Hydrogen (LCOH), Binary Discounting, Energy Policy, Energy Transition