

ABSTRAK

RONI KARUA. Optimasi Operasi Sistem Plts Hybrid 300 Kwp Di Pulau Maratua Menggunakan Metode Simulation-Based Optimization Dan Analisis Sensitivitas Parametrik. Dibimbing oleh Dhami Johar Damiri

Pulau Maratua, sebagai salah satu daerah terluar Indonesia, masih menghadapi tantangan besar dalam penyediaan energi listrik yang andal dan terjangkau meskipun telah memiliki sistem PLTS Hybrid berkapasitas 300 kWp dengan baterai 600 kWh dan PLTD sebagai cadangan, namun sistem tersebut belum beroperasi optimal karena runtime PLTD masih mendominasi dan potensi energi surya belum dimanfaatkan sepenuhnya. Penelitian ini bertujuan untuk mengevaluasi dan mengoptimalkan kinerja sistem PLTS Hybrid menggunakan pendekatan *simulation-based optimization* dengan perangkat lunak HOMER Pro, melalui simulasi berbagai skenario konfigurasi sistem dan strategi operasi berbasis data teknis aktual. Evaluasi dilakukan terhadap parameter seperti Levelized Cost of Energy (LCOE), emisi karbon (CO_2), *unmet load*, dan *Renewable Fraction*, dengan mempertimbangkan variasi beban, iradiasi matahari, harga BBM, dan kapasitas baterai, serta dilengkapi analisis sensitivitas untuk mengetahui pengaruh perubahan parameter terhadap hasil sistem. Hasilnya memberikan gambaran konfigurasi sistem paling efisien sesuai kondisi geografis dan karakteristik beban di Pulau Maratua, serta menawarkan solusi teknis, ekonomi, dan lingkungan yang dapat menjadi acuan pengembangan sistem serupa di wilayah terpencil lainnya, mendukung transisi energi nasional melalui peningkatan bauran energi terbarukan dan pengurangan emisi gas rumah kaca menuju target Net Zero Emission 2060.

Kata Kunci: Sistem PLTS Hybrid, HOMER Pro, Optimasi Operasi, Analisis Sensitivitas, Energi Terbarukan.

ABSTRACT

RONI KARUA. Optimization of the Operation of a 300 kWp Hybrid Solar Power System on Maratua Island Using Simulation-Based Optimization and Parametric Sensitivity Analysis. Supervised by: Dr. Dhami Johar Damiri (Advisor I) and Dr. Joko Muslim (Advisor II)

Maratua Island, an isolated power system in Indonesia, still faces challenges in providing reliable and cost-effective electricity despite operating a hybrid photovoltaic system. This study aims to evaluate and optimize the performance of a PV–BESS–Diesel hybrid system using a simulation-based optimization approach implemented in HOMER Pro, combined with hourly dispatch simulation based on actual operational data. System performance was assessed using key technical and economic indicators, including Levelized Cost of Energy (LCOE), fuel consumption, Renewable Fraction, CO₂ emissions, and system reliability, with sensitivity analysis on load variation, solar irradiance, fuel price, and battery capacity.

The results show that the optimal configuration consists of approximately 300 kWp PV, 600 kWh battery storage, and a 180 kW diesel generator operating under a Load Following strategy. This configuration increases the Renewable Fraction to about 41%, reduces fuel consumption by 30–45%, and achieves an LCOE of approximately Rp3.8–4.1 thousand/kWh with a Net Present Cost of Rp37–39 billion, lower than diesel-only operation without compromising supply reliability. The findings confirm that optimizing operational strategy significantly improves hybrid system performance and provides a practical reference for renewable-based isolated power systems.

Keywords: *Hybrid PV System, Operational Optimization, HOMER Pro, Sensitivity Analysis, Renewable Energy.*