Analisa Kelayakan Pembangkit Listrik *Hybrid* Tenaga Surya Dan Angin Menggunakan *Software* Homer (*Hybrid Optimization Of Multipe Energy Resource*) di Desa Sungai Raja

ABSTRAK

Desa Sungai Raja di Kabupaten Labuhanbatu Utara, Sumatera Utara, menghadapi masalah keterbatasan akses listrik akibat belum tersambung ke jaringan PLN dan ketergantungan pada genset diesel yang mahal serta mencemari lingkungan. Penelitian ini bertujuan menganalisis kelayakan teknis dan ekonomi sistem pembangkit listrik hybrid tenaga surya dan angin menggunakan software HOMER (Hybrid Optimization of Multiple Energy Resources) sebagai solusi energi bersih, mandiri, dan berkelanjutan. Penelitian bersifat kuantitatif dengan pendekatan deskriptif-eksplanatif, mengumpulkan data lapangan seperti radiasi matahari rata-rata 4,48 kWh/m²/hari, kecepatan angin 1,77 m/s, profil konsumsi listrik harian sekitar 1 kWh/rumah, serta spesifikasi panel surya, turbin angin, baterai, dan inverter. Simulasi HOMER menunjukkan konfigurasi optimal berupa panel surya sebagai sumber utama (99% kontribusi energi) dengan turbin angin sebagai pendukung, serta sistem baterai untuk menjaga keandalan pasokan listrik sepanjang hari dan malam. Hasil analisis ekonomi menunjukkan Net Present Cost (NPC) sebesar Rp409,5 juta dan Levelized Cost of Energy (LCOE) Rp5.480/kWh, lebih rendah dan stabil dibandingkan biaya operasional genset diesel. Dari aspek lingkungan, sistem hybrid menghasilkan emisi karbon nol, mendukung target nasional pengurangan emisi rumah kaca. Penelitian ini memanfaatkan teori optimasi sistem energi, teori ekonomi energi, dan konsep sistem hybrid berkelanjutan, menunjukkan bahwa integrasi energi terbarukan di daerah terpencil layak secara teknis, ekonomis, dan ramah lingkungan. Temuan ini diharapkan memberikan kontribusi teoretis pada pengembangan model energi terbarukan berbasis HOMER di Indonesia, sekaligus memberikan rekomendasi praktis bagi pemerintah, investor, dan pemangku kepentingan untuk mendukung perencanaan infrastruktur energi bersih di desa terpencil. Dengan demikian, penelitian ini mendukung kebijakan elektrifikasi mandiri berbasis energi terbarukan, mendukung pembangunan rendah karbon, serta meningkatkan kesejahteraan masyarakat melalui akses listrik yang terjangkau, andal, dan berkelanjutan.

Kata Kunci: *Sistem Hybrid, Energi Surya, HOMER, Kelayakan Ekonomi, Emisi Nol.*

Analisa Kelayakan Pembangkit Listrik Hybrid Tenaga Surya Dan Angin Menggunakan Software Homer (Hybrid Optimization Of Multipe Energy Resource) di Desa Sungai Raja

ABSTRACT

Sungai Raja Village in Labuhanbatu Utara Regency, North Sumatra, faces limited electricity access due to the absence of PLN grid connections and reliance on costly, polluting diesel generators. This study aims to analyze the technical and economic feasibility of a hybrid solar and wind power generation system using HOMER (Hybrid Optimization of Multiple Energy Resources) software as a clean, independent, and sustainable energy solution. This quantitative research uses a descriptive-explanatory approach, collecting field data such as average solar radiation of 4.48 kWh/m²/day, wind speed of 1.77 m/s, daily household electricity consumption of approximately 1 kWh, and technical specifications of solar panels, wind turbines, batteries, and inverters. HOMER simulation results show an optimal configuration with solar panels as the primary energy source (99% energy contribution), supported by wind turbines and a battery system to ensure reliable electricity supply day and night. Economic analysis indicates a Net Present Cost (NPC) of IDR 409.5 million and a Levelized Cost of Energy (LCOE) of IDR 5,480/kWh, which is lower and more stable than diesel generator operating costs. Environmentally, the hybrid system produces zero carbon emissions, supporting national greenhouse gas reduction targets. This study adopts energy system optimization theory, energy economics theory, and sustainable hybrid system concepts, demonstrating that integrating renewable energy in remote areas is technically feasible, economically viable, and environmentally friendly. The findings are expected to contribute theoretically to the development of renewable energy models using HOMER in Indonesia, while offering practical recommendations for government, investors, and stakeholders to plan clean energy infrastructure in remote villages. Thus, this research supports policies for independent, renewable-based electrification, promotes low-carbon development, and enhances community welfare through accessible, reliable, and sustainable electricity.

***Keywords**: Hybrid System, Solar Energy, HOMER, Economic Feasibility, Zero Emissions.*