TUGAS AKHIR

ANALISIS SENSITIVITAS PADA OPTIMASI KAPASITAS SISTEM PEMBANGKIT *HYBRID* ENERGI TERBARUKAN

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ABSTRACT

Developing off-grid microgrid systems based on renewable energy is an effective solution to reduce dependence on diesel power in remote areas. These systems provide sustainable and eco-friendly energy solutions using solar, wind energy, and battery storage. Optimizing the composition of system components is very important to minimize the levelized cost of energy (LCOE). Sensitivity analysis is also needed to evaluate the impact of parameter changes, such as interest rates and diesel prices on the LCOE. Simulations using a genetic algorithm on MATLAB R2023a identified an optimal configuration with an LCOE of $0.348/kWh, a number of photovoltaic is 871 units, energy storage system capacity of 217,617 kWh, diesel generator capacity of 92.33 kWh, and loss of power supply probability (LPSP) is zero, which indicates the system is very reliable. Sensitivity analysis shows that LCOE is significantly influenced by interest rates and diesel prices. A 20% reduction in interest rates reduces LCOE by 7.7%, while a 40% reduction in interest rates reduces LCOE by 12.9%. Meanwhile, an increase in interest rates of 20% increases LCOE by 4%, while an increase in interest rates of 40% increases LCOE by 7.4%. On the other hand, a 5% reduction in diesel prices reduces LCOE by 5.4%, while a 10% reduction in diesel prices reduces LCOE by 8.3%. Meanwhile, a 5% increase in diesel prices reduces LCOE by 4%, while a 10% increase in diesel prices increases LCOE by 7,7%.

Keywords: *Off-grid Microgrid, Genetic Algorithm, Optimization, Sensitivity Analysis, Reliability*

ABSTRAK

Pengembangan sistem *microgrid off-grid* berbasis energi terbarukan merupakan solusi efektif untuk mengurangi ketergantungan pada pembangkit listrik diesel di wilayah terpencil. Dengan memanfaatkan energi surya dan angin serta penyimpanan baterai, sistem ini menyediakan solusi energi yang berkelanjutan dan ramah lingkungan. Optimalisasi komposisi komponen sistem sangat penting untuk meminimalkan *levelized cost of energy* (LCOE). Selain itu, analisis sensitivitas juga diperlukan untuk mengevaluasi dampak perubahan parameter seperti suku bunga dan harga diesel terhadap LCOE. Simulasi menggunakan algoritma genetika pada *MATLAB R2023a* menghasilkan konfigurasi optimal dengan LCOE sebesar $0,348/kWh, jumlah *photovoltaic* sebanyak 871 unit, kapasitas sistem penyimpanan energi sebesar 217,617 kWh, kapasitas generator diesel sebesar 92,33 kWh, serta *loss of power supply probability* (LPSP) bernilai nol, yang mengindikasikan sistem sangat andal. Analisis sensitivitas menunjukkan bahwa LCOE sangat dipengaruhi suku bunga dan harga diesel. Penurunan suku bunga sebesar 20% menurunkan LCOE sebesar 7,7%, sedangkan penurunan suku bunga sebesar 40% menurunkan LCOE sebesar 12,9%. Sementara itu kenaikan suku bunga sebesar 20% menaikan LCOE sebesar 4%, sedangkan kenaikan suku bunga sebesar 40% menaikan LCOE sebesar 7,4%. Di sisi lain, Penurunan harga diesel sebesar 5% menurunkan LCOE sebesar 5,4%, sedangkan penurunan harga diesel sebesar 10% menurunkan LCOE sebesar 8,3%. Sementara itu, kenaikan harga diesel sebesar 5% menurunkan LCOE sebesar 4%, sedangkan kenaikan harga diesel sebesar 10% menaikan LCOE sebesar 7,7%.

Kata Kunci: *Microgrid Off-grid*, Algoritma Genetik, Optimasi, Analisis Sensitivitas, Keandalan