OPTIMASI KAPASITAS BESS BERBASIS VARIABILITAS OUTPUT PLTS KUBU DALAM MENDUKUNG *ENERGY SHIFTING* DAN REDUKSI OPERASI PEMBANGKIT BBM DI SISTEM KELISTRIKAN BALI

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ABSTRAK

Penelitian ini dilatarbelakangi oleh tingginya ketergantungan sistem kelistrikan Bali terhadap pembangkit berbahan bakar minyak, perbedaan daya mampu pasok yang signifikan antara siang hari dan malam hari, serta rendahnya pemanfaatan energi terbarukan yang bersifat intermiten. Penelitian ini bertujuan untuk menganalisis variabilitas keluaran PLTS Kubu dan menentukan kapasitas optimal *Battery Energy Storage System* (BESS) guna mendukung *Energy Shifting* serta meningkatkan efisiensi dan fleksibilitas sistem. Metode yang digunakan adalah *quantile-based scenario* untuk membentuk skenario probabilistik yang diintegrasikan ke dalam model *stochastic optimization* dengan fungsi tujuan memaksimalkan penghematan biaya operasi. Selain itu, penelitian ini juga menggunakan pendekatan *Partial Least Squares Structural Equation Modeling* (PLS-SEM) untuk menganalisis hubungan antar variabel dalam sistem. Hasil menunjukkan bahwa metode yang digunakan mampu menghasilkan kapasitas BESS yang lebih representatif dan *robust*, serta efektif menurunkan operasi pembangkit berbahan bakar minyak melalui pemanfaatan energi surya pada malam hari. Kebaruan penelitian terletak pada integrasi data realisasi PLTS dengan pendekatan skenario dalam optimasi stokastik serta penguatan analisis melalui pendekatan statistik. Implikasinya, BESS berpotensi meningkatkan fleksibilitas dan mendukung transisi energi berkelanjutan di sistem Bali.

Kata Kunci : PLTS, *Battery Energy Storage System*, *Energy Shifting*, *Stochastic Optimization*, *Quantile-based Scenario*, PLS-SEM, Sistem Kelistrikan Bali

OPTIMAL SIZING OF BESS BASED ON VARIABILITY OF KUBU SOLAR POWER PLANT OUTPUT TO SUPPORT *ENERGY SHIFTING* AND REDUCE OIL-BASED GENERATION IN THE BALI POWER SYSTEM

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ABSTRACT

This study is motivated by the high dependency of the Bali power system on oil-based generation, the significant difference in available generation capacity between daytime and nighttime, and the limited utilization of intermittent renewable energy. This research aims to analyze the variability of the Kubu solar power plant output and to determine the optimal capacity of a Battery Energy Storage System (BESS) to enable *Energy Shifting*, as well as to improve system efficiency and flexibility. The method employs a quantile-based scenario approach to construct probabilistic scenarios, which are integrated into a stochastic optimization model with the objective of maximizing operational cost savings. In addition, this study utilizes Partial Least Squares Structural Equation Modeling (PLS-SEM) to analyze the relationships among key variables within the system. The results indicate that the proposed method is capable of producing a more representative and robust BESS capacity, while effectively reducing the operation of oil-based power plants through the utilization of solar energy during nighttime periods. The novelty of this study lies in the integration of actual solar output data with a scenario-based stochastic optimization approach, complemented by statistical analysis. The findings imply that BESS has strong potential to enhance system flexibility and support a sustainable energy transition in the Bali power system.

Keywords : Solar Power Plant, Battery Energy Storage System, *Energy Shifting*, Stochastic Optimization, Quantile-based Scenario, PLS-SEM, Bali Power System