

INTISARI

Target bauran energi baru dan terbarukan (EBT) di Indonesia sampai tahun 2025 adalah 23%. Potensi EBT terbesar di Sistem Jawa Bali adalah pembangkit listrik tenaga surya (PLTS) dengan total potensi mencapai 33.123 MW dan sampai 2025 ditargetkan telah dipasang 2.170 MW. Akan tetapi, PLTS memiliki masalah bagi operasi sistem akibat sifat intermitennya yaitu daya *output* PLTS mengalami variabilitas dan ketidakpastian karena tergantung kondisi matahari dan tidak dapat selalu dikendalikan sesuai kebutuhan. Sifat yang demikian berpotensi mengancam keandalan dan keamanan sistem karena akan menyebabkan terjadinya ketidakseimbangan daya pembangkitan dan beban. Sistem perlu memiliki fleksibilitas yang cukup untuk dapat mengimbangi sifat intermiten PLTS. Evaluasi (*assessment*) fleksibilitas sistem diperlukan untuk menilai kondisi fleksibilitas sistem dan merencanakan peningkatan fleksibilitas sistem. *Capstone project* ini merancang metode *assessment* fleksibilitas berbasis simulasi *unit commitment* (UC) dan melakukan *assessment* Sistem Jawa Bali pada tahun 2025 ketika mendapatkan penetrasi PLTS 2.170 MW. Simulasi UC untuk memodelkan operasi sistem dan dilakukan dengan metode *mixed-integer linear programming* (MILP) dengan bantuan solver IBM ILOG CPLEX, serta dirancang menggunakan Python. Secara umum, rancangan *assessment* fleksibilitas dibagi menjadi tiga langkah, yaitu *assessment* sumber fleksibilitas (sebelum simulasi UC), *assessment curtailment* (dengan simulasi UC), dan *assessment* penyebab kekurangan fleksibilitas (setelah simulasi UC). Rancangan tersebut digunakan untuk melakukan *assessment* fleksibilitas Sistem Jawa Bali tahun 2025. Ada dua skenario simulasi yang dilakukan, yaitu skenario tanpa saluran transmisi dan skenario dengan saluran transmisi. Hasil menunjukkan Sistem Jawa Bali masih memiliki fleksibilitas yang cukup untuk menerima penetrasi PLTS sesuai target tahun 2025, yaitu 2.170 MW, pada semua skenario. Variabilitas profil PLTS dan strategi pemasangan PLTS akan berpengaruh terhadap kemampuan fleksibilitas Sistem Jawa Bali. Saluran transmisi akan membatasi kemampuan fleksibilitas sistem karena membatasi penyaluran daya sumber fleksibilitas. Peningkatan fleksibilitas sistem Jawa Bali belum perlu dilakukan sampai tahun 2025 karena sistem masih memiliki fleksibilitas yang cukup, ditandai dengan tidak terjadinya *curtailment*.

Kata kunci: fleksibilitas sistem tenaga listrik, PLTS, *ramping*, *unit commitment*

ABSTRACT

The target of the mix of new and renewable energy in Indonesia until 2025 is 23%. The largest NRE potential in the Java Bali System is solar power plants (PV) with a total potential of 33,123 MW and until 2025 it is targeted to have installed 2,170 MW. However, PV has problems for system operation due to its dependency to nature, namely the output power of PV experiences variability and uncertainty because it depends on solar conditions and cannot always be controlled as needed. Such properties have the potential to threaten the reliability and safety of the system because it will cause an imbalance in generation power and load. The system needs to have enough flexibility to be able to compensate for the intermittent nature of the solar plant. Evaluation (assessment) of system flexibility is required to assess the condition of system flexibility and plan for improvements to system flexibility. This capstone project designed a flexibility assessment method based on unit commitment (UC) simulation and assessed the Java Bali System in 2025 when it obtained 2,170 MW PV penetration. UC simulation to model system operations and is done by mixed-integer linear programming (MILP) method with the help of IBM ILOG CPLEX solver and implemented using Python. In general, the flexibility assessment method is divided into three steps, namely flexibility source assessment (before UC simulation), curtailment assessment (with UC simulation), and assessment of the causes of flexibility deficiency (after UC simulation). The design is used to assess the flexibility of the Java Bali System in 2025. There are two simulation scenarios carried out, namely the scenario without a transmission line and the scenario with a transmission line. The results show that the Java Bali System still has sufficient flexibility to receive solar penetration according to the 2025 target, which is 2,170 MW, in all scenarios. The variability of PV profiles and PV installation strategies will affect the flexibility of the Java Bali System. Transmission lines will limit the flexibility capability of the system because it limits the power delivery of the flexibility source. Increasing the flexibility of the Java Bali system does not need to be done until 2025 because the system still has sufficient flexibility, characterized by no curtailment.

Keywords: power system flexibility, photovoltaic, ramping, unit commitment