INTISARI

Integrasi pembangkit energi baru dan terbarukan (EBT) seperti pembangkit listrik tenaga surya (PLTS) akan mempengaruhi operasi sistem tenaga listrik (STL). Hal ini disebabkan sifat PLTS bersifat intermiten dan tidak memiliki inersia sehingga akan mempengaruhi kestabilan frekuensi sistem. Untuk menjawab permasalahan tersebut, *capstone project* ini mengusulkan sistem operasi STL modern melalui pengaturan *free governor* dan pengoperasian *batttery energy storage system* (BESS) dengan memperhatikan pola operasi ekonomis dan keandalan. Usulan konfigurasinya adalah pengaturan *free governor* diaktifkan pada semua blok PLTGU Tambak Lorok dengan pengaturan *droop* sebesar 5% dan penambahan BESS berjenis *lead acid* dengan kontrol *inertial response* (IR) dan *primary frequency response* (PFR) dengan kapasitas daya 50 MW dan kapasitas energi 15,63 MWh pada SOC awal 80%. Pemilihan konfigurasi usulan tersebut dilakukan setelah melakukan simulasi dinamis dengan memperhatikan kestabilan frekuensi. Usulan desain operasi sistem diimplementasikan di Subsistem 150 kV Ungaran, Jawa-Madura-Bali. Pengujian desain usulan dilakukan melalui simulasi statis (aliran daya) dan dinamis untuk melihat nilai aliran daya, tegangan, frekuensi, dan pelepasan beban. Simulasi dinamis dilakukan dengan gangguan berupa lepasnya *interbus transformer* (IBT) 500/150 kV Ungaran. Hasil pengujian menunjukkan desain usulan telah memenuhi batas aturan teknis operasi sistem tenaga listrik Subsistem Ungaran. Desain tersebut membuat respons frekuensi mampu mencapai kondisi *steady-state,* mengurangi frekuensi nadir, dan mengurangi *overshoot* frekuensi. Dengan mempertimbangkan biaya penalti akibat pelepasan beban, biaya operasi sistem modern ini lebih kecil dibandingkan konfigurasi eksisting. Dengan demikian, desain yang diusulkan dapat digunakan sebagai acuan operasi sistem tenaga listrik di Subsistem Ungaran dalam menentukan pola operasi pembangkit yang ekonomis dan andal.

ABSTRACT

The integration of renewable energy source (RES) plants such as solar power plants will affect the electric power system operations. This is caused by the intermittent nature of solar power plants and does not have inertia so that it will affect the system of frequency stability. To answer this problem, this capstone project proposes a modern electric power system operating through free governor regulation and battery energy storage system (BESS) operations with due regard to economic and reliability operating patterns. The proposed configuration is that the free governor setting is activated on all Tambak Lorok power plant blocks with a droop setting of 5% and the addition of lead-acid type BESS with the inertial response (IR) and primary frequency response (PFR) with 50 MW power capacity and 15.63 energy capacity MWh at initial SOC 80%. The selection of the proposed configuration is done after conducting dynamic simulations with due regard to frequency stability. The proposed system operation design is implemented in the 150 kV Subsystem Ungaran, Java-Madura-Bali. The proposed design testing is carried out through static (power flow) and dynamic simulations to see the value of power flow, voltage, frequency, and load release. Dynamic simulation is carried out with a disturbance in the form of interbus transformer (IBT) 500/150 kV Ungaran. The test results show that the proposed design has met the limits of the technical rules of the Ungaran Subsystem electricity system operation. The design makes the frequency response-able to reach steady-state conditions, reduce nadir frequency, and overshoot frequency. Taking into account the penalty costs due to load release, the operating costs of this modern system are smaller than the existing configuration. Therefore, the proposed design can be used as a reference for the operation of the electric power system in the Ungaran Subsystem in determining an economical and reliable generator operating pattern.