INTISARI

Penetrasi energi baru terbarukan perlu didukung oleh kemampuan dan kesiapan sistem eksisting. Operasi pembangkit listrik energi terbarukan seperti PLTB menghadirkan beberapa tantangan operasi, antara lain intermitensi daya dan penurunan kemampuan respons frekuensi sistem. Dalam *Capstone Project* ini diusulkan desain operasi berupa optimisasi penjadwalan pembangkit dengan mempertimbangkan regulasi frekuensi primer. Desain diimplementasikan pada sistem Sulawesi Bagian Selatan yang memiliki level penetrasi PLTB yang cukup tinggi. Dari sisi keandalan dilakukan analisis stabilitas sudut rotor akibat pengaruh pertimbangan respons frekuensi primer dan stabilitas frekuensi akibat intermitensi pada PLTB untuk menentukan konfigurasi pengaktifan *free governor* yang optimal. Proses desain dan implementasi diawali dengan pengumpulan data sistem Sulawesi Bagian Selatan, kemudian dilakukan optimisasi penjadwalan pembangkit. Hasil penjadwalan pembangkit yang berupa status operasi dan pembebanan setiap pembangkit kemudian menjadi *input* proses selanjutnya, yaitu simulasi stabilitas transien dan simulasi respons frekuensi. Hasil yang diperoleh menunjukkan bahwa penjadwalan pembangkit dengan hanya mempertimbangkan *reserve* berbasis kapasitas tidaklah cukup untuk menjamin kualitas frekuensi pasca terjadinya kontingensi. Kekangan regulasi frekuensi dalam penjadwalan perlu diperhatikan untuk memenuhi standar operasi yang baik. Selain itu, perlu dirancang suatu kebijakan untuk mengatur partisipasi pembangkit terutama pembangkit non-PLN dalam memberikan respons frekuensi melalui insentif. Simulasi stabilitas transien menunjukkan bahwa penjadwalan pembangkit dengan mempertimbangkan kekangan respons frekuensi membatasi generator agar tidak dioperasikan pada daya maksimalnya dan memberikan kestabilan transien lebih baik. Melalui simulasi respons frekuensi terhadap intermitensi PLTB dapat disimpulkan bahwa pengaktifan *free governor* pada semua pembangkit dalam sistem menghasilkan respons frekuensi yang baik pasca terjadinya intermitensi PLTB, bahkan dengan penurunan yang drastis.

Kata kunci: Operasi sistem, PLTB, intermitensi, *unit commitment*, stabilitas transien, stabilitas frekuensi, respons frekuensi primer

ABSTRACT

The penetration of renewable energy needs to be supported by the capability and readiness of the existing system. The operation of renewable energy power plants such as wind farm presents several operating challenges, including power intermittence and decreased frequency response capability of the system. In this Capstone Project, an operation design in the form of generator scheduling optimization by considering the regulation of primary frequency is proposed. The design is implemented in the South Sulawesi system which has a fairly high level of wind power penetration. From the reliability side, an analysis of the rotor angle stability is carried out due to the influence of consideration of the primary frequency response and frequency stability due to the wind power intermittency to determine the optimal configuration of the activation of the free governor. The design and implementation process begins with the collection of the South Sulawesi system data, then the generator scheduling optimization is carried out. The results of generating scheduling in the form of operating status and loading of each plant then become the next process input, namely the rotor angle stability and frequency response simulation. The results obtained indicate that scheduling the plant by only considering capacity-based reserves is not enough to guarantee the quality of the frequency after contingency. Constraints on frequency regulation in scheduling need to be considered to meet desirable operating standards. Besides, it is necessary to design a policy to regulate the participation of generators, especially non-PLN generators, in providing frequency response through incentives. The transient rotor angle stability simulation shows that generator scheduling by considering frequency response restraints limits the generator from operating at its maximum power thus provides better transient stability. Through the simulation of the frequency response to the intermittence of PLTB, it can be concluded that the activation of the free governor of all power plants in the system produces better frequency response after wind power intermittence, even with a drastic reduction.

Keywords: Power system operation, wind farm, intermittency, unit commitment, transient stability, frequency stability, primary frequency response