ABSTRACT

The integration of renewable energy into power systems creates challenges in maintaining voltage stability, reducing power losses, and ensuring system stability during disturbances. This study examines the impact of Battery Energy Storage System (BESS) integration into the Hulu Rokan power system, focusing on load flow analysis, short-circuit analysis, and transient stability analysis. In addition, this research involves the design of a small-scale prototype to represent voltage and frequency variations resulting from BESS integration.

The research method was conducted through software simulation using load flow analysis to evaluate voltage profiles and power losses, short-circuit analysis to observe fault current characteristics, and transient analysis to assess system responses under disturbances. Furthermore, a small-scale prototype was designed using an inverter, sensors, and a control system to directly observe variations in voltage and frequency under both no-load and load conditions.

The results show that BESS integration reduces reactive power losses, maintains voltage profiles within acceptable limits, and enhances system stability by damping oscillations in voltage and frequency. The prototype testing also successfully demonstrated real-time changes in voltage and frequency, reinforcing the simulation results. Therefore, BESS integration plays an important role in improving the reliability and stability of renewable-based power systems.

Keywords: Battery Energy Storage System (BESS), Power System, Load Flow Analysis, Short Circuit, Transient Stability