

This paper presents a new hybrid wind turbine system that is formed by a continuously variable transmission connection of the turbine drive shaft with an air expander/compressor. A mechanical power split device is designed to synthesize the power delivered by the wind turbine and the air expander/compressor. A small-scale hybrid wind turbine system is mathematically modeled, analyzed, and validated using a laboratory-scale experimental test rig. By utilizing compressed air energy storage, it is shown that the hybrid wind turbine system can provide smooth power output under fluctuating wind speed conditions. Such a direct connection structure reduces the overall system cost by using one generator instead of two compared with the conventional CAES system structure. The study demonstrates the benefit of improved efficiency and flexibility brought to the turbine operation by the hybridization of wind energy and stored energy.

