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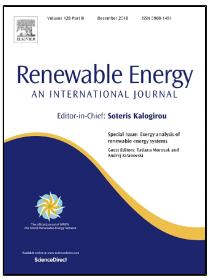

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Analysis of Direct Interconnection Technique for Offshore Airborne Wind Energy Systems under Normal and Fault Conditions

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Abstract- Direct interconnection is a novel technique for interconnecting offshore airborne wind energy (AWE) generators which facilitates the removal of power converters from the offshore generation site. In this technique, unlike the conventional approach, all generators are interconnected directly and after dispatching the generated power to shore, a back to back converter or several paralleled back to back converters change the generated power to grid-compliant power. Considering that the high expenses of offshore operations for back to back converter repair and maintenance and the higher accessibility of shore-side back to back converters, this technique can improve the reliability and economy of the energy generation system. This research aims to implement and study the practicality and reliability of the direct interconnection approach for offshore non-reversing pumping mode airborne wind energy generator systems. The interaction of direct interconnected AWEs in normal and fault conditions is investigated, and synchronisation, frequency control and load sharing control of the AWE farm are examined and discussed.

Keywords: Airborne Wind Energy, Direct interconnection technique, Offshore, Synchronous generator

1. Introduction- Wind energy is the most common type of renewable energy for electrical power production after hydropower (International Energy Agency 2014). It has seen the biggest absolute increase in non-hydro renewable energy output, and it is anticipated that its share in total worldwide electricity generation rises to 4.5% by 2030 (International Energy Agency 2014). In 2015 alone, wind power installation reached 63 GW which represents a 22% increase in just one year (Global Wind Report 2015). In 2016, more than 54 GW wind power has been installed which has raised the total global installed capacity to 486.8 GW (Global Wind Report 2016). Despite the rapid development, wind energy is still expensive. According to International Energy Agency report in 2014, most wind energy projects encounter financing problems. In the US the number of wind power component factories fell from 550 to 500 in 2013. In China the number of wind turbine manufacturers reduced from over 80 in 2009 to about 30 in 2014 and in Europe because of the long economic recession, many manufacturers are considering moving abroad (Renewables 2015 Global Status Report). Researchers are looking for solutions to reduce the total cost of wind energy systems by improving power production through the increase of turbine height or improving subsystems such as blade design, gearbox, back to back converters, energy storage systems, and power systems for power dispatching and grid interconnection. New studies are showing that the amount of electrical power which is possible to be generated by wind turbines is much less than what was predicted previously (Miller et al. 2011; Adams et al. 2013; Miller et al. 2014). Today, we know that in large wind farms the installed wind turbines decrease the wind speed and consequently, they generate less electrical energy than what was anticipated (Miller et al. 2011; Adams et al. 2013; Miller et al. 2014). In 2011, the predicted total electrical energy from wind was 18-68 TW while studies in 2013 and 2014 have shown 20TW or even less (Miller et al. 2011; Adams et al. 2013; Miller et al. 2014). Airborne wind

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