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Investigation of Oscillation Mechanism of a Large-scale Solar Photovoltaic and Wind Hybrid Power Plant

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Abstract : This research presents a real-world power system oscillation incident in 2022 originated by a hybrid solar photovoltaic (PV) and wind renewable energy farm with a rated capacity of approximately 300MW in Australia. The voltage and reactive power outputs recorded at the point of common coupling (PCC) oscillated at a sub-synchronous frequency region, which sustained for approximately five hours in the network. The reactive power oscillation gradually increased over time and reached a recorded maximum of approximately 250MVar peak-to-peak (from inductive to capacitive). The network service provider was not able to quickly identify the location of the oscillation source because the issue was widespread across the network. After the incident, the original equipment manufacturer (OEM) concluded that the oscillation problem was caused by the incorrect setting recovery of the hybrid power plant controller (HPPC) in the voltage and reactive power control loop after a loss of communication event. The voltage controller normally outputs a reactive (Q) reference value to the Q controller which controls the Q dispatch setpoint of PV and wind plants in the hybrid farm. Meanwhile, a feed-forward (FF) configuration is used to bypass the Q controller in case there is a loss of communication. Further study found that the FF control mode was still engaged when communication was re-established, which ultimately resulted in the oscillation event. However, there was no detailed explanation of why the FF control mode can cause instability in the hybrid farm. Also, there was no duplication of the event in the simulation to analyze the root cause of the oscillation. Therefore, this research aims to model and replicate the oscillation event in a simulation environment and investigate the underlying behavior of the HPPC and the consequent oscillation mechanism during the incident. The outcome of this research will provide significant benefits to the safe operation of large-scale renewable energy generators and power networks.

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