

# **Non-linear interaction between a synchronous generator and grid-forming-controlled wind turbines – inertial effect enhancement and oscillation mitigation**

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## **Abstract-**

The integration of grid-forming (GFM)-controlled wind turbines into AC grids introduces complex dynamic interactions that significantly influence the behavior on the AC side. This study explores the non-linear coupling between wind turbines and AC grids and proposes strategies for the enhancement of the inertial effect and the mitigation of oscillations which can arise in case of an AC event such as a grid fault or sudden load change. A simplified synthetic model is developed to elucidate the physical insights of these interactions. The findings reveal that wind turbine dynamics have an impact on the inertial contribution and introduce oscillatory behavior under certain conditions. Advanced control strategies are then proposed. They include the integration of input-shaping filters and lead&ndash;lag compensation to optimize inertial response and damp mechanical oscillations. The theoretical analysis, validated through simulation, demonstrates the effectiveness and limitations of these methods in enhancing the AC side behavior without compromising the performance of the mechanical system.

## **Index Terms-**

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