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Grid-forming converter DC-link control considering the primary energy source

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Abstract-

The gradual substitution of conventional synchronous generators by converter-interfaced renewable energy sources raises concerns about the reduction of conventional inertia in electric power systems and the ensuing threat to their stability. In this regard, grid-forming voltage source converters have been proposed as a key solution to address this challenge. Although a growing body of literature addresses DC-link voltage regulation in grid-forming converters, most existing approaches implicitly assume an ideal and unconstrained DC power source. As a result, the dynamic response and operational limits of the primary energy source, which can critically shape the available DC-side power during transients, are rarely modeled or explicitly accounted for in the design of the DC-link control. This paper demonstrates that incorporating these aspects at the design stage reduces the risk of converter disconnection from the power grid under sudden power imbalances, while enhancing system resilience. A systematic methodology based on a Genetic Algorithm is proposed to tune the control parameters. The performance of the proposed control is validated by simulation using a detailed electromagnetic transient model.

Index Terms- Grid connectivity; Grid-forming; Primary energy source; DC-link; Genetic algorithm

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