Embracing Low Inertia in Power System Frequency Control: A Dynamic Droop Approach

Abstract: The transition into renewable energy sources -with limited or no inertia- is seen as potentially threatening to classical methods for achieving grid synchronization. A widely embraced approach to mitigate this problem is to mimic inertial response using grid-connected inverters. That is, introduce virtual inertia to restore the stiffness that the system used to enjoy. In this talk, we seek to challenge this approach and advocate towards taking advantage of the system's low inertia to restore frequency steady-state without incurring excessive control efforts. With this aim in mind, we develop an analysis and design framework for inverter-based frequency control. We define several performance metrics of practical relevance for power engineers and systematically evaluate the performance of standard control strategies, such as virtual inertia and droop control, in the presence of power disturbances and measurement noise. Our analysis unveils the relatively limited role of inertia on improving performance as well as the inability of droop control to improve performance without incurring large steady-state control efforts. To solve this problem, we propose a novel dynamic droop control (iDroop) for grid-connected inverters -exploiting classical lead/lag compensation from control theory- that can significantly outperform existing solutions with comparable control efforts.