

Probability Density Function Control of Frequency Fluctuations in Uncertainty-Rich Power Systems

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The stochastic nature of variable energy sources (VESs) necessitates treating power system frequency response as a random process with a nonstationary probability density function (PDF). Based upon the stochastic distribution control theory originated by the second author, this paper proposes a novel stochastic controller to improve the frequency PDF in power grids when integrating a large amount of VESs, thereby minimizing the effects of uncertainties and enhancing overall system stability. The key idea is to manipulate the controllable power generation resources so that the frequency PDF is made to follow a target PDF by using the stochastic distribution control theory originated by the second author. The proposed method can easily be plugged into existing automatic generation controls for multi-area transmission grids. The proposed method is validated via a modified Kundur's two area system and 240-bus Western Electricity Coordinating Council systems. The simulation results show that the proposed control shapes the frequency PDF narrower and sharper, leading to a notable improvement toward minimizing the effects of randomness and uncertainty during grid operation.