A Framework to Quantify Technical Flexibility in Power Systems Based on Reliability Certificates

Abstract:

Power systems are increasingly stressed by variable and unpredictable generation from various sources. We identify the qualitative framework of flexibility as an adequate tool to specify requirements that allow the system to handle this variability. An open problem is the quantification of technical flexibility that incorporates limitations from transmission system and component behavior in contrast to existing copper plate supply and demand balance approaches. We develop such a quantitative method for single components on the basis of a priori specified reliability criteria. Our framework bases on a combined static power flow and small signal stability analysis. In a perturbative approach we derive sensitivity-based formula for eigenvalue variations under nonlinear changes of steady power flow set points. To this end, we define rigorously the terms flexibility metric and technical flexibility of single components. We provide an algorithmic procedure for computation of tolerance ranges of individual system components such that the overall behavior remains reliable.