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Transmission and distribution coordination in power systems with high shares of Distributed Energy Resources providing balancing and congestion management services

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Abstract-

This paper presents a literature review on the coordination between transmission and distribution grid operators in power systems, with particular emphasis on the provision of balancing and congestion management services. Firstly, a brief historical background is presented in order to highlight the ongoing changes current power systems are experiencing and that call for greater coordination between transmission system operators (TSO) and distribution system operators (DSO). These include the growth in distributed energy resources (DER), new roles to be adopted by both system operators (SO), and the integration of new agents such as independent aggregators. Next, the paper places its focus on a particular topic which, based on the review presented, is presumably considered as the most relevant issue requiring tighter cooperation mechanisms, that is, the procurement of balancing services from DER by TSOs whilst DSOs procures the same DER flexibility to manage local congestions. Four key elements are identified for this coordination to take place, namely (a) DER flexibility integration, (b) coordination schemes, (c) transmission?distribution optimization, and (d) data exchange. For each one of them, the paper presents a literature review and identifies the main existing technical, economic, and regulatory barriers. These barriers include, among others, the limitation for small DER flexibility to participate in grid service markets, the challenges for independent aggregators, the technical barriers for optimizing a transmission?distribution grid, and the lack of maturity in coordination schemes and TSO?DSO data exchange models.

Index Terms- distributed energy resources, distribution system operator, power distribution, power transmission, transmission system operator, TSO-DSO coordination

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