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**Abstract Format**

**Planning and Operational Implications of High Levels of Distributed  
Energy Resources on the Bulk Power System**

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**Abstract**

The increased installation of Distributed Energy Resources (DER), particularly distributed solar PV, expected in the coming decade in many areas has led to significant concerns about potential impacts on bulk power system reliability and operations. This presentation will describe the concerns and address potential mitigating solutions across two areas, namely interconnection requirements and operational concerns.

With low penetrations of DER, interconnection requirements have tended to focus on ensuring local safety, device protection and maximizing energy production. This means that DER requirements tend to require devices to disconnect quickly during any low voltage or frequency events and prevent control of active and reactive power. With increasing levels of DER, system operators are increasingly concerned about this behavior. Large scale disconnection during a bulk system fault could exasperate an already difficult situation, while the fact that DER displaces traditional sources of active and reactive power control may mean they can make it more difficult to operate the system within desired bounds. This presentation will describe a number of ongoing efforts within EPRI and the industry to address these issues, including revision of current standards, studies to inform such revisions, and survey of changes that are being proposed or have been implemented.

There are also a number of other concerns with power system operations with high levels of DER, particularly distributed solar PV. As distributed PV is a variable resource, and its output cannot be predicted exactly, this can make it more difficult to operate the power system. While it is true that, across the entire system, aggregated solar output is more predictable and less variable, it will still require increased flexibility, which will be described here. These include the requirement for increased visibility and controllability of DER. System operators need to know current output, potential future output and whether they can control the resources, either directly or through aggregation. Forecasting PV across large urban areas will require new techniques which will be described briefly, while the increased reserve requirements and methods to optimally determine reserve requirements will also be described.