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For the operation of an active distribution system by isolated microgrids, it is necessary to include distributed generation (DG) plants with advanced control, as well as install measurement and control devices on the feeder and demand in order to constantly monitor the system. This integration enables to provide ancillary services included in all DERs, like voltage and frequency control, which enables the demand to have an active participation in the operation by isolated microgrids [10].

A flexible and reliable operation that maintains acceptable levels of safety, reliability, and quality is one of the challenges that emerge with DER integration. These concepts are linked to the resilience and the ability of isolated microgrids to provide a continuous supply of electricity to connected users despite the occurrence of events in the system (ancillary services) [11].

This paper seeks to review potential benefits and challenges that are faced when DERs are integrated into distribution systems (especially in isolated microgrids), the state of these resources in the Colombian paradigm, and international experiences related to this topic. The purpose is to define the next steps for the integration of DERs in Colombia by identifying non-interconnected areas as potential natural laboratories to study the behavior and control of these resources.

The paper is organized as follows: Section 1 introduces the integration and inclusion of DERs in the distribution system. Section 2 provides an overview of the situation of DERs in Colombia. Section 3 describes some international experiences related to the integration of DERs. Finally, Section 4 outlines some strategies for the integration of DERs in Colombia by defining the next steps the country should take to incorporate them into microgrid operation. Finally, some recommendations and conclusions are provided.

The evolution towards smart grids poses challenges related to the inclusion of DERs into the distribution systems [12], [13]. These challenges include the integration of active demand participation, DG, and ESS. Incorporating DERs (such as small-scale generation plants, ESS or standby generators) and active demand participation provide the system"s operation with significant value due to operational and market changes [14].

Besides, Demand Side Management (DSM) is defined as the planning, implementation, and supervision of activities aimed at producing changes in the consumption pattern for improving energy efficiency and operating the Electrical Power System (EPS) [20]-[22], which allows microgrids to get closer to the smart grid philosophy [20], [23].

The integration of these new resources to the network leads to the evolution from current to active distribution networks, which migrate to the microgrid mode [27]. This mode of operation enables to maximize the integration of small-scale generation assets, automated distribution networks, and controllable loads to create electrical power subsystems that are independent of the central interconnected system [28].

However, in the mode of operation by isolated local production units, frequency and voltage control are fundamental, because the large inertia formed by the interconnection with the EPS is no longer available. Thus, the controllability of DERs in the microgrid guarantees the continuity and security of the electricity supply to connected users.

Including ESSs is recommended in order to achieve a flexible and reliable operation of isolated microgrids with the capacity to operate by local production units and with the integration of variable generation sources. This resource is one of the most critical and essential elements in microgrid operation, since it could guarantee an uninterrupted electricity supply.