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Distribution planning with reliability options for distributed generation

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ABSTRACT

The promotion of electricity generation from renewable energy sources (RES) and combined heat and power (CHP) has resulted in increasing penetration levels of distributed generation (DG). However, large-scale connection of DG involves profound changes in the operation and planning of electricity distribution networks. Distribution System Operators (DSOs) play a key role since these agents have to provide flexibility to their networks in order to integrate DG. Article 14.7 of EU Electricity Directive states that DSOs should consider DG as an alternative to new network investments. This is a challenging task, particularly under the current regulatory framework where DSOs must be legally and functionally unbundled from other activities in the electricity sector. This paper proposes a market mechanism, referred to as reliability options for distributed generation (RODG), which provides DSOs with an alternative to the investment in new distribution facilities. The mechanism proposed allocates the firm capacity required to DG embedded in the distribution network through a competitive auction. Additionally, RODG make DG partly responsible for reliability and provide DG with incentives for a more efficient operation taking into account the network conditions.

1. Introduction

In the context of the European Energy Policy, ambitious targets have been set concerning improvements in energy efficiency and the use of renewable energy sources (RES) [1]. The electricity sector is meant to play a major role in the achievement of the aforementioned goals. Different economic support schemes for the production of electricity from RES and combined heat and power (CHP) have been implemented at national level. As a consequence of these support schemes, new generation technologies have been developed over the last years. Several of these technologies are generally applied on medium and small-scale installations. This fact has brought about a new concept in the context of electricity production called distributed generation (DG). Other terms used with similar meanings are embedded generation, distributed energy resources, dispersed generation or decentralised generation.

The definition of the term DG has been analysed in detail [2]. In this paper, DG will be considered as electricity generation systems connected to distribution networks, characterized by their reduced size and located near consumption points.

Distribution networks were not originally designed to accommodate generation. Hence, increasing penetration levels of DG are causing profound changes in the planning, operation and maintenance of distribution networks. In order to integrate DG effectively and efficiently, the electricity distribution networks should no longer be passive elements that transmit electricity in one direction. They should become active elements where control, safety and flexibility are very relevant factors.

The impact of DG immersed in distribution networks is currently being analysed in detail. Various aspects are being considered: network planning [3], operation and maintenance [4], ancillary services [5,6], quality of service [7] and regulatory aspects [8].

This paper focuses on the possibility to substitute new network investments thanks to the contribution of DG to meet peak demand. Article 14.7 of the European Electricity Directive [9] states that DSOs shall consider DG as an alternative to network upgrading or replacing network elements. However, this challenge is not exempt of difficulties. In some countries, DSOs may own DG. Therefore they have the possibility of installing either new network elements or new generation units [10,11]. Nevertheless, under the current European regulatory framework, DSOs must be at least legally and functionally unbundled from other activities in the electricity sector. Electricity distribution remains a regulated activity, whereas generation has become a liberalised one. Therefore, DSOs have no direct control over the location and operation of DG.

Two main problems are derived from this situation. On the one hand, the responsibility of continuity of supply resides 100% on

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