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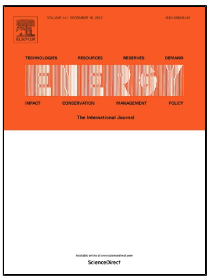

A Flexible Active Distribution System Expansion Planning Model: A Risk-Based Approach

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A Flexible Active Distribution System Expansion Planning Model: A Risk-Based Approach

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Abstract: This paper presents an active distribution network expansion planning framework, which concurrently uses the renewable distributed generations and energy storage systems as capacity expansion options. In order to enhance the network reliability, the model takes into account the island mode operation of the renewable resources and energy storage systems. The proposed planning framework, which is modeled as a probabilistic bi-level optimization problem quantifies and controls the economic risk level associated with the stochastic nature of these resources. The master level is devoted to the here-and-now decisions in the planning phase, whereas the slave level, which is formulated as a two-stage model, is related to the wait-and-see decisions in the operational phase. At the first stage of the slave level, the network operational behaviour is determined by performing an optimal power flow modeled as a mixed-integer linear programming problem. At the second stage of the slave problem, the network reliability is optimized considering island mode operation and taking into account energy-limited nature of storage systems. The effectiveness of the proposed active distribution network planning model is demonstrated through several case studies. Simulation results demonstrate that the proposed approach can result in a flexible low-risk plan for the expansion of the network.

Keywords: Active distribution network planning; Bi- level optimization problem; Energy storage; Reliability; Risk.

1. Introduction

Emerging distributed generations (DGs) in distribution networks, referred to as active distribution networks (ADNs), enables distribution system companies (DISCOs) to deal with the new challenges

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