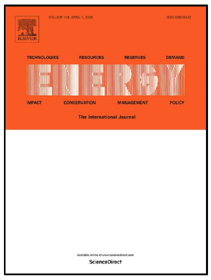

Autonomous Optimized Economic Dispatch of Active Distribution System with Multi-microgrids

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Autonomous Optimized Economic Dispatch of Active Distribution System with Multi-microgrids

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***Abstract*—With the development of the active distribution system (ADS) and multi-microgrids (MGs), increasing numbers of distributed energy resources are connected to distribution networks (DNs) using MGs. The competition between DN and MGs brings a huge challenge to efficient power system dispatching. For the strong decentralized and autonomous characteristic of ADS, this paper proposes an autonomous optimization model of the active distribution system with MGs based on analytical target cascading theory (ATC). DNs and MGs are regarded as topics of different interest. Based on their detailed models, ATC theory is proposed to decouple the dispatching of DNs and MGs by modeling the tie-line flow as a pseudo-generator/load, so that MGs and DNs can autonomously utilize their distinct resources to optimize their operation and economic benefits. Various uncertain factors are also considered by using chance-constrained programming. A modified IEEE 33 system and an actual regional DN are studied to show the effectiveness of the proposed algorithm.**

***Keywords:* active distribution system, analytical target cascading, autonomous optimized economic dispatch, interest game, multi-microgrids.**

1. Introduction

1.1 Motivation

Distributed generation has the characteristics of flexible installation and decentralization, which has become the dawn of the effective use of new energy. The common distributed energy resources (DERs) include micro gas turbines, photovoltaic cells and wind power, etc. In order to cope with the increasing demand for energy and deal with the environmental pollution problems, the voice of actively developing DERs and establishing new mechanism for DERs development is increasing.

As a kind of comprehensive integration technology of DERs and renewable power generation [1], microgrids have great significance in promoting the economic and environmental-protection benefits of power systems [2-3]. But for the traditional DN, the high impedance, large energy loss, and low level of automation make it difficult to satisfy the increasing popularity of DERs [4]. ADSs are used to adjust the distribution of the load flow by flexible network topology, and they proactively control and manage local DERs and multi-microgrids (MGs) [5]. The ADS and MGs are beneficial and economical for microgrids' owners, consumers and network operators. The structure of ADS connected with MGs will potentially play a significant role in energy efficiency, power system reliability and sustainability.

1.2 Related work

The literature includes many studies of intelligent energy management of ADSs with MGs including the strategic decision-making methods of DN operator with multi-microgrids considering demand response [6-8],the economic dispatch model and algorithm for ADS with MGs [9-15], etc. Nima et al. [6] investigates the daily optimal scheduling problem of networked MGs considering intermittent behavior in generation and load, with time of use and real time pricing based demand response programs integrated. Liu et al. [7] proposes a distributed energy management method for interconnected operations of combined heat and power (CHP)-based MGs with demand response. An efficient approximation algorithm for event-based demand response management in microgrids is proposed in [8], which is applied to a feeder from the Canadian benchmark distribution system. Alireza et al. [9] proposed a multi-area dynamic economic dispatch model in real-time operation of ADSs with MGs. An optimality condition decomposition technique was employed along with parallel computation. Connecting multiple MGs (to make a distribution system with networked MGs) can improve the operation and reliability of the system [10-15], and it has good development prospects. It also brings great challenges to the economic dispatch of power distribution systems [16].

The dynamic economic dispatch (DED) of an ADS with MGs can usually be described by a nonlinear optimization model. There are mainly two kinds of modeling method for it: centralized and distributed [17]. The centralized model combines the operation constraints of a DN and MGs into one system model, which is commonly solved integrally by mixed integer programming [18], sequence quadratic programming [19], neural networks [20], etc. This method usually requires the collection of the DER parameters and the internal information of the MGs. When the scale of the DN or the number of MGs is larger, more information must be collected. The calculation burden will also increase, which may lead to the curse of dimensionality. For the centralized model, it is also difficult to reflect the different interests of the MGs and the DN. Nor can the decentralized, autonomous characteristics of a microgrid be described by this kind of model.

The distributed model is the topic of much current research. The DN and MGs are respectively formulated by regarding them as subjects of separate interest. That can ensure the privacy of the interest subjects and refine the operation constraints and interest game for all the participants in DED. Based on this, the curse of dimensionality can be overcome and the decentralized autonomous characteristics of MGs can be clearly described [21-22]. Wang et al. [23] consider the DN and

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