Chapter 21

Optimal Placement and Sizing of Distributed Generation in Distribution System Using Modified Particle Swarm Optimization Algorithm: Swarm–Intelligence–Based Distributed Generation

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ABSTRACT

The electricity demand, fossil fuel depletion and environment issues increase the interest of power engineers to integrate small power generations i.e. called distributed generation (DGs) in the distribution system. The DG in distribution system has many positive effects such as it reduces the system power losses, improves the voltage profile and strengthen the voltage stability etc. The placement and sizing of DG play a major role in optimizing these parameters. Therefore, this chapter proposes a modified Particle Swarm Optimization (PSO) algorithm for finding the optimal placement and sizing of distributed generation in the radial distribution system. Two types of DGs such as an active power and reactive power DGs are tested on standard IEEE 33 radial bus system. Moreover, it can be realized that proposed method gives very effective results when both of active and reactive power DGs are integrated into the distribution system.

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INTRODUCTION

The urbanization, population growth, exhausting of fossil fuels and limitations on the congested transmission lines have pushed the power system to utilize the distributed generations into the distribution system. The distributed generation are a small source of power generation connected near to the load centers. The DGs are also called as a de-centralized generation, embedded generation or dispersed generation. From extensive literature survey (Paliwal, Patidar, & Nema, 2014) it can be summarized that distributed generation has generally been defined on the basis of placement, capacity and type of primary resource. According to (CIRED, 2009) DG is power generation source which is not centrally planned nor centrally dispatched, usually ranging from less than 50-100MW which is connected to the distribution system. Distributed generation is an electric power source which is directly connected to the distribution system or on the customer site of the meter (Ackermann, Andersson, & Söder, 2001). Small generating units usually 30MW or less that are connected at or near customer site to support customer and grid by the economic operation (Chambers, 2001). DG is a small source which may be electric power generation or storage ranging typically from less than few kW to 10 of MW that is not part of the central power source and is connected close to load (Dondi, Bayoumi, Haederli, Julian, & Suter, 2002). Power generating unit which is connected to a distribution network that produces power and supply locally within the network (IEA, 2002). DG refers to a system that generates electricity (and possibly heat), generally takes place close to the point where energy is actually used (Rob van Gerwrent, 2006). IEEE defines the generation of electricity by facilities that are smaller than central generating plants so as to allow to interconnect at nearly any point in a power system (Pepermans, Driesen, Haeseldonckx, Belmans, & D’haeseleer, 2005). The EPRI defines DG as generation from few kilowatts up to 50MW, located at the customer site or within utility distribution grid (Electric Power Research Institute EPRI, 1998). The distributed generations are the small amount of power generation sources, which are connected directly to the distribution systems or on the site of the customer (Ackermann et al., 2001).

From last few years, many countries are taking a keen interest in their legislations for renewable and non-renewable DGs, which are most efficient technically, economically and environmentally. Technically, DGs are benefiting many electric parameters like, it reduces system power losses, improves the system voltage performance, strengthen the voltage stability, reduces the transmission capacity and provides the good service quality to the consumer appliances. Economically, it has opened a new energy marketplace for competitors and investors. DG provides an alternatives fuel sources such as renewable and non-renewable energy which further helps in reduction of peak electricity needs and it also defers the transmission lines upgradation cost. Environmentally, DGs can be operated by many of primary fuels sources, which are environments friendly such as the wind, solar, micro turbine, and fuel cell etc. The power generation from these sources are less pollutant to the environment, which ultimately reduces carbon foot prints, alleviates the global warming and provides the public awareness to promote renewable energies (Georgilakis & Hatzigiayriou, 2013; Paliwal et al., 2014; Tan, Hassan, Majid, & Abdul Rahman, 2013; Viral & Khatod, 2012).

In the early days, DG was used as an active source of power to give a very small amount of power to lower level loads, but with the technology progression, DGs are available in many forms such as, an active source of power, like photovoltaic cell, fuel cell or combine heat and power etc. a reactive source of power, like capacitor banks or synchronous condensers, or STATCOM (static synchronous compensator), and combination of active-reactive power sources like synchronous machines and wind