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Distribution system adequacy assessment accounting customer controlled generator sets

L.D. Arya [a,1], L.S. Titare [b,*], D.P. Kothari [c,2]

[a] Department of Electrical Engg., SGSITS, 23-Park Road, Indore, MP 452 003, India
[b] Department of Electrical Engg., Govt. Engineering College, Jabalpur, MP 456 010, India
[c] Centre for Energy Studies, Hauz Khas, New Delhi 110 016, India

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ABSTRACT

This paper describes a probabilistic approach for the adequacy assessment of a distribution system having distribution generator (DG) sets, which are owned and controlled by customers. Markov modeling has been employed to obtain capacity outage table for DG sets. Available capacity of distribution substation has been assumed as continuous random variable. Discrete capacity distribution is added to continuous distribution of substation capacity and merged with hourly peak load for obtaining probability of failure and expected demand not supplied (EDNS) annually with the help of derived closed form relations. The procedure has been illustrated with a case study.

1. Introduction

The market structure for electric energy and power are changing. In the past, interconnected electric utility systems dealt only with each other to buy and sell power/energy. Only occasionally did non-utility entities become involved, and these were usually large industrial organizations with their own generations (co-generation plants). In more recent years, there has been an opening of the market to facilitate the involvement of more non-utility organizations, consumers as well as generators. Throughout the world there has been a movement towards deregulation of the electric utility industry and an opening of the market to non-utility entities, mainly non-utility generating firms. Various forms of deregulation have been discussed in Ref. [1]. The use of transmission system by parties other than its owner may involve wheeling arrangements. The growth of the number and size of energy transactions has emphasized the need for inter system agreements on power flows over parallel transmission circuits. Two neighboring utilities may engage in the purchase-sale of a large block of power. Sanabria and Dillon [2] presented a methodology for evaluating power system reliability for a deregulated system using the method of cumulants. This technique has been developed for a deregulated system where plant loading is done based on price offer or 'bid'.

Now a days there is a wide spread use of generating units owned by customers and connected to distribution systems say at 11 kV level and each of them may be rated say 100 MVA. These generating units are customer controlled and are known as distribution generators (DG) sets [3,4]. Main advantages with the distribution generators are (i) Public investment is encouraged to maintain the increased demand which the power companies may find difficult. Hence the investment is reduced. (ii) New generation techniques may lead to ecological advantages and higher utility profits. (iii) Load on the transmission networks is reduced which may improve voltage stability. (iv) Real and reactive power losses in the network (transmission and distribution) are reduced. (v) Reliability of distribution system is increased. Advantages are not without problems. Parallel operation of DG sets with distribution network poses operational, control and managerial problems.

Large amount of research efforts have been made in past for probabilistic assessment of generating and transmission system but very few research efforts have been devoted for adequacy assessment of distribution system accounting deregulation [5,6]. Hence this paper addresses probabilistic nature of operation of distribution system accounting the customer controlled distribution generator sets, which operates in parallel with distribution substations. The power company knows the locations and capacities of such DG sets. However availability and unavailability of such DG sets is dictated by consumer. Various customers have different strategies for operating their DG sets and accordingly the process

* Corresponding author. Tel.: +91 9827757938.
E-mail addresses: ldarya@rediffmail.com (L.D. Arya), lstitare@yahoo.co.in (L.S. Titare), dpk0710@yahoo.com (D.P. Kothari).
[1] Tel.: +91 9425955534.
[2] Tel.: +91 9443311334.

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