

Influence of Distributed Generation Penetration Level On Performance Indices of Unbalance Radial Feeder

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Abstract—A stochastic performance analysis is a useful tool for an unbalance distribution feeder having voltage deepened load characteristics under deregulated environment. As the planning, smooth operation, and distributed generation (DG) integration aspects of an unbalance distribution feeder affected by the DG penetration level and may have a favorable or adverse impact on feeder performance. Therefore a cautious analysis to assess the impact on feeder performance with a reasonable penetration level of DG is required. The proposed strategy has been implemented on a modified IEEE 37 feeder having stochastic static ZIP load models. A constant power (PQ) model of distributed generation integrated with above feeder to simulate penetration of DGs with three different scenarios for 24 hours. These scenarios have different penetration level and DG locations with diverse DG capacity frameworks. The outcome has demonstrated the adequacy of the DG penetration levels under time varying scenarios.

Keywords—performance indices; stochastic performance; unbalance load flow; pq distributed generation.

I. INTRODUCTION

A deregulated environment has been constrained the power utilities to upscale feeder performance by utilizing distributed generation (DG) integration, which is a framework for smart grid implementation on the distribution system. A DG penetration level has impacted on voltage profile, power flow directions, reliability and fault level of an existing network. Thus the impact of DG penetration level on feeder performance needed an investigation before physical deployment of DG integration on the feeder.

A transient voltage rises analyzed by considering three different penetration level situations for an IEEE 37 feeder, which is integrated with constant power DG models [1]. In lieu of a weak financial status of utilities, feeder optimal utilization with DG integration is the most desirable option to mitigate power shortages with flexibility, sustainability and reliability concerns. But the feeder operational and constructional aspects limit the expected DG penetration level. Jian Liu and H. D. Chiang proposed a feeder reconfiguration based approach to fortify the maximum allowable DG perforation and loading in a stochastic pattern [2]. Seyed Hossein Hashemi et al., has revealed the critical role of a DG location for an unbalanced feeder by utilizing voltage profile, imbalance in voltage and losses [3]. To evaluate the impact of uncertainty in DG unit outputs, an analysis is carried out and

found very useful to all stakeholders of utilities. Eman Kaddah et al., has taken uncertainties of the DG outcome to know the behavior of an IEEE 34 feeder with the help of “Electrical Transient Analyzer Program (ETAP)” [4]. P. Juanuwattanukul, and M. A. S. Masoum employed a positive-sequence voltage ratio and Vcollapse/Vno-load based approach to place DG units and shunt capacitors separately. DG penetration level impact on voltage profile, losses and voltage stability margin are analyzed by evaluating voltage, losses and voltage security margin in the presence of DG units [5].

The impact of both voltage regulators on the substation and penetration level of DG units studied in terms of voltage profile and system power losses for various IEEE test feeders having ZIP unbalance loads [6]. A stochastic methodology tested on LV grids to evaluate the impact of PV-DG penetration levels on load matching, voltage levels and network losses [7]. As the steady state voltage rise constrained by the degree of DG penetration level. H. M. Ayres et al., proposed an index to impose a penalty / reward against voltage violations in a multi-DG system [8].

J. P. Sharma, and H.R. Kamath has developed performance indices to know feeder loss, substation reserve capacity, branch overloading, power factor, and voltage quality aspects. These indices evaluated for the whole day with 15 minutes metering time interval [9]. The concern of this analysis is to evaluate feeder performance indices in the presence of DG with different penetration level.

II. PROBLEM STATEMENT

In all three DG integration scenarios, constant power (PQ) DG models at unity power factor integrated and these scenarios depicted in table 1 [1]. The substation transformer capacity is taken as 2.5 MVA.

The scenario-1 have 10% penetration level with ten different 2.50 KW sizing PQ DG model at arbitrarily chosen node as shown in table 1. In scenario-2, a 15% penetration level considered with two different cases of DG case 2 (a) and DG case 2 (b). The size of heavy DG as mentioned in table 1 is taken as 375 KW, which is 90% of substation transformer capacity. The rest of nine nodes have each 4.16 KW DG capacity and sum total of these nine nodes DG capacities is 10% of substation transformer capacity. A maximum 38% penetration level is considered in scenario-3 and this