Impact of Distributed Generation on System Stability using PV Curve

Shraddha Sureshkumar Dhoot
ME (EPS)- Student
SSGMCE, Shegaon
SGBAU

Ravishankar Kankale
Assistant Professor
SSGMCE, Shegaon
SGBAU

Abstract – There has been growing concern in distribution system regarding impacts of distributed generation (DG) specifically on voltage stability. The key purpose of this paper is to estimate the voltage stability of power systems with increased level of distributed generation resources based on PV curve. In this technique, the stability of power systems is evaluated with increased penetration level of distributed generation resources. The ultimate objective of this paper is studying the impacts of DG units under diverse Penetration level on few problems such as voltage stability, voltage profile, power flow and PV curve for each bus. In this paper IEEE 14 bus system is simulated in PSCAD and load flow is done in MATLAB.

Index Terms - distributed generation(DG), voltage stability, PV curve, penetration level.

I. INTRODUCTION

In the recent past, one of the problems that received wide attention among utilities is the voltage instability [2]. The integration of distributed generation (DG) to power system networks has quickly increased from renewable-energy sources. This increase can be clarified by elements such as environmental concerns, the growth of electricity businesses, the advance of technologies, goals related to emission reduction, energy independence, improved infrastructure reliability and so on [3].

The voltage stability of a DG integrated grid usually depends on the capacity, the control strategies and the interconnected locations of the DGs [5]. DG units have a small size compared to central power plants so the impact is slight if the penetration level is low (1% - 5%). If the penetration level of DG is increased to 20%-30% of the level, the impact of DG units will be deep [8]. The energy structure of the grid will change if DG penetration increases it affects the grid voltage, power quality and the operational planning [3], among which voltage stability problem is an important aspect. The voltage stability is concerned with the capability of a power system to sustain suitable voltages at all nodes in the system under normal condition and after being subject to a disturbance. Careful engineering can eliminate these adverse impacts that DG penetration could impress on the electric delivery system [4]. We say power system has a state of voltage instability when a disturbance causes a progressive and uncontrollable decrease in voltage level. The size, the technology and the placement of DG play an important role in the operation of distribution systems. For long-term voltage stability analysis, bus-based voltage indices are implemented using Power-Voltage curves (PV curves) to analyze the contribution of DG.

II. VOLTAGE STABILITY

Fig. 1 shows a typical PV curve. Voltage stability problems mainly occur when the system is heavily stressed beyond its capability. While the disturbance leading to voltage collapse may be initiated by a variety of causes, the main problem is the inherent weakness in the power system. Mostly, the P-V curves are used in order to forecast the voltage security. P-V curves are most considerable method to find active power margin and are used to determine the loading margin of a power system. The load of power system is gradually increased and at each increment it is necessary to recomputed power flows until the nose of the PV curve is reached [6].
They are obtained by applying a continuous power flow method [6]. The critical point \( P_{\text{max}} \) in the P-V curve represents the maximum loading of a system. The stability margin is defined as the MW distant from the operating point to the critical point. The penetration of the DG units in a distributed system may increase or decrease the voltage stability margin subject on their operation at unity, lead or lag power factors [3].

III. SELECTION OF THE CANDIDATE BUSES

The buses for DG installation can be selected by calculating voltage stability indices. The base which has the lowest voltage (sensitive base to the voltage stability) is selected as candidate bus. Since this study is focusing on improving the voltage stability of the system, it uses voltage sensitivity analysis to select the buses. Additionally, it should be located in the main feeders of the system. The method is conducted by testing the voltage sensitivity to the change of the DG injected power. The DG units are then modelled as PQ buses, since they are not used to control the system voltage [2]. In this case, it can be used to study the impact of the DG units on voltage stability, voltage profile, power flow and P-V curve.

IV. SYSTEM UNDER STUDY

IEEE standard 14 bus system is taken as system under study, its single line diagram is as shown in Fig. 2. It consists of 14 buses, 20 branches, 2 generation buses, 3 compensator, 11 load buses, total generation of 272.4 MW and 78.5 MVAR, total load of 259MW and 73.5 MVAR.
Fig. 4 PV curve of bus 4 without dg (blue curve) and with DG of (a) 2MW (green curve) and (b) 5MW (red curve).

Fig. 5 PV curve of bus 5 without dg (blue curve) and with DG (a) 2MW (green curve) and (b) 5MW (red curve).

Fig. 6 PV curve of bus 11 without dg (blue curve) and with DG (a) 2MW (green curve) and (b) 5MW (red curve).

Fig. 7 PV curve of bus 12 without dg (blue curve) and with DG (a) 2MW (green curve) and (b) 5MW (red curve).

Fig. 8 PV curve of bus 13 without dg (blue curve) and with DG (a) 2MW (green curve) and (b) 5MW (red curve).

Fig. 9 PV curve of bus 14 without dg (blue curve) and with DG (a) 2MW (green curve) and (b) 5MW (red curve).
2. MATLAB RESULTS:
Continuation power flow method is used to plot PV curve in MATLAB. The general principle behind the continuation power flow is quite simple. It works on a predictor-corrector scheme to find a solution path. It adopts locally parameterized continuation technique. It comprises load

Fig. 10  PV curves of all 14 buses without DG in PSCAD

Fig. 11  PV curves of all 14 buses with DG of 2MW connected in PSCAD

Fig. 12  PV curves of all 14 buses with DG of 5MW connected in PSCAD

Fig. 13 PV curve of bus 8 without dg (blue curve) and with DG (a)2MW (green curve) and (b)5MW (red curve)

Fig. 14 PV curve of bus 9 without dg (blue curve) and with DG (a)2MW (green curve) and (b)5MW (red curve)

Fig. 15 PV curve of bus 10 without dg (blue curve) and with DG (a)2MW (green curve) and (b)5MW (red curve)
parameter, step length for load parameter and state variable. Continuation power flow finds successive load flow solutions according to a load scenario. From a known base solution, a tangent predictor is used so as to estimate next solution for a specified pattern of load increase. The corrector step then governs the exact solution using Newton-Raphson technique employed by a conventional power flow. After that a new prediction is made for a definite increase in load based upon the new tangent vector. Then corrector step is applied. This process goes until critical point is extended. The critical point is the point where the value of tangent vector is zero.

**VI CONCLUSION**

This paper work emphases on analysing voltage stability, voltage profile, power flow and the P-V curve of a system with integrate DG. From the above Fig. no 4 to Fig. no 12, it can be clearly seen that the voltage stability of the buses has been improved whereas it is decreased for bus 8, 9 and 10 refer fig.13, 14 and 15. The simulation results designate the maximum penetration level of the wind turbine units is commended to be placed in the most sensitive voltage buses in order to improve the voltage stability margin. As we go on increasing the DG, loadability increases. So, voltage profile of the buses may increase or decrease depending upon the placement, size and technology used. The technique for continuous load flow has been applied to determine the PV curves of the 14-node IEEE test system, and it has been shown that a 4.545% load increment can lead to the instability of the system, and it also has been determined that the node 14 is the weakest node of the system.

**Table I: Impact of DG on maximum loading point**

<table>
<thead>
<tr>
<th>DG (%)</th>
<th>Lodability (predictor)</th>
<th>Lodability (corrector)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0%</td>
<td>4.05</td>
<td>4.043</td>
</tr>
<tr>
<td>10%</td>
<td>4.418</td>
<td>4.408</td>
</tr>
<tr>
<td>20%</td>
<td>4.418</td>
<td>4.408</td>
</tr>
<tr>
<td>30%</td>
<td>4.507</td>
<td>4.494</td>
</tr>
<tr>
<td>40%</td>
<td>4.55</td>
<td>4.537</td>
</tr>
<tr>
<td>50%</td>
<td>4.566</td>
<td>4.545</td>
</tr>
<tr>
<td>60%</td>
<td>4.545</td>
<td>4.53</td>
</tr>
<tr>
<td>70%</td>
<td>4.507</td>
<td>4.492</td>
</tr>
<tr>
<td>80%</td>
<td>3.765</td>
<td>3.765</td>
</tr>
</tbody>
</table>

**REFERENCES**


[9] Nguyen Tung Linh, Trinh Trong Chuong, “VOLTAGE STABILITY ANALYSIS OF GRIDS CONNECTED WIND GENERATORS”. 