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# Impact of Distributed Generation on Voltage Stability

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***Abstract-***The key purpose of this paper is to estimate the voltage stability of power systems with increased penetration level of distributed generation resources based on PV curve. In this technique, the stability of power systems with increased penetration level of distributed generation resources evaluated. The ultimate objective of this paper is studying the impacts of DG units under diverse Penetration level on some 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.

***Keywords-*** *distributed generation(DG),voltage stability, PV curve, penetration level.*

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## I. INTRODUCTION

Distributed generation is the direction of future power industry. Integration of distributed generation (DG) can improve reliability, decrease power losses, improve power quality, reduce environmental pollution and shrink the need for network expansions. The increasing penetration of power generation from renewable energy sources and the transition from a centralized power production model to distributed generation are expected to pose serious challenges to the development and operation of future power systems. DG includes generation from biomass, biogas, solar power, wind power, and geothermal power. Wind energy is considered as the most widely used clean renewable energy. Distributed wind turbines(WT) are connected to the grid as distributed power sources and have brought significant impact on the system power flow distribution, voltage level and transmission loss. Since the wind power penetration into the grid increases quickly, the influence of wind turbines (WT) on the power quality and voltage stability is becoming more and more important [3].

## II. VOLTAGE STABILITY

Voltage stability is an important issue in power quality. A whenever there is a progressive or uncontrollable drop in voltage magnitude after a disturbance, increase in load demand or change in operating condition, system experiences a state of voltage instability. The main factor, which causes these insupportable voltage profiles, is the inability of the distribution system to meet the demand for reactive power. Under normal operating conditions, the bus voltage magnitude (V) Increases as Q injected at the same bus is increased. When V of any one of the system's buses decreases with the increase in Q for that same bus, the system is said to be unstable. The impact of voltage instability can be wide spread as it depends on the relationship between transmitted P, receiving end V and injected Q.

Voltage stability analysis has been presented by many techniques, including static and dynamic [3].This analysis is mainly conducted to predict the point of voltage collapse using the proposed relation between the receiving power (P) and the voltage (V) at a certain bus in the system which is known as P-V curve or nose curve. The P-V curve is obtained by applying a continuous power flow method. It is performed on a standard IEEE 14 bus radial system. The data for this system is provided in [6]

## III. PV CURVES

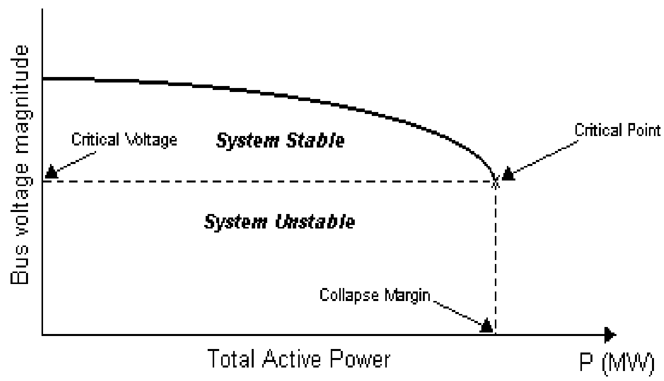


Fig. 1 Characteristics of typical P-V curve

By sketching PV curves the connection between transmitted P and receiving end V is of interest. The voltage stability analysis procedure involves the transfer of P from one region of a system to another, and observing the effects to the system voltages, V. This type of analysis is generally referred to as a PV study. The Fig 1 shows a typical PV curve. It represents the deviation in voltage at a particular bus as a function of the total active power supplied to loads or sinking areas [1]. It can be seen that at the "knee" of the PV curve, the voltage drops rapidly when there is an increase in the load demand. Load flow solutions do not converge beyond this point, which indicates that the system has become unstable. This point is called the Critical point. Hence, the curve can be used to determine the system's critical operating voltage and collapse margin. Commonly, operating points above the critical point signifies a Stable system. If the operating points are below the critical point, the system is diagnosed to be in an unstable condition. The P-V curves are the most-used method of estimating voltage security. They are used to determine the

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loading margin of a power system. The power system load is gradually increased and, at each increment, is necessary recomputed power flows until the nose of the PV curve is reached [5].

## IV. Impact of Increased Penetration Level of DG on Voltage Stability

To study the impacts of penetration we have placed the DG on bus no 5.The candidate buses for placement of DG is so selected that it should have impact on the other buses. The change in the installed capacity should have impact on the voltage profile of other buses because the study is related to the improvement of the voltage profile.

## V. System under Study

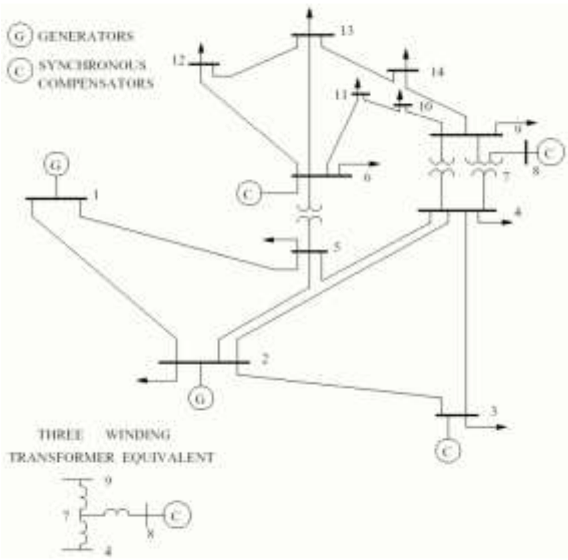


Fig. 3 Single line diagram of IEEE 14 bus system [6].

Fig. 3 shows one line diagram of standard IEEE 14 bus system. We are going to place DG of different sizes on this system and by changing load on the bus. Whereas Fig. 4 shows the simulation of standard IEEE 14 bus system in PSCAD.

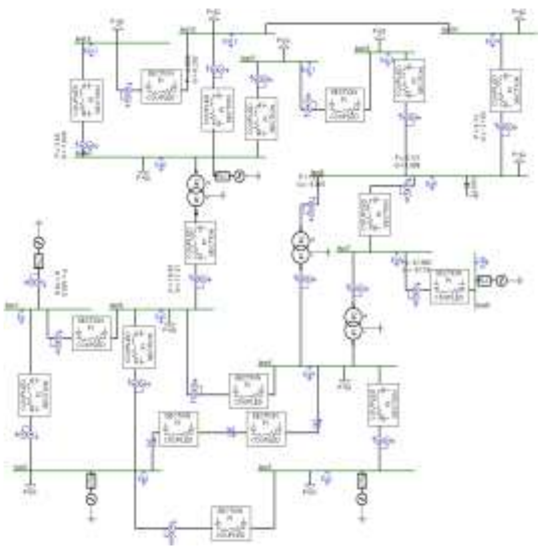

Fig. 4 Simulation of IEEE 14 bus Test system model during Normal condition in PSCAD.

## VI. RESULTS

For evaluating the impacts of DG we have compared three cases.

a) We have drawn PV curve for the system without any type of DG
b) With DG of value 2MW connected
c) With DG of value 5MW connected

Initially we have chosen a candidate bus, on which we connected load. We have to note the different reading at different value of the loads. Graph (a) is plotted without adding any kind of DG or the generating capacity to the selected bus. To candidate bus, attach the DG of the required value. Then by changing the load connected of candidate bus we take the respective reading and plot the PV curve for different capacity value 2MW and 5MW.

Fig. 5 denotes the PV curve of bus no 5. Whereas fig. 6 and fig. 7 denotes PV curves of bus 11 and bus 12 respectively. Table 1 clearly shows that voltage stability is impoved as the Dg is connected, and so the maximum lodability is changed. It should be noted that the value of DG should be greater so as to see the results. If we keep value upto 5 to 10% then its impact is negligible.

Curve with blue colour shows PV curve without DG, it can be clearly seen that when DG is connected the PV curve is shifted upward refer Fig. 5. Which clearly shows voltage stability depends upon the DG penetration level.

Table 1. Value of Voltage at each Base with Different DG Size

| | Without DG | With DG OF 2MW | With DG of 5MW |
|---|---|---|---|
| Voltage of Bus1 | 1.0626 | 1.0626 | 1.0626 |
| Voltage of Bus2 | 1.0466 | 1.0466 | 1.0466 |
| Voltage of Bus3 | 1.0115 | 1.0115 | 1.0115 |
| Voltage of Bus4 | 1.0168 | 1.0041 | 1.0042 |
| Voltage of Bus5 | 1.0197 | 1.0120 | 1.0120 |
| Voltage of Bus6 | 1.0716 | 1.0716 | 1.0716 |
| Voltage of Bus7 | 1.0523 | 1.0291 | 1.0292 |
| Voltage of Bus8 | 1.0911 | 1.0911 | 1.0911 |
| Voltage of Bus9 | 1.0358 | 0.9979 | 0.9980 |
| Voltage of Bus10 | 1.0346 | 0.9635 | 0.9636 |
| Voltage of Bus11 | 1.0493 | 1.0069 | 1.0070 |
| Voltage of Bus12 | 1.0551 | 1.0530 | 1.0532 |
| Voltage of Bus13 | 1.0488 | 1.0418 | 1.0418 |
| Voltage of Bus14 | 1.0232 | 0.9980 | 0.9981 |

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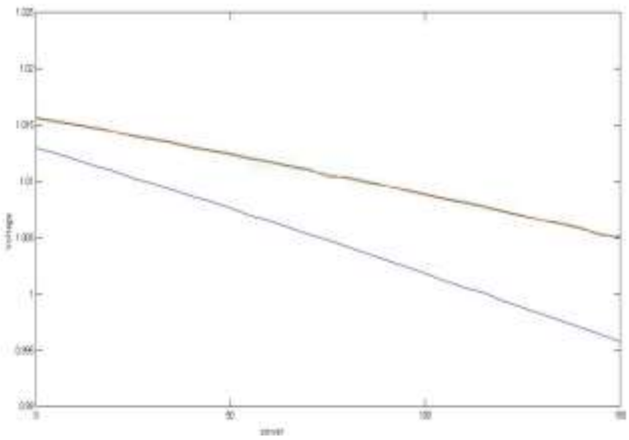

Fig. 5 Bus no 5 plot without Dg ,with dg 0f 2MW and 5MW

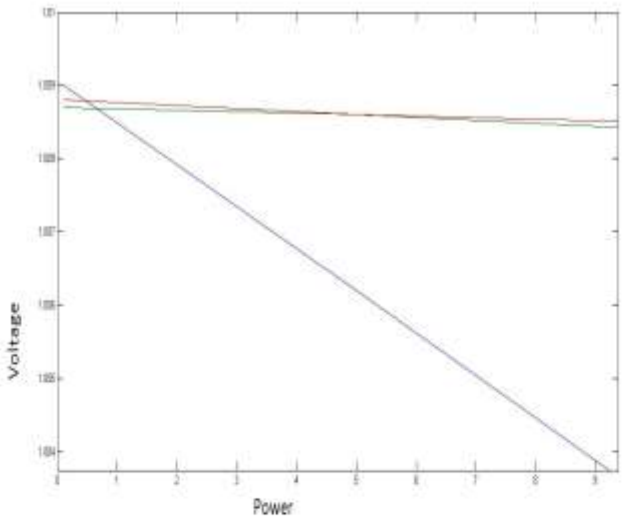


Fig. 6 Bus no 11 plot without Dg ,with dg 0f 2MW and 5MW

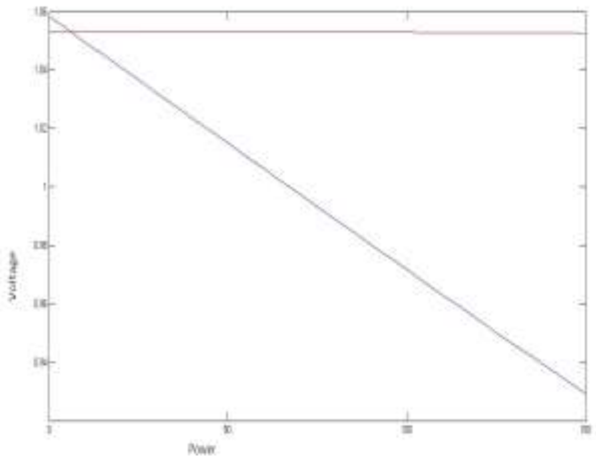

Fig. 7 Bus no 12 plot without Dg ,with dg 0f 2MW and 5MW

## VII. CONCLUSION

These paper work emphases on analyzing voltage stability, voltage profile, power flow and the P-V curve of a system with integrate wind turbine. From the above curves it can be clearly seen that the voltage stability of the buses has been improved. 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.

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