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# Enhanced Loadability and Inapt Locations

**Shilpa Kalambe, Sanjay Jain , Deepak Verma**

***Abstract*: *Inclusion of Distributed Generation in the power system facilitates many features like voltage profile correction, improvement of power factor, network reliability, loadability enhancement that improve the performance of the system. Vast increase in the energy requirements to cope up with emerging trends in the community, all types of loads like residential, commercial, Industrial etc demands network up gradation. The urgency of network restructuring may be differed by an appropriate deployment of Distributed Generation in the system. Whereas, it is found that improper allocation of DGs may also degrade the system performance due to increased power losses, declined voltage profile etc. Thus, now a day's network operators are paying wide attention towards appropriate DG allocation. This paper introduces a Modified Transmission Parameters Method considering the loss minimization as a constraint, for Siting and Sizing the Distributed Generator (DG) for installation in Distribution System based on Two Port Transmission Equations. It demonstrates an implication of Distributed Generator in power system to attain the enhanced system loadability. It also analyses the number of buses swept up from the competition of being an optimal location for DG allocation. Thus, it can be said that the proposed method facilitates enhanced ability of the system to sustain load expansion without network upgrades along with evaluation reduced candidate locations for DG installation called as 'Inapt Locations'.***

***Keywords* : *Distributed Generator, Lodability, Inapt Location power loss,***

## I. INTRODUCTION

Distribution system with DG imposes a different set of operating conditions on the network, may be desirable or adverse which depends on the network structure [1]. The desirable operating conditions flourish the DS with improved performance environment as well as cost effective system management. Conversely, the adverse operating conditions decline the system performance along with reduction of reliability levels imposing the penalties on the Distiribution Network Operators (DNOs) in terms of system with poor power quality, poor power factor, increased system losses, declined stability etc. These detrimental circumstances necessitate DNO's to enumerate properly the impacts of DG installation on system efficiency. The Modified Transmission Parameters (MTP) Method introduced in this paper facilitate the inspection of optimal designing parameters of DG to be installed in the DS. It also enables the system to attain enhanced loadability and investigation of Inapt Locations. These auxiliary utilities assist the methodology to proliferate the system with enriched solution environment.

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## II. PROPOSED METHODOLOGY

### A. Modified Transmission Parameters (MTP) Method

Consider a radial distribution system with G1, G2,...... Gm generator buses and L1, L2,...... Ln load buses. For a given system the two port transmission equations are;

$$V_1 = A\,V_2 - B\,I_2 \quad (1)$$

$$I_1 = C\,V_2 - D\,I_2 \quad (2)$$

The above equations can also be written as;

$$[V_G] = [A][V_L] - [B][I_L] \quad (3)$$

$$[I_G] = [C][V_L] - [D][I_L] \quad (4)$$

Where VG, IG, are generator and VL, IL load voltages and Currents respectively. Rearranging and solving the equations (3) and (4) we will get,

$$V_L/V_G = [A]^{-1} \quad (5)$$

But the value of matrix [A] in terms of Z-parameters is

$$[A] = [Z_{11}/Z_{21}]$$

So, $[A]^{-1} = [Z_{11}/Z_{21}]^{-1} = [Z_{21}][Z_{11}]^{-1}$ (6)

$= [Z_{LG}][Z_{GG}]^{-1}$ (7)

[ZGG] & [ZLG] are corresponding partitioned portions of network Zbus matrix. This matrix may be defined as Impedance Loss Factor (ILF) having dimension L×G.

Thus, $ILF \leq 1$ (8)

The columns and rows of ILF matrix correspond to the generator and load bus numbers respectively. Higher the value of this factor lower will be the loss occurred across the path between respective generator and the load bus to which it will feed the power. Thus this matrix can directly give the proportion of power which should be supplied by each source present in the system to individual load so as to accomplish the total demand with maximum efficiency.

### B. Optimal Loss

By rearranging equation (3), we will get,

$$[V_L] = [A]^{-1}[V_G] + [A]^{-1}[B][I_L] \quad (9)$$

But, $[A]^{-1} = [Z_{LG}][Z_{GG}]^{-1}$

and for simplicity we use the value of $[A]^{-1}[B]$ in terms of Ybus matrix

So, $[A]^{-1}[B] = [Y_{LL}]^{-1}$

So that the final form of equation will be

$$[V_L] = [Z_{LG}][Z_{GG}]^{-1}[V_G] + [Y_{LL}]^{-1}[I_L] \quad (10)$$

Where,

$[Y_{LL}]^{-1}_{L\times L}$ = Corresponding partioned portion of Ybus matrix.

$[V_L]_{L\times 1}$ = Column matrix of load voltages.

$[V_G]_{G\times 1}$ = Column matrix of generator voltages.

$[I_L]_{L\times1}$ = Column matrix of load currents.

Now pre-multiply the above matrix by diagonal matrix [IL] of load currents with dimension L× L we get,

$$[I_L][V_L] = [I_L][Z_{LG}][Z_{GG}]^{-1}[V_G] + [I_L][Y_{LL}]^{-1}[I_L]$$

i.e.

$$[I_L]_{L\times L}[V_L]_{L\times1} = [I_L]_{L\times L}[A]^{-1}_{L\times G}[V_G]_{G\times1} + [I_L]_{L\times L}[Y_{LL}]^{-1}_{L\times L}[I_L]_{L\times1} \quad (11)$$

It will give the power consumed in load which can also be obtained by subtraction of total transmission power losses from the total power supplied by generators, thus we can say

Power consumed in Load $= [P_{Load}]_{L\times1} = [I_L][V_L]$ (12)

Power Supplied From Generators $= [P_G]_{L\times1} = [I_L][A]^{-1}[V_G]$ (13)

Transmission Power Losses $= [P_{Loss}]_{L\times1} = [I_L][Y_{LL}]^{-1}[I_L]$ (14)

Thus we can use the term of transmission power losses given by equation (14) to calculate the total power losses encountered for different structures of power system. In this paper author has used this equation to calculate the power losses in the distribution system for different locations of DG placement apart from this without any separate calculations, the same equation has been also used to calculate the Capacity, Operating Power Factor and Type of DG which should be included in the power system to achieve minimum losses.

### C. Algorithm for Proposed Method

For finding the optimal location, optimal capacity at that location, Operating Power Factor as well as Type of the DG to be installed following algorithm should be followed.

1) For the given test system without DG run the Load Flow and find out the voltage at each bus as well as calculate the total losses.

2) Select next bus as a DG location and consider the remaining buses (except original generator sources & the load bus on which DG is installed) as load buses.

3) Now run the load flow for the case with DG installed at new position and find out the voltage at each bus.

4) By applying equation number (13) calculates both active as well as reactive power losses.

5) Now select all next buses individually as DG location & repeat the steps from 2-4.

6) Rank the buses in ascending order as per the amount of losses encountered at that location.

7) Consider the top ranking bus as the best location for DG installation.

8) Then calculate the optimal capacity of DG to be installed at optimal location from equation (13).

Figure 1) shows the flowchart for the proposed algorithm.

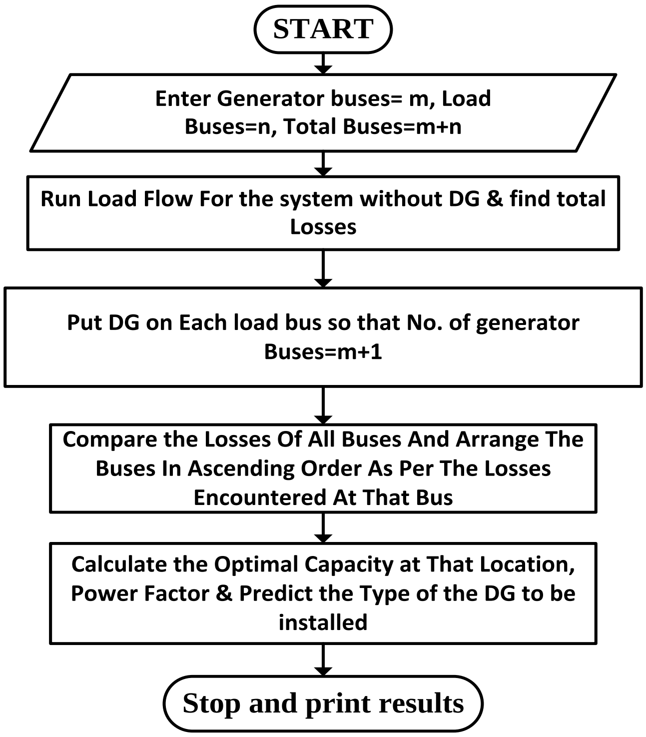


**Fig. 1.Flow-Chart For Obtaining Optimal Location, Optimal Size At That Location, Operating Power Factor As Well As Type Of The New DG To Be Installed In The Existing System To Minimize The Losses By MTP Method.**

### D. *Enhanced Loadability*

System loadability depends on the reactive power support provided to the system. The reactive power support is accompanied with the system voltage as well as the critical bus voltage correction. Placement of DG with appropriate size at an apt location can reduce the power flows in the significant portion of the system. Consequently, reduces the I2R losses accompanied by the considerable correction in the voltage profile of the system as well as critical bus. The proposed method incorporates the indices, which indicates the percentage of system voltage as well as critical bus voltage improvement with the addition of the DG. Therefore, DG insertion at an optimal location with optimal size and type suggested by proposed method can provide the maximum possible voltage profile correction of system and critical bus, which ensures the enhanced reactive power support provided to the system. Therefore, the loadability of the system increases with an increase in the reactive power support attained with DG addition. Static voltage stability in a power system can be analyzed using P–V curve. The voltage collapse point in this curve represents the maximum loading of the system. To investigate the enhancement in the maximum loading of the system with DG addition, the PV curve is obtained by gradually increasing active and reactive load of the system as given by the following equations,

$$P_{Load,i} = P_{L0,i}(1+\alpha\Delta P_{Load}) \quad (15)$$

$$Q_{Load,i} = Q_{L0,i}(1+\alpha\Delta Q_{Load}) \tag{16}$$

Where, α 0, 1, 2, 3,………
i critical bus

The value of α is increased until the voltage collapse point is attained. The DG addition at an appropriate location and size can delay the voltage collapse point to occur because of enhanced voltage stability limit of the system.

DG allocation planned according to the proposed method improves the system as well as critical bus voltage profile. Therefore, the enhanced loadability without system up gradation is possible. To demonstrate this trait of the proposed methods following studies are performed on 33 bus [2] and 69 bus [3] system.

As given in Table 1, in 33 bus system MTP method suggests bus 6. Thus to verify the enhanced lodability attained by proposed methods, DG is installed at bus 6 and system stability is studied.

### E. Investigation of Enhanced Loadability by Installing DG at an Optimal Location with Optimal Design and Type Recommended By MTP Method

In this case, initially the load of critical bus of the system without DG is gradually increased until the voltage reaches to a critical value called as $V_{CRw/oDG}$, beyond which the further increment of load will make the system unstable. Critical voltage, $V_{CR}$ can be defined as the minimum permissible voltage beyond which system may collapse. The load at which the system becomes unstable or voltage collapses is called as the critical load, $P_{CRw/oDG}$.

In this case, as per the MTP method, Type 3 DG of 3.22 MVA operating at 0.82 power factor is installed at bus 6 of 33 bus system and a Type 1 DG of 2.37 MVA operating at 0.86 power factor is installed at bus 61 of 69 bus system. Thereafter the load of critical bus is again gradually increased from its initial value up to a critical value, $P_{CRDG}$ at which the voltage reaches the critical point, $V_{CRDG}$. Then the difference between PCRw/oDG and $P_{CRDG}$ indicates the maximum limit of load expansion denoted by ΔPE. Similarly the difference between $V_{w/oDG}$ (operating voltage of the P-V curve without DG) and $V_{DG}$ (operating voltage of the P-V curve with DG), indicates the Voltage Gradation, ΔVG (at that operating point) attained after successful and beneficial DG addition in the system.

Figures 2 and 3 reflect that in both the systems the significant load expansion is possible with DG installed at optimal location with the optimal designing parameters suggested by MTP method as indicated in Table I.

Table II, indicates various parameters expressing the enhanced loadabilty of both the systems attained after DG insertion. In 33-bus system, 54.78% of load expansion with 8.24% of voltage gradation is possible by the DG addition whereas in 69-bus system 25.54% of load expansion is attained with 6.81% of voltage gradation at initial value of load.

### F. Loadability Investigation by Installing DG at an Optimal Location and Examination of Impact of Load Models on It

Efficacy of proposed model in optimal DG location inspection in terms of enhanced loadability is demonstrated and an impact of various voltage dependent load models on the system losdability is investigated. The load of critical bus is increased gradually from its initial value up to $P_{CRw/oDG}$ until voltage reaches the value, $V_{CRw/oDG}$ after which the voltage collapses. Then the DG is installed in the system with constant load models. As shown in Table III, the load of critical bus is again increased gradually from its initial value up to $P_{CRDG}$ until voltage reaches the value, $V_{CRDG}$ after which the voltage collapses. Subsequently, ΔPE, ΔVG and the corresponding load expansion as well as voltage gradation percentage are evaluated. The process is repeated for the entire system configuration with various load models and the corresponding changes in loadability enhancement is studied.

Fig. 4 depicts that voltage dependency of the loads shows increased percentage of load expansion as compared to constant load model. All the voltage dependent load models show similar pattern of P-V curves whereas constant power load model shows significant change in the stability parameters as well as P-V curve pattern. Fig. 5 shows the similar variations in P-V curve with voltage dependent and constant load assumption in 69 bus system.

Results furnished in Figures 4 and 5 indicate that a significant variation in the P-V curves can be observed with the constant and voltage dependent load model assumptions. The summary of results obtained in this case from the PV curves given in these figures for different load models is presented in Table III. It indicates that load model plays a key role in designing as well as in forecasting the operational conditions of DS after DG insertion.

### G. Inapt Locations

The selection of the best places for installation and the preferable size of the DG units in large distribution systems is a complex combinatorial optimization problem. [4,5,6]. Many optimization techniques and methods are available in literature [7,8] to handle this complex problem. Most of the methods demand either iterative processes or excessive computations, which ultimately makes the problem time consuming and tiresome. The proposed method investigates not only an optimal access location but also furnishes an information about inappropriate locations called as Inapt Locations to site the DG. This subsidiary information may help the researchers to reduce the search space of this area.

### H. Significance of Inapt Locations

Inapt Locations are defined as the system nodes at which DG installation may create undesirable operating conditions such as reverse power flows, declined voltage profile etc. In this research such locations are categorized in to two classes such as;

- Adverse Impact locations (AILs) – buses at which if DG is installed, leads to declined system performance due to the adverse impacts imposed on the system in terms of increased system losses,

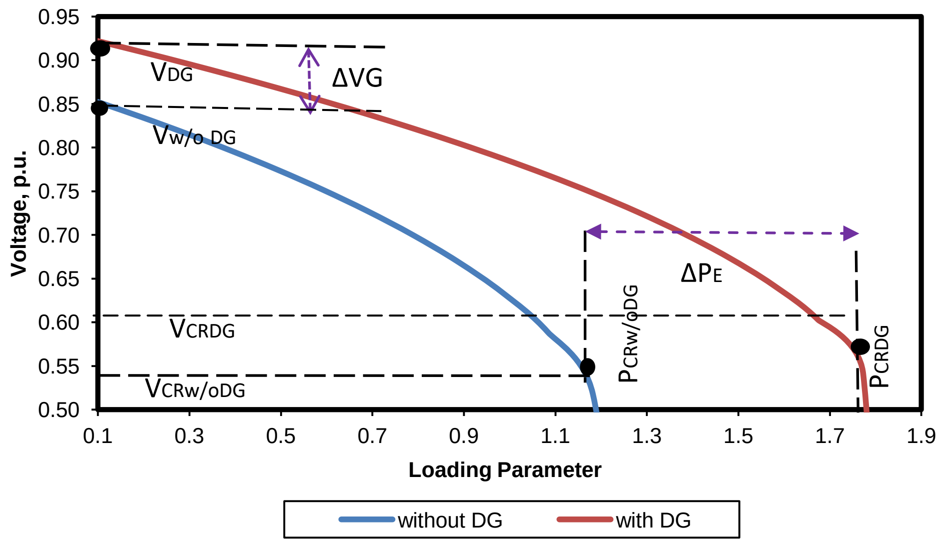


**Figure 2 P-V curves for 33 bus system**

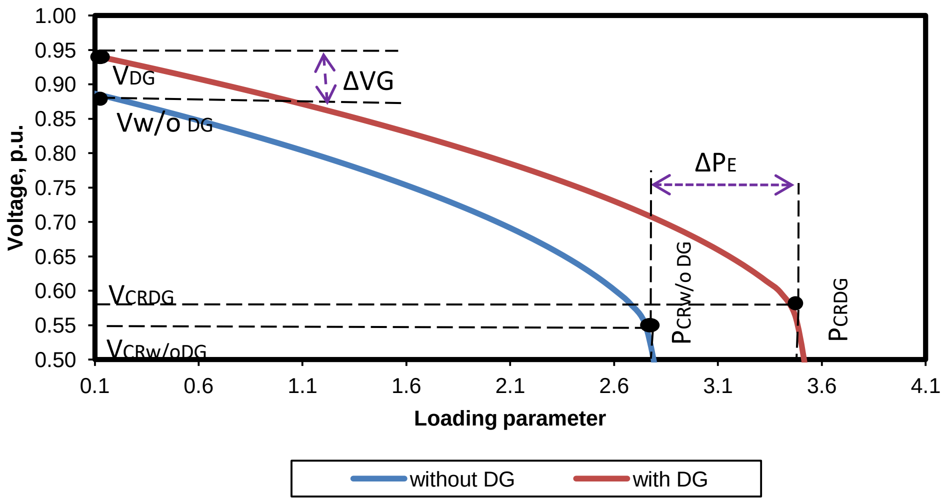


**Figure 3 P-V curve for 69 bus system**

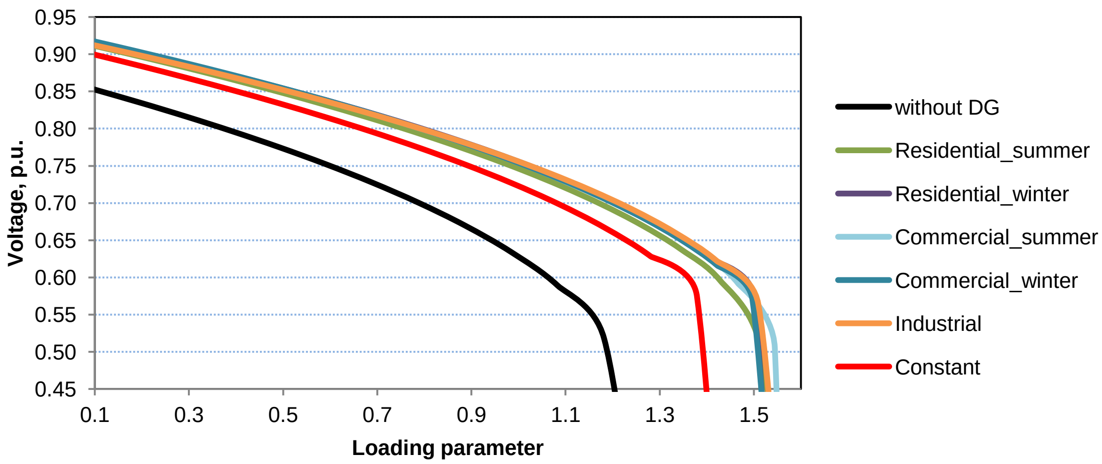


**Figure 4 Impact of load models on P-V curve (33 bus system)**

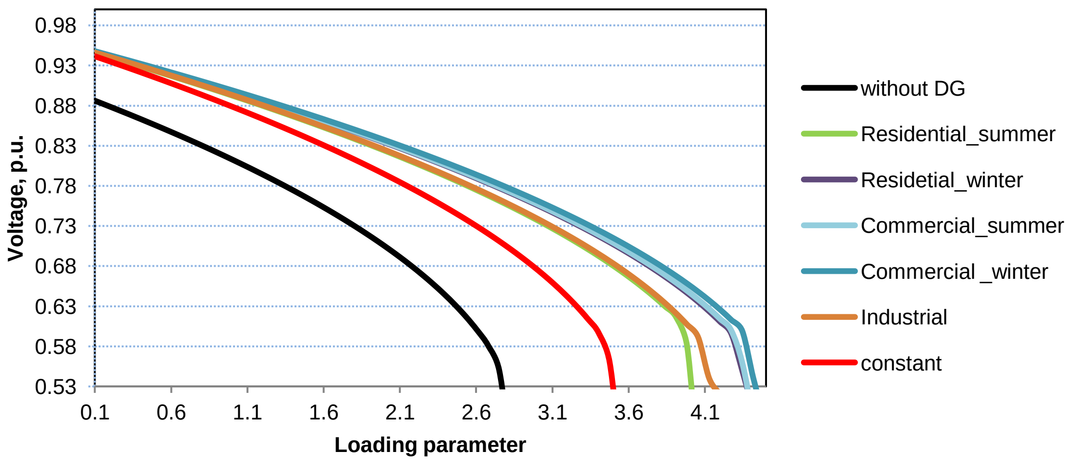


**Figure 5 Impact of load models on P-V curve (69 bus system)**

declined voltage stability and lower capacity release percentage of the main source i.e. substation.

- Consecutive bus (CB) [9] – bus which is immediately next to main sub-station.

## I. ADVERSE IMPACT LOCATIONS (AILS)

In the distribution system, DG cannot be installed at every bus. Some buses may found to be the bad locations for installing DG as incompatible selection of location and size of DG may lead to greater system losses or reduced voltage stability than that without DG [10] due to reverse power flows, such buses may be defined as Inapt Locations for DG installations. DG installation at an Inapt Locations imposes adverse impacts on distribution system. The reactive power indices developed in this research is used to investigate such locations. The function can identify incompatible locations from the complete system nodes. Negative or zero value of the indices obtained for the candidate locations indicates its incompatibleness for DG installation with respect to that index. Higher value of negative index indicates the severity of the adverse impact imposed by the DG installation at respective locations.

## J. CONSECUTIVE BUS (CB)

If DG is installed at the bus that is immediately next to main sub-station then approximately zero power will be shared from the substation and the total power will be delivered by the DG alone. Therefore high capacity DG is required to supply the power if placed at Consecutive Bus despite of that very less amount of loss minimization is possible from this location.

## III. RESULTS AND ANALYSIS

After implementation of MTP method, an optimal access location for DG insertion as well as inapt locations can be investigated. To demonstrate this attribute it is implemented on 33 bus and 69 bus systems and the summarized results are furnished in Table IV and V

Table 4 and Fig. 6 show that in 33 bus system, bus 2 is located next to main sub-station and after DG installed at this bus indicates that zero power will be shared from the substation and the total power will be delivered by the DG alone. Thus, bus 2 can be considered as an Adverse Impact location as well as Consecutive Bus.

Results furnished in Table V, show that in 69 bus system, bus 2 can be referred as the consecutive bus. Apart from this many buses (3, 4, 5, 28, 29, 30, 31, 32, 33, 34, 35, 45, 46, 47 and 69) show negative impact of DG allocation on the system and thus can be referred as AILs.

## IV. CONCLUSION

This paper explores efficiency of MTP method for efficient insertion of DGs in DS. It also exhibit two utilities of the proposed method. Enhanced loadability attained after DG insertion and the Inapt Location investigation. It also demonstrates the impact of load model assumptions on load expansion anticipation. It is observed that significant system load expansion is possible by DG insertion at an optimal location and design recommended by the MTP methods. Nonetheless, for accurate load expansion prediction proper load modeling is mandatory.

**Table-I: Optimal DG design suggested by the proposed method and proportional voltage profile correction**

| System | Method | State | $OL_{DG}$ | $OS_{DG}$, MVA | $OPF_{DG}$ | Type | Critical bus | Critical Bus Voltage |
|---|---|---|---|---|---|---|---|---|
| 33 bus | ---- | w/o DG | ---- | --- | --- | --- | 18 | 0.85 |
| | MTP | With DG | 6 | 3.22 | 0.82 | 1 | 18 | 0.92 |
| 69 bus | ---- | W/O DG | ---- | --- | --- | --- | 65 | 0.89 |
| | MTP | With DG | 61 | 2.37 | 0.86 | 1 | 65 | 0.94 |

**Table-II: Summarized parameters showing enhanced system loadabilty**

| System | $P_{CRw/oDG}$ | $P_{CRDG}$ | $\Delta P_E$ | % Load expansion | $V_{CRw/oDG}$ | $V_{CRw/oDG}$ | $V_{w/oDG}$ | $V_{DG}$ | $\Delta VG$ | % Voltage gradation |
|---|---|---|---|---|---|---|---|---|---|---|
| 33 bus | 1.15 | 1.78 | 0.63 | 54.78 | 0.54 | 0.57 | 0.85 | 0.92 | 0.07 | 8.24 |
| 69 bus | 2.78 | 3.49 | 0.71 | 25.54 | 0.55 | 0.58 | 0.88 | 0.94 | 0.06 | 6.81 |

**Table- III: Summarized parameters showing enhanced loadabilty of the system with constant and voltage dependent load models**

| System | Loadability Parameters | Constant | Residential | | Commercial | | Industrial | |
|---|---|---|---|---|---|---|---|---|
| | | | Summer | Winter | Summer | Winter | Summer | Winter |
| 33 bus | $P_{crw/oDG}$, MVA | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 | 1.2 |
| | $P_{crDG}$, MVA | 1.4 | 1.5 | 1.46 | 1.52 | 1.48 | 1.49 | 1.49 |
| | $\Delta P_E$ | 0.2 | 0.3 | 0.26 | 0.32 | 0.28 | 0.29 | 0.29 |
| | $V_{CRw/oDG}$, Volts | 0.54 | 0.54 | 0.54 | 0.54 | 0.54 | 0.54 | 0.54 |
| | $V_{CRDG}$, Volts | 0.6 | 0.55 | 0.56 | 0.55 | 0.6 | 0.6 | 0.6 |
| | $V_{w/oDG}$, Volts | 0.85 | 0.85 | 0.85 | 0.85 | 0.85 | 0.85 | 0.85 |
| | $V_{DG}$, Volts | 0.9 | 0.912 | 0.918 | 0.919 | 0.92 | 0.913 | 0.913 |
| | $\Delta VG$ | 0.05 | 0.062 | 0.068 | 0.069 | 0.07 | 0.063 | 0.063 |
| 69 bus | $P_{crw/oDG}$, MVA | 2.82 | 2.82 | 2.82 | 2.82 | 2.82 | 2.82 | 2.82 |
| | $P_{crDG}$, MVA | 3.45 | 4 | 4.3 | 4.29 | 4.25 | 4.12 | 4.12 |
| | $\Delta P_E$ | 0.63 | 1.18 | 1.48 | 1.47 | 1.43 | 1.3 | 1.3 |
| | $V_{CRw/oDG}$, Volts | 0.54 | 0.54 | 0.54 | 0.54 | 0.54 | 0.54 | 0.54 |
| | $V_{CRDG}$, Volts | 0.6 | 0.615 | 0.61 | 0.61 | 0.6 | 0.6 | 0.6 |
| | $V_{w/oDG}$, Volts | 0.88 | 0.88 | 0.88 | 0.88 | 0.88 | 0.88 | 0.88 |
| | $V_{DG}$, Volts | 0.943 | 0.947 | 0.949 | 0.949 | 0.949 | 0.948 | 0.948 |
| | $\Delta VG$ | 0.063 | 0.067 | 0.069 | 0.069 | 0.069 | 0.068 | 0.068 |

**Table-IV: Investigation of Inapt Locations in 33 bus system**

| Location | Active power loss, MW | Reactive power loss, MVAr | AIL | CB |
|---|---|---|---|---|
| w/o DG | 212.5 | 142 | --- | --- |
| 2 | 198.5 | 145.9 | √ | √ |
| 3 | 141.4 | 104.6 | --- | --- |
| 4 | 123.2 | 95.3 | --- | --- |
| 5 | 105.6 | 86.4 | --- | --- |
| 6 | 68.2 | 53.8 | --- | --- |
| 7 | 71.4 | 57.9 | --- | --- |
| 8 | 78.8 | 57.7 | --- | --- |
| 9 | 89.9 | 63.5 | --- | --- |
| 10 | 96.2 | 66.6 | --- | --- |
| 11 | 97.2 | 66.8 | --- | --- |
| 12 | 99.3 | 67.3 | --- | --- |
| 13 | 106.7 | 72.5 | --- | --- |
| 14 | 109 | 75.1 | --- | --- |
| 15 | 113.3 | 78.2 | --- | --- |
| 16 | 118 | 80.9 | --- | --- |
| 17 | 126.3 | 89.3 | --- | --- |
| 18 | 130.3 | 91.4 | --- | --- |
| 19 | 199.5 | 134.9 | √ | --- |
| 20 | 202.1 | 135.3 | --- | --- |
| 21 | 202.2 | 135.3 | --- | --- |
| 22 | 202.6 | 135.6 | --- | --- |

| | | | | |
|---|---|---|---|---|
| **23** | 154.2 | 112.1 | --- | --- |
| **24** | 160.3 | 113.9 | --- | --- |
| **25** | 167.4 | 117.3 | --- | --- |
| **26** | 69.3 | 54.2 | --- | --- |
| **27** | 70.4 | 54.7 | --- | --- |
| **28** | 70.8 | 53.8 | --- | --- |
| **29** | 68.6 | 50.5 | --- | --- |
| **30** | 68.8 | 53.3 | --- | --- |
| **31** | 79.5 | 58.9 | --- | --- |
| **32** | 83.5 | 62.4 | --- | --- |
| **33** | 90.1 | 70.1 | --- | --- |

**Table-V: Investigation of Inapt Locations in 69 Bus System**

| Locations | Active power | Reactive power | AIL | CB |
|---|---|---|---|---|
| **w/o DG** | 214.72 | 97.17 | --- | --- |
| **2** | 225.7 | 101.94 | √ | √ |
| **3** | 225.63 | 101.76 | √ | --- |
| **4** | 225.44 | 101.3 | √ | --- |
| **5** | 223.5 | 99.05 | √ | --- |
| **6** | 188.93 | 81.87 | --- | --- |
| **7** | 155.7 | 65.5 | --- | --- |
| **8** | 148.22 | 61.77 | --- | --- |
| **9** | 144.54 | 59.96 | --- | --- |
| **10** | 155.16 | 64.93 | --- | --- |
| **11** | 155.9 | 65.53 | --- | --- |
| **12** | 160.03 | 68.17 | --- | --- |
| **13** | 166.24 | 71.77 | --- | --- |
| **14** | 169.3 | 73.81 | --- | --- |
| **15** | 170.92 | 75.09 | --- | --- |
| **16** | 171.11 | 75.26 | --- | --- |
| **17** | 171.65 | 75.66 | --- | --- |
| **18** | 171.66 | 75.66 | --- | --- |
| **19** | 172.6 | 76.18 | --- | --- |
| **20** | 173.16 | 76.49 | --- | --- |
| **21** | 173.98 | 76.96 | --- | --- |
| **22** | 174.03 | 76.98 | --- | --- |
| **23** | 174.75 | 77.33 | --- | --- |
| **24** | 176.21 | 78.04 | --- | --- |
| **25** | 179.22 | 79.49 | --- | --- |
| **26** | 180.31 | 80.02 | --- | --- |
| **27** | 180.92 | 80.31 | --- | --- |
| **28** | 216.63 | 97.96 | √ | --- |
| **29** | 214.86 | 97.21 | √ | --- |
| **30** | 214.79 | 97.19 | √ | --- |
| **31** | 214.78 | 97.18 | √ | --- |
| **32** | 214.76 | 97.17 | √ | --- |
| **33** | 214.72 | 97.16 | √ | --- |
| **34** | 214.7 | 97.15 | √ | --- |
| **35** | 214.7 | 97.16 | √ | --- |
| **36** | 214.68 | 97.08 | --- | --- |

| | | | | |
|---|---|---|---|---|
| **37** | 214.84 | 97.17 | √ | --- |
| **38** | 214.77 | 97.13 | √ | --- |
| **39** | 214.75 | 97.12 | √ | --- |
| **40** | 214.75 | 97.12 | √ | --- |
| **41** | 214.66 | 97.06 | --- | --- |
| **42** | 214.63 | 97.04 | --- | --- |
| **43** | 214.63 | 97.03 | --- | --- |
| **44** | 214.63 | 97.03 | --- | --- |
| **45** | 214.62 | 97.03 | √ | --- |
| **46** | 214.62 | 97.02 | √ | --- |
| **47** | 218.99 | 98.72 | √ | --- |
| **48** | 214.36 | 95.77 | --- | --- |
| **49** | 212.64 | 91.99 | --- | --- |
| **50** | 212.62 | 91.98 | --- | --- |
| **51** | 154.34 | 64.91 | --- | --- |
| **52** | 169.56 | 70.81 | --- | --- |
| **53** | 139.46 | 57.53 | --- | --- |
| **54** | 133.29 | 54.55 | --- | --- |
| **55** | 124.76 | 50.44 | --- | --- |
| **56** | 116.53 | 46.46 | --- | --- |
| **57** | 71.71 | 31.53 | --- | --- |
| **58** | 51.02 | 24.63 | --- | --- |
| **59** | 43.25 | 22.07 | --- | --- |
| **60** | 34.89 | 19.57 | --- | --- |
| **61** | 24.17 | 14.17 | --- | --- |
| **62** | 26.01 | 15.16 | --- | --- |
| **63** | 28.81 | 16.66 | --- | --- |
| **64** | 40.99 | 22.99 | --- | --- |
| **65** | 61.25 | 33.05 | --- | --- |
| **66** | 161.08 | 67.74 | --- | --- |
| **67** | 161.19 | 67.78 | --- | --- |
| **68** | 170.77 | 73.32 | --- | --- |
| **69** | 170.82 | 73.35 | √ | --- |

## AUTHORS PROFILE


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