Distrubuted Generation impact on Rural Distribution Network –a case study

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Abstract— In this paper, analysis regarding rural distribution network of rural feeder with integration of DG fo voltage profile improvement and loss reduction , DG with solar energy resources on integration with optimal locations on distribution feeders, which reduces loss reduction and improve in voltage profile. A proposed methodology is developed for deciding the appropriate location for DG integration in rural distribution network distribution network; simulations are performed in power world simulators which quantify the loss reduction and system improvement by having distributed generation. Finally The analysis reveals the improvement in voltage profile, significant energy loss reduction in distribution network and an increase in network capacity.

Keywords— **distributed generation ,rural distribution network, voltage profile**

I. INTRODUCTION

Power system are becoming complex in structure the demand for electrical energy is increasing, the demand and supply gap is currently in peak and average load load electricity consumed in India is generated by thermal power plants, 21.73%–by hydroelectric power plants, 2.78% by nuclear power plants and 10.73% by Renewable Energy Sources. More than 50% of India's commercial energy demand is met through the country's vast coal reserves. The DG integrations has also invested heavily in recent years in renewable energy technology the rural distribution network with poor integration and voltage support , The rural networks with less access to reliable power supply, the rural areas suffers from frequent power cuts , voltage regulation problems, high energy losses with large number interruptions etc. . The necessity for reliability of power supply with loss reduction and less environmental throughout a power system, to provide the electric power needed by electrical customer. Such locally distributed generation, has several merits from the viewpoint of environmental restriction and location limitations, as well as transient and voltage stability in the power system. The integrating techniques of the DG allocation can be obtained by a complete enumeration of all feasible combinations of sites and sizes of DGs in the network. The number of alternatives could be very large, however load flow should be performed for each feasible combination and selection of the optimized solution among these alternatives is an important task. The problem is to determine optimal placement of DG that minimizes the distribution power losses under the condition that number of DGs and total capacity of DGs are known.

II. PROBLEM FORMATION

The case study is based on a rural distribution network of , with peak load of 1.08MW has a total line length of 28 km which supplying power to agricultural & irrigational pump- set motors, The details of the connected load to the rural distribution DG integration with power quality improvement in the rural areas where grid connected is difficult. The study reveals about DG integration in rural network for rural electrification during peak loading for voltage profile improvement rural distribution system have limited or no reserve capacity with peak loading conditions . This case study, provides solution for real time improvement of distribution feeder and improve in voltage magnitude and reactive power compensation and integration of DGs with RES with solar resources avai;ab;ity for voltage magnitude improvement . This analysis improves in the distribution feeder with DG integration in rural distribution power network and techniques to exact the DG locations for determining real power and reactive power with voltage profile improvement for with and without DG Integration . The relabity of rural distribution network is improved

The distributed generation and integrating techniques are considering with optimum allocation of DG in distribution network for providing peak loading conditions and considering the agricultural pump sets for solar pumps for providing the peak loading conditions DG plays a very important role for remote and rural to setup rural micro grids ,nanogrids , and alternative supply of rural areas ,with DG integration in rural areas tariff rtes depending upon the wheeling charges and providing continues power supply and improving the rural distribution feeder

the study of existing rural distribution network revels that the major problem faced by the consumers voltage magnitude with real and reactive power loss and less peak loading capacity, and during peak load condition the voltage magnitude of rural feeder reduces up to lower voltage level and with DG integration voltage has to be improved

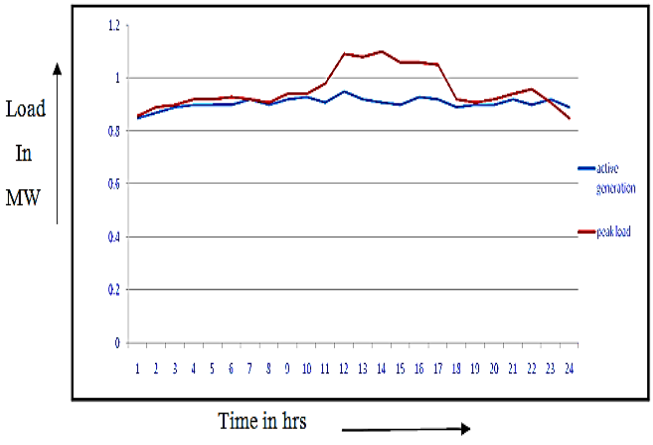

Fig.2 Average Load on the Feeder

With Fig.2 with rural feeder loading conditions graphs with increase in the peak loading conditions for same voltage profile during the peak loading conditions the load varies in which voltage magnitude is reduced across the buses for peak loading condition

III. FEATURES OF POWER WORLD SIMULATOR (PWS)

Simulation software with PWS planning and operational stages of power system. The application of software used for for power system research with different configurations and techniques used for the power system planning techniques

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- Load flow analysis techniques
- Distribution network and analysis
- Optimal operation of generation
- Power system audits and analysis
- Voltage profile improvement techniques
- Feeder loss analysis

IV. CASE STUDY : BEFORE DG

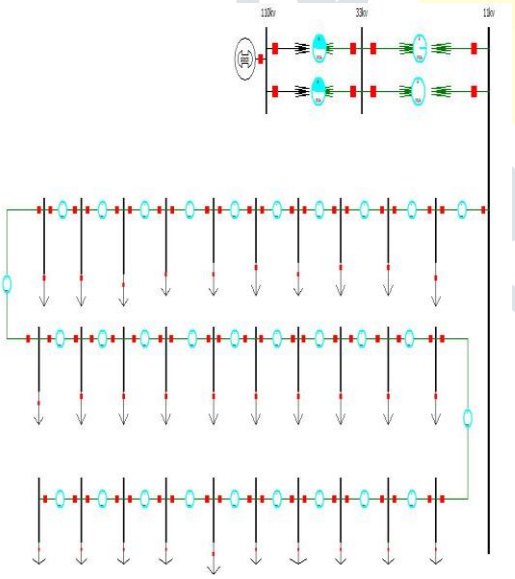


Fig.3 Rural distribution network before DG

rural feeder of rural distribution network with peak load of 1.08 MW and transmission line length of 28km the feeder loading with rural areas primary distribution system drawing power with 110kv substation and the power transferred secondary transmission level with transformer capacity 20MVA with magnitude of each voltages of 11kv buses and power transferred to feeders in which rural feeder integration with DG allocation

The distribution feeder has the following problem associated .

- High energy losses.
- Voltage regulation problems.
- Large number of interruptions and interrupted power supply.
- Overloading in the sections.

TABLE 1 DETAILA OF TRANSFORMER CONNECTED

Serial no	Details	Transformer rating HV/LV	Type of connection HV/LV	Impedance(%) rating (z)
T-1	10MVA	110/33KV	Delta/Star	7.15
T-2	5MVA	33/11KV	Delta/Star	6.35

V. PROPOSED METHODOLOGY

The case study regarding the methodology of multiple DG integration in rural distribution network for loss reduction and improvement of voltage magnitude of the system. The different algorithm techniques and available of DG integration techniques and improving reactive power In a distribution feeder there may be some optimum locations and sizes for a DG unit but one of them is the best location and size between them. The proposed algorithm of this paper gives the most optimum location and size of a DG unit in a distribution system. is based on iterative approach

- Designing the single line diagram for rural distribution network
- Mathematical analysis with calculation of voltage profile, loss reduction with load flow
- Integrating the multiple DG strategic location for voltage magnitude
- Select the min and max real power and reactive power limits of a DG
- Integrating the multiple DG in rural distribution network
- Change in for different DG values in steps.
- Continue the above these steps for all of the buses and find the best size of The multiple DG unit.
- Compare the losses of each for multiple DGs
- find the minimum loss in the distribution system.
- Compare the voltage profile improvement in each unit of buses. With multiple DGs and improve in rural distribution network
- Select the best size of DG integration for min losses & voltage magnitude with location. In Integrating multiple DGs

The power flow analysis in a rural distribution and the distribution network considered for alternative PV power generation capacity improvement in rural feeder and Optimal allotting the solar PV as size of DGs

practically algorithm for locations for the real distribution networking in rural feeder and also . Maintaining coordination of multiple DGs with simulation approach with existing constraints.. with invest ting the solar resources availability the proposed methodology for wide range of operating condition considering of seasonal solar radiation and short-term fluctuation

VI. CASE STUDY : AFTER DG

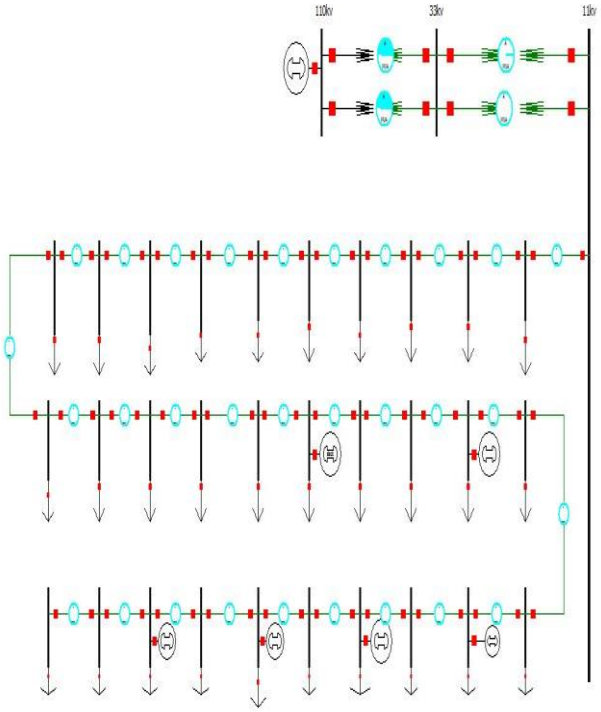


Fig.4 Rural distribution network After DG

Therefore, appropriate sizing and locating a decentralized generator improves the quality of power supplied to the feeder and also reduces the distribution losses. With PV technology as DG integration as multiple DGs

The integration methods and techniques suggests that DG as PV in which solar resources availability in rural areas benefits both the local consumers with improve in reliability of feeders and also for creating local grids in remote areas with increasing peak load penetration also supply with continues availability with backup power or spinning reserve

VII. DG : SOLAR ENERGY

PV generation in which solar resources availability converting solar radiation into direct current electricity using semiconductors that exhibit the photovoltaic effect. PV with integration techniques for multiple DG allocations and rural reliable power supply networking PV techniques are commonly used in alternative supply for rural areas demand for renewable energy sources, the reliability of power supply and improve in quality of power in rural areas

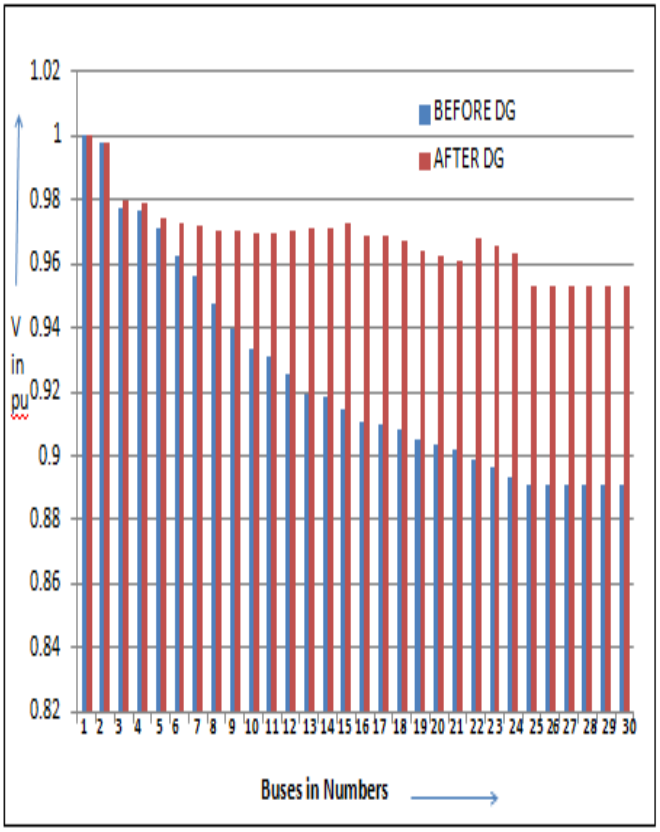
the solar irradiance level is to with peak hours of rural areas with location of distribution network with an average of five hrs of peak matching the demand with solar resources availability and rural feeder

Solar resources availability in rural area assessment and implementation of PV integration techniques also studying the assessments and metrological conditions and it also upon solar radiation availability with average earth temperature, The common findings of resources availability was obtained through.

- Latitude and longitudes of solar resources
- Solar irradiance level in rural areas.
- Max and min azimuth angle
- Peak Sunshine aviablity hrs
- Optimum tilt angle for MPPT tracking

VII.SIMULATION RESULTS

Above Fig. 5 Reveals the voltage magnitude in pu values of rural network It reveals that before DG integration the voltage magnitude under lower limits with DG integration techniques the voltage magnitude is raised above the high penetration level of voltage magnitude considering before and after the DG permissible limit (the best practice as per IEC standard is 0.95pu) , after DG the voltage magnitude raises up to 0.95pu which is under permissible limit



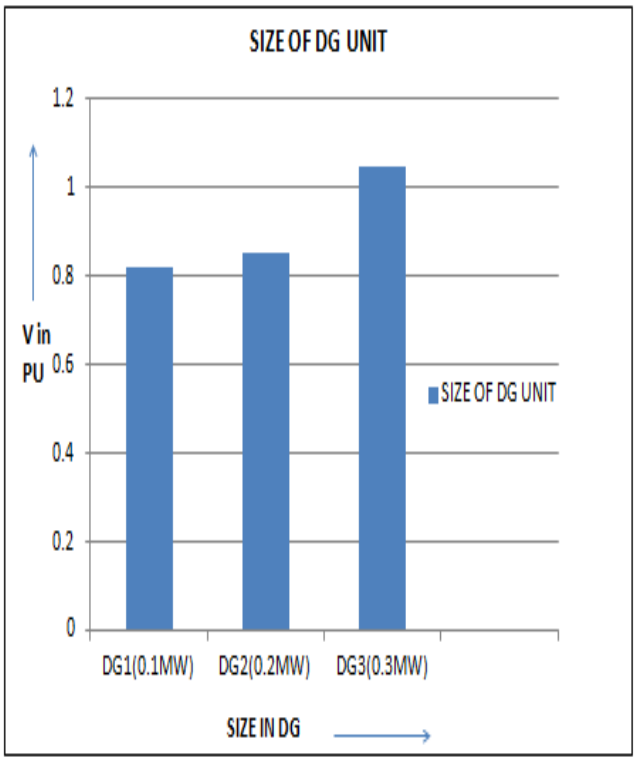


Fig.6 Voltage Profile with different sizes of DG units

The optimal allocation of DG installation with different sizes of DG units shows in Fig.6, voltage profile in PU at different sizing of the DG units of rural distribution network. It reveals that from size DG 1-DG3 there is no changes in voltage magnitude, at size DG 3 voltage raises which is under the permissible limits, The DG-3 which is considered as best optimum size of DG for voltage profile improvement Since the control of voltage regulation is usually based on radial power flows, the inappropriate sitting and sizing can cause voltage disturbance in the network. With system model and available resources for the solar PV

Rural feeder which locates in a remote areas (buses) are considered to be available agricultural pumps . Through 30 buses at the current network, the rural sites as rural agricultural land or rooftop photovoltaic solar panel and can be integrated utility grid at LV power distribution level. Allocation of DG location and size without any methodology will cause the system technically and economically to be inefficient and costly, even worse than the case with no DG installation. The technical issues mostly rise with voltage deviation

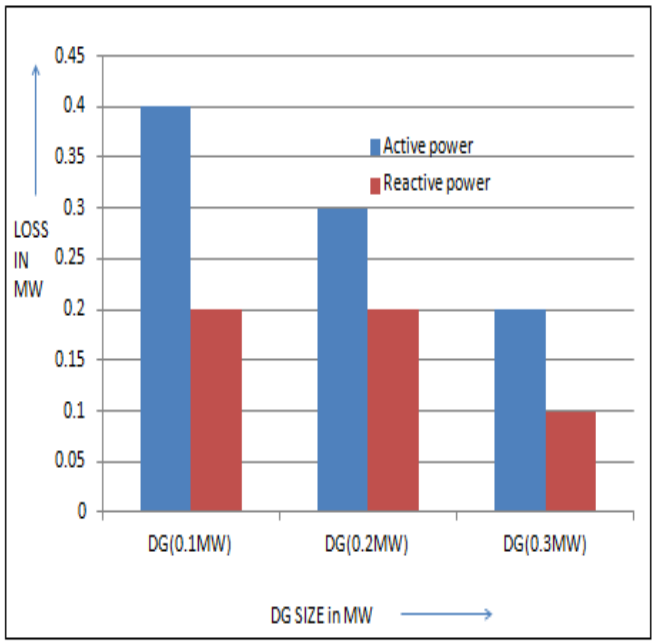


Fig. 7 Loss Reduction with different sizes of DG units

Above figure shows line loss reduction in MW at different sizing of the DG units of rural distribution network. It reveals that from size DG(0.1MW- DG0.2MW)there is no changes in line loss reduction of active & reactive power, At size DG(0.3MW) line losses slightly reduces, but at DG(0.3MW) the line losses of active &reactive power reduce up to 0.2MW & 0.1MVAR which is considered as best optimum size of DG for line loss reduction. GA is a method of solving both constrained and unconstrained

It is approached at this reveals technique for obtaining the optimal locations and sizes of DGs at the system. Simultaneously, the most accurate power flow analysis method, NR is selected to conduct the loadflow.The connection of DG integration in rural grids , with considering the permissible limits of IEEE pu systems during normal operations The distribution losses in the system is which will be affected by increase or reduction based on the configuration of renewable energy mainly as DG. Meanwhile, power flow techniques provide the exact location of DG and exhibit the impact of DGs on the network parameters.

Voltage improvement techniques and algorithm uses system analysis and design that shows real and reactive power flows, currents, and voltages on every bus in the system. Load flow mathematical calculation

The planning of power system network in rural areas power system operation and planning in which the system is with operating conditions, the rural distribution network is considered as a rural proposed model, operating underbalanced condition Commonly, there are four parameters tackling in the power-flow analysis as voltage peak loading , voltage profile reactive power support,The rural feeder bus is taken as reference bus where magnitude and phase angle of the voltage are specified. The role of this bus is to make up the difference between the scheduled loads and generated power. Another one is the load bus where active and reactive powers are specified. The magnitude and the phase angle of the bus voltages are unknown. Finally, the regulated bus with the

Specified real power and voltage magnitude is known as voltage controlled bus. The voltage phase angle and the reactive power are

CONCLUSION

In this paper, I have examined the opportunities for Multiple DG integration in rural distribution network with . PV integrating technologies in agricultural feeder of rural distribution network with increasing in peak loading and improvement in voltage profile improvement . I undertook a case study of a rural feeder to study the impact of a decentralized power generator located in the feeder. There is a significant improvement in the voltage profiles and reduction of distribution losses. This creates a possibility of setting up of rural micro-grids generation

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