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Based on Load Maximum Capacity of Distributed Generation unit in RadialPower System

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Abstract

Distributed generation (DG) has been rising in distribution networks as a result of technological advancement, energy market liberalisation, and environmental concerns. DNOs get a number of requests each year for the installation of additional generators in their current networks. The distribution networks are expected to undergo a radical change as a result of this circumstance. In order to keep the power system stable and operational at all times, energy and service must be included in the system's overall structure. As part of this article, it was examined how DSM regulations may assist the growth of distributed generation in a particular distribution system, as well as the economic gains that utilities can get by using both distributed resources in tandem. Real-world distribution networks have been used to conduct simulations that demonstrate the impact of DSM intervention on the expansion of distributed generation (DG) and the resulting technical and economic advantages.

Key Words : Distributed Generation Unit, Radial Networks, Maximum Cost and Penalty Factor. Energy Savings, Environmental Issues and Demand Side Management.

Introduction

1.1 Distributed Generation (DG)

When a client or independent energy producer instals a power production technology at the distribution level of the electric grid, it is known as distributed generation. All on-site generating, such as solar systems serving a home or a cogeneration facility serving an office, is included in this category (Hoff.T., 2007). The definition offered intentionally omits information about the subject matter.

• Power rating and technological advancements are included in this category.

• Effects on the environment

• The area in which the goods will be delivered.

• The method of action

For example, deep and shallow connection costs, as well as protection features, are comparable for all forms of distributed generation. This allows for a more generic examination of numerous aspects.

The most important advantage of a distributed generating system is the guarantee of obtaining electricity from the utility even if your system is not operational. Renewable energy sources like solar and

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wind, which provide intermittent electricity, and other technologies that may need to be shut down for maintenance, need this. Management of the Demands (DSM)

1.2 Demand Side Management (DSM)

In addition to distributed generation, DSM is an equally essential and effective alternative for addressing the energy situation. As demand grows, we are merely meeting it with new energy sources, but there is still a long-term shortfall. Because of this, more effective methods of using the existing energy must be adopted on the demand side. Energy conservation is the primary goal of demand side management, and the most important aspects of energy conservation include (Garcial A. A., 1987).

- Any device or appliance that uses, generates, transmits or supplies energy must meet energy conservation criteria.
- Mandatory energy audit for all specified customers, as and when necessary by the authorised authorities.
- Energy conservation, consumer education, and advice should be promoted at both the federal and state levels.
- Energy conservation funds should be established at the federal and state levels to use any grants or loans made available for this purpose.

According to the findings of this research, a utility can afford to pay for these alternatives when the system capacity is not affected by the distributed resource, and when there are no uncertainties about the change in system capacity.

Problem Formulation

Demand-side management (DSM) and distributed generation are combined in radial linked networks. It is well-known that the voltage increase generated by DG may be shown using the simple circuit seen in Figure 1. An MVA-level distributed generator, G, is shown in this diagram as part of a basic distribution system. Compensation devices play a vital part in the formulation process.. During mild load situations, compensation devices are activated, which removes reactive power from the load bus and returns it to the load bus when demand rises. Activated networks are examined in this study.

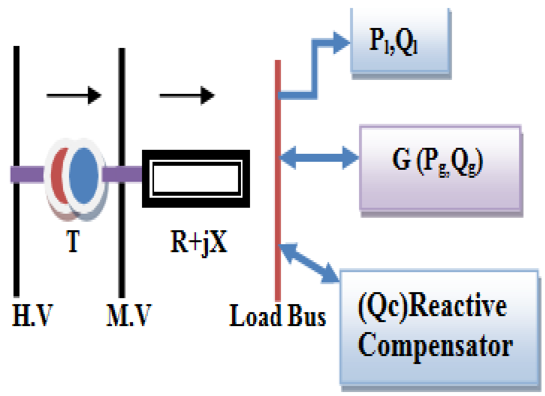

Figure 1 Radial Connected Power System

However, in order to compare the impact of a DSM action capable of reducing peak load by boosting energy consumption during low load conditions, the issue formulation process was followed. One option is to relocate certain loads so that they behave differently and require more energy during off-peak hours, which may be controlled by DSO and then linked when appropriate (for example, loads with storage characteristics).

2.1. Relation between maximum generation and loadconnected

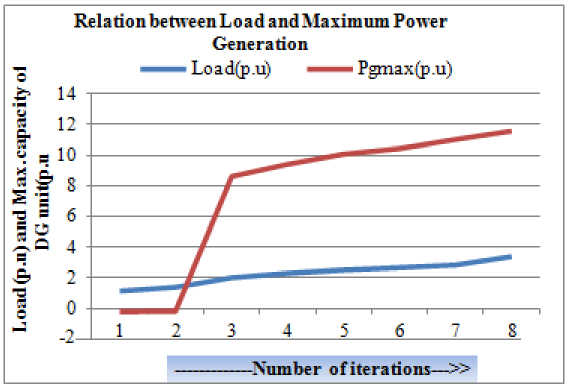

Figure 2 Relation between load and Maximum Power Generation

The findings of the evaluation are given graphically in fig 2. On the vertical axis, the variation of maximum distributed generation unit capacity (Pgmax) per unit, and the variation of load (Pl,Ql) per unit on the horizontal axis w.r.t. number of iterations on the horizontal. DG units deployed at the load bus have expanded in capacity as demand for power on the consumer side grows. In these kinds of circumstances, demand side management (DSM) aims to encourage consumers to utilise the smallest load possible. Otherwise, the function of a distributed generating firm enhances that impact per unit of consumption cost.

2.2 Showcase your work

Figure 1 depicts a Radial linked network that serves as the basis for this study.

Power generation units are turned off when the load (Pl,Ql) on the load bus falls below a predetermined threshold, however if the consumer side's demand exceeds this threshold, the DG unit is activated. This equation is used to determine the maximum power produced by the DG unit for the load connected to the load bus (G. Celli, E. Ghiani, S. Mocci, F. Pilo, E. Pazzola, 2005)

$$P_{gmax} \leq (V_{2max} - V_1)/R \quad (1)$$

Where
V_{2max}= maximum voltage present at load bus
V_1= voltage at bus 1
R= resistance of tie line between bus 1 and bus 2.

The voltage V_{2max} is further calculated by using this equation:

$$V_{2max} = V_1 + R \times (P_g - P_l \pm P_{dsm}) \pm X[(\pm Q_g - Q_l \pm Q_c)] \quad (2)$$

P_{dsm} is the portion of total load that can be moved from peak hours to off peak hours.
X= reactance of tie line between bus 1 and bus 2.
P_g and Q_g is active and reactive power of DG unit.
P_l and Q_l is active and reactive load connected with load bus.
Q_c is reactive power of compensating device.

When load on consumer side is maximum/Normal than The maximum output of distributed generation unit (P_{gmax}) is calculated by using this equation.

$$P_{gmax} \leq (V_{2max} - V_1)/R + \Delta P_{dsm}/R \quad (3)$$

Use (2) equation to figure out how much voltage is present on the "load" bus. As the maximum permissible level of the DG unit rises, so does the proportion of loads that are subject to the DSM programme, as shown by Equation 3. Because they can sell more energy during peak hours, they agree to pay a price for the active network service (which in this instance, the active network service is formed by the action on loads), but they may make a significant profit.

The following relation is used to determine the maximum cost that a DG unit may receive or pay.

$$C[P_g] = \lambda[a \times (P_{gmax})^2 + b \times P_{gmax}] \quad (4)$$

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Where a and b are constants.

An example of a common cost characteristics equation used to estimate the cost of DG unit operating is shown in the following equation. It is the penalty factor () that determines the rate at which electricity is taken or delivered from the DG unit.

Maximum power generated by DG unit during operation

Consumer demand is assumed to be always rising in this research. Load centres' active and reactive power outputs determine how the distributed generating unit operates. According to the following table, peak load situations necessitate the use of DSM. The bigger the load, the greater the DG unit's capacity.

Related data is shown in the following table. Using a simulation tool, 8 rounds of analysis are performed. Based on a 100 kVA basis, the output power (Pgmax) may be converted to MW.

Table 1 Maximum power generated by DG unit based on load connected

Iteration	P_l(p.u)	Q_l(p.u)	P_{gmax}(p.u)	P_{gmax}(MW)
1	0.8	0.34	-0.2	-20
2	1	0.4	-0.16	-16
3	1.4	0.62	8.61	861
4	1.58	0.72	9.4	940
5	1.72	0.8	10.07	1007
6	1.8	0.86	10.43	1043
7	1.94	0.9	11.02	1102
8	2.4	0.98	11.57	1157

Take- Z (p.u) =0.05+j0.15, V_1=2.0 p.u, Base = 100 MVA

There is enough power available at the load bus to meet the needs of customers in the first two iterations. If a DG unit is put in such a situation, it uses electricity from the load bus to operate. An operating penalty factor is used to calculate the cost of a DG unit.

The cost of operating a distributed generation (DG) unit is determined in this study. It takes electricity from the load bus under normal conditions and feeds power back to the load bus during times of high demand. Two firms are in charge of setting the fee for this operation (one is main company and other company consists DG unit). During peak and off-peak loads, the penalty factor is regarded to be the same. It's here that the findings of this conversation are documented. For all phases of the load, the penalty factor is set at 1.0.

Table 2 - Maximum capacity of DG unit installed with fixed penalty factor

Iteration	P_{gmax}(MW)	P_{cost}(Rs/MW)
1	-20	-299
2	-16	-239
3	861	13004
4	940	14188
5	1007	15206
6	1043	15768
7	1102	16651
8	1157	17504

Conclusions

Increases in load enhance the DG unit's capacity and, conversely, the DG unit's maximum generation. Prices established by competing firms in response to changing demand can affect capacity. Operational efficiency is greatly enhanced when two organisations sign an agreement. The overarching goal here is to save energy. The penalty factor is used by consumers to determine peak and off-peak tariffs. DSM further integrates this paradigm.

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