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Research Article

Efficient The optimal sitting and sizing of Photovoltaic generation with load growth Regards

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Abstract

Nowadays distributed generations are connected to the distribution network. The proper installation of DG improves the technical and economic impact of the system. The optimal siting and sizing improves system reliability and improves the capacity of the system. This paper discusses the optimum location and calculation of PV with load growth in the 400V and the 11kV feeders were studied. The load growth is made at the feeder up to the actual losses in the system. The test is conducted at each percentage of the load growth.

Keywords: Load growth, radial distribution, siting and sizing distributed generation.

Introduction

The rising need requires increased facilities to the consumers. Using an alternate way to meet rising demand is to employ the distributed generation (DG) system. The proper allotment of DG in the delivery system improves the voltage profile, reliability and lessens the grid reinforcement and system power losses.

Mallikarjuna, et al. discuss the optimum placement and dimensioning of DG needed to obtain the desired microgrid with optimal stability at the optimum rate. The method of simulated annealing is used to optimize the system [1]. Zulpo, et al. discuss the optimum placement and dimensioning of DG based on the power loss decrease and voltage variance reduction through a classical optimization approach. The test is carried out in a KNITRO, approximates the system appropriately and the result is compared with Power System Analysis Toolbox (PSAT). This study shows the proper location and capacity improves the voltage profile and lessens the power losses [2]. Sunaina, et al. discusses the distribution network's actual power loss decline through distributed generation integration by employing selective particle swarm optimization (SPSO). The main feature used in the work is to diminish the actual power deficit in the system. PSO and SPSO carry out the optimum siting and sizing. The PSO and SPSO have compared each other. The SPSO gives a better result than the PSO [3]. The improvement of voltage profile in the radial distribution scheme is discussed by Vinoth, et al. with the optimum method of actual and reactive power management [4]. Selvi, et al. uses the fuzzy-EP scheme for optimum siting and dimensioning of distributed generation. The test is carried out in the IEEE-34 bus radial distribution system. The optimal location of the distribution scheme is determined by the deficit sensitivity factor and L-index. This paper aims to lessen the power loss cost and the capital cost of DG by optimum placement and dimensioning of distributed generation at two types of DG. The low-capacity multiple distributed generation is further advantageous than the larger capacity single DG. In multiple distribution systems, the voltage variation index is reduced to zero [5]. To find the optimum position and dimension of a Type-I and Type-II DG in the radial distribution structure to lessen deficits and thus increase bus voltages, Navdeep, et al. address the particle swarm optimization-based method. The study is carried out and the findings are compared with the mathematical approach and other recorded

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outputs in the 69-bus and 33-bus radial distribution schemes. The optimum placement and dimensioning augment the voltage profile and eliminate losses. The Type-I distribution system gives a better result than the Type-II distribution system [6]. In radial distribution network preparation, to mitigate the overall daily voltage breaks and regular energy deficits, Maryam, et al. address the optimum DG allocation and sizing strategy. To resolve the resultant constrained optimization problem, the metaheuristic cuckoo search algorithm was used. The results demonstrated a minimum DG penetration of 25kW resolved all under voltage problems [7]. Abud discusses the voltage control of DG in distribution systems with a remarkable increase in DG penetration. Open DSS has been used to simulate a real Brazilian distribution network to examine the effect of various types of PV system inverter controls [8]. Anis, et al. discuss the stability and economic evaluation of a distribution network with the integration of DG under several load growths. In this work, the CBDGI algorithm is developed for the optimum site and dimension [9]. Lei, et al. address the placement and dimensioning of DG depending on the minimal transmission deficit cost. The aim is to lessen the transmission loss cost. The siting and sizing are augmented using an adaptive genetic algorithm [10]. These researches are not discussing the load growth at a given distribution system with optimal location and sizing of feeders.

Test system studied

a. *400V radial distribution feeders*

In the Kanchipuram district distribution system, in Tamil Nadu, Fig 1 shows the 400V radial distribution feeders 1 and 2. The resistance and reactance of the feeder are given in Table 1. The optimal siting and sizing are 32kW PV at node 16.

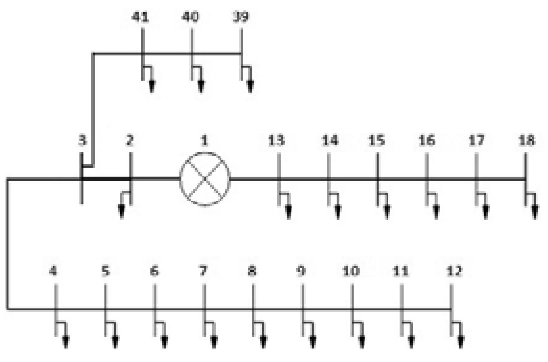

Fig 1: Single-line diagram of the 400V radial distribution feeders 1 and 2

Table 1: Test system load data

BUS	2	3	4	5	6
P[kW] Q [kVAR]	2.238 1.678	- -	12.628 9.471	0.520 0.39	3.73 2.797
BUS	7	8	9	10	11
P[kW] Q [kVAR]	3.73 2.797	4.476 3.357	2.238 1.678	2.238 1.678	3.730 2.797
BUS	12	13	14	15	16
P[kW] Q [kVAR]	2.238 1.678	4.370 3.357	0.080 0.06	17.278 12.958	13.37 10.02
BUS	17	18	41	40	39
P[kW] Q [kVAR]	2.238 1.678	2.238 1.678	2.238 1.678	2.238 1.678	11.19

Table 2: Test system resistance and reactance

LINE	1-2	2-3	3-4	4-5
Resistance (Ω) Reactance (Ω)	0.0194 0.01387	0.0235 0.0167	0.1170 0.0835	0.0306 0.0219
LINE	5-6	6-7	7-8	8-9
Resistance (Ω) Reactance (Ω)	0.03066 0.0219	0.0996 0.07117	0.2646 0.3968	0.2044 0.3066
LINE	9-10	10-11	11-12	13-14
Resistance (Ω) Reactance (Ω)	0.165 0.252	0.644 0.966	0.1064 0.1596	0.152 0.378
LINE	14-15	15-16	16-17	17-18
Resistance (Ω) Reactance (Ω)	0.152 0.1722	0.13832 0.304	0.1383 0.304	0.1938 0.426
LINE	3-41	41-40	40-39	
Resistance (Ω) Reactance (Ω)	0.4718 0.7077	0.1848 0.2772	0.084 0.126	

b. *11kV radial distribution feeder*

The 11kV feeder analyzed is shown in Fig 2. The feeder resistance and reactance values are given in Table 4.

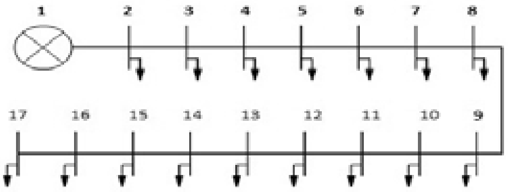

Fig 2: 11kV distribution feeder

Table 3: Load data of the test system

BUS	2	3	4	5	6
P[kW]	80	80	120	140	80
Q[kVAR]	60	60	90	105	60
BUS	7	8	9	10	11
P[kW]	50.4	160	80	190.4	151.2
Q[kVAR]	37.8	120	60	142.8	113.4
BUS	12	13	14	15	16
P[kW]	160	110.4	80	40	80
Q[kVAR]	120	82.8	60	30	60
BUS	17				
P[kW]	50.4				
Q[kVAR]	37.8				

Table 4: Test system resistance and reactance

LINE	1-2	2-3	3-4	4-5
Resistance (Ω)	0.22	0.43	0.19	0.68
Reactance (Ω)	0.0823	0.1608	0.0710	0.2544
LINE	5-6	6-7	7-8	8-9
Resistance (Ω)	1.30	0.62	0.25	0.43
Reactance (Ω)	0.486	0.231	0.0935	0.1608
LINE	9-10	10-11	11-12	12-13
Resistance (Ω)	1.24	0.74	1.05	0.37
Reactance (Ω)	0.4639	0.276	0.392	0.138
LINE	13-14	14-15	15-16	16-17
Resistance(Ω)	1.04	0.74	0.37	0.81
Reactance(Ω)	0.389	0.276	0.1384	0.3030

Discussion of results

3.1 Outcomes of 400V feeder studied

50% of load growth at feeder 2

The power loss without PV at actual load is 22. 933kW. The optimal location and sizing are measured for the 400V feeders [11]. The lowest voltage level attained at node 16 with 50% of load growth is 0.747p.u. The feeder power deficit with 50% of load growth is 17.386kW. The energy loss in the feeder with 50% of load growth is 45690.408 Units.

75% of load growth at feeder 2

The power loss without PV at actual load is 22.933kW. The lowest voltage level attained at node 16 with 75% of load growth is 0.627p.u. The feeder power deficit with 75% of load growth is 22.933kW. The energy deficit in the feeder with 75% of load growth is 60267.924 Units.

3.2 Outcomes of the 11 kV feeder evaluated

50% of load growth in the feeder

The power deficit without PV at actual load is 128.388kW. The optimal location and sizing are measured in the 11kV feeders [11]. The lowest voltage level acquired at node 17 with 50% of load growth is 0.947p.u. The feeder power deficit with 50% of load growth is 109.264972W. The feeder energy deficit with 50% of load growth is 287148.346 Units.

62% of load growth in the feeder

The power deficit without PV at actual load is 128.388kW. The lowest voltage level attained at node 17 with 62% of load growth is 0.938p.u. The feeder power deficit with 62% of load growth is 126.621kW. The feeder energy deficit with 62% of load growth is 332759.988 Units.

Conclusion

It is obvious that the implementation of PV systems in the transmission network, as developed in many countries through their experience, is economically advantageous to both the utility and the user. As mentioned above, this was confirmed by our studies. The implementation of PV systems at the load points or on the feeder is certainly an additional resource to meet the increasing demand of the power system network. Alternate energy sources such as solar, wind, etc. need to be utilized economically and efficiently to meet needs in the system especially when coal reserves are being depleted. The findings of these investigations confirm that utilities such as electricity boards will benefit significantly if they allow LT and HT industrial customers to employ solar power stations through effective subsidy schemes at their consumption points. If they employ PV systems at their load points and enjoy the other advantages addressed above, the affordable domestic and agricultural customers would be free of power quality issues.

The impact of load growth in the Kanchipuram district is discussed in the system. In the 400V feeder, 75% of load growth is obtained in the system. In the 11kV feeder, the 62% load growth is obtained. The impact of load growth in each node with losses is measured in the system.

Although the advantages of distributed generating systems using PV generation are well established, distribution engineers still do not have simple guidance on the economic aspects to define the load locations and isolated user communities. For stakeholders involved in setting up sustainable rural electrification projects with PV systems, this work provides a clear but detailed decision-making method.

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