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Optimal Placement of Multiple Distributed Generators in HVDC System for Performance Improvement

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Abstract

Distributed generators are one of the important external sources in the power distribution system. Installing DGs at the optimum load centers will prevent the new transmission lines extension to energize substation. The placement of the DC in HVDC system is become a research topic for researcher in power system. Various algorithms are used to optimize power injection in bus system. Analytical optimization methods (Newton Rapson etc.) have been developed for identifying the week bus in the HVDC system. In this paper, genetic algorithms (GA) is use for the identifying the power injection in 30 bus system. Optimized selection of multiple DG has been efficiently achieved using Genetic algorithm (GA). The results of DG placement has been given in the paper.

Keywords: GA, DG , NR etc.

Introduction

Distributed generation technologies are renewable and nonrenewable. Renewable technologies include solar, photovoltaic or thermal, wind, geothermal, ocean. Nonrenewable technologies include internal combustion engine, combined cycle, combustion turbine, ice, micro turbines and fuel cell. Most of the DG energy sources are designed using green energy which is assumed pollution free.

Installing DGs at the load centers will prevent the new transmission lines extension to energize new substation, DG is capable of providing some or all of the required power without the need for increasing the existing traditional generation capacity or T&D system expansion. DG capital cost is not large due to its moderate electric size and modular behavior as it can be installed incrementally unlike installing new substations and feeders, which require large capital cost to activate the new expanded distribution system. The technical benefits include improvement of voltage, loss reduction, improved utility system reliability and power quality and increasing the durability of equipment, relieved transmission and distribution congestion, improving power quality, total harmony distortion networks and voltage stability by making changes in the path through which power passes. These benefits get the optimum DG size and location is selected. If the DG units are improperly sized and allocated leads to real power losses increases than the real power loss without DG and reverse power flow from larger DG units. So, the size of distribution system in terms of load (MW) will play important role is selecting the size of DG. The reason for higher losses and high capacity of DG can be explained by the fact that the distribution system was initially designed such that power flows from the sending end (source substation) to the load and conductor sizes are gradually decreased from the substation to consumer point. Thus without reinforcement of the system, they have use of high capacity DG will lead to excessive power flow through small sized conductors and hence results in higher losses.

Currently, most distributed generation (DG) connect with the distribution network based on a so-called ‘‘fit and forget’’ policy, which is consistent with passive network management. Under this mode, DG is without control in the operation, the task of balancing supply and demand as well as the task of securing frequency and voltage has been left solely to large production units, and therefore the positive role of DG on improving branch power flow and node voltage is weakened.

Genetic algoritm

The genetic algorithm (GA) is an optimization and search technique based on the principles of genetics and natural selection. A GA allows a population

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composed of many individuals to evolve under specified selection rules to a state that maximizes the fitness. (i.e., minimizes the cost function).The method was developed by John Holland (1975) over the course of the 1960s and 1970s and finally popularized by one of his students, David Goldberg. Genetic algorithm is an iterative stochastic optimizer that works on the concept of the survival of the fittest, motivated by Darwin, and uses methods based on the principle of natural genetics and natural selection to construct search and optimization procedures that best satisfies a predefined goal. Genetic algorithms search about the solution space of a function through the use of simulated evolution, i.e., the Survival of the fittest strategy. In general, the fittest individuals of any population who tend to reproduce and survive to the next generation, so improving a successive generation. However, inferior individuals can, by chance, survive and also reproduce. Genetic algorithm has been show to solve linear and nonlinear problem by exploring all regions of the state space exponentially exploiting promising areas through mutation, crossover, and selection operation applied to individuals in the population. Genetic algorithms use principles of natural evolution. And there are five important features of (GA) as follow.

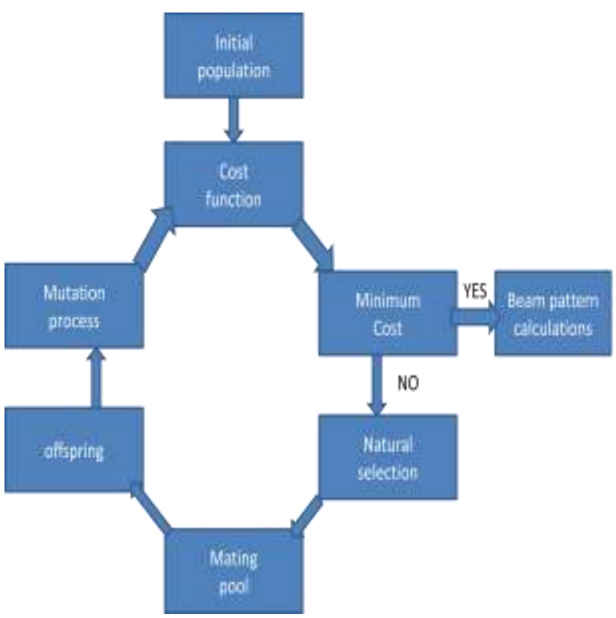

Figure: 3.1 Flowchart of Genetic Algorithm

Busdata

Bus network design which generates bus lines with respect to some limitations such as fleet size and budget is one of the most important problems of transportation planning. In general, users are faced with many problems in transit operation such as long waiting time at stations, inaccuracy in bus arriving time, incompatibility between the bus routes and paths of most passengers, and insufficient capacity. These facts encourage some users to shift to a private transportation. Some unfavorable effects of using a private vehicle are congested network and increasing in fuel consumption, wear and tear of car parts, and number of accidents. One of the main reasons results in inefficiency in transit operation is that bus lines do not cover the network very well. A bus network designer aims to remove mentioned occurrences by choosing the best routes associated with proper frequencies. It is not optimal to considerer very route in a bus network due to deficiency in fleet size and the budget. Moreover, it is not practical to cover the entire network with bus lines. Therefore, the designer must choose the best bus lines to have the maximum network coverage taking fleet size and other constraints into consideration.

Bus classification

In a power system a bus is a node at which one or many lines, one or many loads and generators are connected. Each node or bus is associated with 4 quantities, as magnitude of voltage, phage angle of voltage, true or active power and reactive power in load flow problem, out of these 4 quantities two are specified and remaining 2 are required to be determined through the solution of equation. Depending on these quantities that have been specified, the buses are can be classified into 3 categories. Buses are classified according to which two out of the four variables are specified as

A. Slack Bus
B. Generator Bus
C. Load Bus

Results and discussion

Power system Data :

A. Bus data:

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Table 1: The 14 bus data from the IEEE has been taken for the simulation. The bus data is shown as follows,

Bus No.	Type	V	Angle	Pd	Qd	Pg	Qg	Pgmin	Pgmax	Qsh
1	1	1.06	0	0	0	0	0	0	0	0
2	2	1.04	0	21.7	12.7	40	0	-40	50	0
3	0	1	0	2.4	2.4	0	0	0	0	0
4	0	1.06	0	7.6	7.6	0	0	0	0	0
5	2	1.01	0	94.2	94.2	0	0	-40	40	0
6	0	1	0	0	0	0	0	0	0	0
7	0	1	0	22.8	22.8	0	0	0	0	0
8	2	1.01	0	30	30	0	0	-10	40	0
9	0	1	0	0	0	0	0	0	0	0
10	0	1	0	5.8	5.8	0	0	-6	24	19
11	2	1.08	0	0	0	0	0	0	0	0
12	0	1	0	11.2	11.2	0	0	0	0	0
13	2	1.07	0	0	0	0	0	-6	24	0
14	0	1	0	6.2	6.2	0	0	0	0	0
15	0	1	0	8.2	8.2	0	0	0	0	0
16	0	1	0	3.5	3.5	0	0	0	0	0
17	0	1	0	9	9	0	0	0	0	0
18	0	1	0	2.2	3.2	0	0	0	0	0
19	0	1	0	17.5	9.5	0	0	0	0	0
20	0	1	0	0	2.2	0	0	0	0	0
21	0	1	0	3.5	17.5	0	0	0	0	0
22	0	1	0	0	0	0	0	0	0	0
23	0	1	0	0	3.2	0	0	0	0	0
24	0	1	0	2.4	8.7	0	0	0	0	4.3
25	0	1	0	10.6	0	0	0	0	0	0
26	0	1	0	0	3.5	0	0	0	0	0
27	0	1	0	0	0	0	0	0	0	0
28	0	1	0	3.4	0	0	0	0	0	0
29	0	1	0	2.4	2.4	0	0	0	0	0
30	0	1	0	10.6	10.6	0	0	0	0	1 0

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B. Line data:

Table 2: The line data for 14 bus system has been taken for the simulation. The line data is shown as follows,

From Bus	To Bus	R	X	V	Tap changing ratio
1	2	0.0192	0.0575	0.0264	1
1	3	0.0452	0.1852	0.0204	1
2	4	0.057	0.1737	0.0184	1
3	4	0.0132	0.0379	0.0042	1
2	5	0.0472	0.1983	0.0209	1
2	6	0.0581	0.1763	0.0187	1
4	6	0.0119	0.0414	0.0045	1
5	7	0.046	0.116	0.0102	1
6	7	0.0267	0.082	0.0085	1
6	8	0.012	0.042	0.0045	1
6	9	0	0.208	0	0.978
6	10	0	0.556	0	0.969
9	11	0	0.208	0	1
9	10	0	0.11	0	1
4	12	0	0.256	0	0.932
12	13	0	0.14	0	1
12	14	0.1231	0.2559	0	1
12	15	0.0662	0.1304	0	1
12	16	0.0945	0.1987	0	1
14	15	0.221	0.1997	0	1
16	17	0.0824	0.1923	0	1
15	18	0.1073	0.2185	0	1
18	19	0.0639	0.1292	0	1
19	20	0.034	0.068	0	1
10	20	0.0936	0.209	0	1
10	17	0.0324	0.0845	0	1
10	21	0.0348	0.749	0	1
10	22	0.0727	0.1499	0	1
21	22	0.0116	0.0236	0	1
15	23	0.1	0.202	0	1
22	24	0.115	0.179	0	1
23	24	0.132	0.27	0	1
24	25	0.1885	0.3292	0	1
25	26	0.2544	0.38	0	1
25	27	0.1093	0.2087	0	1
28	27	0	0.396	0	0.968
27	29	0.2198	0.4153	0	1
27	30	0.3202	0.6027	0	1
29	30	0.2399	0.4533	0	1
8	28	0.0636	0.2	0.0214	1
6	28	0.0169	0.0599	0.065	1

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Simulation result:

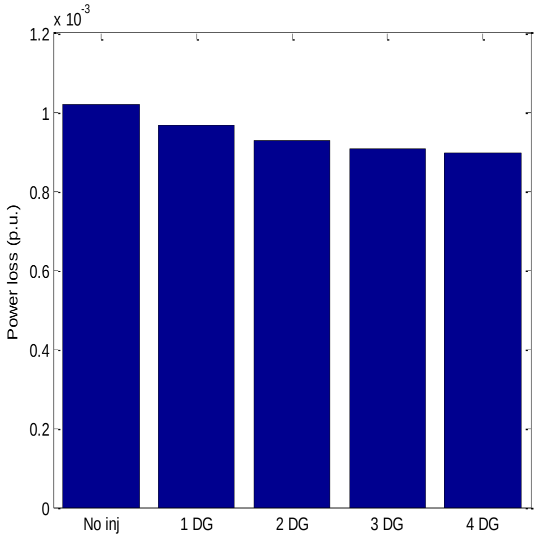

Figure 6.1 Power loss optimization in 30 bus system with multiple DG injection

Conclusion

The 30 Bus system is analyzed in term of power loss and voltage profile. The analysis has been performed with and without DG placement. The significant improvement has been observed with the DG placement. The improvement is getting reduce with increase in no. of DG placement. Power loss becomes half after placement of 4 DG.

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