ABSTRACT

This paper contains a strategy to minimize energy losses in an electrical distribution network. In order to develop the strategy, a model was constructed to simulate an electrical distribution network, and different parameters were included that help in estimation of technical losses in medium voltage (MV) distribution network. The main objective of this paper is to minimize technical and non-technical losses in power systems. There are losses in power systems that cannot be predicted or calculated beforehand, these are the non-technical losses. The bulk of these losses are likely caused by electricity theft, rather than the other possibilities such as poor maintenance of meters, and calculation and accounting mistakes, some power systems may suffer from both. The strategy is applied on a part of real distribution network. The network segments consist of different network buses delivering electrical energy from substation to supply different customers. In this network, the load supplied by one bus is a varying load for different times especially at maximum load conditions.

Key Words: Technical losses, non-technical losses, Maneuvers, PRAO software, Multi-objective genetic algorithm, Electrical distribution network.

INTRODUCTION

Every element in a power system (a line or a transformer etc) offers resistance to power flow and thus consumes some energy while performing the duty expected from it. In order to study power losses in a distribution network, which constitute a portion of the total losses in electrical power systems, the logical first step is to understand the complete picture of power systems losses.
optimization system has smaller worst voltage drops, overloads, and energy losses. Reduction of losses improves system quality, security, and reliability. It can improve utilization factors of existing facilities and defer feeder expansion projects. As a result, a utility can produce power with higher quality and lower electricity price, which will attract customers to the utility and enhance the utility’s competitive ability in the deregulated environments. The network configuration management technique is considered on top of these solutions. At first, they considered two objectives such as optimization of voltage drop and overload then, loss reduction in distribution systems. So, an attempt was made to solve the network reconfiguration problem having multiple objectives such as minimization of power losses, load balancing among supply transformers, minimization of the worst voltage drop and overload. Pareto front [2] had proposed a GA based approach to solve the optimization problem of technical losses in the electrical distribution networks. The reconfiguration algorithm directly constructs an optimal solution for voltage drop, overload and minimum losses accounting for the major constraints on maneuvers such as the network must not have any closed loops, and the limitations of line capacities or voltage drops are satisfied.

THE PROPOSED GENETIC ALGORITHM

A genetic algorithm developed by J.H. Holland (1975) [3] is a model of machine learning, which derives its behavior from a metaphor of the processes of evolution in nature. GAs are executed iteratively on a set of coded chromosomes, called a population, with three basic genetic operators: selection, crossover and mutation. Each member of the population is called a chromosome (or individual) and is represented by a string all the strings and applies three operators in order to optimize the function. [4-5], GAs uses only the objective function information and probabilistic transition rules for genetic operations.

a) Selection
This operator is used by the algorithm to choose the best individuals or chromosomes based on their fitness values (as the fitness of the individual increase it becomes more likely to be selected) to form the initial population. [4].

b) Crossover
This operator is used by the algorithm to enhance the fitness value of the individuals. In this operator, two randomly selected individuals (called parents) exchange some of their genes together in order to get two new two individuals are called offspring. And the method that was used is crossover probability with a probability value equals to 0.8 which means that crossover operator will be applied on 80% of the individuals in the current population. This technique was chosen due its superiority among the other crossover techniques as it ensures the transportation of the best traits in the current generation to next one [4-6].

c) Mutation
This operator prevents the algorithm from being trapped in local minima as it helps in the recovering of the lost traits due to the crossover operator. It also helps in the exploration of the search space thus adding more diversity to the population.

The technique used in this research was the mutation probability in which the algorithm flips certain number of bits (from zero to one or vice versa) in each of the selected individuals to be mutated in the aim of increasing the individual fitness. The probability value used was 0.2 (i.e. 20% of the individuals will be mutated). The value was low comparably with the crossover ratio in order to keep the exploitation/exploration balance. The GA will run for several preset time, or the difference in the fitness value does not change for several preset number of generations. Fig. 1 Shows a flow chart describes how GA works to reach the optimum solution.
the backup condition based on evolutionary algorithms for multi-criterion optimization. [8]. Those analyses are a basis for variant planning of the medium or long term (up to 10 years) distribution network development, during which a year by year electricity supply quality verification and the economical evaluation of every investment and the whole long term investment plan is performed. Further important data is outage frequencies of the system elements (overhead lines, cables, transformers.). Clearly, it is necessary to have organized system of data acquisition (measurement) and data storage (database) to successfully overlook the network performance and development. Important part of the distribution network planning is criteria and assumptions used in the planning process. Below are the examples used in the practice in Egypt, divided into three parts, according to the type of the analyses they are used in. Load flow and voltage profile and power loss are analyses in the normal conditions are conducted according to two criteria: “Load of the lines and transformers up to 80 % of thermal current and admissible voltage drop in 11kV network up to 6 %. The equivalent criteria are lower: load of the overhead lines and transformers up to 100 % of thermal current and admissible voltage drop in 11 kV network up to 6%”

NETWORK INITIAL STATE ANALYSES

The first step of the distribution network planning is analyses of its initial state with intention to encounter possible defects. The example given in this paper is based on the simple network fed from 66/11 kV substation in Cairo region, with very long feeders. Overview of the relative loads of lines and voltage drops indicates that the major power supply problem in this network is high voltage drop. The consequence is low power delivery quality in the entire region, despite existing connection lines between feeders. The picture shows expected number of permanent outages and expected yearly duration of outages per consumer and placement of (manually operated) switches in the 11 kV network. Average power delivery quality data for feeders and the entire network are given in the Table I.

<table>
<thead>
<tr>
<th>Basic Data of EXISTING SITUATION:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of nodes</td>
<td>24 node &amp; (sources: 1 - feeders: 7 - transformers: 2)</td>
</tr>
<tr>
<td>Number of segments</td>
<td>61 (open: 10)</td>
</tr>
<tr>
<td>Overload</td>
<td>6857.4 kVA</td>
</tr>
<tr>
<td>Sum of losses</td>
<td>723.8kW</td>
</tr>
<tr>
<td>Max. voltage drop</td>
<td>8.38 %</td>
</tr>
<tr>
<td>Minimum transit margin</td>
<td>-3000.3kVA</td>
</tr>
<tr>
<td>Total length</td>
<td>38.639 km</td>
</tr>
<tr>
<td>Total powered load</td>
<td>14287.8kVA</td>
</tr>
</tbody>
</table>

SOLUTION METHODOLOGIES

Collection and analysis done of the existing data of the electric network of the part of distribution network and main feeding system (substations 66/11kV) and distribution panel (11 kV). Network fed from 66/11KV substation; this is mainly formed of 11 bus bars. The network consists of 24 nodes, including the main substation bus bar. With total installed capacity of 15.730MVA, and a maximum load of 14287.8MVA, this means a utilization factor of about 0.806at system peak. Table II, Present the input data of nodes and sections expressed in node numbering respectively. Fig. 3 presents the single line diagram for the network showing incoming and outgoing feeders for sample network.

From PRAO program, all sections are shown in Fig. 4 in the normal operation scheme. [9].

CONFIGURATION NETWORK

For optimization and reconfiguration using PRAO software is based on GA and the construction of an initial population of feasible individuals this technique using the system loops and applying specialized genetic operators as in the short example, the Result after 12 iteration (maneuver) by open and close the switches as follows in Table III:
The calculation of the technical losses in the sample network load of distribution network under normal operating conditions. Feeder reconfiguration to reduce technical losses and balance the energy dissipation or the unavoidable component of technical affecting both types of losses has been presented. The magnitude be divided into technical and non-technical. Study of the factors deals with the electrical losses in distribution system which can economically justified investments in such areas. This paper reconstructions of the existing conductor, are just not solutions for those problems, new MV cable or major and unacceptably low power delivery quality. Classic causing two major problems: unacceptably high voltage drop consumption and long small cross sectioned conductor, important in medium networks characterized with low quality assessments, operation reliability analyses and above classic load flow and voltage profile analyses, power delivery electricity distribution network planning includes, besides Multi-objective optimization analysis, management of system to reach the acceptable limit.

Results of the paper show that the multi criterion algorithm has succeeded to reduce technical loss for all sample networks of the system loss to reach the optimum configuration for the system. While observing the over load and voltage drop combined with while ignoring in any calculations. System miscalculation on the part of the utilities, due to accounting errors, poor record keeping, or other information errors may also contribute to NTL [12].

- Non-technical losses are calculated by the use of statistical analytical methods for detecting electricity theft by analyzing utility billing information.
- Smart Grid can capture the identification and reduction of non-technical losses through aggregation of load and collecting voltage data at points throughout the network, fig.6 shows those modern meters that can delete non-technical losses.

CONCLUSION

In this paper, approach based on Genetic Algorithm in order to Multi-objective optimization analysis, management of electricity distribution network planning includes, besides classic load flow and voltage profile analyses, power delivery quality assessments, operation reliability analyses and above all economic evaluation of all investments. This is especially important in medium networks characterized with low consumption and long small cross sectioned conductor, causing two major problems: unacceptably high voltage drop and unacceptably low power delivery quality. Classic solutions for those problems, new MV cable or major reconstructions of the existing conductor, are just not economically justified investments in such areas. This paper deals with the electrical losses in distribution system which can be divided into technical and non-technical. Study of the factors affecting both types of losses has been presented. The magnitude of energy dissipation or the unavoidable component of technical losses depends largely on the system configuration, pattern of loading of distribution conductors, magnitude and types of loads, characteristics of equipment’s etc. There is a formulation of the feeder reconfiguration to reduce technical losses and balance the load of distribution network under normal operating conditions. The calculation of the technical losses in the sample network was calculated using multi criterion algorithm. Multi criterion algorithm has been used to reduce the system power losses. This algorithm is based on reconfiguration of the system under study, while observing the over load and voltage drop combined with system loss to reach the optimum configuration for the system. Results of the paper show that the multi criterion algorithm has succeeded to reduce technical loss for all sample networks of the system to reach the acceptable limit.

Non-technical losses such as unanticipated increases in system losses due to equipment deterioration over time, but are usually ignored in any calculations. System miscalculation on the part of the utilities, due to accounting errors, poor record keeping, or other information errors may also contribute to NTL [12].

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**REFERENCES**


