

ECONOMIC LOSS OPTIMIZATION TECHNIQUE FOR DISTRIBUTION TRANSFORMER SIZING

Master of Science Dissertation



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ECONOMIC LOSS OPTIMIZATION TECHNIQUE FOR DISTRIBUTION TRANSFORMER SIZING

A dissertation submitted to the
Department of Electrical Engineering, University of Moratuwa
in partial fulfillment of the requirements for the
Degree of Master of Science

by

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February 2011

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Declaration

The work submitted in this dissertation is the result of my own investigation, except where otherwise stated.

It has not already been accepted for any degree, and is also not being concurrently submitted for any other degree.

UOM Verified Signature

R/M H L Thushara
15th February 2010



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Abstract

The Distribution system is a dynamic system which requires frequent system augmentation to ensure customer satisfaction and optimum system operation. Planning of such a system needs to consider many variables and alternative solutions in a complex process to select the system components at their economical size combination. Since distribution transformer is the major cost contributor in the secondary distribution network, correct sizing should be achieved via economical optimization in avoiding under utilization. Adoption of a global design methodology is preferred in this case.

This research was intended to implement a model based secondary distribution planning strategy which will be capable enough to provide final solution in a minimum time with economic evaluation. The application of geometry to represent distribution transformer service area is helpful in the system analysis and it simplifies greatly the complexity of the system while allowing comparison of alternative arrangements in a faster manner. Several options are analyzed during this study in comparing actual system data of large number of distribution transformers in Lanka Electricity Company's (LECO) 11kV/400V system. It is concluded that the model of hexagonal geometric service cell area with trapezoidal separation per feeder is the best fit model to represent a secondary distribution transformer service area. This selection is based of voltage oriented. This includes three main feeders originating from the distribution transformer located at the center of the hexagon.

Set of application charts for commonly available distribution transformers are developed in the research. This gives faster method of investigation about voltage drop and power loss for a particular distribution transformer in various configurations. The computer program is finally implemented in MATLAB to generate final solution for the optimum transformer capacity. Existing network expansion or reinforcement is investigated in this program. Economic optimization is implemented in both cases where Genetic Algorithm is used as an optimizing technique for the first option which achieves converged to the global optimum point in a few seconds. A detail case study is done with actual system data to verify the final results.

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Abbreviations

Z_1	Impedance of the main line (Ω/km)
Z_2	Impedance of the spur line (Ω/km)
r_1	Resistance of the main line (Ω/km)
r_2	Resistance of the spur line (Ω/km)
a	Feeder length (km)
ρ	Load density (kVA/km^2)
V_L	Line voltage (kV)
TR_Capacity	Transformer capacity
R	Resistance of the transformer in p.u.
X	Resistance of the transformer in p.u.
$\text{Cos}\phi$	Power factor of the entire network in weighted average
Total_Load	Total load connected to the transformer
FC_{tx}	Fixed cost of distribution transformer
VC_{tx}	Variable cost of distribution transformer
FC_{mf}	Fixed cost of main feeders
VC_{mf}	Variable cost of main feeders
FC_{sp}	Fixed cost of spur lines
VC_{sp}	Variable cost of spur lines

