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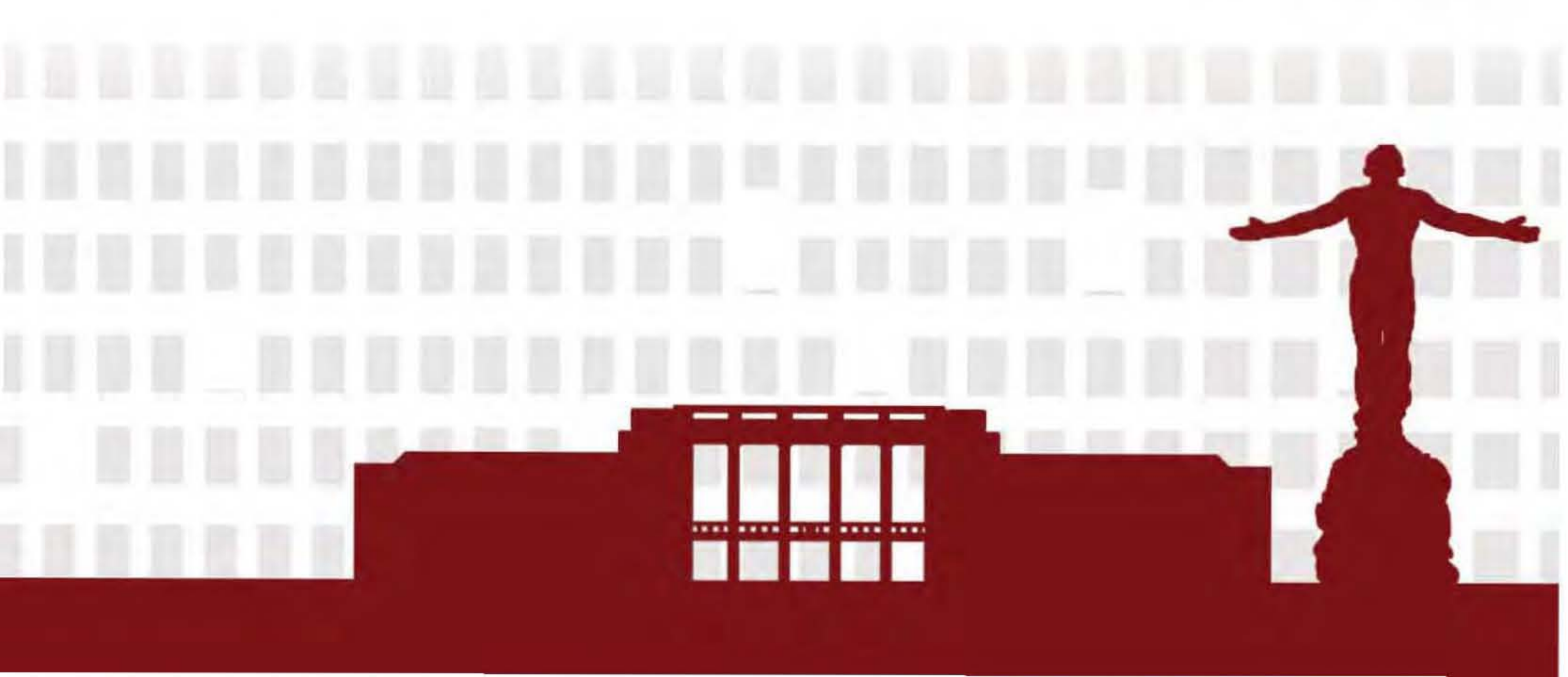

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OPTIMAL PLACEMENT AND SIZING OF CONTROLLABLE AND INTERMITTENT DISTRIBUTED GENERATORS CONSIDERING SYSTEM RELIABILITY

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ABSTRACT

Distributed Generators (DG) are relatively small scale generating units that are directly connected to the distribution system. One of the most common area of study on DG is its optimal placement and sizing. Placement refers to finding the best part of the network to which DG should be connected and sizing refers to finding the optimum capacity of DG to be installed. As an optimization problem, the most common objectives are line loss, reliability and cost.

This thesis proposal aims to prove that a consolidated methodology on optimal DG placement and sizing may be formulated. The proposed methodology will be the first of its kind for it will simultaneously consider a more complete set of objectives (line loss, reliability, installation and O&M cost) and decision variables (placement, sizing, DG types according to power injection, and intermittent nature of photovoltaics and wind turbines).

For the test system, an IEEE 33-bus system will be used. Test system data such as load demand per bus, line impedances, line ampacity, bus voltage limits, number of faults per year and number of customers connected will be gathered. Sizes of commercially available DG will also be gathered for the different types of DG according to power injection. The corresponding installation and O&M costs per KW generation will also be gathered.

A multi-objective function (OF) is formulated, Equation (1), which is a summation of three objectives: cost of line losses, cost of Energy Not Served (ENS), and installation and O&M cost. The cost of ENS will serve as reliability metric for the energy that will not be supplied to the customers when interruptions occur. Line loss (P) and reliability (R) are dependent on the placement (p) and size (s) of the DG, whereas the installation and O&M costs are dependent only on the size of the DG.

$$\min OF(p,s) = P(p,s) + R(p,s) + C(s) \tag{1}$$

For every placement and sizing configuration, the multi-objective function will be evaluated. Using power flow analysis, the total system line loss will be calculated. Calculation of ENS involves fault simulation. For every fault, faulted island is isolated, DG capacities for islanding operations are checked, and the interrupted loads are added. Fault is simulated for every bus, and the average of the interrupted loads is calculated. The installation and O&M costs will depend on the type and size of the DG and will simply be added. To calculate the multi-objective function, the line loss and ENS will be converted to their respective cost equivalents and then added to the installation and O&M costs.

The search algorithm will be programmed in MatLab. Genetic Algorithm (GA) will be used to search for the optimal solution of the optimization problem. GA is a heuristic search algorithm that randomly generates an initial set of solution, called population, which will be continually updated using GA operators, such as elitism, cross-over, and mutation, until the convergence criterion is met. The algorithm will be run 10 times and the best output will be the optimal solution. At the end of the optimization, the fittest chromosome will be decoded to extract the following information: placement, size, line loss, ENS, and installation and O&M cost.

Elitism is selection of fittest chromosomes to automatically become part of the next population. In this proposal, the top 10 chromosomes will automatically be a part of the next population. Cross-over is where randomly selected chromosomes (parents) will be used to generate one chromosome (child) for the next population. The remaining 90 chromosomes will be the resulting child of the cross-over of random parent chromosomes.

Single-point type of cross-over will be implemented and the cross-over point will also be randomized. The random selection of parent chromosomes will depend on the fitness value of the parent chromosomes. Hence, the more fit chromosomes will have a higher chance of being selected. Mutation involves randomly changing a child chromosome, in order to escape from local optima. For this project, one random bit of the child chromosome will be varied.

To validate the result of the algorithm, two steps will be performed: constraint checking and sensitivity analysis. The constraints that will be checked are the number of DG, voltage limits and current limits. The algorithm should output a number of DG that is equal to the inputted number of DG. The placement and sizing of DG should not cause undervoltage, overvoltage, and overcurrent in any point of the test system. Sensitivity analysis involves comparison of the optimal solution to neighborhood configurations. For the placement sensitivity analysis, the DG will be connected to the adjacent bus. For the size sensitivity analysis, the capacity of DG will be changed to the next higher and lower value. In every neighborhood configuration, the OF will be evaluated and will be compared to the optimal solution. The optimal solution from the algorithm should yield a better value of the OF.

Keywords: Distributed Generator, intermittent, optimal placement and sizing, reliability.

References

[1] M. Heidari and M. Banejad, "Value-based Distributed Generation Placements for Reliability Criteria Improvement", *Journ. Electrical Engineering and Technology*, vol. 8, no. 2, Pages 223-229, 2013.

[2] D. Hung and N. Mithulananthan, "Multiple Distributed Generator Placement in Primary Distribution Networks for Loss Reduction", *IEEE Trans. Industrial Electronics*, vol. 60, no. 4, Apr. 2013.