Abstract

Distributed Generation (DG) has gained increasing popularity as a viable element of electric power systems. DG, as small scale generation sources located at or near load center, is usually integrated within the distribution system. The increasing penetration of DG in power distribution systems presents technical and economical benefits as well as integration challenges to utility engineers. Governments are beginning to acknowledge DG as an economically viable alternative to deferring investment at generation, transmission and distribution levels, meeting demand growth and improving distribution network performance and security. Integration of DG has many technical and economical benefits such as

- Reduced line losses
- Voltage profile improvement
- The potential for improved reliability and security
- Reduced GHG emissions from central power plants
- Reduced or deferred investment in generation, transmission and distribution infrastructure upgrades due to relieved T&D congestion
- Lower operating costs due to peak shaving

Several optimization studies have been performed to quantify these benefits and identify DG penetration threshold limits by optimally locating and sizing DG to improve a particular objective, or a combination of objectives.

Optimal placement and sizing problem of DG has a lot of variety; each with all the possible combinations of constraints whichever applicable. Problems considered in this thesis are:

(a) Optimal single and multiple Capacitor placement and sizing for active power loss minimization

(b) Optimal multiple DG placement and sizing for active power loss minimization
(c) Optimal multiple DG and Capacitor simultaneously placement and sizing for active power loss minimization

(d) Optimal multiple DG placement and sizing for simultaneously active power loss and annualized investment cost minimization (A multi–objective approach)

In this thesis, the DG integration problem for multiple installations is handled via metaheuristic methods. Since the optimal DG placement and sizing problem suffers from “combinatorial explosion,” the application of heuristic algorithms in solving optimal DG allocation is justified. This is because although analytical and deterministic methods are more accurate compared with metaheuristic methods for smooth objective functions, the solutions for a non-smooth, i.e. discrete, problem such as optimal DG allocation are likely to be trapped in local optima. In contrast, metaheuristic methods are based on a systematic random exploration of the solution space increasing the chances of finding the global optimum. The Modified Teaching Learning Based Optimization (MTLBO) algorithm has been used to address the optimal placement and sizing problems as mentioned above.

This research presents a comprehensive three stage technique: optimal placement, optimal sizing and financial evaluation of cost savings over a defined planning period to quantify the economic benefit to a distribution company of DG connections in a distribution system. All the studies have been done based on the systems studied most in the research literature. The findings from the thesis reveal that evolutionary techniques used, outperform the conventional methods. Also, the latest evolutionary techniques hold statistically an edge over the older evolutionary techniques. The suitability of the evolutionary algorithms on the optimal placement and sizing problem has been verified from previous existing literature and also from the superior solutions obtained from this particular research work.

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