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# A hybrid particle swarm optimization approach for explicit flexibility procurement in distribution network planning

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**Abstract-**

**Flexibility services enable distribution system operators to actively manage the grid for accommodating demand and generation growth while potentially reducing or delaying investments in grid reinforcements. This paper proposes a novel hybrid particle swarm optimization and linear programming methodology that analyzes explicit flexibility procurement as an alternative to conventional network reinforcements in electricity distribution network planning. The distribution system planning problem is decomposed into a master problem and an inner problem. Binary particle swarm optimization (BPSO) is used to determine the optimal investment decisions, binary variables, from a set of candidate grid reinforcements in the master problem. At the inner linear programming optimization problem, a market-based procurement of flexibility services is performed. The inner optimization problem obtains the total cost of flexibility and the volume of flexibility at each network bus required to defer or avoid part of the grid reinforcements. A real 500-bus medium voltage network is used to validate the proposed methodology. Results illustrate cost-effective network plans that combine flexibility procurement with network reinforcements. A sensitivity to the cost and availability of flexibility services is also conducted to calculate the thresholds where flexibility becomes an efficient alternative to reinforcing the network.**

**Index Terms- Distribution network planning; Demand response; Flexibility; Network reinforcement; Investment deferral**



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