Allocation for Energy Storage System Considering PV Distribution

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Abstract— Renewable Distributed Generations (DG) with high penetration becomes the requirement for PV. In the proposed work, among the many benefits of an energy storage system, the improvement of power system output can be improved voltage profile with the help of Ant Colony Optimization (ACO), which suits the power quality requirement. IEEE bus system is utilized to simulate the measure the power flow and DG placement using MATLAB. The power system for maintaining the power in the grid system. The work helps to provide one time solution for power loss and time optimization in the power flow system. Initially, line data, bus data and power flow data are analyzed and ACO is performed. According to the optimization, the DGs are placed over the PV. The experimental results are shown in the simulation graphs plotted against the proved that ACO is efficient in reducing the power loss.

Key words: Photovoltaic (PV), Distributed Generation (DG), Ant Colony Optimization (ACO), Power System, energy storage, reduced power loss

I. Introduction

Over the last five decades, power flow has been the attractive subject of research for addressing the problems associated with power systems. The capacity of the distributed Generation (DG) can be increased by connecting the plant to the distribution networks.The connection of DGs primarilymodifies the operation of distribution network and creates a variety of well-knownimpacts that ranges from bi-directional power flows to increased fault levels although the capacity is principallylimited by the voltage rise in more rural networks. The mis-match between the location of renewable resources and the capability of the network to adapt to the new generation. Thus Power Flow (PF) has been developed extensively through power systems research to address problems ranging from economic dispatch to loss minimization.

With the dawn of power markets, a diversity of applications for load management activities has come up in recent times. The demand response is indispensable to a fully functioning deregulated electricity market has been extensively accepted fact. The power loss problem in a distribution network is the area of study that requires lots of details. The researchers have tried all the combination of configurations to deal with the issue. In general, a power system must have the following characteristics to have Power Flow (PF)

- Operational cost minimization
- Reduction of network losses
- Minimization of emissions
- The demand for power supply must be satisfied to every customer, at every time.
- The power quality is required to be optimum
- All the safety requirements must be met.
- The power loss problem in a distribution network is solved using various PF techniques. The Power Flow (PF) techniques are developed that has the following merits over PF such as
- Strategy to optimize dispatch generation over the network.
- The dispatch made within the time-horizon
- Model the inter-temporal techniques
- Analysis of the impacts due to energy storage, demand flexibility and ramp rates of the generator.
- Interruptible demand type modeling possible
- The Distribution Networks (DN) are well managed

The Distributed Networks (DN) helps in real-time monitoring of DNs. Hence the penetration of the renewable energy to the plant through DG is increased. The network constraints are minimized using the DN. In order to evaluate the performance of the proposed design for active distribution network, IEEE bus system is used. The IEEE standard bus system provides an environment to study the requirement of the issue of the power system and based on the requirement the proper standard bus system can be chosen from the following types of IEEE bus standard system.

- IEEE-30 system

These are some of the available IEEE bus systems that can be adopted for testing the newly optimized design over power system. These helps to have a robust system with flexible controllability.

The main objective of the proposed system is to place the Distributed generators (DG) in the appropriate place using the proposed algorithm. Also the work focuses on the balanced power maintenance in the bus network. It is implemented by feeding the optimization module with the bus data, line data and power flow data of the power system. The PSO algorithm is overtaken by the Ant Colony Optimizations (ACO) in their power balancing mechanism with the help of DG networks without any power loss. The IEEE bus system is used to verify the proposed system and its performance. The system feasibility with AC optimization is analyzed with the previous system.

The following part of the paper is organized as follows. The prior works related to the DG placement and power balancing mechanisms are discussed with their methodologies and challenges associated with the each modules of those systems in section II gives detailed information on the proposed Ant Colony Optimization (ACO) and their working. Section III gives the evaluation which is supported by the simulation screen shots to prove their applicability in active DG networks. IV Case study in IEEE 30 bus system PV & ESS. The concluding words are provided in section

II. Proposed Method

The ultimate aim of any power system is to reduce the transmission losses and to supply them effectively on demand. The distribution network looks after these requirements with the help of the proposed ant colony optimization in place of earlier heuristic approach combined with particle swarm optimization methods. The basic flow diagram of the optimal power flow system is shown in Fig. 1. In this the bus system is utilized for the power flow analysis of the active distributed network. Based on the analysis made, few parameters are estimated, to control the power and transmit them without loss and with improved quality. The existing system used particle swarm optimization to optimize the power flow by regulating the placement of Distributed Generators. The system produced mere average results while making a comparative analysis with the proposed system.

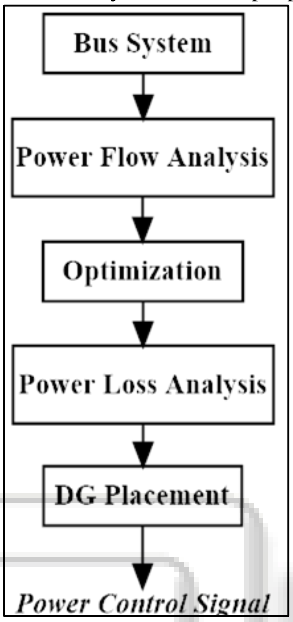

Fig. 1: Flow Diagram of the proposed scheme

In the proposed Ant Colony Optimization system, the Power flow is made possible in the distribution network with good power quality, the power is curtailed based on the demand.

The basic block of the proposed system is listed below and described in detail in the later sections

1) IEEE Bus 30 System
2) Data Collection
3) Ant Colony Optimization
4) DG Placement
5) Photovoltaic (PV)
6) Energy Storage System

A. IEEE Bus 30 System:

The standard network of data is utilized to address the problems associated with the power system. Various type of generation can be made with various numbers of generators in a proper coordinated manner. The values are obtained from the IEEE 30 bus system for the grid system. It is the medium sized network that helps to traverse data from one block to other with the stipulated time and cost frame.

B. Ant Colony Optimization (ACO):

ACO algorithm is introduced to iteratively find the optimal solution of the target problem through a guided search. ACO is an optimization technique, which is based on the foraging behavior of real ant colonies. It is a simple population based ant colony algorithm, which is mainly used to select the index for power flow. The proposed ACO algorithm is a new meta-heuristic algorithm and a successful paradigm of all the algorithms that takes the advantage of the insect's behavior.

C. DG Placement:

The DG placement is the strategy adapted to place the generator in the place of the optimization buses. DG placement is done based on the power and cost requirement of the process. The generator denoted by different cost based on w/hr^2, w/hr and constant terms. This block mainly performs the following functions

– Calculation of the generator power
– Estimation of the total number of generator used
– Placing them appropriately to reduce and maintain the power to an efficient level based on DG placement strategy.

The merits of the proposed ACO includes

– Efficient real time analysis
– Provides most feasible solution for dynamic applications

D. Photovoltaic (PV):

PV systems are like any other electrical power generating system; just the equipment used is different than that used for conventional electromechanical generating system. PV array produces power when exposed to sunlight, a number of other components are required to properly conduct, control, convert, distribute, and store the energy produced by the array. Depending on the functional and operational requirements of the system, the specific components required may include major components such as a DC-AC power inverter, battery bank, system and battery controller, auxiliary energy sources and sometimes the specified electrical load (appliances). In addition, an assortment of balance of system (BOS) hardware, including wiring, overcurrent, surge protection and disconnect devices, and other power processing equipment. Figure 2 show a basic diagram of a photovoltaic system and the relationship of individual components

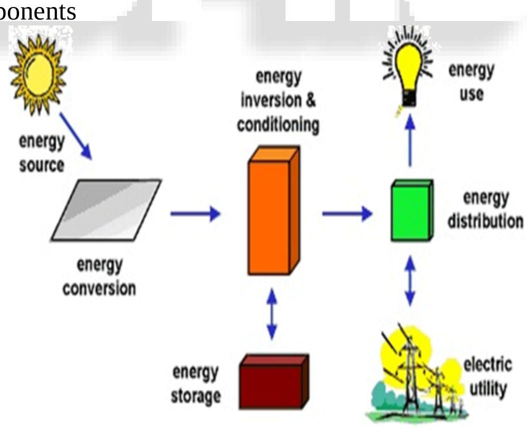

Fig. 2: Block Diagram PV scheme

E. Energy System Storage:

Also called large-scale energy storage is a collection of methods used to store electrical energy on a large scale within an electrical power grid. Electrical energy is stored during times when production (especially from intermittent power plants such as renewable electricity sources such as wind power, power, solar) exceeds consumption, and returned to the grid when production falls below consumption.

III. PERFORMANCE ANALYSIS

The power flow (PF) is simulated in the MATLAB power flow analysis platform. The architecture of the proposed system enables to arrive on the possible solutions for problems in the optimal power flow. The localization of the Distributed generators was the main area of study which is achieved under the time horizons as well. The study is performed over active distributed network which is composed of inter-temporal components. The work is performed for radial network in a remote distribution network. This network must follow certain power flow equations. The system is evaluated with the help of simulations, the metrics used by the system are

1) State of Charge (SOC)
2) Quality
3) Time efficiency

These parameters serve as the measure of system efficiency. The simulated results show 43.20 MW power losses before optimization while the power loss after application of ant colony optimization is found to be reduced to 18.25MW

A. *State Of Charge (SOC):*

The state of charge is an inter-temporal variable defined as the part of total energy capacity used by the energy storage system. The SOC graph is drawn based on the charging and discharging of occurring over multiple time steps. It is validated for DOPF across the time horizons. Fig. 4 presents the SOC of the proposed system. The SOC constraint is given by the following strategy for energy storage in a two generator model of ESS

Fig. 3: SOC for DOPF

B. *Computational Cost:*

Cost minimization for importing is most required for the DOPF in an ADN. Even a feasible solution can be non-optimal. Hence such solutions are avoided to obtain the framework with less computational cost. The following Fig. 4 illustrates the low cost of computation of the proposed system.

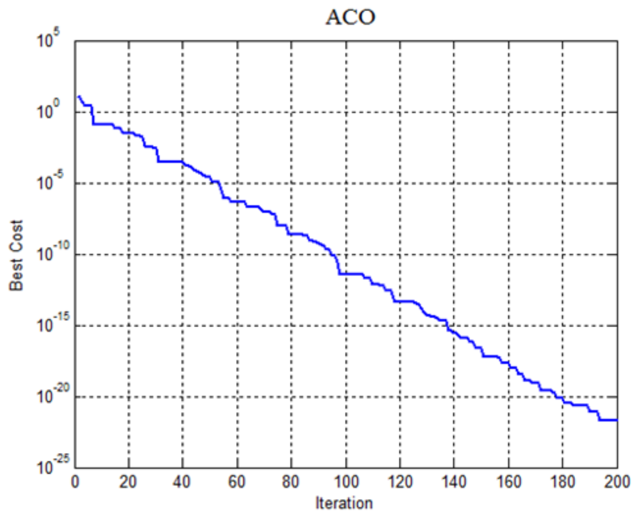

Fig. 4: Computational Cost for ACO

C. *Quality:*

The power quality is the prime requirement of the power system. In an active distribution network. The quality of the power transmitted over a network is based on various factors like DG placement, optimization strategy used and cost estimated traversal with in particular period of time. The proposed system produces a qualitative output which is depicted in the Fig. 5.

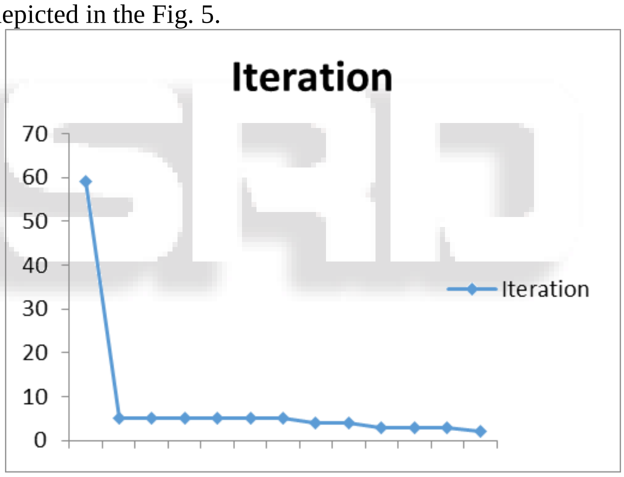

Fig. 5: Performance study of proposed System

D. *Time Efficiency:*

The system is designed in such a way that the time take for execution of the proposed Ant colony optimization is less. Lower the time taken higher will be the time efficiency of the system. Based on the heuristics and Particle Swarm Optimization, the need for active distributed network is approximated. Based on the need, the ACO produces an optimal power floe within the network. The optimal need and the maximum output produced within the minimum possible time by the ACO method are well illustrated in the Fig. 6.

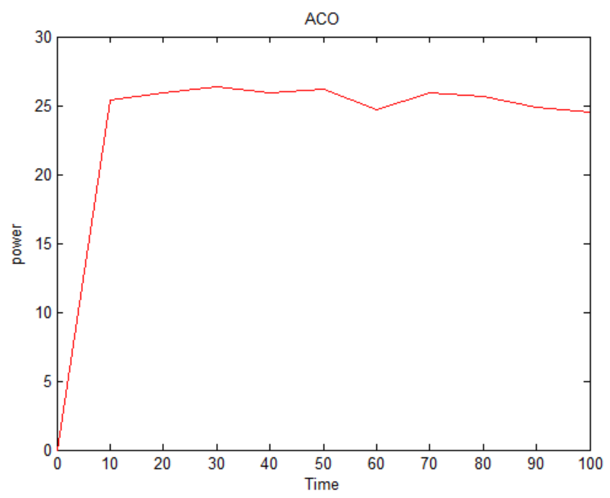

Fig. 6: Time Efficiency of the proposed system

IV. Case Study Result

The case studies of 30 bus system have to optimizing then the result is allocation of PV and ESS Fig.7

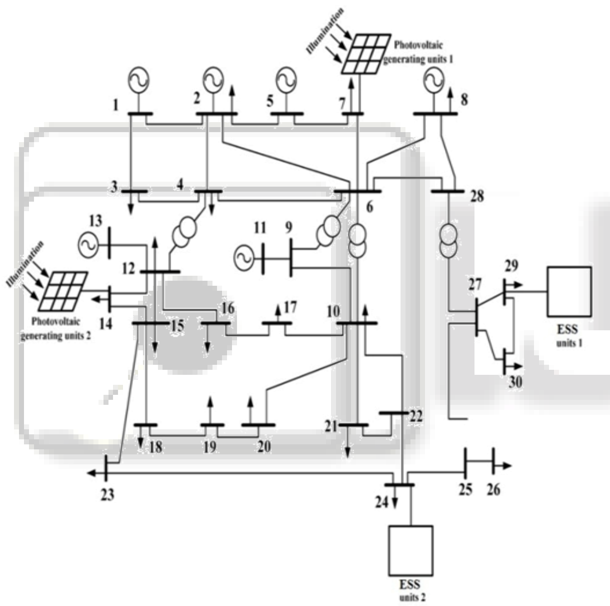

Fig. 7: case study of IEEE 30 bus PV & ESS

V. Conclusion and Future Work

The proposed Ant Colony based Optimization (ACO), enables to schedule the active distributed network for good power balance and power quality. The work focuses on the optimized positioning of the Distributed Generator (DG) in a power system network with dynamic optimal power flow. IEEE 30 bus system is used for running the real time data sets and hence the feasibility of the system is studied. The data from the line, bus and the power flow inside the network is analyzed to arrive with the appropriate scheduling framework using the proposed ACO strategy. The framework is then utilized to determine the DG placement and total number of DG required for efficient power system. The work is then simulated using MATLAB for comparing their performance with the earlier strategy such as Particle Swarm Optimization (PSO). The proposed system is evaluated with their performance metrics such as time efficiency, curtailment, quality of power based on demand with optimistic results.

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