A Review on Meta-Heuristic Approaches for Optimal DG Placement and Sizing Problem

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***Abstract* - Recently, the concept of distributed generation (DG) as a small-scale electric generator located near the load is becoming a very popular topic. This phenomenon happened due to three major reasons; the rapid growing electricity demand of the world's population, the shortage of conventional sources and the increasing concern over greenhouse gas emission. A lot of renewable resources are utilized for DG such as Solar Photovoltaic (PV), Fuel Cells, Wind Power, Mini Hydro Power, etc. Many researches show the significant increase of DG trend worldwide. It is expected that the overall world's new electricity generation is needed 3,000 GW by 2020 and half of them would be generated by DG. This paper reviews all the work done in this field and analyses them for their pros and cons.**

***Keywords* - distributed generation, optimal sizing, meta-heuristic approaches.**

I. INTRODUCTION

Since energy demand is growing rapidly and fossil fuel resources are running out, the world is moving toward distributed generation (DG). Renewable energy resources (RES) have been utilized and developed for DG technology to promote environmental friendly. Among those technologies, solar photovoltaic (PV), wind generators and small hydro power are the fastest growing renewable energy resources in the world (P.K.Olulope, 2010). However, hydro power plant still have big problem about difficulty in finding new site.

Several problems are identified with respect to solar PV and wind integration. Wind power which is mostly induction generators is not grid friendly because they consumes reactive power instead of supply it (Dahal & Mithulananthan, 2010). Solar PV is categorized as inverter based active power generator which has no moving part. Therefore, solar PV has very low system inertia compared to conventional synchronous generator. In practical operation, the operation of inverter can be changed due to various factors such as temperature, solar irradiation, and variation of load. It means that characteristic of inverter can impact the dynamic behavior of power system.

II. INTEGRATION AND SCHEDULING OF DG

The integration of DG in distribution system would lead to improving the voltage profile and reduce active power loss in Power supply. Optimization is a mathematical tool which can be used to locate and size the DG units in the system, so as to utilize these units optimally within certain limits and constraints. The optimal power flow problem has been introduced by Carpentier in 1962. It has taken over decades to develop efficient algorithms for its solution because it is a very large, non-linear mathematical programming problem. Many different mathematical approaches have been applied for seeking its solution. The methods discussed in the literature use one of the following five methods. They are
Lambda iteration method as found in economic dispatch problem solving, Gradient method, Newton-Raphson Method, Linear programming and Interior point method.

III. META-HEURISTIC ALGORITHMS

Apart from analytical approaches, there also exist heuristic search methods. Newly developed heuristic approaches called PSO have been introduced. This method combines social psychology principles and evolutionary computation to motivate the behavior of organisms such as fish schooling, bird flocking, etc. A novel PSO algorithm for distribution system for minimization of active power loss, voltage drop with respect to their loading capabilities.

IV. OPTIMAL DG ALLOCATION

Recently, Distributed Generation (DG) is an interesting topic. New DG technologies are developed and researched widely. However, considering the past, DG is not quite new idea. (Driesen & Belmans, 2006; Zareipour et al., 2004). In the past, people need to produce their own energy because there is no centralized power transmitted via grid such as using cook stove and diesel engine. Then DC electricity has proposed but there is the limitation about voltage drop when DC electricity is transmitted over long distance. So, AC electricity were developed and widely used.
Nowadays, the fossil fuel such as oil and natural gas which is the primary energy being used for conventional generation is running out. In addition, the environmental impact about carbon emission is highly concern. Therefore, renewable energy becomes the alternative choices due to its environmental friendly. Mostly DG is produced by renewable energy such as solar PV, wind and hydro power. This leads to widely development in DG technologies. IEA has confirmed that DG interest is renewed due

to modern technology, economic issue and environmental concern (The international Energy Agency, 2002).
In general, DG may be defined as small-scale electric generator located locally at customer site. However, there is no official agreement on defining what exactly DG is. Many literatures/countries/organizations defined DG more specific depending on their own basis. Mostly they use generation capacity (MW), voltage level, or generation technology as criteria. Following are some sample definitions of DG.
CIGRE defined DG by using capacity rating and location. DG is generation units which have 50 to 100 MW maximum capacities and normally connect to distribution network. Therefore, according to this definition, any generation units installed at transmission network cannot be considered as DG.

V. MULTIPLE DG ALLOCATION

Haesen and Espinoza [8] proposed the optimal Distributed Generation downside for single and multiple Distributed Generation filler. They used Genetic Algorithm methodology to reduce the distribution systems active power flow. Optimization tool is used for finding the Distributed Generation filler and placement issues. Reduced objective perform for used methodology was the world network value. A combination of two algorithms; namely- Genetic Algorithm and simulated tempering meta-heuristic ways has been utilized by Gandomkar et al. [9] to solve best Distributed Generation power output. Time variable load is applied during this optimization to achieve pragmatic results in the meantime all of the study and their necessities are supported cost/benefit forms.
Other methodologies have been utilized like the Tabo search methodology for finding the best Distributed Generation size [10, 11]. The target of their formulation was to reduce system losses. Finally to unravel this multi-objective downside a completely unique approach supported dynamic programming is employed. To size the Distributed Generation optimally further, reactive sources among the distribution system is also taken care of. Nonlinear optimization downside by minimizing.

VI. CONCLUSION

All literature regarding DG allocation problem has been thoroughly studied and presented in this paper. The paper attempts to analyze the optimal sizing and placement problem in case of DG units in IEEE bus systems. The problem becomes a multi-objective constraint optimization problem and meta-heuristic approaches have been utilized by researchers in the recent past to solve this problem.

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