Energy Conversion and Management 98 (2015) 411–429

Contents lists available at ScienceDirect

Energy Conversion and Management

journal homepage: www.elsevier.com/locate/enconman

Blackout risk prevention in a smart grid based flexible optimal strategy using Grey Wolf-pattern search algorithms

Belkacem Mahdad ⇑, K. Srairi

Department of Electrical Engineering, Biskra University, Algeria

article info

Article history:
Received 5 January 2015
Accepted 2 April 2015
Available online 18 April 2015

Keywords:
Power system planning
Risk prevention
Black out
Grey Wolf Optimizer
Pattern search
Reactive power planning
Load shedding
Voltage stability
FACTS

abstract

Developing a flexible and reliable power system planning strategy under critical situations is of great importance to experts and industrials to minimize the probability of blackouts occurrence. This paper introduces the first stage of this practical strategy by the application of Grey Wolf Optimizer coordinated with pattern search algorithm for solving the security smart grid power system management under critical situations. The main objective of this proposed planning strategy is to prevent the practical power system against blackout due to the apparition of faults in generating units or important transmission lines. At the first stage the system is pushed to its margin stability limit, the critical loads shedding are selected using voltage stability index. In the second stage the generator control variables, the reactive power of shunt and dynamic compensators are adjusted in coordination with minimization the active and reactive power at critical loads to maintain the system at security state to ensure service continuity. The feasibility and efficiency of the proposed strategy is applied to IEEE 30-Bus test system. Results are promising and prove the practical efficiency of the proposed strategy to ensure system security under critical situations.

1. Introduction

Security power systems planning under sever loading conditions and at critical situations due to faults in generation units and transmission lines is a vital research area [1]. The security of power system under these situations requires intelligent planning strategy before and after faults to relieve or minimize the effect of possible blackout and to ensure delivering power to the maximum of consumer within the desired and acceptable power quality indices. The research area in security power system planning can be classified into three large categories, the first category known as the static economic dispatch (ED) and dynamic economic dispatch (DED) which is largely treated by researchers during more than fifty years and many mathematical and global optimization methods have been proposed and applied to solve this problem with accuracy. In the literature a large number of review papers are suggested by authors to facilitate the analysis and evolution of different mathematical methods proposed to solving the standard OPF. In this work three excellent review papers are proposed to recapitulate the application of mathematical methods so solving the OPF problem. In [2] authors present a survey of the optimal power flow literature, in [3] a review of selected optimal power flow literature to 1993, this second of a two part paper offers a survey of literature on optimal power flow from 1968–93, this part treats Newton-based, linear programming and interior point method, and finally a recent review [4] present various conventional methods adapted and applied with success to solving many problems related to power system planning, operation and control. The simplified optimal power flow (OPF) solutions was first introduced by Dommel et al. in [5], in [6] the OPF is solved considering steady state security, in [7] the OPF is solved by using an improved interior point method by dynamic adjustments of step sizes and tolerances. The physical aspect of this first planning category is related to minimization of total fuel cost considering many practical constraints, in this category the security of power system such as reactive power limits of generating units, the voltage deviation, and the voltage stability are not considered. In [8], Firefly algorithm (FFA) is applied to solving non-convex economic dispatch problems with valve loading effect, many nonlinear characteristics of power generators, and their operational constraints are considered, such as generation limitations, prohibited operating zones, ramp rate limits, and transmission loss, the results show that the FFA outperforms other metaheuristic methods, in [9], a firefly algorithm is also proposed for solving the combined economic emissions problem taking into account the environmental concerns about the emissions produced by fossil-fuelled power plants, the

⇑ Corresponding author.
E-mail addresses: bemahdad@nselab.org, bemahdad@yahoo.fr (B. Mahdad).

http://dx.doi.org/10.1016/j.enconman.2015.04.005
0196-8904/