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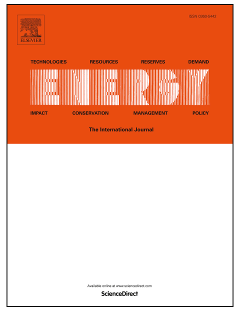

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Houria Smail, Rezak Alkama, Abdellah Medjdoub

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OPTIMAL DESIGN OF THE ELECTRIC CONNECTION OF A WIND FARM

Houria Smail[1], Rezak Alkama[2], and Abdellah Medjdoub[3]

1. Laboratoire de Génie Electrique, Faculté de Technologie, Université de Bejaia, 06000 Bejaia, Algeria; email: houria.smail2014@yahoo.com
2. Laboratoire de Génie Electrique, Faculté de Technologie, Université de Bejaia, 06000 Bejaia, Algeria; email: rezak_alkama@yahoo.fr
3. Laboratoire de Génie Electrique, Faculté de Technologie, Université de Bejaia, 06000 Bejaia, Algeria; email: a_medjdoub@yahoo.fr

Abstract

The network of a wind farm is composed of an internal medium voltage grid which represents several wind turbines and substations, and a high voltage transmission system. The capital cost of the internal grid constitutes a significant part of the total cost of the farm. Thus designing the optimal architecture of a wind farm is a key element in the profitability of a project. In this context, this paper presents a novel solution algorithm for connecting the internal grid of a wind farm. This algorithm is based on a combination between genetic algorithm and a specific algorithm. Genetic algorithm is used to optimize both the position of the electrical substation and the number of its cable feeders, whereas the specific algorithm considers the shortest distance to connect the wind turbines between them and the electrical substation. The proposed approach is tested on a real model of wind farm; the obtained results proved that the proposed algorithm is usefulness during the planning phase of a radial or meshed electrical network in a wind farm.

Keywords: Optimization; wind farm; Genetic Algorithm; network planning

1 INTRODUCTION

A wind farm is composed of several wind turbines (WTs) interconnected by a medium voltage (MV) network, an electrical substation (SS), and a connection point (CP) which is connected to the substation by a high voltage (HV) transmission (see Figure 1). The low-voltage output of each WT generator (generally 690 V) is connected by a step-up transformer to the MV grid (typically 33 kV). Then, each group of WTs is linked to the SS through MV cables. These several parts constitute the internal MV grid [1]. The power collected by the SS is sent to the CP by a HV transmission system, either in High Voltage Alternating Current (HVAC) or in High Voltage Direct Current (HVDC) [2,3].

Due to its advantages, wind energy attracts many researchers in the last decade. Some authors focused their research on problems relating to the participation of this energy in ancillary services like in [4], where authors investigate a new strategy of pitch angle control to ensure a balance between the power generation and power consumption. Due to the inflexible nature of these variable energy sources [5–8], many alternative flexibility sources are considered in [9–12] to face the high penetration of wind power in the electricity supply. Others are more interested in selecting potential sites for wind farms development and working on models and various identification techniques [13–15]. Others researchers are interested in the wind farm micro-siting and working in various models and optimization techniques so that the wind farm can reach the maximal extracted power or economic benefit [16–19]. The most criteria of this optimization are related to the wake effect [20–22] and the aerodynamic characteristics of the site.

Once the positions of the WTs are fixed, the wind farm connection topology that minimizes the total investment cost can also be optimized. Generally, the most common approach to determine the best connection topology of a wind farm is based on comparing feasible architectures. However, there are many possible configurations to connect all the WTs, which complicate the problem. In addition, this complexity is proportional to the size of the wind farm (number of turbines) due to the increase in the number of variables that enlarges the search space of solutions [23,24].