Chapter 24

Analysis of Renewable Energy Power Systems: Reliability and Flexibility during Unbalanced Network Fault

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ABSTRACT

Due to different concerns, renewable energies stand out as an opportunity for a sustainable future. Wind/Photovoltaic Hybrid Systems are one important type of renewable energy power systems. In order to increase renewable energies integration rate, this chapter proposes a utility interactive grid-connected wind-PV hybrid system with storage batteries. Facing modern electricity industries, the hybrid system considers the dispatch-ability and the quality of its power injection into the grid. The adopted modeling approach has been based on energy exchange considerations taking into account the converters structures. Particular attention has been given to cases where the hybrid system is connected to an unbalanced grid. This chapter develops a new control strategy, which aims to isolate the hybrid system of the adverse impact of the grid fault. The results point out thoroughly the applicability of the proposed control scheme under unbalanced grid conditions.

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1. INTRODUCTION

Nowadays, the polluting effects associated with the growth of energy consumption in all conventional forms are at the heart of concerns about the future of the planet to deal with the requirements of sustainable development and environmental care (Chao & Chuang-lin, 2013; Draghicescu et al., 2010). In this sense and at the onset of the liberalization of electricity markets, new offerings of electricity generation are being developed. A major advantage was developed by renewable energies which intervene increasingly in the electricity market.

In addition, various renewable sources of electricity generation have been massive investments to increase their penetration rates: the most widespread are wind Energy Conversion Systems (WECS) (Zuher & Mehrdad, 2013) and Photovoltaic Systems (PVS). Whether wind or photovoltaic sources, these electricity generating systems have fluctuating nature. In order to reduce the random and unpredictable nature of a renewable source potential, the multiplication of various kinds of sources is needed as a convincing solution.

Among the combinations of hybrid systems, that of wind-PV is particularly distinguished giving the availability, the ecological balance favor and the ability to combine them with other sources. Indeed, the advantage of a hybrid system compared to pure wind or photovoltaic pure system depends on many fundamental factors: the type of load, the wind speed, the solar radiation, the cost and the availability of energy, the relative cost of wind machine, the photovoltaic panels, the storage system efficiency and other factors.

Assessment methods of stand-alone (Qi et al., 2011; Valenciaga et al., 2005; Kellogg et al., 1998; Shi et al., 2008) or grid-connected (Mohammadi et al., 2012; Abbassi 1 & Chebbi, 2012; Kim et al., 2008; Chen et al., 2007) wind-photovoltaic hybrid system and their advantages have grown dramatically in recent years. But given the constraints that limit their use, namely production capacity often uncertain and fluctuating uncorrelated to load changes, optimization of the wind-photovoltaic energy depends heavily on economic models of each system taken separately.

The Technologies of hybrid renewable energy systems (HRES) are becoming among the most promising production technologies driving the demand for distributed generation. Indeed, the combination of renewable energy sources can provide a solution for generating electricity in remote areas and can fully optimize the power generation systems, both from a technical and economic point of view. In addition, wind-solar hybrid systems are distributed generation which could be integrated into the grid.

In addition, the increasing penetration of distributed power generation systems made it necessary to think more to conditions of their connection to balanced or unbalanced network. One appropriate requirement is that distributed power generation systems should provide systems service even under grid imbalances. Indeed, facing the behavior of different sources of renewable energy, we thought to use the power electronics that initiated the revolution of hybrid systems. We intend to operate in exploiting the possibilities of controlling power converters that are interfaces between decentralized production units and the network. This is essential because if these systems are not properly controlled, their connection to the utility grid can produce problems on the consumers side (Abbassi 1 & chebbi, 2012; Xiong et al., 2010; Yazdani, 2009). Therefore, considerations of the production of electric power, safe operation and synchronization of the network must be made before connecting these systems to the utility grid (Saccomando et al., 2001; Meddeb et al., 2010; Suul et al., 2012); (Karimi et al., 2012; Karimi et al., 2004).

The presented work focuses on this application and aims to achieve a beneficial impact on energy production in terms of cost and availability, and to solution the problem of the impact of energy on