Available online at www.sciencedirect.com
ScienceDirect
Energy Procedia 83 (2015) 299 – 309
Energy Procedia

7th International Conference on Sustainability in Energy and Buildings

Energy Management for an Autonomous Renewable Energy System

A. Rabhi, J. Bosch, A. Elhajjaji

Laboratory of Modelization, Information and Systems

University of Picardie Jules Verne 3 rue Saint Leu - 80039 Amiens Cedex 1 - France

Abstract

In this paper a controller and an management of production systems focusing on energy from renewable sources is presented. The main result is optimize the energy extracted from renewable sources to and effectively control the charging and discharging of the battery. An algorithm based on fuzzy logic is developed to determine the degree of involvement of each source. Then we develop the controls in power converters installed in the system to properly manage and respond to instructions from the management algorithm. To validate this technique, simulation results are presented.

Peer-review under responsibility of KES International
Keywords: Management, control, energy, photovoltaic, power, fuzzy, renewable

1. Introduction

Scarcity of energy resources, increasing power generation costs and ever-growing demand for energy need an optimal economic dispatch in modern power systems. Optimal management of the combination of renewable energy sources can be a supplement or an alternative to diesel generators commonly used to generate electricity in areas not connected to the public grid. The major issue in energy management is to meet the energy needs of the load efficiently, promoting renewable sources and optimizing cost. Several studies have been made to overcome these problems by adjusting the size of the system or the degrees of implications of different sources. There are several studies in the literature for energy management [1][2][3][4]. They have a common goal: continually meet the needs of the installation, ensure maximum use of the energy produced by renewable sources, minimizing the cost of the energy produced by sources and minimize additional cycles of charging and discharging of the battery and superconducting if they exist [5][6]. They have been made to the study of the different design renewable sources to meet the load while optimizing the cost of installation. For this, we must take into account the high cost of storage facilities and the nature

* Corresponding author. Tel.: +33322825916
E-mail address: abdelhamid.rabhi@u-picardie.fr

Peer-review under responsibility of KES International
doi:10.1016/j.egypro.2015.12.184

of sunlight and wind speed, which greatly influences the quality of the power produced. We must therefore design the photovoltaic panels, wind generators and batteries. So, it takes a good sizing photovoltaic panels, wind generators and batteries. Borowy and al [7] proposed a method for optimal sizing of photovoltaic panels and batteries in a hybrid system. The system is simulated for different combinations and calculates the probability of loss of power generated (LPSP). An alternative method for optimizing the sizing of a system PV/ wind turbine was proposed in the work of Koutroulis et al [8].The optimization was done using genetic algorithms. For our study, we proposed to use the results given by Wang et al [9] for the sizing of renewable energy and battery. The economic aspect is not well treated here, but this system ensures a reliable supply of electricity.

2. Modeling and dimensioning of the different parts of the system

The hybrid system considered here is designed to satisfy a low power load. The average hourly power demand for our load. A wind generator rated power of $1kW$ is assumed in this work. The goal of the sizing here is to minimize the difference between the power generated by renewable sources and the power required by the load over a period of time T. The multi renewable energy sources can be either stand alone or connected to the public network. There are different topologies of autonomous hybrid networks [1].
In this work, we use a hybrid network architecture autonomously series feeding a DC bus with renewable sources like: a photovoltaic generator, a wind turbine and additional sources such as batteries only. This simple structure

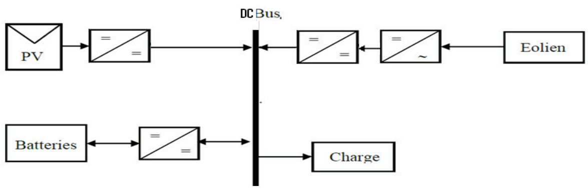

Fig. 1. Multi-source system architecture developed in this work

considered, provides continuous power to the load and allows good control cycles of charging and discharging of the battery.

2.1. PV system

The photovoltaic generator transforms solar energy into electrical energy. It is realized by series connection and parallel modules. In the literature [2], [8] and [9] the photovoltaic cell is often represented as a current generator whose electrical behavior is equivalent to a current source shunted by a diode. The expression for the current I_p of a photovoltaic module according to the output voltage V_p of the module is given by the following equation:

$$I_p = I_{sc}[1 - C_1(e^{(\frac{V_p - \Delta V}{C_2 V_{oc}})} - 1)] + \triangle I \tag{1}$$

Where C_1 and C_2 are constants given by:

$$C_1 = \left(1 - \frac{I_{MPP}}{I_{SC}}\right) e^{\left(\frac{-V_{MPP}}{C_2 V_{oc}}\right)} \tag{2}$$

$$C_2 = \frac{\left(\frac{V_{MPP}}{V_{oc}} - 1\right)}{ln\left(1 - \frac{I_{MPP}}{I_{SC}}\right)} \tag{3}$$

The $\triangle I$ and $\triangle V$ are given by the following equations:

$$\begin{cases} \Delta T = T - T_{ref} \\ \Delta I = \alpha\left(\frac{L}{L_{ref}}\right)\Delta T + \left(\frac{L}{L_{ref}} - 1\right) I_{SC} \\ \Delta V = -\beta \Delta T - R_s \Delta I \end{cases} \tag{4}$$