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ScienceDirect

Energy Procedia 136 (2017) 356–361

Energy Procedia

www.elsevier.com/locate/procedia

4th International Conference on Energy and Environment Research, ICEER 2017, 17-20 July 2017, Porto, Portugal

Distributed photovoltaic systems in Algeria and control of DC-DC converters for grid integration - an overview

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Abstract

This paper describes the current situation of the renewable energies (RE) in Algeria and the structure of the national grid. In view of studying the issues of grid integration of injection of renewable energy produced by distributed systems. The main issues to be considered actually in Algeria are the lines upgrade and the protections design, to prepare the near future of large share of renewable electricity in the national energy mix. For grid integration, due to continuously decreasing cost of battery storage, the modeling and the structure of control of a photovoltaic grid connected system is given.

Peer-review under responsibility of the scientific committee of the 4th International Conference on Energy and Environment Research.

Keywords: Algeria; distributed systems; grid integration; Photovoltaic; renewable energy

1. Introduction

The grid integration of large shares of renewable energy requires a detailed knowledge not only of the grid itself but also the characteristics of the energy mix, as well as the available renewable resources. This knowledge is necessary to optimize the solutions for the grid integration of increasing power production by distributed systems. In this work, first, the structure of the different networks of the Algerian grid is described along with the interconnections with the neighbor countries (Tunisia and Morocco). Second, the current situation of renewable energy in Algeria is

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1876-6102
Peer-review under responsibility of the scientific committee of the 4th International Conference on Energy and Environment Research.
10.1016/j.egypro.2017.10.289

briefly presented. Actually, the renewable energy share in the electricity is very low, but a rapid increase of large photovoltaic power plants is planned according to a national renewable energy program, and at a lower scale, wind energy systems are to be implemented as shown in table [1]. Since less than 2% of electricity is produced from renewable resources, there is no actual grid integration issue of RE in the Algerian grid. But, the share of renewable energy is expected to reach 27 % of the electricity production by 2030. For this reason, this work introduces the study of the grid issues and their mitigation by the use of storage technologies. The structure of a grid management system based on the control of DC/DC converters and inverters is understudy. The different models used to implement the different components of a photovoltaic (PV) system connected to the grid are described in the last section.

Nomenclature

I_L	Photocurrent
I_0	Saturation current
q	Charge of electron
K	Boltzmann's constant
m	Ideality factor
T	Junction temperature
Rs	Series resistance
Rsh	Parallel resistance
IM	Maximum current
VM	Maximum Voltage
ISC	Short circuit current
VOC	Open circuit voltage
Vt	Thermal voltage
Vbatt	Battery voltage
E0	Battery constant voltage
K	Polarisation resistance
Q	Battery capacity
it	Actual battery capacity
R	Internal resistance
i	Battery current
i*	Filtered current
Exp	Exponential zone voltage
u	Charge or discharge mode
A	Exponential zone amplitude
B	Exponential zone time constant inverse

2. Electricity sector in Algeria

2.1. Electricity production

In 2015, 99.1 % of the population in Algeria has access to electricity [2]. The installed capacity increased from 7492 MW in 2006 to 17238.6 MW in 2015[2]. This amount represents nearly 1 GW of additional electrical power production in about ten years. The average growth rate of the electricity demand is 7.2% in the North of Algeria. This rate is larger in the Southern area, the average increase is 14.86% per year concerning the pole of In Salah, Adrar and Timimoun (PIAT); the average rate is 12.44 % per year for the isolated networks (mini grids) which are based on Diesel and gas turbine power generation. To meet the rapidly rising demand in the isolated regions of the Algerian Sahara, many small power plants have been implemented between 2012 and 2015. The total demand for electricity in isolated regions in 2015 was 64.7 TWh, representing a rise of 6.9% as compared to the year 2014 [3].