Available online at www.sciencedirect.com

ScienceDirect

Energy Procedia 141 (2017) 76–80

Energy Procedia

www.elsevier.com/locate/procedia

4th International Conference on Power and Energy Systems Engineering, CPESE 2017, 25-29 September 2017, Berlin, Germany

Groundwater sources assessment for sustainable supply through photovoltaic water pumping system, in M'zab valley, Ghardaia

Azzedine Boutelhig[a]*, Aicha Melit[a] and Salah Hanini[b]

[a]*Unité de Recherche Appliquée en Energies Renouvelables, URAER, Centre de Développement des Energies Renouvelables, CDER, 47133, Ghardaïa, Algeria.*

[b]*Laboratoire LBPT, Energie Renouvelable, Université Yahia Farés, Médéa, Algeria*

Abstract

The solar photovoltaic water pumping system seems to be the best suited technology to supply water for domestic usage, in the remote desert areas. The Algerian high plateaus and Sahara are the main candidate regions. However, the system performance optimality is generally affected by different dynamic variability parameters, in particular solar radiation and ambient temperature. Nevertheless, other parameters have an important impact on the system performances; as the provided/required water volumes, spatial characteristics of the area, the kind and type of crops, as well as the techniques adopted in collecting and conducting water. In this view, a survey study on spatial area of the M'Zab valley, Ghardaia, has been conducted, including the assessment of the groundwater source behavior. The goal was to select the appropriate wells suitable for standalone PVWPS installations. Accordingly, a field investigation has been carried out throughout different locations of the M'Zab valley to determine the hydraulic structure of the water table and the spatial characteristics distribution of the region. According to the statistical data, obtained, previously, it has been averred that the valley involves abundant water table within static average between 100 and 150 m, on upstream and between 50 and 80 m on downstream. The phreatic water table is reached between 20 and 50 m, as medium averages, whereas, the Ben-Isguen, Bounoura and AL-Atteuf zones are considered to be the suitable for PVWPS installations.

Peer-review under responsibility of the scientific committee of the 4th International Conference on Power and Energy Systems Engineering.

Keywords: Dynamic variability, spatial characteristics, groundwater, suitability, distribution

1. Introduction

The permanent water supply ensures the sustainability and environment protection. Supply water in the wide Algerian desert regions is currently the main concern. Recently, the demand on water for irrigation and for satisfying livestock has been increased in these regions, regarding the new rehabilitated agricultural farms and grasslands. Nonetheless, the current requirement on water leads to increased demand on electricity to feed the pumps to extract the needed water quantities. Despite the availability of huge groundwater aquifer, the supply of energy stills the main constraint, due to the far of the main grid. The cost to supply fuel for diesel pumps which are the only adopted system in pumping water is very high, due to the far of the fuel supply stations. Moreover, the absence of paved roads can be another inconvenience for transport means. Fortunately, the abundant solar irradiation, covering the whole Algerian south, throughout the four seasons of the year consists an important free, sustainable and clean

* Corresponding author. Tel.: +213 561355424 ;.
E-mail address: boutelhig@yahoo.com

1876-6102 © 2017 The Authors. Published by Elsevier Ltd.
Peer-review under responsibility of the scientific committee of the 4th International Conference on Power and Energy Systems Engineering.
10.1016/j.egypro.2017.11.015

source of energy. In other hand, the Algerian south is attracting great number of investors in the agricultural sector and in ranching, due to the availability of aquifer and fertile lands which provide high quality and large crop productivity. As consequences, the renewable- powered pumping systems, in particular the PV-powered pumping system becomes the most required method to supply water. Accordingly, both research and government efforts are being focusing on the development of this new technology. The objective is focused on strengthening the national market in vegetables and fruits, providing feed for cattle and reducing the import invoice. Consequently, the best living conditions and sustainable development will be created in the way to prevent the rural exodus. Additionally, fighting desertification, halting the land degradation, conserving the grassland areas, protecting the biodiversity and ecosystems consist another challenge. In this view, various research works were focused on the PV water pumping system sizing, optimality and installations, especially in the North African and Middle East desert regions. The performances, modeling, optimality sizing of PVWPS are presented by many authors. Bouzidi et al. [1] studied and compared the two different renewable-powered water pumping systems of solar and wind sources, which were applied in the Adrar region, Algeria. They concluded that the system equipped with motor-pump SP5A-12 doesn't show any deficit at total dynamic head 24 m. They also carried out an assessment study, where he evokes the strategy of a photovoltaic pumping system in the Algerian Sahara [2]. The water pumping field was opened widely on modeling, regarding the different used input data. Hamidat et al. [3], proposed a PV water pumping system based on pump model and they validated by experimental results, obtained following several tests undertaken at the water pumping test facility, in Algeria. In the meanwhile, Ould-Amrouche examined a PV water pumping system with evaluation of their CO2 emissions [4]. Haddadi et al. [5] investigated different methods based on Artificial Neural Networks (ANNs) for estimating the hourly flow-rate, using hourly air temperature and irradiance data, acquired from PVWPS installed at Madinah site, Saudi Arabia. Accordingly, A. Benatiallaha et al. [7] studied the performance of solar pumping system in Algeria and they concluded that the climatic and social condition can affect the system operation and its profitability. Thus the optimality of the system in configuration and efficiency has been investigated, in Ghardaia, Algeria [10,11]. Regarding, climatic variations influenced directly on the water management, R. Benniou et al. [12, 13] examined the climate change impact on agriculture, by using the ground various parameters, in semi-arid region in Algeria. They concluded that the culture can benefit from the first year fall to avoid the dryness from end cycle, due to the lack of water. Recently, novel optimization procedures were proposed, taking into consideration socio-economic multi-objectives, as the availability of groundwater resources and the effect of water supply technique [14 -16]. In the meanwhile, Techno-economic feasibility has also been adopted by P.E. Campana [17], in the aim to obtain reliable and optimal PVWPS system for irrigating grassland and farmland, in China. Following to these mentioned contribution, the groundwater behavior in M'zab valley has been assessed by considering different parameters, in the way to look for the eventual suitable technically and economically PV water pumping system.

Nomenclature

ANRH Agence Nationale des Ressources Hydrauliques (National Agency of Hydraulic Resources)
OPVM Office de Protection du Valley de M'Zab (Office of Protection and Management of M'Zab valley)
LATPSud Laboratoire d'Analyse Topologie du Sud (Laboratory of Topology Analysis of South)

2. General survey of M'Zab valley

2.1. Spatial map of M'zab valley

In the heart of the Sahara, southern of Algiers from about 600 km, the M'zab valley splits through a limestone plateau, within the coordinates: 32° 26' and 32°31' latitude North, and 3°37' and 3°46' longitude east. It involves five fortified agglomerations, located on rocky outcrops, called "Kosars".The total area of the five Ksours is estimated of about 75 km^2 and it includes: El'Atteuf (Tadjnint) built in 1012, Bounoura (Has Bunur) built in 1046, Ghardaia (Taghardait) built in 1053, Melika built in 1124, and Beni-Isguen built in 1347 [18]. The width of the valley varies between 2.35 and 1.5 km upstream and decreases progressively downstream to reach 0.55 km to the south of the EL-Atteuf. The altitudes are relatively low; they decrease progressively from upstream to downstream, 514 to 508 m in Ghardaia area and 455 to 450 m in EL-Atteuf zone, and about 435 m at Ahbas the lowest point of EL-Atteuf oasis. The main flora is the oasis, vegetable crops and fruit trees, and fodder. Surface water occurred in flood periods, which recharge aquifers is the main source of water supply. The occupancy map drawn up by satellite IKONOS (2000) (LTPsud) shows that the total area is 31.18 km^2 (3118.8 hectares), 30% occupied by town (10.63 hectares), oasis 40% (14.10 hectares). The fig.1 presents the Google map of the M'Zab valley.