Available online at www.sciencedirect.com

ScienceDirect

Energy Procedia 93 (2016) 66 – 73

Energy Procedia

Africa-EU Renewable Energy Research and Innovation Symposium, RERIS 2016, 8-10 March 2016, Tlemcen, Algeria

Wind energy for electricity generation in the far north region of Cameroon

Dieudonné Kaoga Kidmo[a]*, Kodji Deli[a], Danwe Raidandi[a], Serge Doka Yamigno[b]

[a]*Higher Institute of the Sahel, University of Maroua, P.O. Box 46 Maroua, Cameroon*
[b]*Higher Teachers Training College, University of Maroua, P.O. Box 46 Maroua, Cameroon*

Abstract

This paper explores mountain ridges around Kousseri and Maroua in the far north region of Cameroon for assessing the potential for wind energy development and electricity generation. A 28-year (1985-2013) wind speed data measured at 10 m above ground level (AGL) is statistically analysed using Weibull Distribution, a widely accepted model to probabilistically describe wind speeds variations. Weibull scale and shape parameters are determined using an iterative method, namely, the moment method. The power law relationship is considered to extrapolate Weibull parameters and wind profiles at exposed ridge-tops in the range of 100-300 m AGL. The results show that the selected ridge-tops fall under Class 3 or greater of the international system of wind classification and are deemed suitable for most wind turbine (WT) applications. A performance assessment of five commercial WT (50 to 2000 kW) for electricity generation is then realized through the computation of their respective capacity factors, power and energy outputs. Amongst explored WT, YDF-1500-87 (1500 kW) emerges as the most attractive option for installation, with the highest capacity factor and the lowest cost of energy.

Peer-review under responsibility of the organizing committee of RERIS 2016

*Keywords:*Wind energy; wind turbine; electricity; energy output; capacity factor; cost of energy.

* Corresponding author. Tel.: +237 696745644; fax: +237 222 293 112.
*E-mail address:*kidmokaoga@gmail.com

1876-6102
Peer-review under responsibility of the organizing committee of RERIS 2016
doi:10.1016/j.egypro.2016.07.151

1. Introduction

Electricity is one of the main drivers that contribute to improve economic opportunities and, even a better quality of life. In Cameroon, the annual growth in electricity consumption (7 to 8 %) requires at least 100 MW of new electricity generating capacity. So far, the supply of electricity is lacking far behind. Access to electricity stands at 18.5 and 87.5 % for rural and urban populations, respectively. In the Northern Interconnected Grid (NIG) region, the above rates are estimated at 3 times lower than that of national averages. The need for electricity keeps rising as population continues steadily to grow. For more than 30 years, access to electricity in the NIG region has been achieved through grid extension only. A very high rate of grid losses (24 to 30 %) makes grid extension not a cost-effective option for the National Electricity Utility Company, ENEO. Furthermore, the majority of households are dispersed and have no access to electricity due to low incomes, coupled with high grid-connected cost [1]. On the other hand, off-grid standalone solar or wind energy systems are considered the best alternatives in the NIG region to locally provide electricity.

Globally, wind energy has proved to be one of the cheapest forms of low carbon electricity [2]. Under ambitious growth rates, the wind power could generate between 16.7 and 18.8 % of the global electricity by 2030 and help save over 3 billion tons of CO_2 emissions annually [3]. Worldwide, 52,016 MW of new generating capacity was added at the end of 2014, bringing the total cumulative installed WT capacity to 372,961 MW, to just about 3 % of the global electricity supply [4]. Although solar photovoltaic (PV) experienced the fastest capacity growth rates of any energy technology, with 39.0 and 38.2 % in 2013 and 2014 respectively, wind energy achieved the most power capacity added of any renewable technology. In Africa, sustained growth of commercial scale WT has so far occurred in Morocco, Tunisia, Algeria, Egypt, South Africa, Ethiopia and Cape Verde [5]. Despite representing 0.77 % of the global wind power generation capacity in 2014, the wind industry in the African continent saw the highest capacity growth rates (48.20 %) in the last six years. The continent reached 2,778 MW commissioned by end-2014, against just 1,942 MW online a year earlier. South Africa contributed the most in terms of newly installed wind capacity, with 560 MW brought online at the end of 2014. It was followed by Morocco (300 MW) and Egypt (10 MW) [4]. In Cameroon, the wind energy sector is not well-known and the country has no previous experience in wind power generation. Based on the available literature, very few studies have been accomplished up to now [6–8]. No reference is made to studies on performance evaluation of WT for electricity generation in the country.

In this study, a 28-year (1985-2013) wind speed data measured at 10 m AGL has been statistically analysed using the Weibull Probability Density Function (PDF). Weibull PDF, among various other distributions functions models [9] such as Rayleigh, Pearson, lognormal, normal, gamma to name few, is by far preferred by the majority of the researchers involved in wind speed and energy modelling as a consequence of its simplicity and up to standard precision level [10]. The present study has considered the moment method (MM), an iterative calculation process to estimate and extrapolate Weibull parameters, in addition to predict wind energy outputs, capacity factors and cost of electricity generated by five commercial WT ranging from 50 to 2000 kW. The objective of this study is to assess the performance of WT for electricity generation as well as to estimate the costs of wind energy production at hilltops and exposed ridge-tops around Kousseri and Maroua. The wind flow at selected hilltops with well exposed sites is considered within the scope of linear models for vertical extrapolation of wind speed data measured at 10 m AGL. Therefore, the power law relationship is considered to extrapolate Weibull parameters and wind profiles at exposed ridge-tops in the range of 100-300 m AGL.

1.1. Description of the localities and region

Kousseri and Maroua are located in the Far North Region of Cameroon, in semi-arid sudano-sahelian climate. The Far North is characterized by annual rainfall of between 400-900 mm during a rainy season that lasts about four months, between July and October. Maroua, is located at latitude 10°35’50” N and longitude 14°18’57” E, with an elevation of 384 m above sea level. On the other hand, Kousseri, which is approximately 184 km (air distance) far from Maroua, is positioned at latitude 12°04’42” N and longitude 15°01’51” E, with an elevation of about 271 m above sea level. The districts of Kousseri and Maroua are surrounded by highlands, hilltops and inselbergs that are part of the Mandara Mountains.