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Assessment parameters and matching between the sites and wind turbines

A.Chermitti[a,b] , M. Bencherif[a], Z. Nakoul[a], N. Bibitriki[a], B. Benyoucef[a]

[a]*Unité de Recherche Matériaux et Energies Renouvelables (URMER)*
Université Abou-Bekr Belkaid, B.P. 119, Tlemcen, Algérie
[b]*Laboratoire d'automatique Departement GEE / Faculté-Technologie*
Université Abou-Bekr Belkaid, B.P. 230, Chetouane Tlemcen, Algérie

Abstract

The objective of this paper is to introduce the assessment parameters of the wind energy production of sites and pairing between the sites and wind turbines. The exploration is made with the wind data gathered at 10 m high is based on the atlas of the wind of Algeria established by the National office of the Meteorology runs 37 stations of measures. The data is used for a feasibility analysis of optimum future utilization of Wind generator potentiality in five promising sites covering a part of landscape types and regions in Algeria.

Detailed technical assessment for the ten most promising potential wind sites was made using the capacity factor and the site effectiveness approach.

The investigation was performed assuming several models of small, medium and big size wind machines representing different ranges of characteristic speeds and rated power suitable for water pumping and electric supply. The results show that small wind turbines could be installed in some coast region and medium wind turbines could be installed in the high plateau and some desert regions and utilized for water supply and electrical power generation, the sites having an important wind deposit, in high plateau we find Tiaret site's but in the desert there is some sites for example Adrar, Timimoun and In Amenas, in these sites could be installed a medium and big size wind turbines.

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Keywords: Wind energy; Wind characteristics; wind speed distribution; capacity factor; site effectiveness.

1. Introduction

To seize the range of renewable energies in Algeria and the stakes considerable, it is suitable first of all, to remind the considerable and inexhaustible existing resources of renewable energies not yet exploited, namely the exceptional solar layer which covers a surface of 2.381.745 km2, with more than 3000 hours of solar radiation per year and and an appreciable potential of wind energy and geothermic that can be easily mobilized.. In addition, these energies are clean, renewable and are used where they are and their decentralized character is appropriate well at the scattered state of the zones with low density of population**.**

Consequently, they can contribute to the environmental protection and be regarded as future and

* Chermitti ali. Tel.: 0213 526 0591. *E-mail address*:a.chermitti@yahoo.fr

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alternative resources of energy in relation to the conventional resources. These energies are foreseen of the future of the rural world and against its insulation and for health of their inhabitants and to supply water, electrical power generation and telecommunications and to struggle against deforestation. What induces the stabilization of the populations on their origin places with promising prospects as for their living conditions. The ratification of the protocol of Kyoto and the law on the promotion of renewable energies within the framework of the durable development came to confirm the Algerian political good will and the engagement of our country for the exploitation of renewable natural resources and without polluting , thanks to an increased mobilization of the efforts of research and development for the control of the technologies implemented in the installations of conversion of the power renewable energies.

Nomenclature
E output energy, MWh/year
f(V) winds peed frequency distribution function
Pr rated output power of the turbine
Vc cut-in wind speed
Voff cut-off wind speed
Vm mean wind speed
V3m, cubic mean wind speed
Vo operational wind speed
Vr rated winds peed
CF capacity factor
ε Site effectiveness
η WECS overall efficiency

2. Wind distribution and available power

In many cases, the Weibull probability density function allows to model the availability of wind energy for a specific region by means of the probability of occurrence of the wind speed. The Weibull and Rayleigh probability density functions are commonly used and widely adopted in wind power studies. It is important to keep in mind that Rayleigh is only a subset of Weibull probability density function. The Weibull probability density function is defined as, [1, 2, 3, 4, 5]:

$$f(V) = \frac{k}{c}\left(\frac{V}{c}\right)^{k-1} \exp\left(-\left(\frac{V}{c}\right)^{k}\right) \tag{1}$$

The cumulative distribution function of the velocity V gives us the fraction of time (or probability) that the wind velocity is equal or lower than V. Thus the cumulative distribution F (V) is the integral of the probability density function [3, 6]:

$$F(V) = 1 - \exp\left(-\left(\frac{V}{c}\right)^{k}\right) \tag{2}$$

k : is the shape factor of the Weibull law, describing the distribution of the winds velocity.
C : in m/s is the scale factor of the Weibull law, it is connected to the mean velocity by the shape factor k.

3. Energy conversion model

The model of energy conversion used for the evaluation of the wind turbine siting and potentiality is the linear model, which is given by a single equation relating electrical power output to wind power input by the following relation [1, 5]:

$$P = (\eta_{me}\eta_{el})Pa = 0.5\rho(Cp\,\eta_{me}\eta_{el})V^{3} \tag{3}$$

Where *Pa* is the fraction of power extracted from the power in the wind and η is the global output of the system, which takes account various efficiency; electric (ηel), mechanics (ηme) aerodynamics (CP).

As for the power curve model of a real wind turbine, it can be modelled by four parameters: the cut-in speed Vc, the rated speed Vr, the cut-off speed Voff, and the nominal power Pr.