Feasibility Assessment for Use of Wind Energy in Ardebil
and Zanjan Provinces

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Extended Abstract

Introduction

In comparison with fossil fuels which pollute the lower layer of the atmosphere, use of wind energy has many environmental and economic advantages. Wind is a clean and renewable energy resource and use of the energy in the recent decades has been welcomed so much in the world. Energy plays an important role in the development of each society. All different activities including housing, transport, industry and agriculture may be dependent on this source of energy. The use of clean and renewable energy such as wind has environmental advantages compared with fossil fuels. The increase of population and demand for energy has caused that wind energy potential is considered as an alternative source of energy. Wind speed is the most important parameter of the wind energy. This is used in the analyses relating to this energy because wind power has a cubic relation with wind speed.

Methodology

The parameters of Weibull distribution is used to estimate the parameters related to wind energy

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and determine the sites which have wind energy potential. Thus, it is important to use proper methods in the estimation. In this paper, 6 distinct methods for estimating parameters of Weibull distribution have been considered. For this purpose, 5 synoptic station which have adequate 3 hours wind speed data from 1987 to 2009 (23 years) have been selected. These stations are: Ardebil, Parsabad, Khalkhal, Zanjan and Khoramadare. The method of moments, empirical, graphical, energy pattern factor and maximum likelihood methods and probably weighted moments have been employed to estimate scale (m/s) and shape parameters (dimensionless) of Weibull distribution. For determining the best parameters estimating method using cumulative distribution function of the Weibull distribution ($F(v)$), expected values have been generated. The Chi square test has been used to select the appropriate method. Cumulative distribution function has also been used in order to calculate the probability that wind speed is smaller than or equal to 5 m/s. In addition to 10 m height, Weibull distribution parameters and parameters related to wind energy potential namely, wind power density (Wm^{-2}), wind energy density ($Kwh^{-1}m^{-2}$), the most probable wind speed (ms^{-1}) and the maximum energy carrying wind speed (ms^{-1}) have been computed in 20 and 40 m.

Results and Discussion

Among considered methods, method of moment because of having higher significance level and lower chi square compared with other methods has been selected as the best one to estimate Weibull distribution parameters. Using this method, scale and shape parameters of Weibull distribution at 20 and 40 m height has also been estimated. Then, wind energy characteristics, namely, wind power density (Wm^{-2}), wind energy density ($Kwh^{-1}m^{-2}$), the most probable wind speed (ms^{-1}) and the maximum energy carrying wind speed (ms^{-1}) have been computed. The results have showed that at monthly time scale and in 10 m height, the maximum value of k was observed in Zanjan and Khalkhal stations on June and the lowest value of k in Khalkhal station in January. The maximum value of c was observed at Ardebil in Februrary and the lowest value of c at Parsabad in November. Using the wind power density all the stations are ordered as following: Ardebil, Khoramdareh, Khalkhal, Parsabad and Zanjan. This order shows that Ardebil has high potential of wind energy and Zanjan has the minimum potential.

Conclusion

We can summarize main conclusions drawn from this investigation as following:

- In this study, among the considered methods, the method of moment is specified as the proper one and using parameters obtained from this method, features relating to wind energy in studied stations were estimated.
- Among the studied stations, the maximum of wind power density is observed at Ardebil. In this station, in 40 meter height the largest value of wind power density which was equal to 491w/m^2 is also observed. The minimum value of wind power density is observed in Zanjan which is equal to 107.2 w/m^2.
- The probability that wind speed is smaller than or equal to 5 m/s was calculated using

cumulative distribution function for the studied stations in 3 heights namely 10, 20 and 40 meter. The results showed that in 10 m height, among studied stations the highest probability belongs to Ardebil. After Ardebil station, the highest probability was observed in Khoramdare.

- In 10 meter height, at Parsabad, Khalkhal and Zanjan in all the year the probability is lower than Ardebil and Khoramdareh. So, in these stations the operating possibility of wind turbines will be low.