Estimating the Maximum Potential Energy of the Wind in Lorestan Province using Satellite Data

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Extended Abstract

1. Introduction

Given all types of renewable energies, the use of solar and wind energies appears to be more cost-effective in Iran. Despite the superiority of solar energy over other means of new energy production, attention must be paid to a few important points; first, the efficiency of photovoltaic cells in converting solar energy into electricity is 10-15%. Second, using solar energy requires considerable expenses; subsequently, more attention is paid to wind energy today. In addition, since power plants are dispersed and decentralized, they are less vulnerable during wartime or other natural disasters compared to centralized power plants (Saghafi, 1993). Substituting fossil fuels with clean and renewable energies in this province, making proper use of the wind energy given the environmental necessities, diversifying energy sources, and lack of dependence on other provinces in the area of energy are of substantial importance. Accordingly, the wind energy is placed under assessment in this study in order to pave the way for the use of this energy in this province.

2. Review of Literature and Theoretical Framework

Since many years ago, it has been proven that the wind energy can be used mechanically or electrically. Meanwhile, fossil energy resources involve a number of particular financial and environmental challenges. Moreover, in addition to its intense environmental consequences such as nuclear waste, etc., nuclear energy requires considerable costs and highly advanced technology. As a result, man has always been seeking new energy sources to substitute the aforementioned sources of energy. Bailal et al. (2013) examined the possibility of converting the wind energy into electricity at north-eastern shore of Senegal. Fazelpour et al. (2017) used the Windograher software and satellite data to estimate and assess the potential energy of the wind in Sistan and Balouchestan province. Their results showed that cities including Zahedan, Zabol, and Zahak had a high capacity for

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producing energy from the wind's density force. Asaakereh et al. (2019) used the Windograher software to assess the wind power at Ardabil synoptic station since 1990 until 2008. Their obtained results showed the average wind speed at Ardabil station as 7.4 m/s.

3. Method

The potential energy of the wind was estimated based upon hourly data obtained from 8 selected stations during the period of 2000-2019 using satellite data from MERRA-2 Modal. Satellite data were then validated relative to station data by collecting hourly data on the wind speed from the weather forecast organization. In addition, satellite data were further assessed and validated relative to station data at 10-meter height level by calculating the correlation coefficient, mean error, and root of the mean square error. Next, the wind rose was drawn using the Windographer software and Weibull probability distribution was used for data fitness. The annual density force of the wind was calculated at height levels of 30, 50, 100 meters.

4. Results and Discussion

Following the validation of satellite data relative to station data with an error value of 0.4047218, it was shown that the satellite data are suitable to be used in this study. According to calculations, the highest potential energy of the wind at 30 meters level belong to stations including Borujerd, Alashtar, Kamalvand, Azna, Aligoudarz, Nour Abad, Doroud, and Kouhdasht with values of 128, 102, 98, 86, 69, 57, 50, and 41 Watt/m^2 per hour, respectively. At 50 and 100 meter levels, these values increase with a specific proportion as they also rise at the 30 meter level for other height levels at all stations. There is a suitable potential for producing energy from the wind density force in stations including Borujerd, Alashtar, Nour Abad, Azna, and Kamalvand at height levels of 30, 50, and 100 meters as well as Aligoudarz, Kouhdasht, and Doroud stations at 100 meter height level.

5. Conclusion

The results suggest the desirability of the wind's potential energy and possibility of establishing wind turbines in Borujerd, Alashtar, Nour Abad, Azna, and Kamalvand at height levels of 30, 50, and 100 meters from sea level; findings also point to the same results in Aligoudarz, Kouhdast, and Doroud only at the 100 meter level as the potential energy in these regions are not sufficient at 30 and 50 meters. The natural texture of the region is, in fact, the best guide for selecting a site for wind turbines. Drawing the wind rose in the region can also be another proper initial indicative for the possibility of using the wind energy. As a matter of fact, wind roses are drawn charts that demonstrate the frequency distribution of wind's direction and speed. Therefore, it can be expressed that establishing wind turbine farms across the province is currently practical and cost-effective.

Keywords: Weibull Distribution, Wind Density Force, Satellite Data, Lorestan Province

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