Wind Energy Potential Assessment in Chalus County in Iran

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Abstract- This study presents wind energy potential assessment in Chalus county in Iran. Wind data are collected 14 months from 2006 to 2007 in the time interval of 10 minutes at heights of 30 and 40 meters. The values of k (dimensionless Weibull shape parameter) at 40 m height were ranged from 1 to 1.34 with a mean value of 1.14, whereas the values of c (Weibull scale parameter) were ranged from 1.85 to 3.43 with a mean value of 2.83. At 40 m height, monthly mean wind speeds during 14 months, were ranged from 1.75 to 3.42 m/s with annual mean wind speed of 2.69 m/s. Possibility of monthly mean wind speeds of over 4 m/s has not been observed for both 40 m and 30 m. Feasibility of installing a small wind turbine was studied. The type of the wind turbine is "Bergey XL.1" with cut-in wind speed of 2.5 m/s. In 7 successive months of the year, April, May, Jun, July, August, September and October, especially in August, the mean wind speed is between 2.5 m/s and 3.3 m/s (for both 30 m and 40 m) which seems to be adequate for installing this wind turbine. However because of low energy production of the wind turbine (493 kWh/yr), low capacity factor (5.6 %) and having low monthly mean wind speeds (less than 4 m/s), it is not economical to install this small wind turbine in this site. According to the statistics it was concluded that the wind potential of studied site is not capable for using wind energy in order to produce electricity but is probably capable for mechanical applications such as water pumping.

Keywords- Chalus; Iran; Wind energy potential; Assessment; Wind turbine; Weibull.

1. Introduction

In the year 2010 worldwide wind energy capacity reached 196,630 Megawatt. China became number one in total installed capacity (44,733 MW) and added 18,928 Megawatt within one year. In this year, altogether 83 countries, one more than in 2009, used wind energy for electricity generation. Among these 83 countries Iran was rated 39th (about 100 MW capacity) [1]. Preliminary studies have shown an estimated practical wind power potential of at least 6,500 MW. Wind power in Iran generated 220 GWh of electricity over the year, which was slightly lower than the figure in 2009 (230 GWh) due to some technical difficulties [2].

The amount of power that can be produced from wind in Iran is estimated 20000 MW. The capacity of wind power in Iran is 92 MW up to 2011 statistics. Table 1 shows installed capacity of wind farms in Iran up to 2011 [3].

Iran that is located in a low-pressure area on the one hand, & on the other hand, due to its proximity to high-pressure areas in north & northwest, generally it is affected by 2 kinds of wind:

1. Winds that are blowing in winter from the Atlantic Ocean & Mediterranean sea and also central Asia.
2. Winds that are blowing in summer from Indian Ocean & also from northwest.

In the year 2002, SUNA organization, started a wind potential assessment project for producing wind atlas of Iran. This project was finished in 2009. In this wind atlas, 26 areas of Iran including 45 sites were investigated [3].

1.1. The wind energy potential assessment review

The wind characterization in terms of speed, direction and wind power is the first step to obtain the initial feasibility of generating electricity from wind power through a wind farm, in a given region. In the wind energy literature, many relevant works have been developed in this aim:

Table 1. Installed capacity of wind farms in Iran up to 2011 [3].

Region	Row	Number of Wind Turbines	Wind Turbine Capacity (kW)	Install Date	Total Installed Capacity (MW)
Manjil	1	28	330&550	2003	12
	2	10	300	2005	3
	3	10	550	2006	5.5
	4	22	660	2006	14.52
	5	17	660	2007	11.22
	6	15	660	2008	9.9
	7	9	660	2009	5.94
Binalud	1	20	660	2006	13.2
	2	23	660	2007	15.18
Zabol	1	1	660	2009	0.66
Tabriz	1	1	660	2009	0.66
Isfahan	1	1	660	2011	0.66
Total Installed Capacity					92.44

1.1.1. Recent studies in the world

Laerte de Araujo Lima et al [4] analyzed wind characterization and wind power potential in Brazilian northeast region and showed the wind map and the wind power density map using WAsP program. G. Bekele et al [5] studied wind potential assessment at four locations in Ethiopia. The study showed that, three of four locations have the average wind speed of 4 m/s whereas another one has the mean wind speed of less than 3 m/s. A. ouammi et al [6] carried out a study about monthly & seasonal assessment of wind energy characteristics at four monitored locations in Liguria region in Italy. They used wind speed data collected between 2002 & 2008.it is found, capo vado is the best site. The highest energy produced may be reached in December with a value of 3800 MWh. Fyrippis et al [7] studied the wind energy potential assessment in Naxos island, Greece using the Weibull and Rayleigh distribution functions at 10 m height. Wind power density at 10 m height was found 420W/m^2. Yanıktepe et al [8] presented an assessment of wind power potential in Osmaniye, turkey at the height of 10 m. Their results showed that the power generating from the wind energy is low in Osmaniye. Al-Yahyai et al [9] assessed the wind energy potential of 29 weather stations in country of Oman. During five years study of hourly wind data in Oman it was concluded that QayroonHyriti, Thumrait, Masirah and Rah Alhad have high wind power potential and that QayroonHyriti is the most suitable site for wind power generation. Hassan et al [10] analyzed wind speed data from 21 major Canadian airports between the years 1971-2000. On the one hand, their simulation indicated that locations of St. John's, Newfoundland and Labrador could produce the highest amount of total annual power (i.e. 883,993 kWh), and Charlottetown, Prince Edward Island, on the other hand, could produce the least amount (i.e. 344,508 kWh in total, annually). Al-Abbadi [11] presented a study about wind energy potential assessment in five locations in Saudi Arabia. Daily, monthly and frequency profiles of the wind speed at 40 m height at the sites showed that Dhulum and Arar sites have higher wind energy potential with annual wind speed average of 5.7 and 5.4 m/s and speeds higher than 5 m/s for 60 and 47% of the time, respectively.

1.1.2. Recent studies in Iran

Alamdari et al [12] analyzed wind speed data for 68 sites at different heights in Iran. GIS themes of wind potential were also used in this study. Mostafaeipour et al [13] carried out a study about wind energy potential assessment in the city of Shahrbabak in Iran. The mean wind speed data of three-hour interval long term period from 1997 to 2005 was adopted and analyzed. It is found that the city is not an appropriate place for construction of large-scale wind power plants but is suitable for employment of off-grid electrical and mechanical wind driven systems. An economic evaluation was done in order to show feasibility of installing small wind turbines. Reiszadeh et al [14] presented a study about wind energy potential assessment in Bardekhun station in Bushehr province in Iran. A Matlab code using the blade-element-momentum theory has been developed to design and analyze the three-blade wind turbine rotor. Saeidi et al [15] studied the wind resource assessment in two province of Iran, north & south Khorasan. Mostafaeipour [16] analyzed wind speed data over a period of almost 13 years between 1992 and 2005 from 11 stations in Yazd province in Iran, to assess the wind power potential at these sites. The results showed that most of the stations have annual average wind speed of less than 4.5 m/s which is considered as unacceptable for installation of the large-wind turbines. Mirhosseini et al [17] assessed the wind energy potential at five towns in province of Semnan in Iran using Weibull model. They used the power law for extrapolation of 10 m data to determine the wind data at heights of 30 m and 40 m. Keyhani et al [18] analyzed three-hour period measured wind speed data of eleven years for the capital of Iran, Tehran at height of 10 m based on the Weibull model. Their study showed that, the studied site was not suitable for installing large-scale wind turbines.

1.2. The studied site

Chalus county is a county in Mazandaran province in Iran. At 2006 census, its population was 119,559. The county has three cities: Chalus, Kelardasht, and Marzanabad.

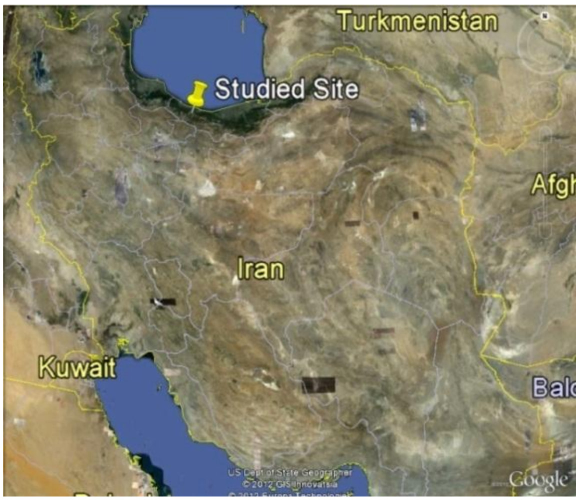

Fig. 1. Position of studied site in Iran.

The studied region is located in Kelardasht in Senar village (36.50417 N, 51.25722 E). It is near to Caspian Sea. The precipitation in Kelardasht is very high. Fig. 1 shows the Position of studied region in Iran [3, 19].

2. Material and methods

2.1. Weibull probability distribution function

Statistical analysis can be used to determine the wind energy potential of a given site and estimate the wind energy output at this site. To describe the Statistical distribution of wind speed, various probability functions can be suitable for wind regimes. Weibull distribution is the best one, with an acceptable accuracy level. This function has the advantage of making it possible to quickly determine the average of annual production of a given wind turbine [17].The wind speed probability density function can be calculated as eq.1 [18]:

$$f(v)=\frac{k}{c}\left(\frac{v}{c}\right)^{k-1}\exp\left[-\left(\frac{v}{c}\right)^{k}\right] \quad (k>0,\ v>0,\ c>1) \qquad (1)$$

Where f (v) is the probability of observing wind speed v, c is the Weibull scale parameter and k is the dimensionless Weibull shape parameter. The Weibull parameters k and c, characterize the wind potential of the region under study. Basically, the scale parameter, c, indicates how 'windy' a wind location under consideration is, whereas the shape parameter, k, indicates how peaked the wind distribution is (i.e. if the wind speeds tend to be very close to a certain value, the distribution will have a high k value and is very peaked) [18].

2.2. Wind power density

Wind power density (WPD) is a truer indication of a site's wind energy potential than wind speed alone. Its value combines the effect of a site's wind speed distribution and its dependence on air density and wind speed.WPD is defined as the wind power available per unit area swept by the turbine blades and is given by the eq.2 [20]:

$$WPD=\frac{1}{2n}\sum_{i=1}^{n}\rho(v_i^3) \qquad (2)$$

Where n is number of records in the averaging interval, ρ is air density, v_i^3 is cube of the ith wind speed value [20].

2.3. Cumulative distribution function

Another important statistical parameter is the cumulative distribution function f (U). It represents the time fraction or probability that the wind speed is smaller than or equal to a given wind speed, U. It can be shown in eq. 3 [17]:

$$f(U)=1-\exp\left[-\left(\frac{U}{c}\right)^{k}\right] \qquad (3)$$

2.4. Turbulence intensity

Wind turbulence is the rapid disturbance or irregularities in the wind speed, direction, and vertical component. It is an important site characteristic, because high turbulence levels may decrease power output and cause extreme loading on wind turbine components. The most common indicator of turbulence for siting purposes is the standard deviation σ of wind speed. Normalizing the value with the mean wind speed gives the turbulence intensity (TI) and can be calculated by eq. 4[20]:

$$TI=\frac{\sigma}{U} \qquad (4)$$

Where σ is standard deviation of wind speed, U is the mean wind speed [20].

2.5. Energy pattern factor

The energy pattern factor, K_e, whose application is in turbine aerodynamic design, can be defined as the total amount of power available in the wind divided by the power calculated from cubing the average wind speed is given by eq. 5 [18]:

$$k_e=\frac{1}{N\bar{U}^3}\sum_{i=1}^{N}U_i^3 \qquad (5)$$

Where N is the number of time steps, U_i is the wind speed at time step i, Ū is the mean wind speed [17].

2.6. Energy content of the wind

Energy content of the wind can be calculated as eq. 6 [20]:

$$\frac{\bar{E}}{A}=\frac{\bar{P}}{A}\cdot\frac{8760hr}{yr}\div\frac{1000W}{kW} \qquad (6)$$

Where $\bar{E}$/A is the average wind energy content ($kWh/m^2/yr$), $\bar{P}$/A is the average wind power density (W/m^2) [21].

2.7. Wind shear profile

Wind shear refers to the change in wind speed with height above ground. The wind speed tends to increase with the height above ground. The variation in the wind speed with height above ground is called the wind shear profile. In the field of wind resource assessment, analysts typically use one of two mathematical relations to characterize the measured wind shear profile: the logarithmic profile (log law) and the power law profile (power law). Brief descriptions of each follow [21]:

2.7.1. Logarithmic profile

The logarithmic law (or log law) assumes that the wind speed varies logarithmically with the height above ground according to the eq. 7 [21]:

$$U(z) = \frac{U^*}{k} \ln\left(\frac{z}{z_0}\right) \quad \text{If } z > z_0 \text{ , } U(z) = 0 \text{ if } z \le z_0 \qquad (7)$$

Where U (z) is the wind speed at some height above ground z, U* is the friction velocity, k is von Karman's constant (0.4), z_0 is the surface roughness, ln is the natural logarithm [21].

2.7.2. Power law profile

The power law assumes that the wind speed varies with the height above ground according to the eq. 8 [21]:

$$U(z) = \beta z^{\alpha} \qquad (8)$$

Where U (z) is the wind speed at some height above ground z, β is a constant, α is the power law exponent (alpha) [21].

3. Results and discussion

Wind data are collected over one year, from 2006 to 2007 in the time interval of 10 min at heights of 30 m and 40 m and was analyzed by Windographer 2.5 software [22]. The meteorological masts with 40 m height were installed in suitable coordinates by power ministry. The data logger used has three sensors of velocity at 10 m, 30 m and 40 m heights and also two sensors of direction at 30 m and 37.5 m. Table 2 shows the general information about the studied site.

Table 2. General information about the studied site.

Variable	Value
Latitude	N 36.50417
Longitude	E 51.25722
Elevation	1200 m
Start date	2006/07/11
End date	2007/08/27
Length of time step	10 minutes
Mean temperature	14° C
Mean air density	1.06 kg/m^3

3.1. Average wind speed

The annual mean wind speed was calculated 2.69 m/s & 2.59 m/s for 40 m & 30 m heights respectively. Monthly mean wind speed at heights of 40 m and 30 m is shown in fig. 2.

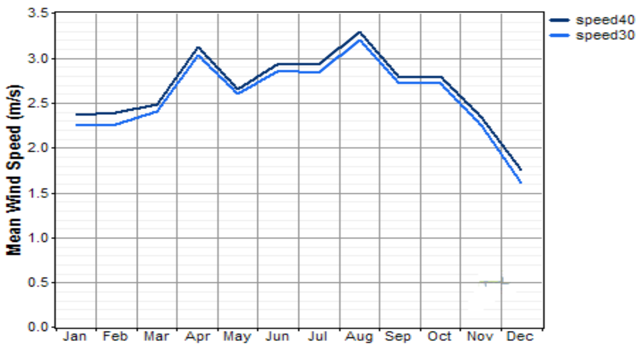

Fig. 2. Monthly mean wind speed for 40 m and 30 m heights (plotted in average of one year).

In addition, in tables 3 and 4, the mean wind speed with standard deviation & Weibull parameters are shown for each month for 40 m & 30 m heights.

Table 3. Monthly mean wind speed with standard deviation & Weibull parameters for 40 m.

Year	Month	Mean (m/s)	Std.Dev (m/s)	Weibull k	Weibull c (m/s)
2006	Jul	3.31	2.99	1.08	3.42
2006	Aug	3.42	3.27	1	3.43
2006	Sep	2.78	2.44	1.15	2.93
2006	Oct	2.78	2.49	1.20	2.98
2006	Nov	2.34	2.11	1.18	2.49
2006	Dec	1.75	1.76	1.15	1.85
2007	Jan	2.36	2.65	1.11	2.48
2007	Feb	2.38	2.19	1.19	2.55
2007	Mar	2.48	2.18	1.21	2.65
2007	Apr	3.12	2.45	1.34	3.41
2007	May	2.64	2.20	1.26	2.86
2007	Jun	2.93	2.46	1.18	3.11
2007	Jul	2.66	2.33	1.15	2.80
2007	Aug	3.17	2.81	1.12	3.32

Table 4. Monthly mean wind speed with standard deviation & Weibull parameters for 30 m.

Year	Month	Mean (m/s)	Std.Dev (m/s)	Weibull k	Weibull c (m/s)
2006	Jul	3.22	2.98	0.99	3.21
2006	Aug	3.35	3.22	0.96	3.29
2006	Sep	2.72	2.43	1.10	2.82
2006	Oct	2.71	2.40	1.18	2.88
2006	Nov	2.24	2.02	1.14	2.35
2006	Dec	1.60	1.68	1.01	1.61
2007	Jan	2.24	2.44	1.07	2.31
2007	Feb	2.25	2.10	1.09	2.33
2007	Mar	2.39	2.10	1.17	2.54
2007	Apr	3.02	2.36	1.32	3.29
2007	May	2.60	2.19	1.21	2.78
2007	Jun	2.85	2.44	1.11	2.96
2007	Jul	2.58	2.32	1.07	2.65
2007	Aug	3.09	2.79	1.06	3.16

As it can be seen, at height of 40 m, the lowest wind speed occurred in Dec 2006 with a value of 1.75 m/s. whereas the maximum wind speed occurred in Aug 2006 with a value of 3.42 m/s & with a maximum Weibull c, 3.43 and minimum Weibull k, 1. Jul (2006), Aug (2006), Apr (2007) & Aug (2007) are four months that the mean wind speed is upper than 3 m/s. the maximum standard deviation occurred in Aug (2006) with a value of 3.27 m/s.

Diurnal mean wind speed is demonstrated in fig. 3. This figure shows hours of day that have a suitable wind speed in all over the year. Best wind speeds almost occur at 11 am - 4 pm at heights of 40 m and 30 m with wind speed values of upper than 4.5 m/s.

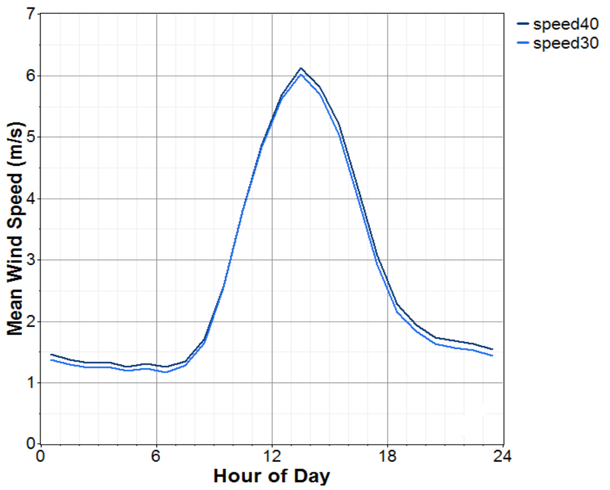

Fig. 3. Diurnal mean wind speed for 40 m & 30 m heights.

3.2. Wind speed distribution

Wind speed frequency distributions have been estimated using Weibull probability function. By looking at the graphical result, it can be seen from the Figs. 4 and 5 that the Weibull distribution fits actual distribution data well. Mean shape (*k*) and mean scale (*c*) values of the Weibull function were calculated for each month and they can be seen in table 5. In addition, energy pattern factor & wind energy content were also calculated in table 5.

Table 5. Mean Weibull parameters with other wind features.

Variable	40 m height	30 m height
Weibull k	1.14	1.08
Weibull c (m/s)	2.83	2.67
Mean energy content (kWh/m^2/year)	428	385
Energy pattern factor	4.79	4.83

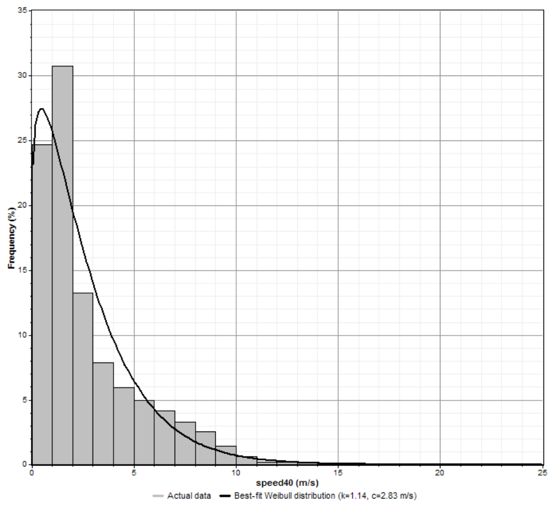

Fig. 4. Wind speed distribution at 40 m.

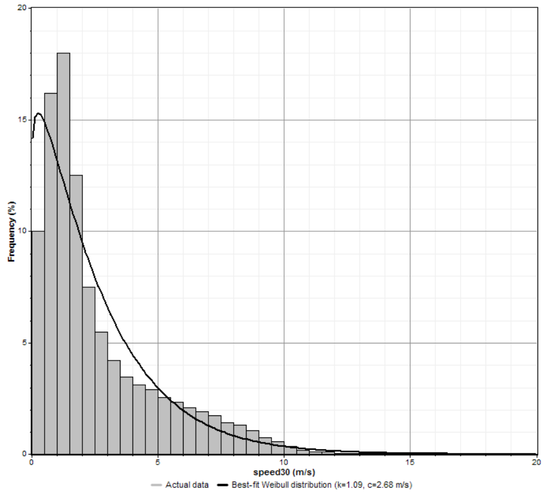

Fig. 5. Wind speed distribution at 30 m.

3.3. Cumulative distribution

Fig. 6 shows the cumulative distribution at two heights. It can be noted that, for example, the wind speed at 30 m and 40 m heights is greater than 4 m/s just for 23% of the time in the year. The 4 m/s limit is important since this is the cut-in speed of many commercial wind turbines.

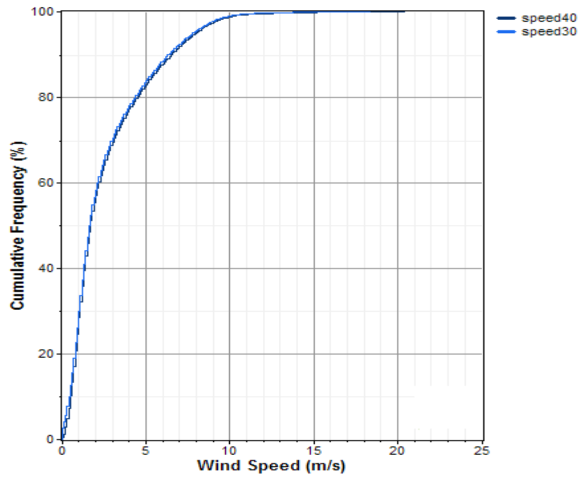

Fig. 6. Cumulative distribution for 40 m and 30 m heights.

3.4. Wind direction

Determining wind speed according to wind direction is important to conduct wind energy researches and displays the impact of geographical features on the wind. The cycle (360°) is divided in 12 sectors. As it can be seen in table 6, for wind speed at height of 40 m versus wind direction sensor at 37.5 m, the maximum wind speed, occurred in 45° - 75° with a value of 4.28 m/s, whereas, the lowest wind speed is in 105° -135° with a value of 0.96 m/s. the direction status at 37.5 m height is close to 30 m height. The wind roses at two heights (30 and 37.5) are shown in figs. 7 and 8, indicating this fact that the direction of wind is from north east for both 30 and 37.5 m heights. In the wind rose for 37.5 m, the frequency with which the wind blows from the north east direction (at a wind speed above the calm threshold) is about 17%. At the top right of each wind frequency rose, There is a calm frequency, or the frequency with which the wind speed is equal to or less than the calm threshold. In the example in fig. 8 the calm frequency is 77%. Wind roses in figs 7 & 8 do not include these calm winds in the wind rose diagram. In this study, calm threshold was considered 4 m/s.

Table 6. Wind direction statistics for wind speed at 40 m height versus direction sensor at 37.5 m.

Direction Sector (°)	Mean (m/s)	Std.Dev. (m/s)	Weibull k	Weibull c (m/s)
345 -15	1.40	1.14	1.29	1.52
15 -45	2.77	1.80	1.58	3.09
45 -75	4.28	2.52	1.73	4.80
75 -105	1.23	0.87	1.52	1.38
105 -135	0.96	0.83	1.28	1.04
135 -165	1.21	1.16	2.38	1.91
165 -195	2.03	2.76	2.36	4.02
195 -225	1.83	2.46	2.80	4.27
225 -255	1.26	0.92	6.32	4.16
255 -285	1.20	0.88	1.55	1.35
285 -315	1.21	1.43	3.59	3.47
315 -345	1.22	1.18	1.16	1.29

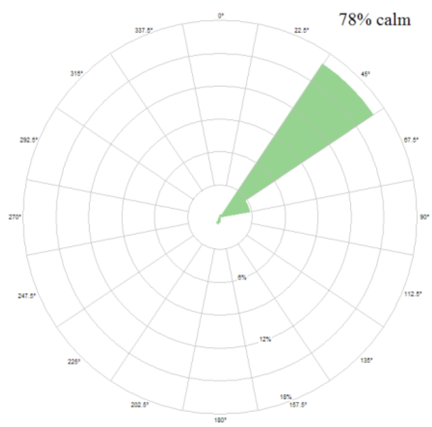

Fig. 7. Wind rose at 30 m.

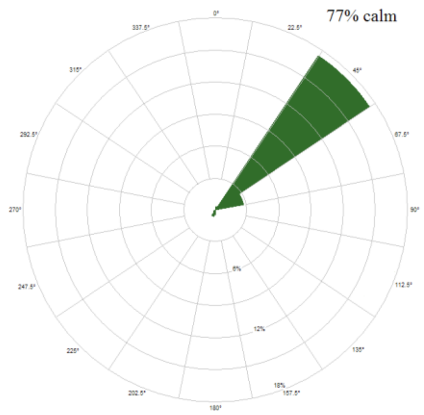

Fig. 8. Wind rose at 40 m.

The wind rose in fig. 9 is for plotting the total amount of wind energy coming from each direction sector at 40 m height. This example shows that about 67% of the total amount of energy in the wind comes from the north east direction.

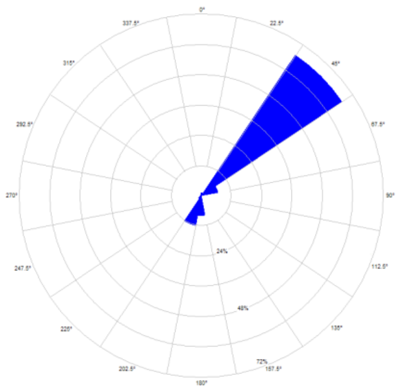

Fig. 9. Wind rose for total energy at 40 m.

Figs. 10 and 11 show the mean (average) value of wind speed at 40 m & 30 m heights versus wind direction at 37.5 m height. For example, it can be seen, Wind rose in fig.10 indicates that winds from the north east direction tend to be the strongest, with an average wind speed of over 4.5 m/s. Winds from other directions tend to be the lightest, averaging less than 3 m/s.

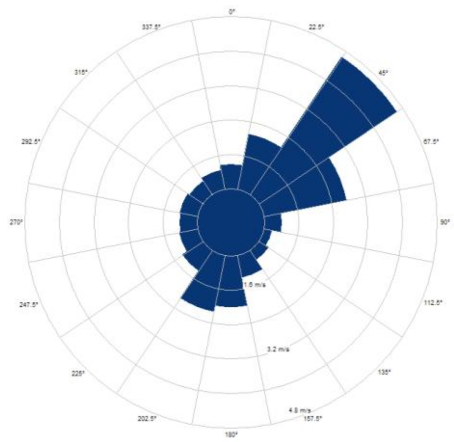

Fig. 10. mean wind speed at 40 m vs. wind direction at 37.5 m.

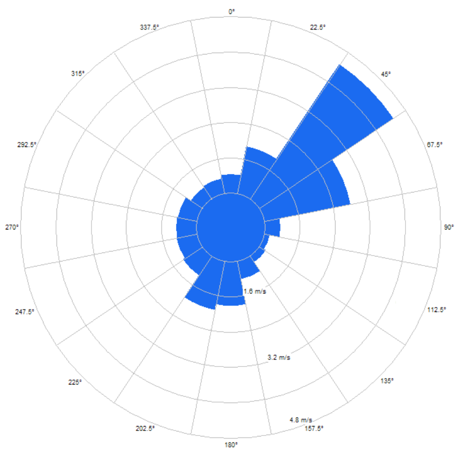

Fig. 11. mean wind speed at 30 m vs. wind direction at 37.5 m.

3.5. Turbulence intensity

In figs. 12 and 13, Maximum of turbulence intensity is shown about 3.7 and 4.2 for 40 m and 30 m heights respectively. In addition, the average of it is 0.305 and 0.345 at heights of 40 m and 30 m respectively.

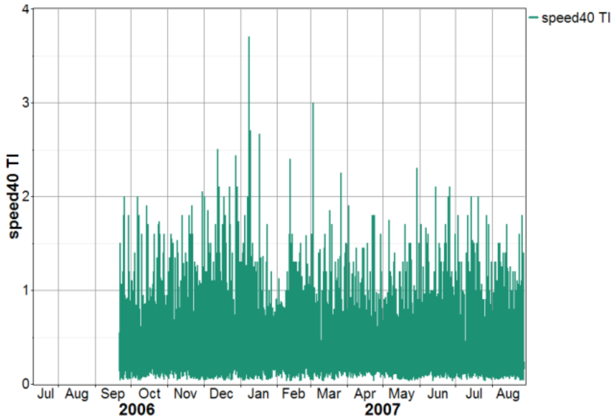

Fig. 12. Monthly measured turbulence intensity at 40 m.

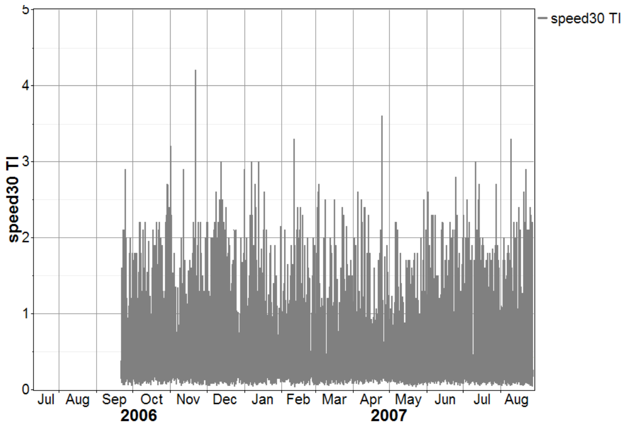

Fig. 13. Monthly measured turbulence intensity at 30 m.

In figs. 14-17, mean turbulence intensity versus wind direction was plotted for two heights of 30 m & 40 m at two direction sensors of 30 m & 37.5 m. it can be noted for example in fig.14, the maximum mean turbulence intensity occurred in direction sector of 112.5° with a value of 0.487.this wind rose also shows that in north-west and south-east, the value of turbulence intensity is upper than other directions.

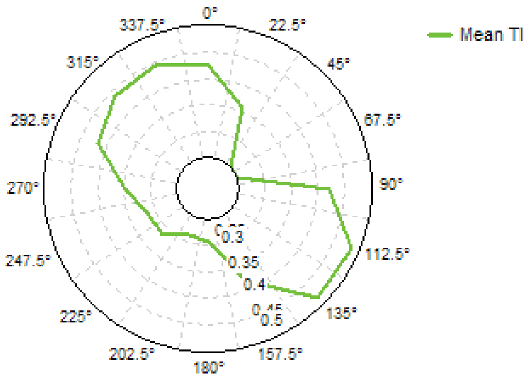

Fig. 14. Mean turbulence intensity at 40 m versus wind direction sensor at 37.5m.

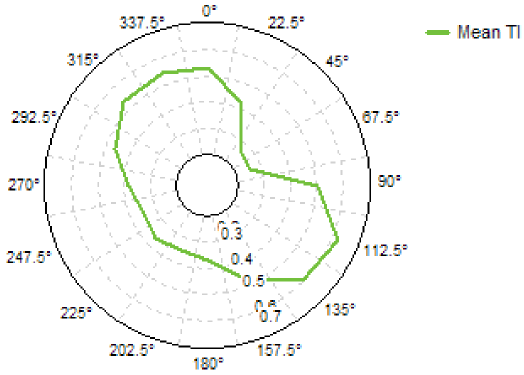

Fig. 15. Mean turbulence intensity at 30 m versus wind direction sensor at 37.5m.

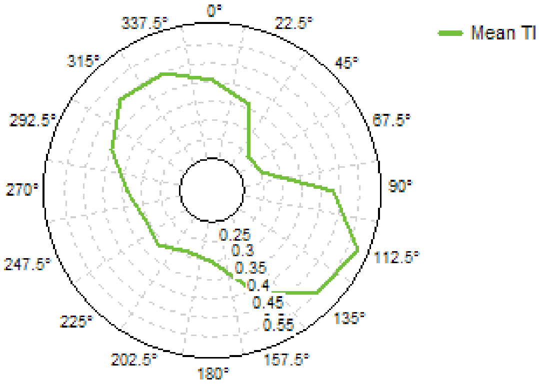

Fig. 16. Mean turbulence intensity at 40 m versus wind direction sensor at 30m.

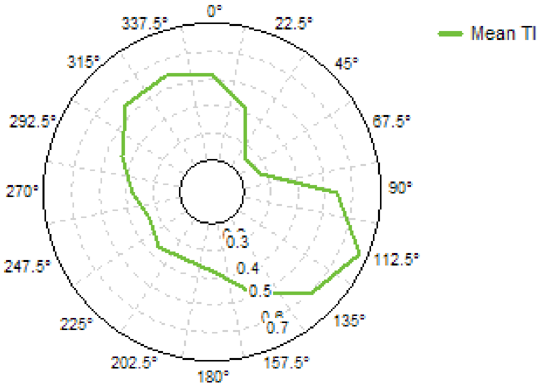

Fig. 17. Mean turbulence intensity at 30 m versus wind direction sensor at 30m.

3.6. Atmospheric conditions

Atmospheric conditions were also considered in this study. The mean air temperature and the mean air humidity were found 14° C and 77.6% respectively .Fig 18. Shows the diagram for monthly temperature and monthly air humidity. As it can be seen, air temperature is ranged from 4 °C to 24.2 °C, whereas the air humidity is ranged from 60 % to 86 % in all over the year. In addition the mean air pressure was found 87.78 kPa.

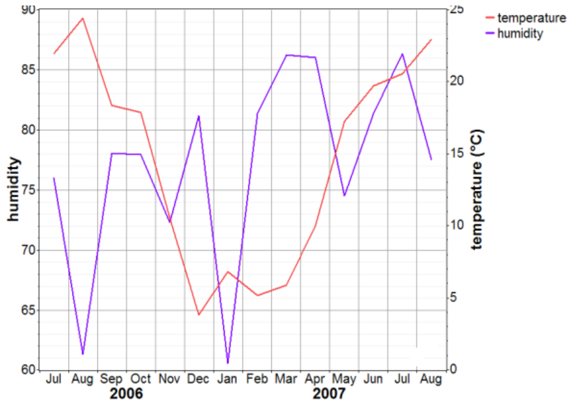

Fig. 18. Monthly mean air temperature and humidity (during 14 months).

3.7. Vertical wind shear profile

In this study, vertical extrapolation of wind data at 30 m & 40 m heights using power law & log law was used to plot the diagram of wind speed versus height above ground. This is useful, because the wind speed at higher heights can be estimated. As it can be seen in fig.19, it can be concluded that, Chalus site hasn't good potential for using wind energy at higher heights because even at height of 80 m; the wind speed hardly reached to 2.9 m/s.

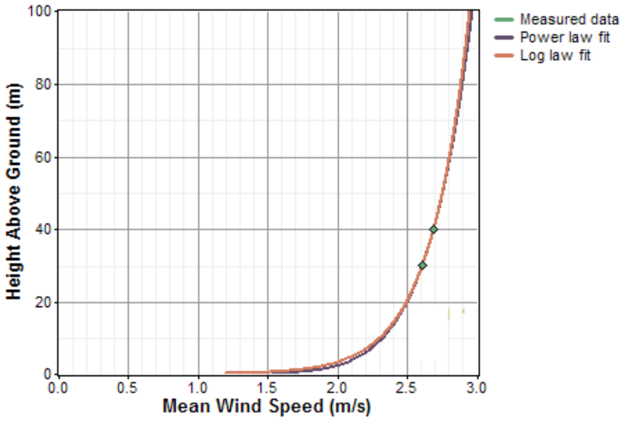

Fig. 19. Vertical wind shear profile.

3.8. Wind power density

In fig. 20 the monthly wind power density at two heights is determined by measured data. The maximum power density for 40 m height occurred in Aug (2006) with a value of 92 W/m^2 and the minimum value occurred in Dec (2006) with a value of 21 W/m^2. July (2006), Aug (2006) & Aug (2007) are three months that the mean wind power density is upper than 60 W/m^2 for both 40 m and 30 m heights. Generally, the mean wind power densities were found 49 W/m^2 and 44 W/m^2 for heights of 40 m and 30 m heights respectively. According to the wind power classes in [23], it can be concluded that wind power class for both 40 m & 30 m heights is 1 (poor).

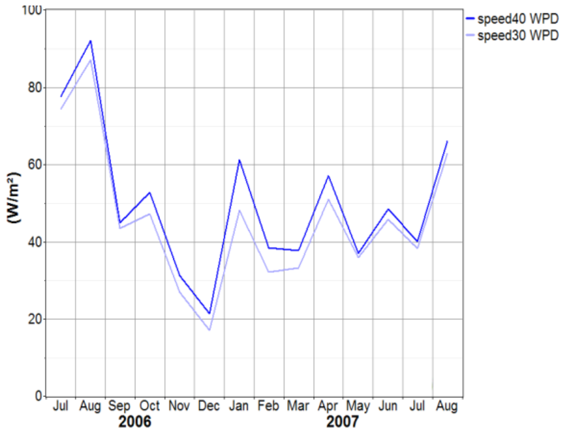

Fig. 20. Monthly mean wind power density (during 14 months).

3.9. Feasibility of installing a small wind turbine

In this part of study feasibility of installing a small wind turbine of type "Bergey XL.1" produced by Bergey wind power company was studied.This wind turbine has pitch control and it has a capacity of 1 kW, hub height of 30 m and rotor diameter of 2.5 m. The power curve of this wind turbine can be seen in fig.21 [24]. The mean net energy output of the wind turbine was calculated 493 kWh/yr and the capacity factor was found 5.6 %. The cut-in wind speed for this wind turbine is 2.5 m/s. according to fig.2 it can be seen that in 7 successive months of the year, April, May, Jun, July, August, September and October, especially in August, the mean wind speed is between 2.5 m/s and 3.3 m/s (for both 30 m and 40 m heights) and seems to be adequate for installing this wind turbine. However because of low energy production of the wind turbine (493 kWh/yr), low capacity factor (5.6 %) and having low monthly mean wind speeds of less than 4 m/s during the year, it is not economical to install this small wind turbine in the studied site.

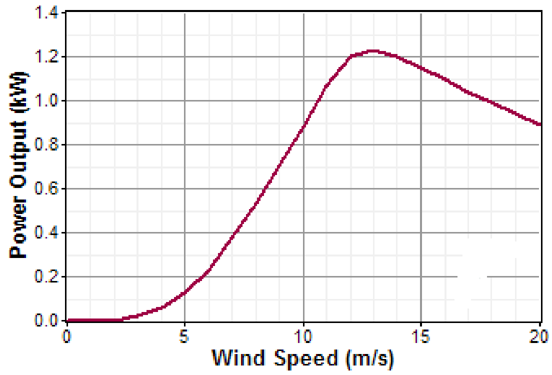

Fig. 21. Power curve for "Bergey XL.1" [24].

4. Conclusion

In this paper, analyzing of wind data at 30 m and 40 m heights was carried out to determine the potential of wind power in Chalus site, it can be concluded that:

1. The Weibull distribution presented in this paper in figs. 4 and 5 for 40 m and 30 m heights indicates a good agreement with the data obtained from actual measurements.

2. Cumulative distribution shows that, 77% of the winds that are blowing in Chalus site at 40 m height are less than 4 m/s (78% for 30 m height), indicating this fact that Chalus site hasn't good potential for using wind power.

3. Vertical wind shear profiles using power law & log law, shows the mean wind speed versus height above ground, it can be seen in fig.19 that Chalus site hasn't good potential for using wind power even at higher heights.

4. According to the tables 3 and 4, it can be concluded that: 1.at height of 40 m, the possibility of the wind speed over 3 m/s occurred in July (2006), Aug (2006), Apr (2007) and Aug (2007). 2. At height of 30 m, the possibility of wind speed upper than 3 m/s can be seen in July (2006), Aug (2006), Apr (2007) and Aug (2007). The possibility of the mean wind speed over 4 m/s for each month never occurred at two heights of 30 m and 40 m.

5. Wind Rose analysis showed that, prevailing wind directions are from north-east.

6. The mean wind power densities were found 49 W/m2 and 44 W/m^2 for heights of 40 m and 30 m respectively.

7. August is the best month in the year that wind speed is better than other months. The maximum wind speed and the maximum standard deviation at 40 m height during 14 months study of wind data occurred in August with values of 3.42 m/s and 3.27 m/s respectively.

8. Feasibility of installing a small wind turbine studied. The cut in wind speed of the turbine is 2.5 m/s. it was determined that in 7 successive months of the year, April, May, Jun, July, August, September and October, especially in August, the mean wind speed is between 2.5 m/s and 3.3 m/s and seems to be adequate for installing this wind turbine. However because of low energy production of the wind turbine (493 kWh/yr) and low capacity factor (5.6 %) and having low monthly mean wind speeds of less than 4 m/s during the year, it is not economical to install the small wind turbine in this site.

9. One year study of wind data at Chalus site has showed that this site hasn't good potential for using wind power. It should be mentioned that the current work is only a preliminary study. For better estimation of wind potential of a region, evaluation of long-term wind data is quite necessary that maybe carried out in next studies.

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