WIND ENERGY ASSESSMENT OF ELSPIAA TRIPOLI, LIBYA

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ABSTRACT

In this study, the Statistical wind data were obtained from measurements for two years (24-month) periods from January 2013 to December 2014 at ElSpiaa, Tripoli, Libya. The site coordinates are 32°32'24.66 (N°) and 13°10'13.31 Longitude (E°). The elevation of the site is 15 m above mean sea level (AMSL). It is found that the maximum wind speed was U =11.97 m/s for data of the year 2014 at a height of 40m, which has the maximum probability (10.25%). The wind power density, E, (W/m²) was expressed in terms of the Weibull shape and scale parameters, (k and c). It is found that the yearly wind power density of the year 2013 at both heights of 10 and 40 m is (651.02 W/m²) and (814.61W/m²) respectively. And the yearly wind power density for the year 2014 at 10 and 40 m are (715.85W/m²) and (980.41 W/m²) respectively.

INTRODUCTION

The energy demand in Libya will reach 141.575 GWh by the end of 2022. where this cannot be covered by generation stations in the country. Elspiaa has a very important station which is located in North-west Libya, South of Tripoli about 30 km, the wind farm located one 25 kilometres away from the coast.

There were few important studies about wind energy carried out at different locations in Libya; [El-Osta,1995] have selected a small wind farm of 1.5MW to be a pilot wind project. They have investigated different sites in Tripoli. The average wind speed was found as 6.9m/s at 10m height with an available power of 399 W/m2. Their results were promising for the wind farm project.

[Mohammed, 2013] have investigated the utilization of renewable energy in Libya. They concluded that Libya is rich in renewable energy including wind energy but needs a more comprehensive energy strategy and more financial and educational investment.

[Elmnefi, 2014] have obtained wind speed measurements for 12 months period at Benina site in Libya. The results showed an average wind speed of about 11 m/s at 10m height which indicates the high wind energy potential in Benina site. [Elfarra, 2019] have selected four sites close to the Libyan coast and conducted the technical and economical assessment of wind power generation using real measured wind data. The results have shown the electricity cost of all the sites is below the world average electricity price. Very recently [Elmnefi, 2019] have analyzed wind speed distribution and economical evaluation at Misurata city and the results were very promising to use wind turbines for power generation. Other studies for the wind potential in other centuries such as Turkey [Kaplan, 2016], Italy [Basile, 2015], Algeria [Charrouf, 2016], and Iran [Hossieni, 2014] and India [Umesh, 2017] have also been performed.

This work aims to study the possibility of generating electrical energy from wind energy by analysing the information for wind speed obtained from the meteorological station of Elspiaa, Tripoli city. Knowing the wind energy potential within this location zone. The use of wind energy as an additional source for power generation in the city of Tripoli will contribute to electrical energy savings and will reduce the emission of greenhouse gases. The achievability of wind energy improvement relies upon

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the specific social, financial, and physical attributes of both the investigation range and the wind asset. In this postulation one site is chosen, as the case to demonstrate wind energy accessibility in the shoreline of Libya and to design a reasonable by considering normal wind speed of ElSpiaa, Tripoli _Libya station, the areas of this site is introduced in Fig. (1).

Figure 1. Location of the meteorological station of Elspiaa, Tripoli, Libya.

METHOD

Elspiaa has a very important station which is located in North-west Libya, South of Tripoli about 30 km. The statistical wind data set was analyzed using Weibull distributions to determine the Weibull shape parameter K and scale parameters scale parameter C. Weibull function is a commonly used one in wind energy [Elmnefi, 2014; Oyedepo, 2012, and Mostafaeipour, 2014]. It is one of the most widely used methods where a good description of speed distribution is given throughout the year probability distribution function Possibility be expressed as:

$$f(v) = \frac{k}{c}\left(\frac{v}{c}\right)^{k-1} e^{-\left(\frac{v}{c}\right)^{k}} \qquad [1]$$

Where (k) and (C) are parameters the Weibull shape and scale parameter, the density function is recognized as cumulative distribution function and Possibility be expressed as:

$$F(v) = 1 - e^{-\left(\frac{v}{c}\right)^{k}} \qquad [2]$$

There are many methods were used for determining the Weibull distribution parameters [Costa Rocha, 2012 and Guenoukpati, 2020].

In this study, the parameters of the Weibull distribution were determined using the graphical method. In this method, the cumulative distribution function can be rewritten as:

$$\text{In}\left[-\,\text{In}\left(1-F(v)\right)\right] = k\,\text{In}\,v - k\,\text{Inc} \qquad [3]$$

To estimate the Weibull shape and scale parameters, a graphical method is introduced and used as shown in Figure. 2.

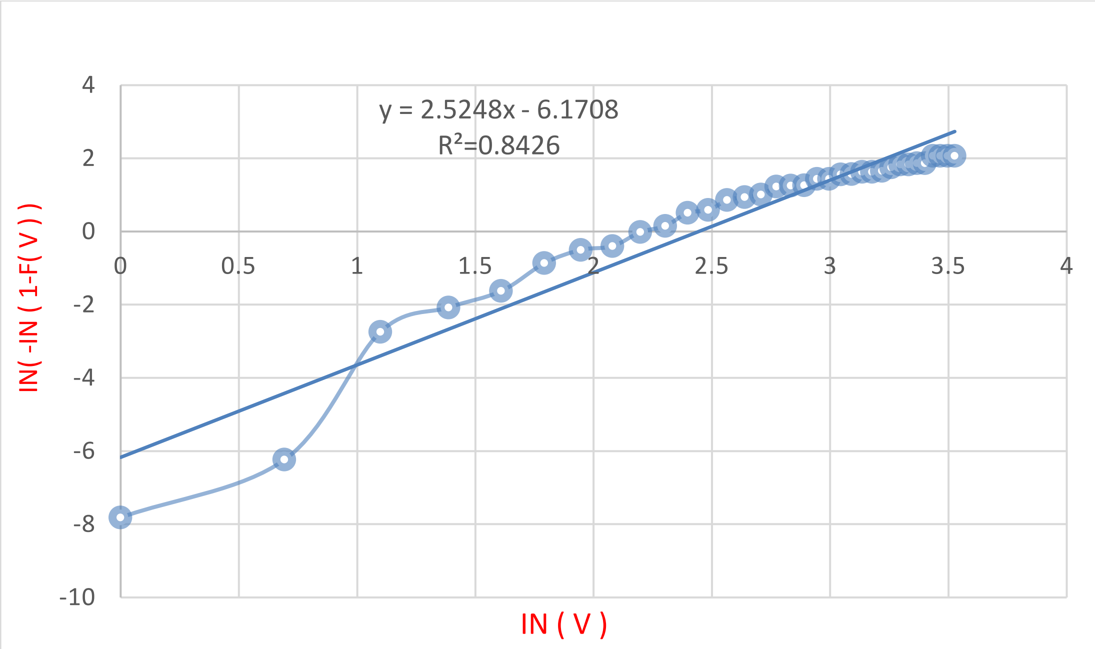

Figure 2. The graphical method used to obtain Weibull parameters for the year 2013 at height of 10m

Wind power density can be communicated regarding the Weibull shape and scale parameters, k and c, utilizing the relationship displayed by:

$$E = \frac{1}{2}\rho c^3 \left(1 + \frac{3}{k}\right) \qquad [4]$$

where ρ is the air density (kg/m^3).

Results and Discussion

The wind speed has been measured at a height of 10 m over the ground level utilizing 3 cup anemometers. Moreover, wind speed has been calculated at a height of 40 m. The vertical variation of wind speed can be expressed by the power exponent function:

$$U(z) = U(z_r)(\frac{Z}{Z_r})^{\alpha} \qquad [5]$$

Where U(z) is the wind speed at the selected height z, and Ur is the wind speed at the reference height (z_r) above the ground level.

Figure 3 and figure 4 shows the monthly variation of the average wind speed for years 2013 and 2014 at heights of 10 and 40m respectively, the minimum value of average wind speed is in the September 2013(5.12 and 6.24 m/s) and the maximum value is in the May 2014(8.10 and 9.87 m/s) for both of the heights.

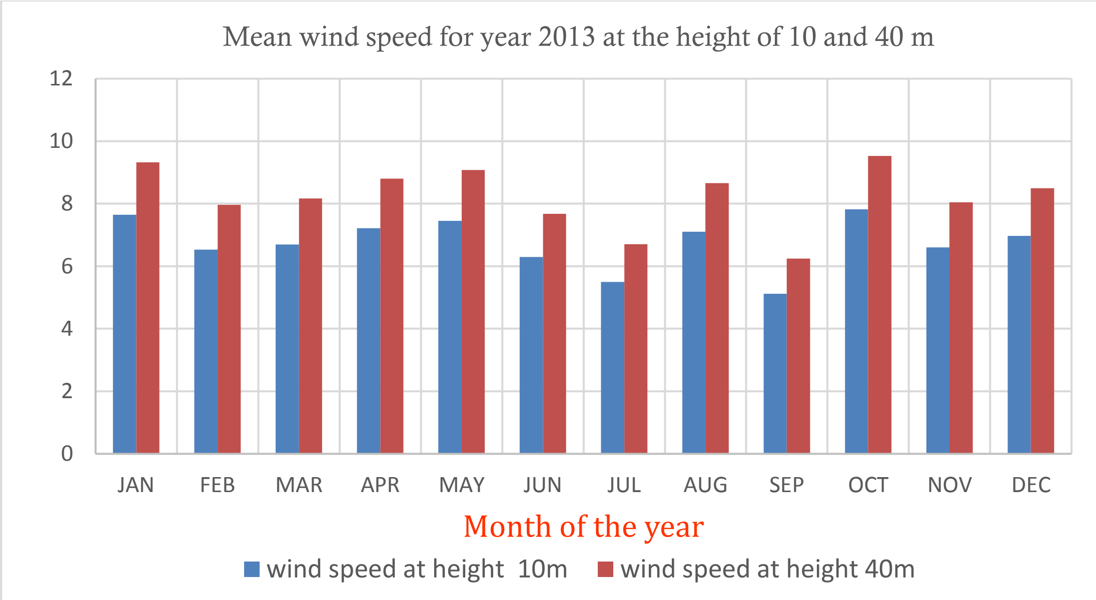

Figure 3. Mean wind speed values for the year 2013

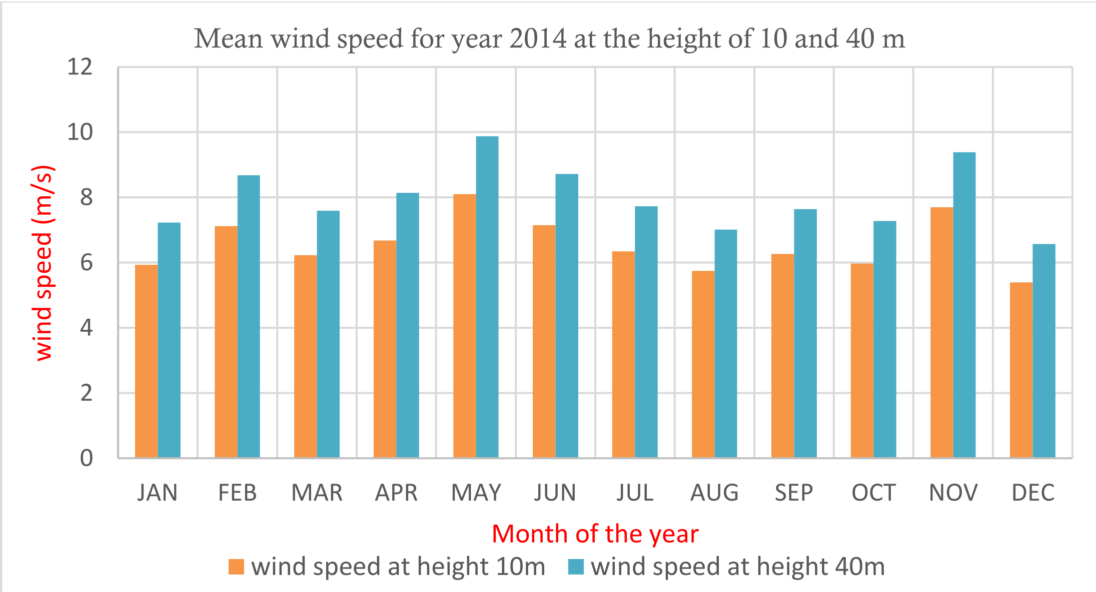

Figure 4. Mean wind speed values for the year 2014

The probability density functions and the cumulative frequency functions calculated from the measured wind speeds for years 2013 and 2014 at 10 m and calculated wind speeds at 40 m at Elspiaa, Tripoli are shown in Figures (5 and 6) and Figures (7 to 10) respectively. It was found that the yearly Weibull shape parameter, k, for years 2013 and 2014 at 10 m were 2.5248 and 2.6314 respectively. The yearly Weibull scale parameters, c, for 2013 and 2014 at a height of 10 m was 7.8608 m/s and 8.1739 m/s. Furthermore, the shape and scale parameters k and c have been obtained for the years 2013 and 2014 at 40 m high. For this case, the shape parameter k were 2.6263 and 2.7367 and scale parameter c were 8.5308 m/s and 9.1402 m/s respectively.

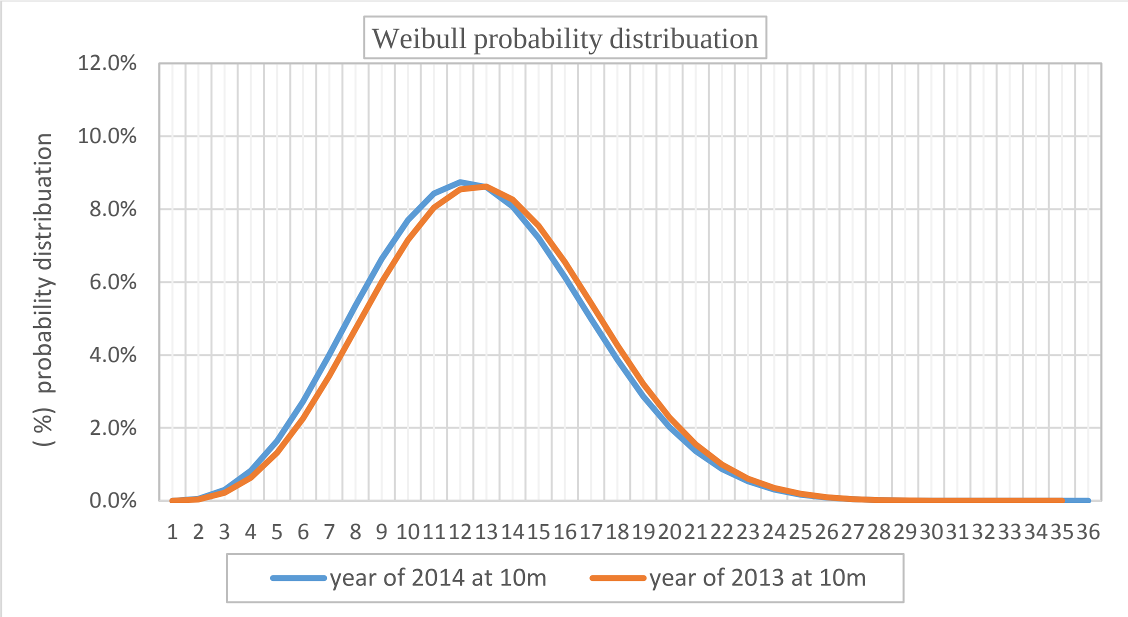

Figure 5. Yearly Weibull distribution for the year 2013 and 2014 at 10 m height

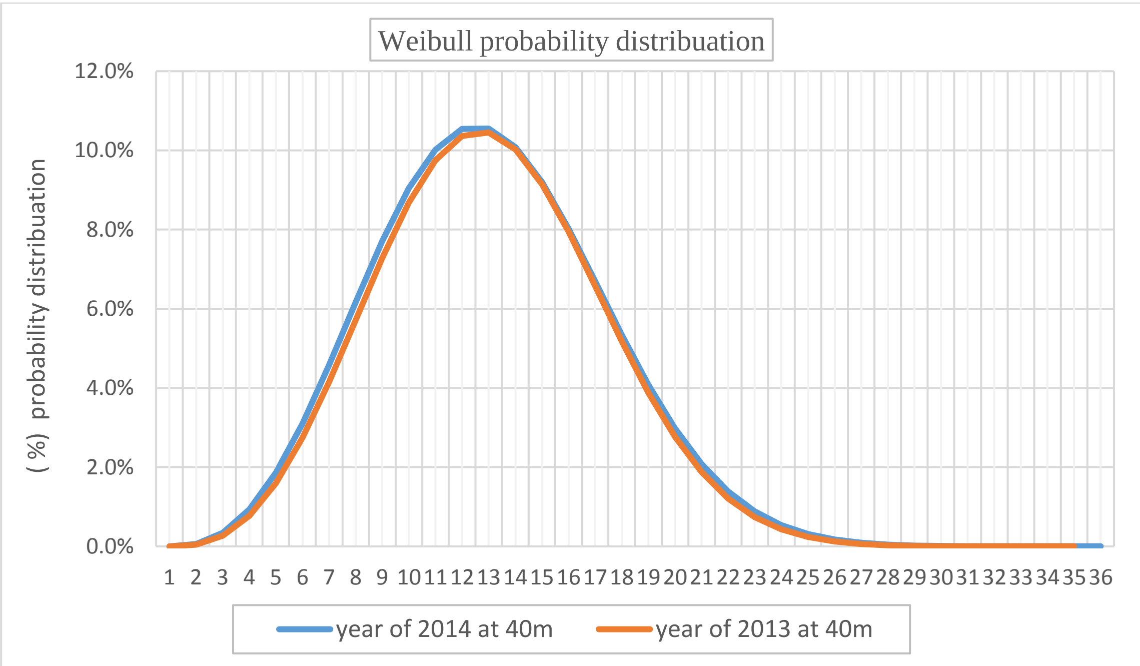

Figure 6. Yearly Weibull distribution for the year 2013 and 2014 at 40 m height

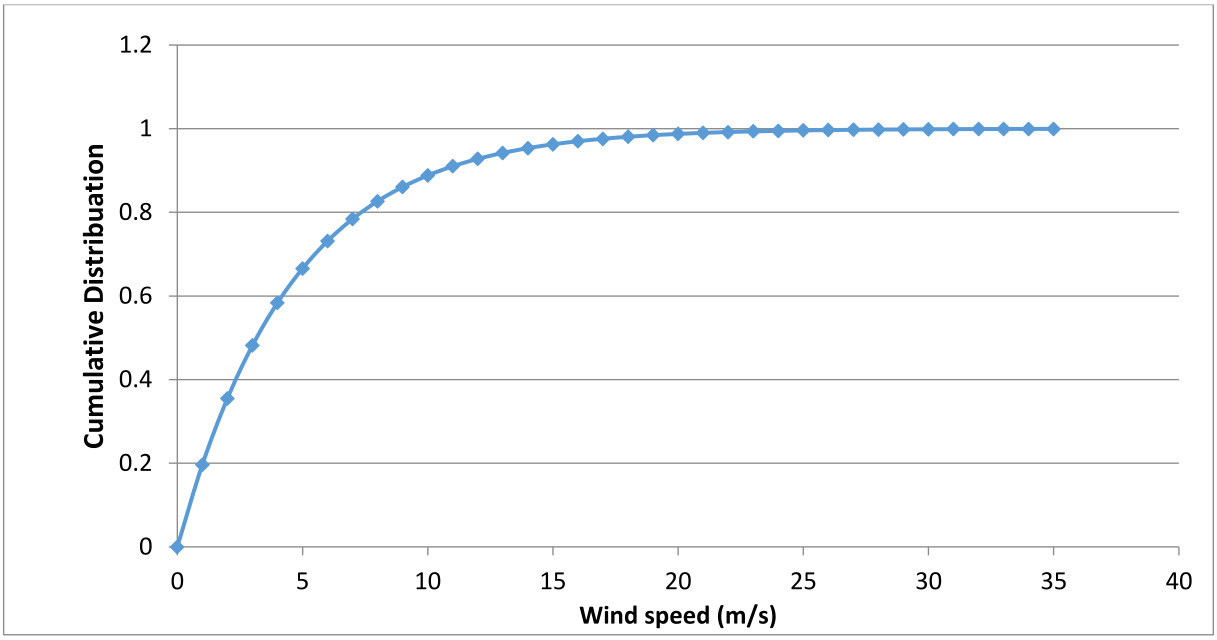

Figure 7. Cumulative probability of the year 2013 at height 10m (AGL)

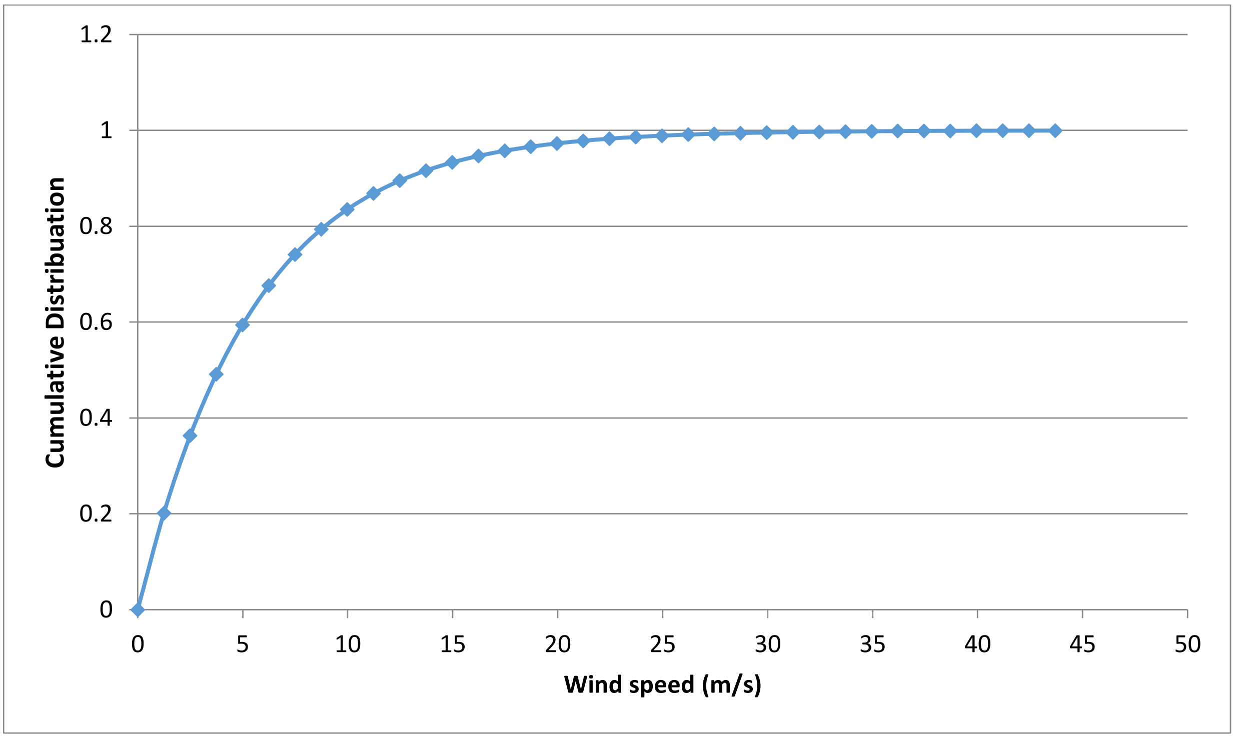

Figure 8. Cumulative probability of the year 2013 at height 40m (AGL)

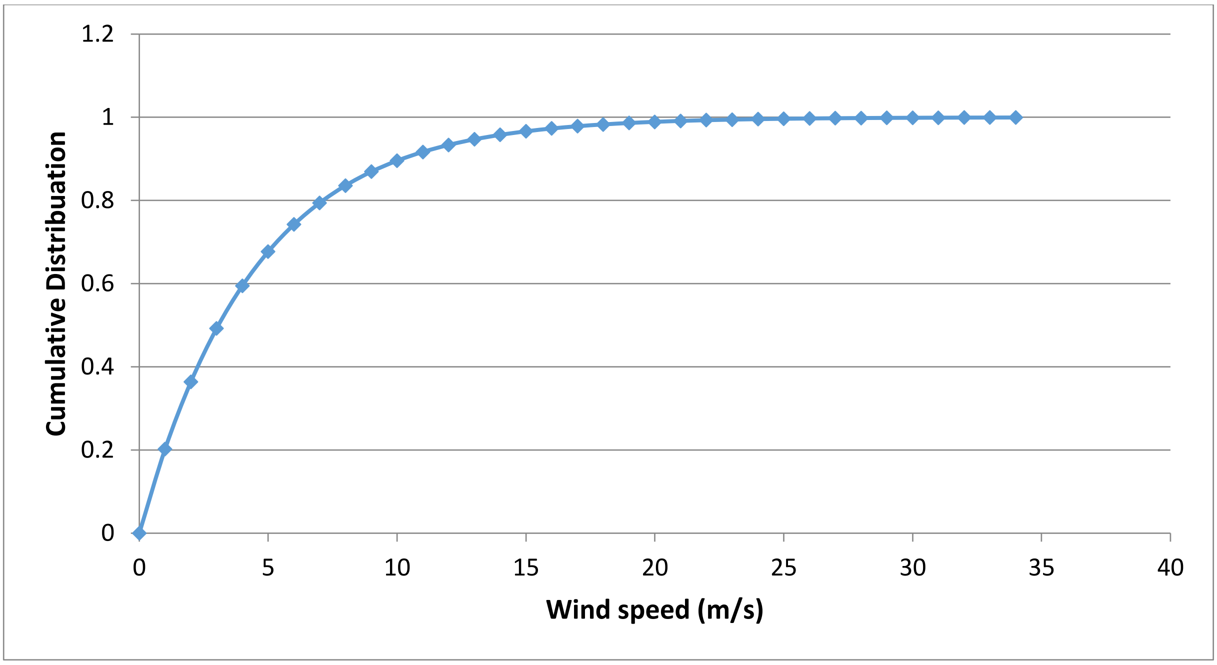

Figure 9. Cumulative probability of the year 2014 at height 10m (AGL)

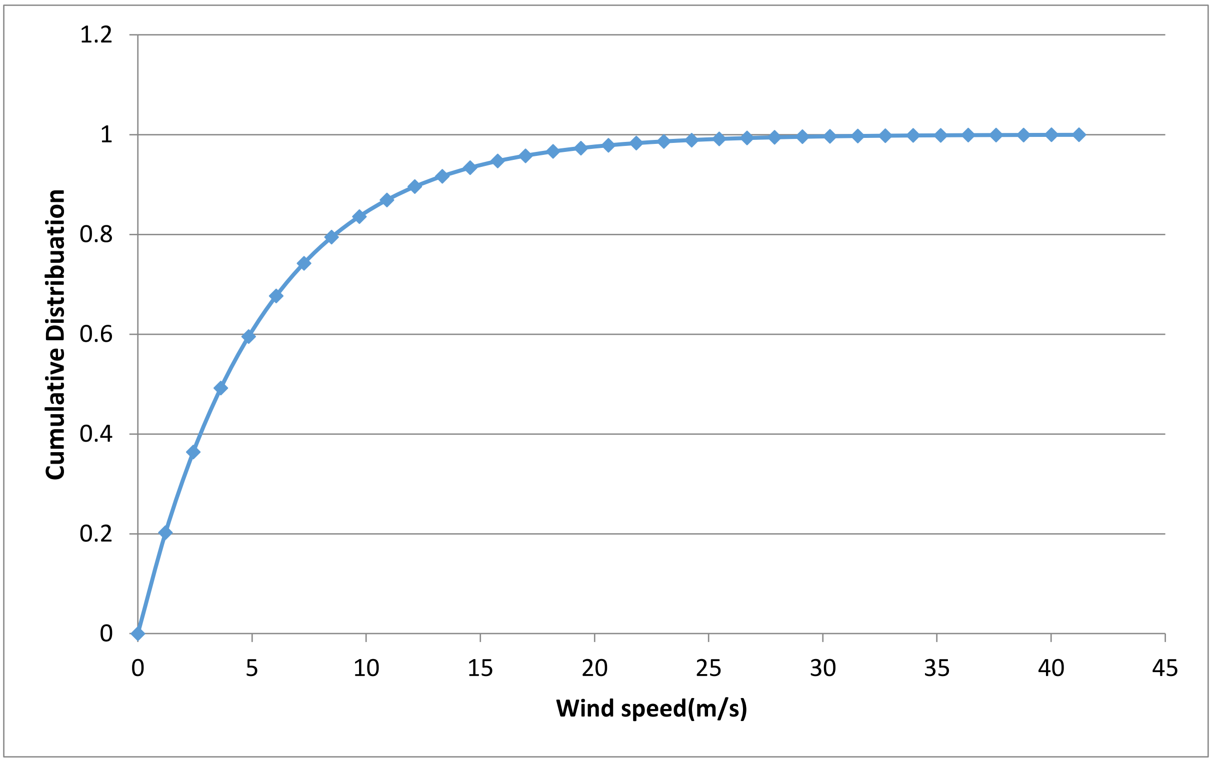

Figure 10. Cumulative probability of the year 2014 at height 40m (AGL)

Conclusion

It is concluded that the Weibull distribution using the graphical method is a useful technique to conduct wind speed analysis from observed wind speed data at El-Spiaa, Tripoli in western Libya. This study shows that wind energy is available in El-Spiaa, and it could be used to generate electricity, also wind energy may use for other applications like water sea desalination. From the observed wind speed data during January 2013 to December 2014, It was found that the yearly Weibull shape parameter, k, for years 2013 and 2014 at 10 m were 2.5248 and 2.6314 respectively. The yearly Weibull scale parameters, c, for 2013 and 2014 at a height of 10 m was 7.8608 m/s and 8.1739 m/s. Furthermore, the shape and scale parameters k and c have been obtained for the years 2013 and 2014 at 40 m high. For this case, the shape parameter k were 2.6263 and 2.7367 and scale parameter c were 8.5308 m/s and 9.1402 m/s respectively. The wind power density, E, (W/m²) can be expressed in terms of the Weibull shape and scale parameters, k and c, and it is found that the yearly wind power density of the year 2013 at both heights of 10 and 40 m is (651.02 W/m²) and (814.61W/m²) respectively, also the yearly wind power density for the year 2014 at 10 and 40 m are (715.85W/m²) and (980.41 W/m²) respectively.

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