A Preliminary Assessment of Wind Energy in Dujaili Site at Wasit Province – Iraq (Case Study)

Dr. Firas A. Hadi, Dr. Mohammed A. Salih, Dr. Kamal H. Latif

Abstract---The adoption of sustainable energy systems for the purpose of generating electricity at any site requires real good readings and an estimate of wind source in any site. This paper includes an assessment of wind energy source in Dujaili site using data available in the wind Geosun map. Then this data was used to guess the purpose of the potential energy of the site. It was also estimate the number of working hours by using Weibull coefficients of the site and specification of certain wind turbine, in addition to the economic feasibility study which serve the investor to determine the investment benefit extent in that region.

Keywords--- Wind energy, Feasibility study, Wind map, Number of generating hours.

1 INTRODUCTION

In any wind energy project the assessing of resource from productive capacity and economic feasibility is the first and basic step to determine the extent of the success of that project.

Initial assessment of the site in general is easy in case of the existence of high-resolution wind data. Thus, the specialist in meteorology or wind power must determine the best location for the purpose of exploitation of existing wind energy by giving results nearly approval of reality. In our case all of this is linked to the available wind data, maps, mathematics, and statistics through which we get a preliminary assessment of the project. Through this step it could be justified to continue increasing the investment by set up approval to the proposed site.

2 STUDY AREA

The proposed site lies in Wasit governorate, southeast of Baghdad, as shown in the Fig. 1, which shows the location on the map of Iraq

Figure 2 shows the image taken by satellites of the site, and through it is clear to us that there are agricultural areas, residential sectors, streets and empty spaces.

- *Dr. Firas A. Hadi: Wind Energy Department/Renewable Energy Directorate/Ministry of Science and Technology, Iraq E-mail: firashadi76@gmail.com.*
- *Dr. Mohammed A. Salih: Department of Planning/Ministry of Electricity, E-mail: dr_masalih_abutaeb@yahoo.com.*
- *Dr. Kamal H. Latif: Renewable Energy Directorate/Ministry of Science and Technology, Iraq, E-mail:kamalhlatif@yahoo.com.*

Fig. 1. The Iraqi map showed the area of study.

Fig. 2. Dujaili site satellite image.

3 THE CHARACTERISTICS OF THE REGION

The possibility to rely on this energy is determined by physical characteristics of the wind source and the area of study, and that the study area lies in Wasit (Dujaili) in the south of latitude 33 south of Iraq, northwest governorate of Maysan, specifically between Maysan governorate and the

center of the governorate (Kut), where 97 km from the governorate of Maysan center and 47 km from the center of the governorate in Wasit and about 207 km from Baghdad governorate center on site 46.271146, 32.297699 Decimal Degrees (Table 1) and at 12m above sea level. Fig. 3 shows the landing area to the east of Iraq close to the Iranian border line.

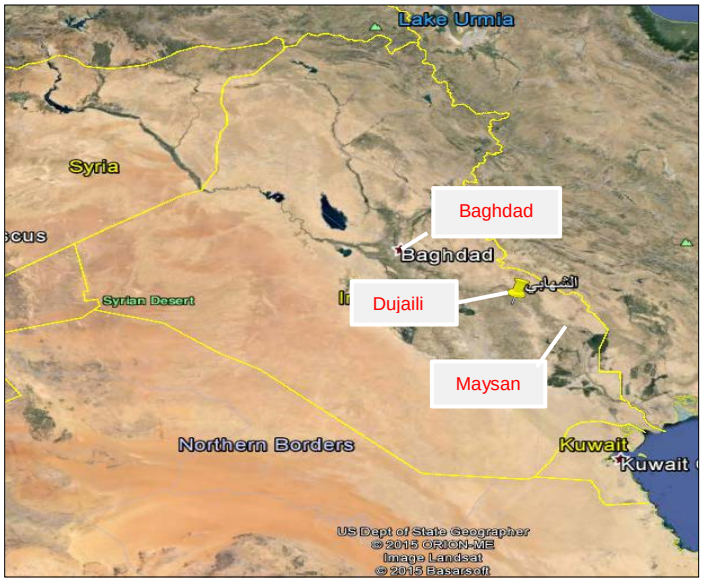


Fig. 3. The Iraqi map illustrate Dujaili site.

4 WIND MAP OF THE AREA

Figure 4 and 5 illustrate the distribution of wind power density and wind speed at a height of 50 m, where the increasing gradient towards red indicates an increase power density and wind speed, thus the site at a height of 50 m gives between 500-600 W/m² as shown in Fig. 4, while Fig. 5 gives the distribution of wind speed at height 50m and where the average velocities ranging between 7-8 m/s.

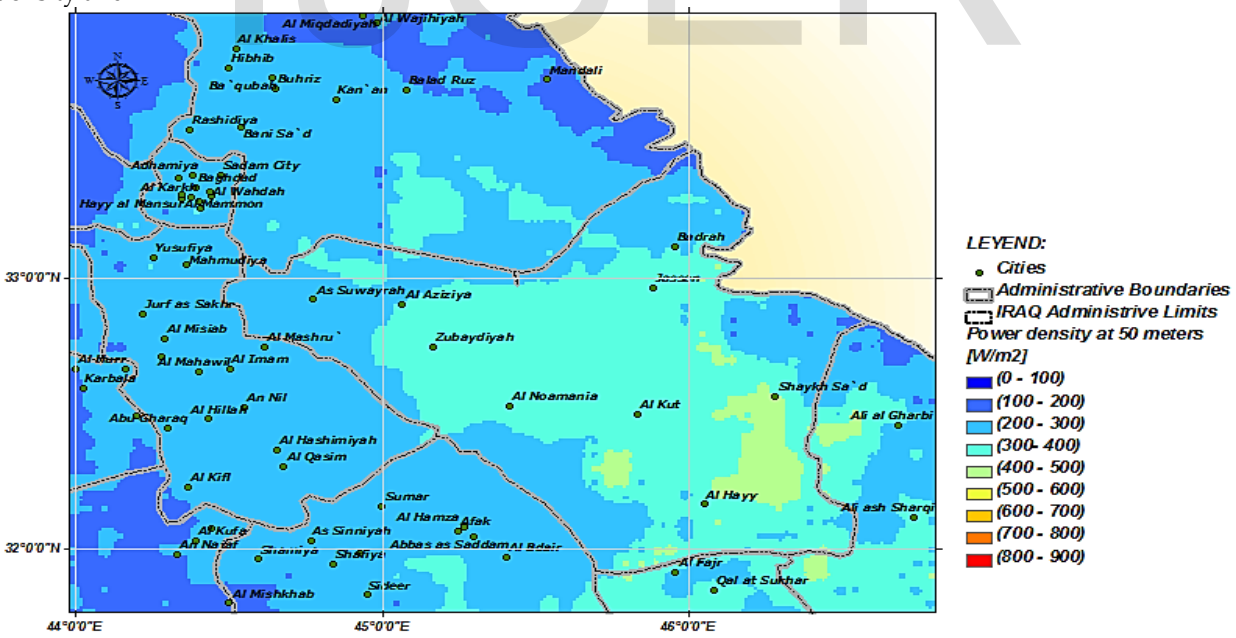


Fig. 4. The intensity of wind power density at height 50 m of the site study, [1].

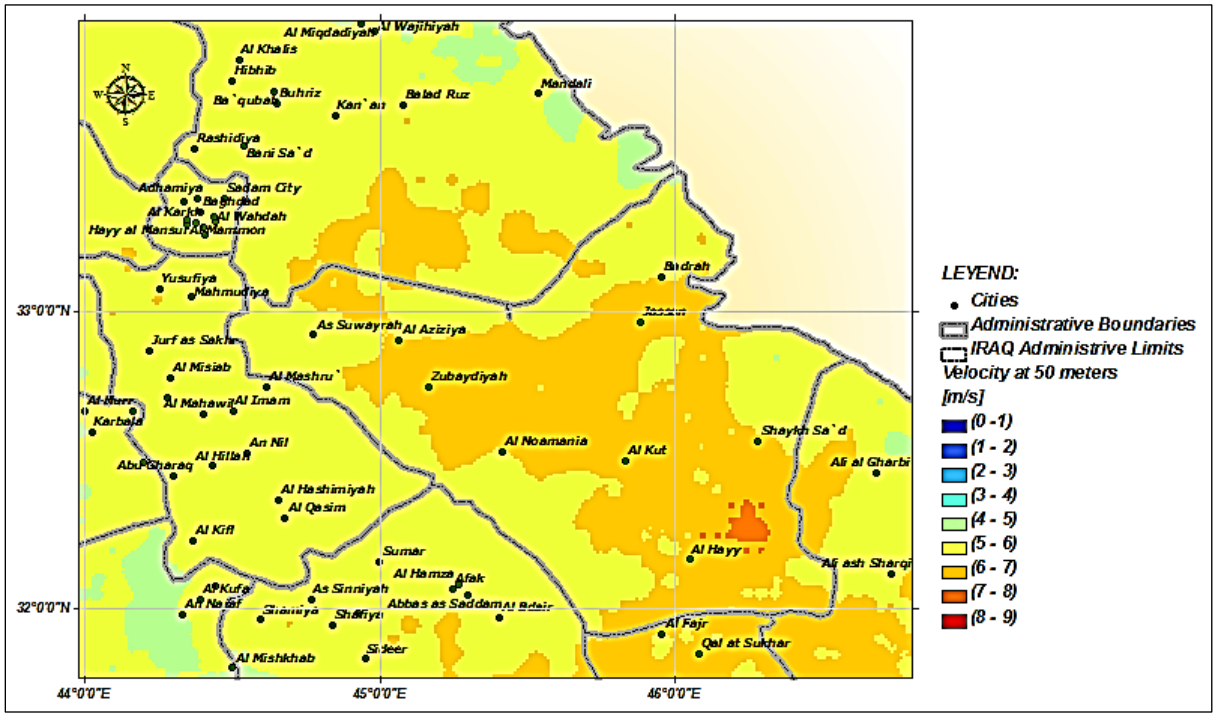


Fig. 5. Distribution of wind speed at height 50m for the study area, [1].

Fig. 6. The area of the proposed site, [1].

5 THE COORDINATE OF SITE

Table 1 shows the geographic coordinate of site and how is far from capital Baghdad.

Table 1
The Coordinates of the Suggested Site

Locations	46.271146 32.297699 Dec. Deg.
Distance from Baghdad	207km

6 THE PROPOSED SITE AREA

The area of the proposed site, which could be a promising field for the production of electrical energy from wind turbines is estimated as 10 km × 22km. Fig. 6 shows that area and the location of the tower in Wasit province.

7 THE POTENTIAL OF THE WIND

The potential energy of the wind in the selected site at height of 50m is estimated between (500-600) W/m² approximately, which fall within the excellent category as shown below in the standard classification (Table 2)

TABLE 2
Classification of Intensity of Wind Capacity to 10 and 50 Meters, [2].

Wind Class	WPD at 10 m (W/m^2)	$\overline{v}$ at 10 m (m/s)	WPD at 50 m (W/m^2)	$\overline{v}$ at 50 m (m/s)	Description
1	0 - 100	0.0 - 4.4	0 - 200	0.0 - 5.6	Poor
2	100 - 150	4.4 - 5.1	200 - 300	5.6 - 6.4	Marginal
3	150 - 200	5.1 - 5.6	300 - 400	6.4 – 7.0	Satisfactory
4	200 - 250	5.6 - 6.0	400 - 500	7.0 - 7.5	Good
5	250 - 300	6.0 - 6.4	500 - 600	7.5 - 8.0	Excellent
6	300 - 400	6.4 - 7.0	600 - 800	8.0 - 8.8	Prominent
7	400 - 1000	7.0 - 9.4	800 - 2000	8.8 - 11.9	Splendid

8 THE EXPECTED CAPACITY OF THE FARM

The 60 turbines may be placed in the previous area. Each turbine has a circular area with a diameter of 54 meters, the supposed distance between the turbine and the other is five times the diameter of the turbine. So we can guess the output power from the farm as shown in Table 3 and assumption the turbines of type 1 MW.

TABLE 3
The Expected Wind Farm Output Power

No. Turbines	60
Turbine types	1 MW
Efficiency	16%
Expected output power	9.6 MW

9 ROSE WIND

The wind rose at the studied site is represented in Fig. 7, where the frequencies of wind speed in all sectors is plotted in order to demonstrate from which direction the most wind blowing is, and here is the north-west and south-east.

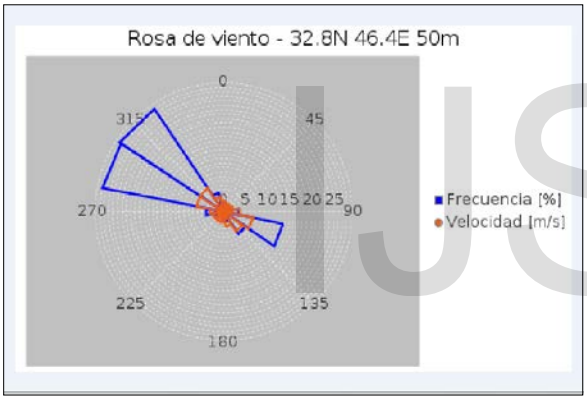


Fig. 7. Rose wind in the study site, [3].

10 STATISTICS

Figure 8 shows the distribution of wind speed during the study period from 11/29/2014 to 04/19/2015.

Fig. 8. Distribution of wind along the study period values.

Also, most of Statistics of the wind was calculated by Weibull distribution function where value of c and k, respectively, of approximately 8.38 m/s and 1.87.

TABLE 4
Wind Statistics for the Region

Property	Value
Mean wind speed	7.5m/s
Median wind speed	6.88m/s
Speed facing higher power density	12.36 m/s
Wind speed slandered devotion	4.3
Max power density	517 w/m²
c	8.38 m/s
k	1.87

11 EXPECTED NUMBER OF GENERATING HOURS

The number of generating hours for 1MW wind turbine is depending on site characteristics and wind turbine specifications (given in Table 5). Table 6 shows the number of expected generating hour for 1MW wind turbine at Dujaili site.

TABLE 5
Wind Turbine Characteristics

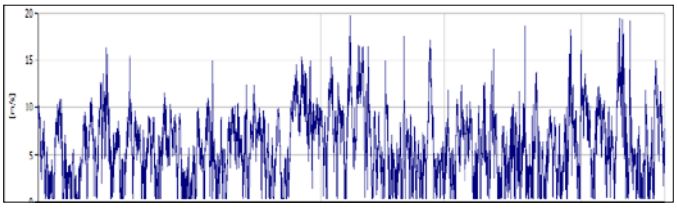
Power	Hours
Cutin speed	2m/s
Rated speed	17m/s
Cutoff speed	25m/s
Capacity factor	0.25
Evaluated turbine cost	$1000000

TABLE 6
Number of Generating Hours for Dujaili Site

Cut- in (m/s)	Hours
8	**3498**
9	**2789**
10	**2174**
11	**1656**
12	**1233**

12 FEASIBILITY STUDY

In order to estimate the economic side and see how the feasibility of wind power project, it is assumed that a wind turbine has a specification as that in Table 5 is installed at Dujaili site. From the data recorded at this site it could accepted an encouraging output power for wind farm so we will do the calculations on the basis of 60 MW, and this will lead us to the assumption that the number of wind



turbines 60 turbine as the first assumption.

13 COST CALCULATIONS

Self-evident, the cost of the turbine is not only one that affect energy calculation, but there are a number of factors that must be taken into account regarding final cost

calculation. Table 7 shows some calculations towards the price of the kilowatt- hour.

TABLE 7
Costs Dollar Accounts

Item	Cost in $
Turbine cost	60,000,000
Civil cost	10,000,000
Install	20,000,000
Bank Fee	10,000,000
Total	100,000,000

13008600	Net of 6th year
12877200	Net of 7th year
12745800	Net of 8th year
12614400	Net of 9th year
12483000	Net of 10th year
12351600	Net of 11th year
12220200	Net of 12th year
12088800	Net of 13th year
11957400	Net of 14th year
11826000	Net of 15th year
11694600	Net of 16th year
11563200	Net of 17th year
11431800	Net of 18th year
11300400	Net of 19th year
11169000	Net of 20th year

14 THE COST OF ELECTRICITY UNIT

It is possible to calculate the total output power from the wind farm depends on the number of generating hours per year and the capacity factor as a relationship between the turbine and location characteristics, Table 8 shows that: -

TABLE 8
Calculation of Electricity Unit Price

Wind farm output power	131,400,000 kWh
1st five years unit cost	76 Cent
Unit cost at each year (from 5 years)	15 cent almost

In addition, there are 3 cents as wage worker, spare parts, and profits investor. This will make total cost is 19 cents. Note that it must pay 15 cents for the as initial costs, but in case of 19 cents as initial payment cost then the first five years would be reduced to approximately four. Here following accounts will be based on 15 cents.

15 THE PRICE OF THE ANNUAL PAYMENT

As assumption that the operational life of the turbine is 20 years, so it is possible to split this period in two stages. The first stage includes five years, and the investor can pay expenses to nearly 20 million in first five years depending on 15 cents for energy output from wind farm (131,400,000 kWh). Net expenses after the first 5 years = 0

16 THE FIRST FIVE YEARS PROFIT

If the unit price increased 1 cents as a profit for the investor, then it can calculate the total profit in five years as follows: - Assuming that profit for the investor 0.01 and the overall output energy per year is 131, 400,000 kWh. Hence, 1,300,000 dollars will be the profit of each five first years, and the total profit through the 5 years is 6,500,000.

17 THE NEW PRICE OF THE ELECTRICITY UNITE AFTER 5 YEARS

It is the second stage where it could make the unit price after 5 years, 10 cents after the payment of all dues (except workers' wages and spare parts which was estimated nearby 3 cents). The point that should be taken in our mind is that the annual output of the plant will be reduced after five years as shown in Table 9:

TABLE 9
Net Profit in 15 Years

18 RECOMMENDATION

1. There is possible investment opportunity in Dujaili site belongs to the province Wasit as shown in the study, in which we've made the possibility of building a wind farm capacity of 60 MW.
2. The opportunity to invest in Dujaili is higher than in Shehabi region, based on data of both site.
3. The study showed the appropriate work of the wind turbine of the type 1 MW in this region.
4. Rises 50 meters and above is the most appropriate and with the higher economic feasibility, but there are limits to such heights, a lack of compatibility with the reality of the country and its potential.

5. Investor can recover his expenses in the first five or six years at maximum and beyond is his profit.
6. It can reduce the tariff rate after the fifth year to 10 cents per kilowatt.

19 REFERENCES

[1] Wind Resource Map of Iraq, Geosun renewable energy, Spain.
[2] Ahmed S. A., Mahammed H. O., "A Statistical Analysis of Wind Power Density Based on the Weibull and Ralyeigh models of Penjwen Region Sulaimani/ Iraq", Jordan Journal of Mechanical and Industrial Engineering, Vol.6, No.2, pp.135 – 140, Apr. 2012.