DOI: 10.24996/ijs.2019.60.6.9

ISSN: 0067-2904

Prepare A Map for the Number of Hours of Electricity Generation for Different Wind Turbines in The Province of Wasit – Iraq

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Abstract
Wind energy is becoming one of the renewable energy that has attracted great attention all over the world. This research work aims to build a map by which the user can have a thought about the number of generation hours of electricity from wind through all the year at the location of study (Wasit-Iraq). To interact the idea, this study included using the work included using different wind turbines at different heights. The results show that Gamesa G58-850 KW wind turbine gives more generated hours at 50 meters height.

Keywords: Wind energy; hours generation; Weibull parameters and wind turbine characteristics.

اعداد خارطة لعدد ساعات توليد الطاقة الكهربائية لمختلف توربينات الرياح في محافظة واسط – العراق

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الخلاصة
أصبحت طاقة الرياح واحدة من الطاقات المتجددة التي جذبت اهتماما كبيرا في جميع أنحاء العالم. يهدف هذا البحث إلى اعداد خارطة يمكن للمستخدم من خلالها تمثيل عدد ساعات توليد الكهرباء من الرياح طوال العام في موقع الدراسة (واسط–العراق). لتهيئة هذه الفكرة، شملت هذه الدراسة استخدام العمل المتضمن استخدام توربينات الرياح المختلفة في ارتفاعات مختلفة. وأظهرت النتائج أن توربينات الرياح من نوع كاميسا G35–850 KW تعطي ساعات توليد أكثرفي ارتفاع 50 مترا.

Introduction

In nature, the difference in temperature by sun radiation will make a change in atmospheric pressure; As a result, wind movement will be generated in order to equalize the differences in pressure. Wind flows from areas of higher to lower pressure in order to equalize the imbalance in air pressure.

statistically, the most important factors which characterize wind regime are speed, direction, and gustiness.

The output power is proportional to the cube wind speed, double the wind speed will increase the capacity by eight times, so any slight change in wind speed can lead to significant changes in power production and hence in the economics of the wind farm [1].

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The information on the change in velocity and direction of the wind within a year is vital from the perspective of wind energy. Statistical study of wind characterizes for a site requires data of the nearest meteorological station and the specialized computer program, Winds on a surface weather map do not blow up exactly parallel to the isobars; instead, they cross the isobars, moving from higher pressure area to lower pressure area [2].

For many decades before energy crisis, thousands of small windmills have spinning arms in a stiff breeze, pumped water, sawed wood, and even supplemented the electrical needs of small farms. after the energy crisis we seriously considered wind turbines, to work generators that produce electricity [3].

Wind power shows up an interesting way of delivering energy, it is free gas emission, and unlike solar energy isn't limited to daytime utilize[4].

In order to produce electricity from the wind turbine, not just any wind must be available, but a flow of air with a certain speed (neither too weak nor too strong). Slow wind speed will not turn the blades beside high wind gust could severely damage the wind turbine. In this manner, moderate and steady wind speed will make the best location for wind energy generation [5].

Materials and Methods

The project of wind energy totally depends on the physical characteristics of the location beside the wind regimenat the same area. These two things will determine the feasibility and output energy for any project. Our suggested area is located in the area between Maysan and Wasit. The distance from Wasit to that location is about (85)km, it is 112km far from Maysan, and about (220)km far from Baghdad. The study area is located at position (32.77)°N (46.70)°E; Figure-1 shows the location of the chosen site in the eastern region near the border between Iraq and Iran.

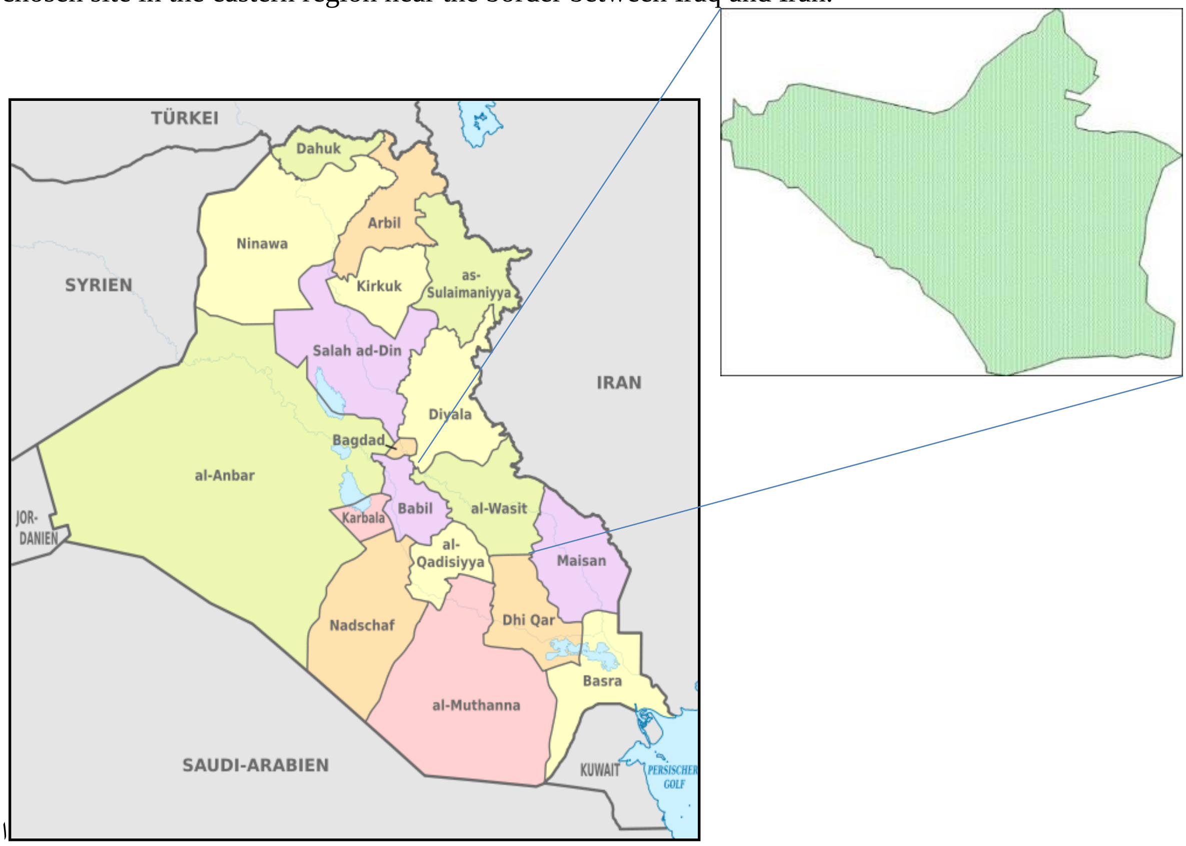


Figure 1- Shows the location of study in Iraq.

Geosun map

Geosun map is a wind resource map of Iraq at 3 heights above ground at high resolution (1 km × 1 km). The wind map is generated with the atmospheric Mesoscale model SKIRON and offered in Geographic Information System (GIS) format [6].

This wind map allows users to view wind data in an interactive environment, as well as modifies, copy, and print maps. With the selected methodology it is possible to obtain virtual hourly datasets at any specified position and any height above ground level.

This study, allowed us to determine the optimum spatial resolution and the best input data to obtain hourly wind data. In the case of a wind energy assessment, this methodology allows us to get a wind velocity map, virtual wind series or wind power density map at any height above ground level.
From Geosun map, it is plotted Iraqi wind map at height 50m Figure (2-a) and 100 m height Figure-(2b, 3, 4), which expounded that the wasit site have a higher offset of wind speed from (9-10)m/sec at height 100m and from (8-9) m/sec at height 50m.

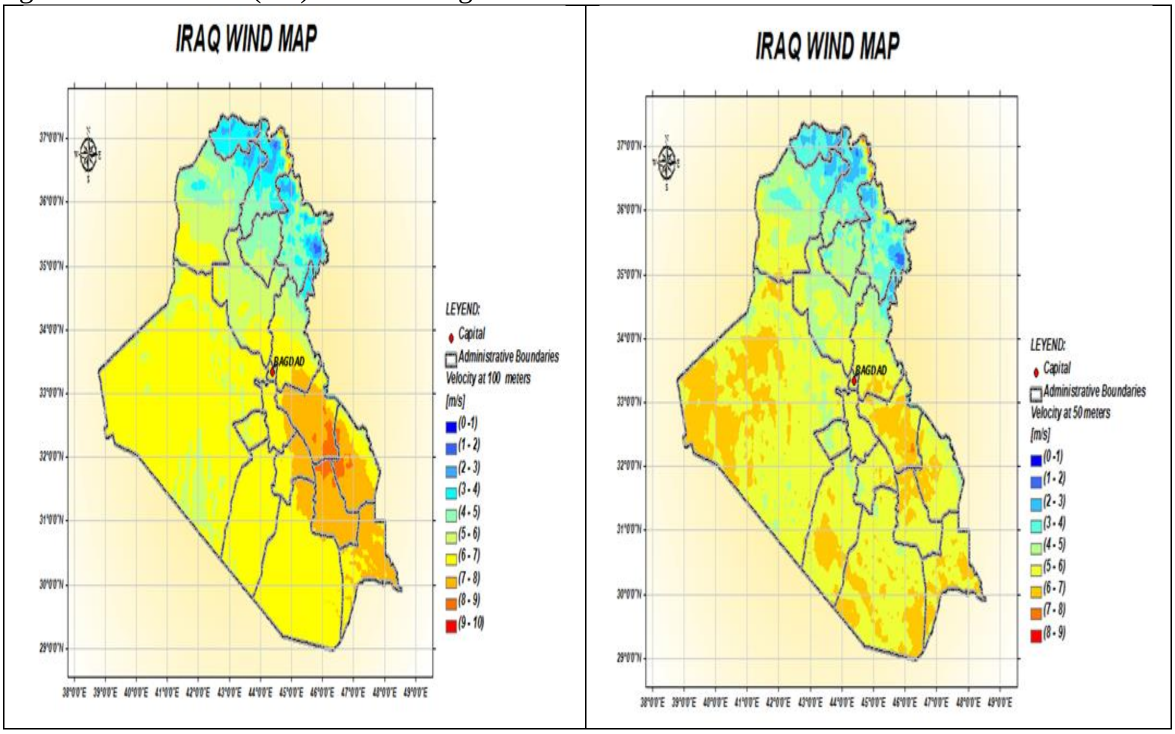


Figure 2- Iraq wind map at height 100m and 50m respectively.

Weibull distribution

When the percentage frequency distribution is plotted against the wind speed, the frequency distribution grows as a curve. The top of this curve is the most frequent wind speed. This frequency distribution is used also to distinguish the most suitable wind turbine for the position [7].

Weibull parameters

Weibull distribution is determined by three important parameters where they give the most general term of the Weibull pdf. An important aspect of the Weibull pdf is how each of
- shape parameter k,
- scale parameter c,
- location parameter (g)
- and the wind speed variable (v)

affects the pdf curve. These effects will appear below.

$$f(v) = \frac{k}{c}\left(\frac{v-g}{c}\right)^{k-1} exp\left(-\left(\frac{v-g}{c}\right)^{k}\right)$$

Where

$$f(v) \geq 0\,, v \geq 0 \;\; or \;\; g\,; \quad k > 0\,, c > 0, \quad \infty < g < \infty$$

And:

$f(v)$ = the probability of observing wind speed v,
g = the location parameter
k = the dimensionless Weibull shape parameter (or factor)
c = the scale parameter in the units of wind speed (m/sec)

Weibull shape parameter, *K*

Shape factor is a measurement of the width of the distribution. various values of the shape parameter can have effects on the behavior of the distribution [8].

Here, Weibull distribution shape is the same as exponential form k=1

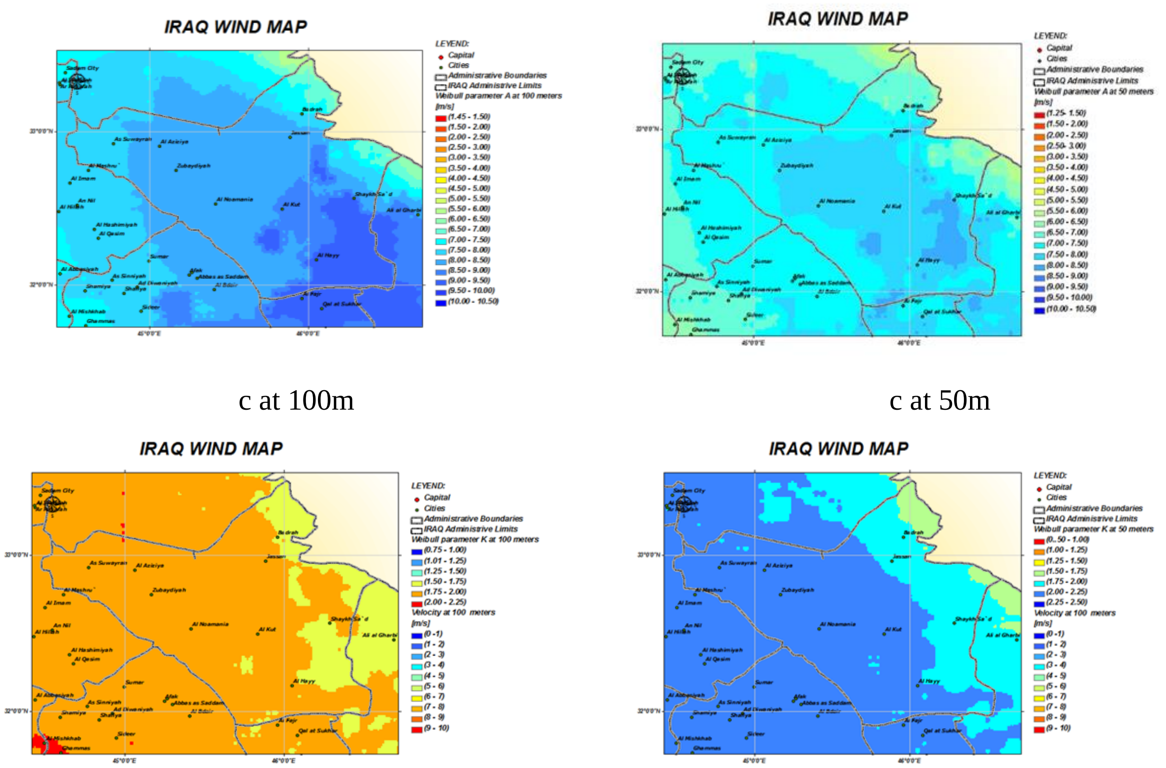
Here, Weibull distribution shape is the same as Rayleigh distribution formk=2

Here, Weibull distribution will approximate the normal distribution for best estimation k=3-4

Weibull scall parameter, c

Scale factor is nicely related to the mean wind speed. Holding the shape parameter constant while we increase the scale parameter value will give the following properties, [9]:

- Suppose that k and g are constant, while c goes to high values, then the distribution will be stretched to right and its height decreases.
- Suppose that k and g are constant, while c goes to low values, then the distribution will be stretched to the left and its height increases.
- The unit of c is the same unit of wind speed.



c at 100m c at 50m

k at 100m k at 50m

Figure 3- Weibull parameters (c , k) at height 100m and 50m heights.

Weibull location parameter (*g*)

The parameter(*g*) is known as the location parameter. This implies that any change in its value will slipt the axis of wind speed distribution. The direction of sliding is either to the right (if $g > 0$) or to the left (if $g < 0$) [9].

Types of used turbines and the power curves

Wind turbine generally has six main components: the rotor, the gearbox, the generator, the control and protection system, the tower and the foundation. These primary components of used turbines in this paper is shown below [6]:

Suzlon S64-950KW

- Manufacturer: Suzlon (India)see Figure- 5:
- Model: S64/950
- Nominal power: 950 kW
- Rotor diameter: 64 m

- Swept area: 3,217 m²
- Power density: 3.39 m²/kW
- Number of blades: 3

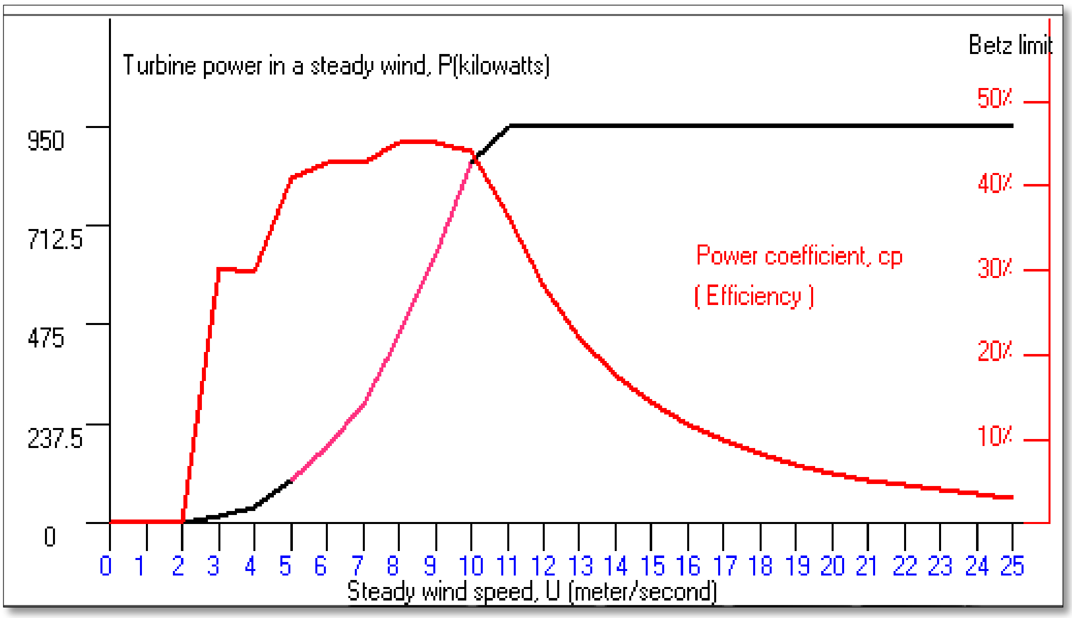


Figure 4- Suzlon S64-950kW power curve and power coefficient.

GAMESA G58-850KW

- Gamesa (Spain) see Figure- 5:
- Model: G58/850
- Nominal power: 850 kW
- Rotor diameter: 58m
- Wind class: IEC IIIb/IIa
- Offshore model: no
- Swept area: 2,643 m²
- Power density: 3.11 m²/kW
- Number of blades: 3

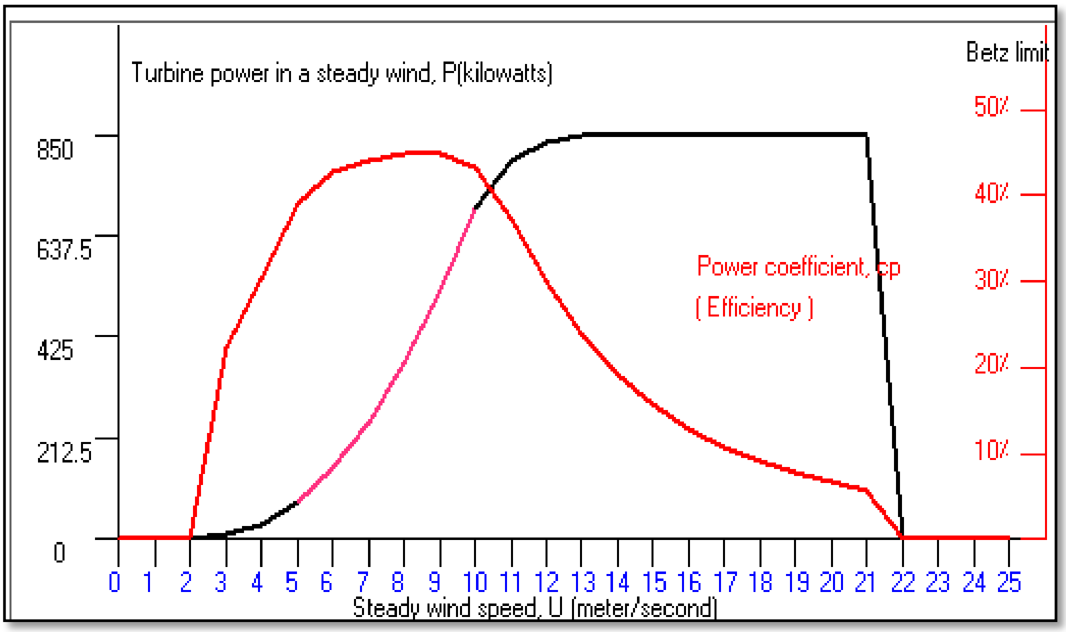


Figure 5- Gamesa G58-850kW power curve and power coefficient.

The operating hours of the wind turbine

The cumulative distribution can be used for forecasting the time at which winds is within a certain velocity interval. The monthly operating hours in a year can be estimated as following [10]:

$$p(v_c < v < v_f) = \left(e^{-\{v_c/c\}^k} - e^{-\{v_f/c\}^k}\right) * tm$$

Where v_c is the cut-in speed, v_f is the cut-of speed. **tm** is the monthly or yearly hours number (30 day chosen for each month or 365 day chosen for each year), k is the weibull shape factor and c is the weibull scale factor.

Results and discussion

The Figure-6 shows that the higher hours is about 1050 hour/year at height 50m by using Gamesa turbine which applied in surfer program.

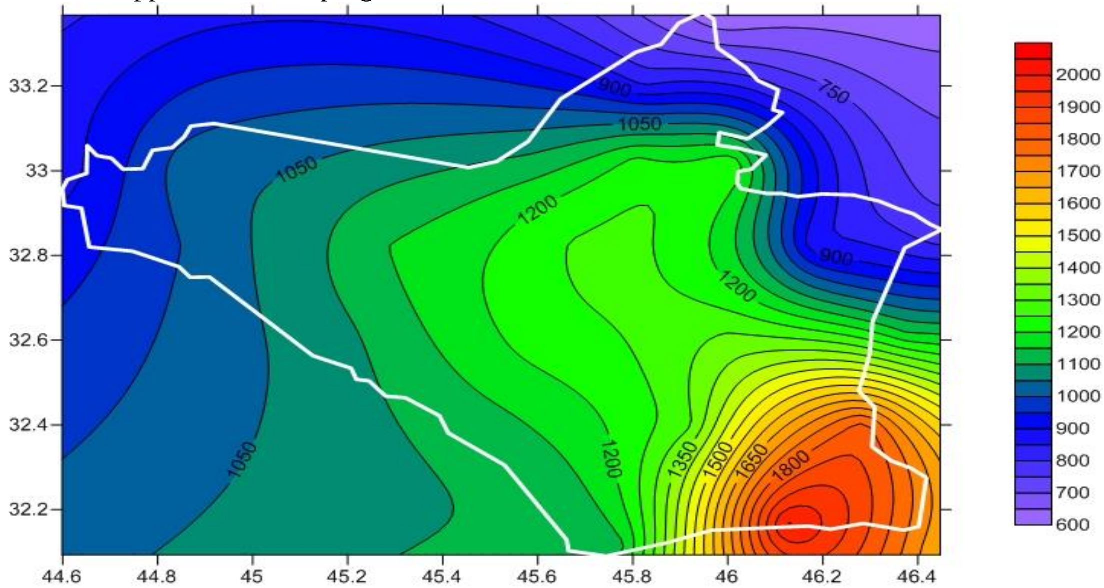


Figure 6- The number of hours of power in Gamesa at 50m height.

The Figure-7 shows the higher amount of power is 2000 hour/year at 100m in the south east of wasit by using Gamesa turbine.

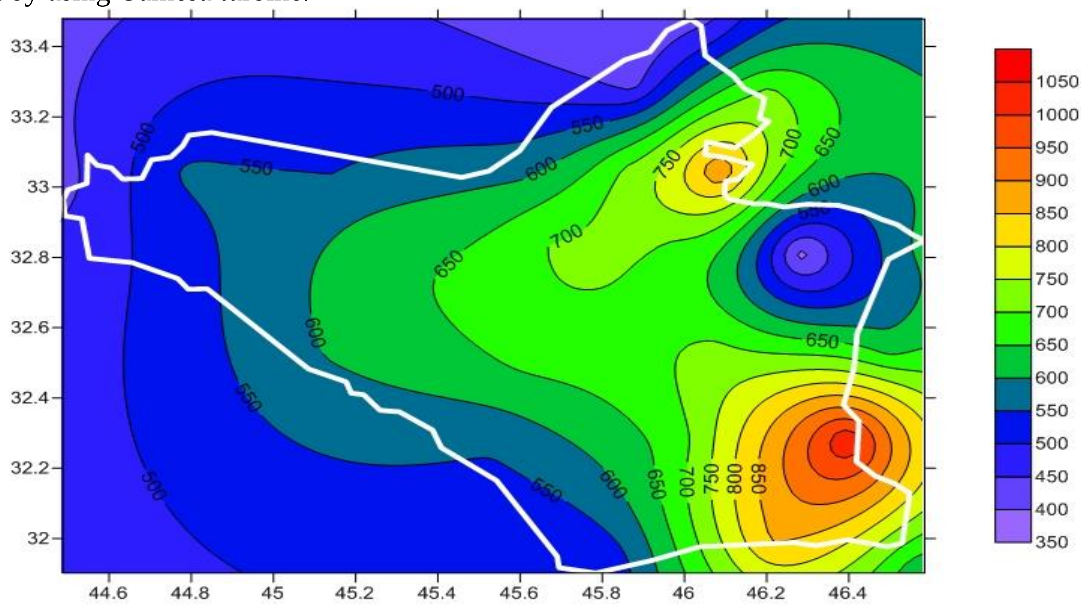


Figure 7-The number of hours of power in Gamesa at100m height.

The Figure-(8-a) and (8-b) shows the higher amount of power is about 2250 hour/year at 50m and about1450hour/year at 100m in the south east of wasit by using Suzlon turbine.

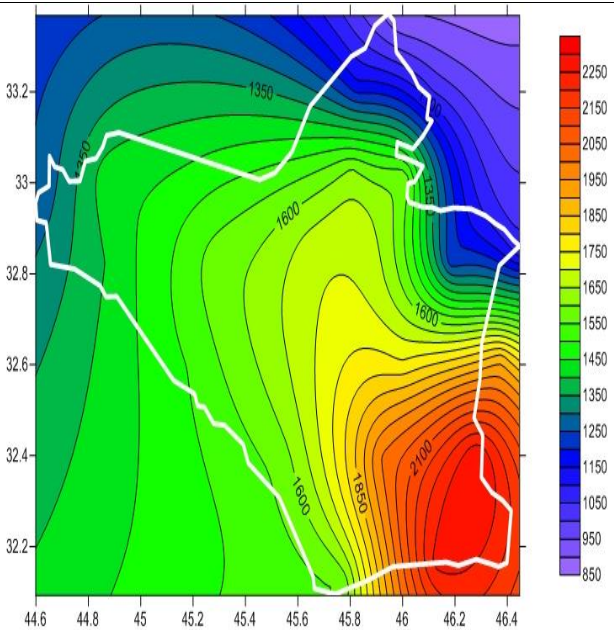


Figure 8(a)-The number of hours of power in Suzlon at 50m height

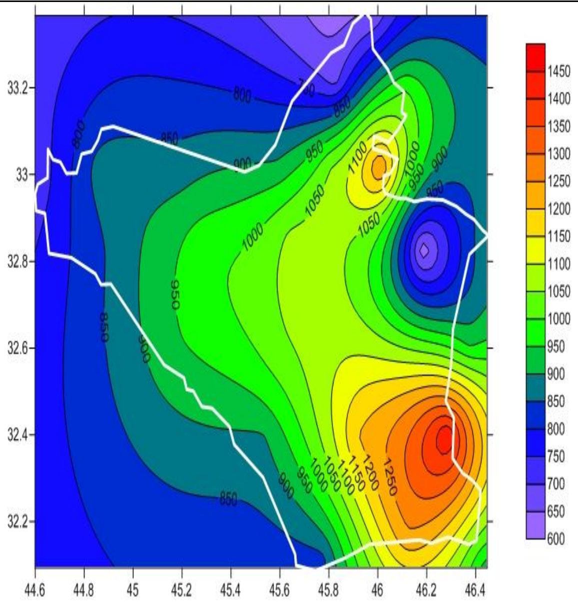


Figure 8(b)-The number of hours of power in suzlon at 100m height

Figure 8-the number of hours of power in suzlon at (50, 100)m height.

Conclusion

1- The number of hours depend on the range of wind speed which taken in our considration (rated to cutout wind speeds). In Gamesa wind turbine this range located between 12-23m/s, while it is located between 11-25m/s in Suzlon wind turbine type.

2- Gamesa G58-850 KW gives more generated hours per year than Suzlon S64-950KW, such that the 1st one gives about 1050 hour per year at 50 meters height. While the 2nd one gives 2250 hour/year.

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