EVALUATION OF THE ELECRICAL WIND ENERGY IN IRAQ

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1- ABSTRACT:

The energy requirements nowadays are proportional to the generated electrical energy using the ordinary steam and thermal methods.
This research includes the study of the climate changes in the different Iraqi cities in order to achieve the suitable places for the wind farms in the country. The renewable energy is widely distributed leading to increase the problems in installation and production. These problems such as the connection methods to the gird and the society resistance because of disadvantages.

The wind energy results in the different Iraqi cities using histrograms to choose the best places for distributing the wind turbines.

2- INTRODUCTION:

The human race has been harnessing the energy of the wind as far back as 5000 BC. The earliest known use was in Egypt where the wind propelled boats along the Nile River. The utilization of wind has been the primary form of power for transportation of vehicles across water until recent times. The first windmills were found in 200 BC, they used and designed to automatic relatively simple tasks like gain grinding and water pumping. The first use of a large windmill for electricity generation was in 1888. This was the first use of a step-up gearbox in a windmill which was to rotate the generator at the required rotational speed. Industrialization in the world led to a gradual decline in wind generation. The steam engine and the use of the cheap fossil fuels led to this decline. For a wind speed of 30 m/hr(13.4 m/s) the turbine was rated at 1.25 MW. This was used to power the local utility during the second world war. [1]

A windmill was designed in the shape of an eggbeater in the 1930s, Fig.(1). This was utilizing a vertical axis for the shaft rather than a conventional horizontal shaft. This design was not widely adopted.

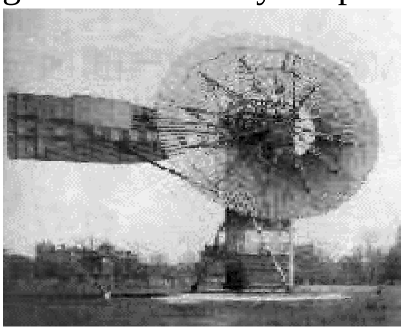

Fig.(1) a windmill

The end of the second world war shown a dropping in the prices of fossil fuel and also the interest in wind turbines. The rising in the energy price and the questionable availability of fossil fuels led to the realization that alternative means of power generation were required. The development and refinement of the wind turbine continued but it was not until the development of machines rated at 55kw in 1980 that the market for wind turbines took off. Fig.(2) shows a modern wind farm. The development brought very little radical changes to the designs but the ratings of the turbines increased and produced devices of 4.5 MW. [1,2]

Effectively all renewable forms of energy (with the exceptions of geothermal and tidal) are types of solar energy. It is the power that radiates from the sun which enables renewable technologies of energy to exist. In a single hour the sun radiates approximately 175 billion kwh of energy and conservation of energy approximately 1-2 percent of this is converted into wind energy. [2]

Fig.(2) a modern wind farm

The earth circulates around the sun and receives light and heat from the sun daily. It is the heat that the earth receives to create wind. Fig.(3) shows that the surface of the earth has a temperature gradient. The majority of the heat from the sun is received at the equator and it gradually reduces towards both poles.[3]

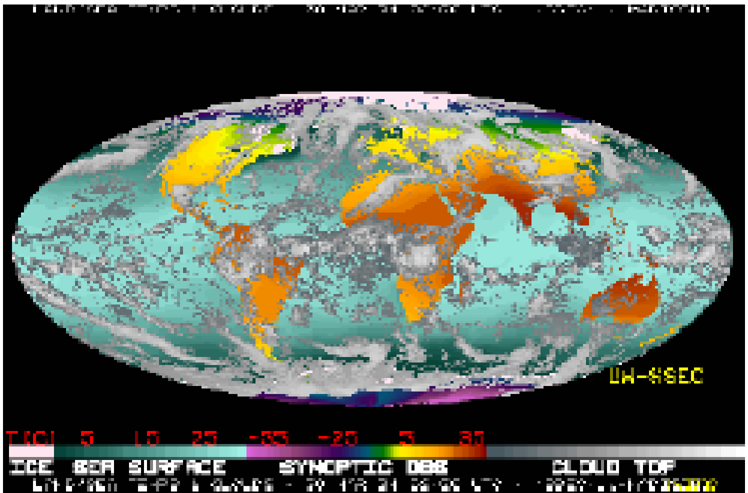

Fig.(3) Earth surface temperature variations

This temperature gradient creates wind. The wind forms due to the movement of air from areas of high pressure to low pressure zone. [3]

2.1 Basic Design of Wind Generators:

Wind turbines are classified into two general types: horizontal axis and vertical axis. A horizontal axis machine has its blades rotating on an axis parallel to the ground. A vertical axis machine has its blades rotating on an axis perpendicular to the ground. There are a number of available designs for both and each type has certain advantages and disadvantages. However, compared with the horizontal axis type, very few vertical axis machines are available commercially. The horizontal axis is the most common wind turbine design. Some of these designs are shown in Fig.(4) [5]

Fig.(4) Different designs of wind rotor

The power density is given by: [7]

$$\mathbf{P = \tfrac{1}{2}\, \rho_a\, A\, \upsilon^3} \quad ..../1/$$

where **P** is the power (w), $\boldsymbol{\rho_a}$ is air density (kg/m^3), **A** is the cross-sectional in square meters swept out by the wind turbine blades and $\boldsymbol{\upsilon}$ is the wind speed (m/s).

The simplified power equation in metric units is: [7]

$$\mathbf{P = 0.625\, A\, \upsilon^3} \quad ..../2/$$

where **P** is power in watts, and $\boldsymbol{\upsilon}$ is the wind speed in meters per second.

Swept Rotor Area is given by:

$$\mathbf{A = \pi r^2} \quad ..../3/$$

where (**r**) is the rotor radius(half the diameter, or the distance from the hub to a blade tip).

A short-hand method for calculating wind power density in metric units(w/m^2) when the wind speed is known is: [7]

Wind power density= 0.056 υ^3 **…………………………/4/**

Where υ is in miles per hour. When υ is in meter/second, then:

Wind power density= 0.625 υ^3 **………………………/5/**

where υ is in meters per second.

The ratio of the actual power output compared to the theoretical available is known as the power coefficient(C_p).

C_p=*Actual power/Available power* ………………/6/

Therefore the power density of the wind turbine in terms of (C_p) is: [7]

$P=1/2\ C_P\ \rho_a\ A\ \upsilon^3$ ………………………/7/

C_p is very unlikely to exceed the value of 0.593.

The above equation shown shows that the wind speed has a major effect on the power output from the turbine. The power in the wind is proportional to the cube of the wind speed. The relationship between the power output and the wind speed can be shown from Fig.(5).

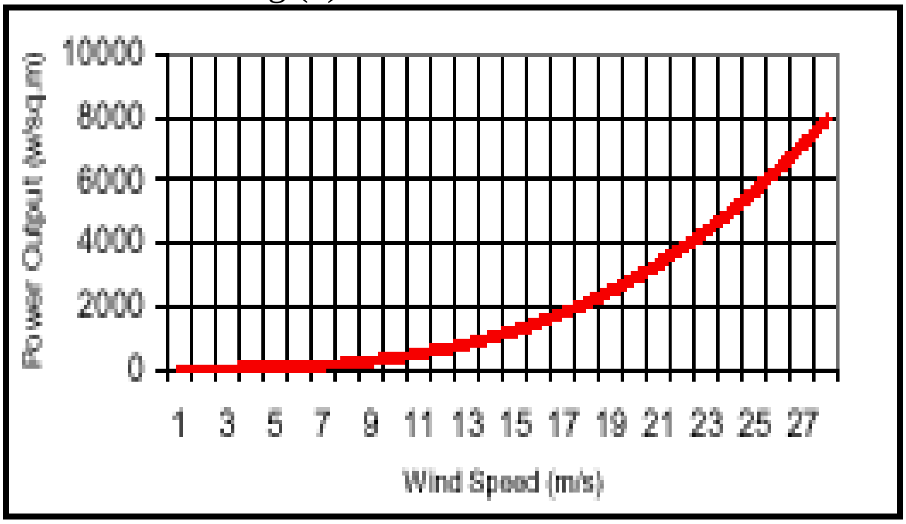

Fig.(5) Output power vs wind speed

2.2 Correlation factor:

The correlation factor of the wind energy generation is important and can be calculated by dividing the average speed of the wind at the site by its average speed at the station.

$$\frac{\textbf{Site} = 10.7\ \text{m/hr}}{\textbf{Weather station} = 11.5\ \text{m/hr}} = 0.93 \ldots\ldots\ldots /8/$$

For an example, if the site's estimated annual average wind speed is:

11.1 m/hr x 0.93 = 10.3 m/hr…………………/9/

Ideally, the correlation should be done for each of eight sections of wind direction. [7]

3. CALCULATIONS AND RESULTS:

3.1 Distribution of wind farms in Iraq:

To apply the distribution of the wind farms along the country measurements for the average wind speed (monthly and annually) in some areas must be studied to give the appropriate decision of choosing the suitable areas for this purpose. Table-1 gives the actual wind speed(m/s) in Iraqi governorates for the period of (1981-2000). [9]

Month	J	F	M	A	M	J	J	A	S	O	N	D	Annual
Mosul	2.0	2.3	2.3	2.4	2.7	2.8	2.7	2.6	2.2	1.8	1.6	1.6	2.2
Kirkuk	2.7	3.1	3.0	3.1	3.3	3.0	2.8	2.4	2.7	2.5	2.4	2.3	2.8
Nasiriyah	3.3	3.7	3.9	4.8	5.1	4.7	5.1	4.4	4.0	3.3	3.2	3.1	3.9
Hilla	3.0	3.3	3.5	3.1	3.3	4.1	4.0	3.6	3.3	2.8	2.7	2.7	3.3
Barah	2.8	3.1	3.4	5.3	3.4	5.1	4.7	3.4	2.9	2.5	2.5	2.5	3.1
Rutba	3.5	3.7	4.3	4.1	3.7	3.7	4.2	3.5	2.7	2.6	2.5	2.8	3.4

Table-1: Monthly wind surface speed for some areas in Iraq

The annual average distribution of wind the speed in Iraq for the period of(1981-2000) is shown in Fig.(6). The direction of these winds in Iraq is illustrated in Fig.(7), from which a decision can be attained to choose the suitable areas for the distribution of wind farms along the country. [9]

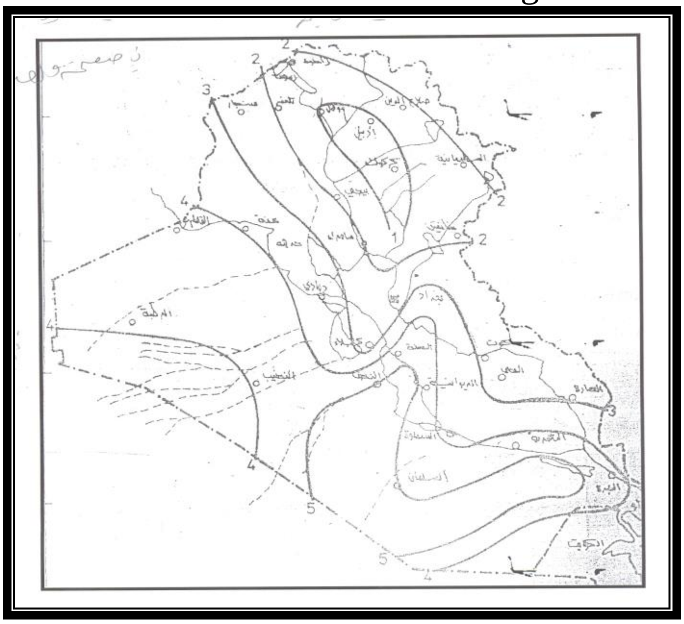

Fig.(6) Annual average distribution of wind speed

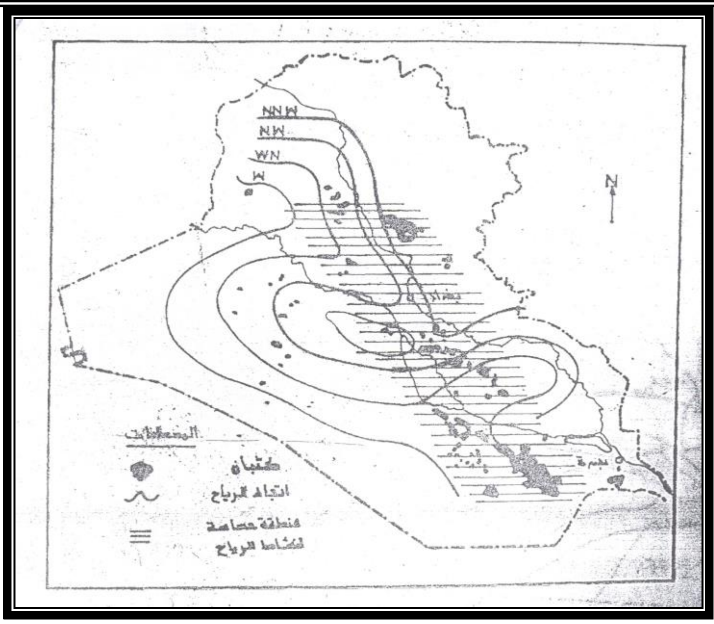

Fig.(7) Wind direction in Iraq

3.2 Calculations:

For the calculations, the wind speed of one meter per second is changed to be as 2.24 miles per hour. One square meter is taken 10.78 square feet. The area swept by most wind turbine blades is circular.

For a wind speed of 15 m/hr , standard air density, and with a rotor radius of 10 feet. The wind power can be calculated from equation /1/ as:

$$\mathbf{P = 0.0052\ A\ \upsilon^3 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots../10/}$$

$$\mathbf{P = 0.0052(314\ ft^2)(15m/h)^3}$$

$$\mathbf{P = 5.511\ kilowatts}$$

Wind power density is normally expressed in metric units which are watts per square meter(w/m^2). The wind power density then:

$$\mathbf{w/(A/10.76) = 5511w/(314ft^2/10.76ft/m^2)}$$

$$\mathbf{= 5511w/(29.182w/m^2)}$$

$$\mathbf{= 189\ w/m^2}$$

The results of obtained power of the selected governorates are illustrated in Figs.(8-14).

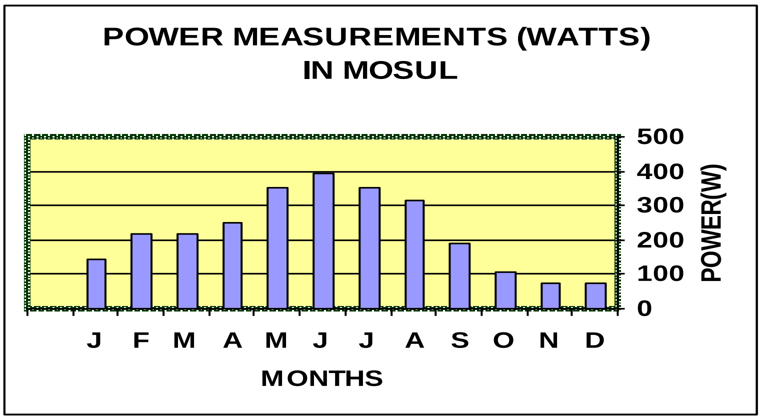

Fig.(8) power measurements for Mosul

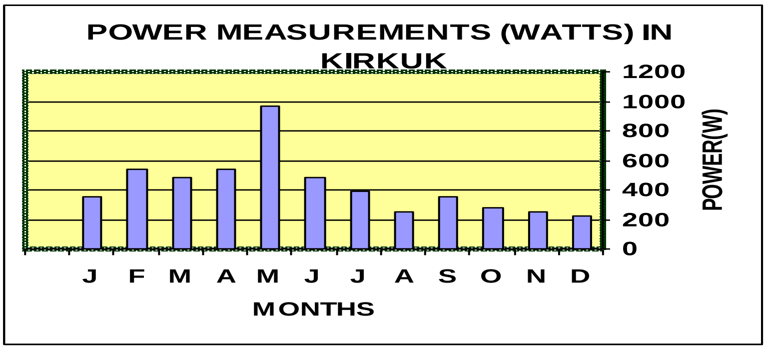

Fig.(9) power measurements for K

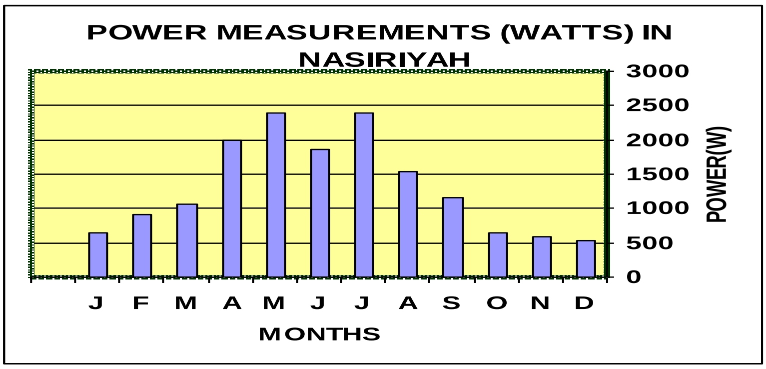

Fig.(10) power measurements for Nasiriyah

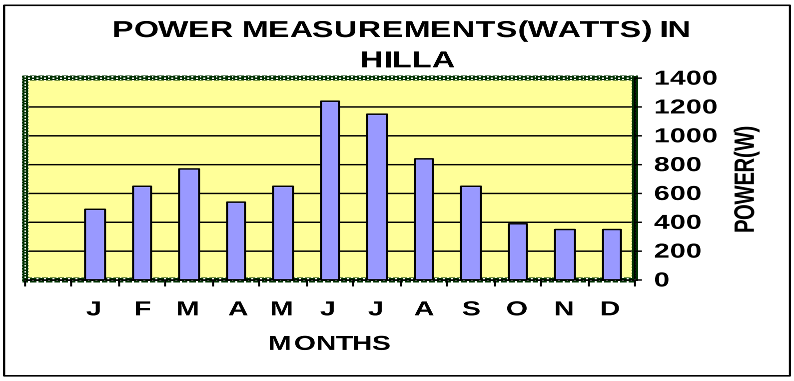

Fig.(11) power measurements for Hilla

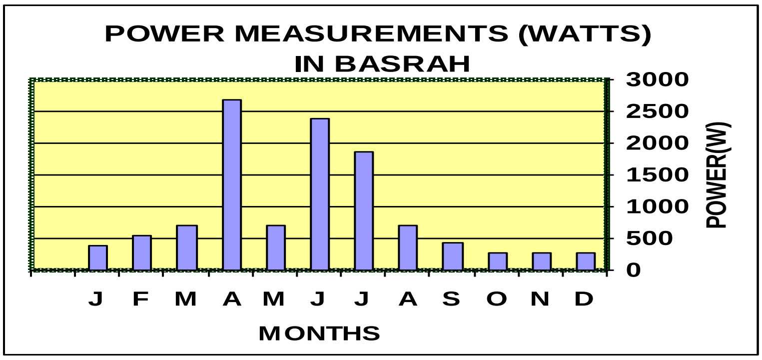

Fig.(12) power measurements for Basrah

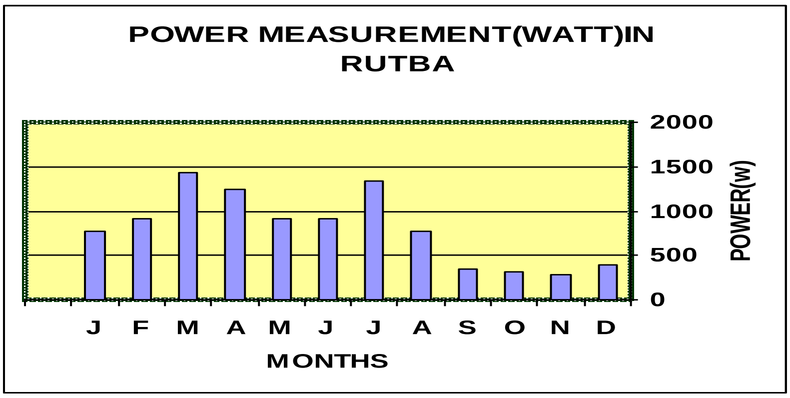

Fig.(13) power measurements for Rutba

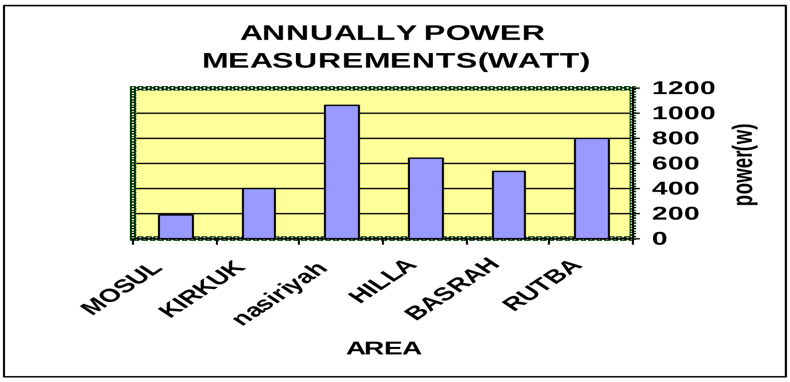

Fig.(14) Annually average power measurements for some areas in Iraq

More work was done to calculate the power measurements in the recommended areas of Iraq with different dimensions of blades.

4.DISCUSSION AND CONCLUSION:

- The energy supply market is very competitive, le by utilities and fuel companies that meet nearly all our energy demands. Alternative energy sources like wind power provide new options and certain advantages, but to be truly competitive with conventional energy sources, they also must be economical.
- The cost of a wind system has two components: initial installation costs and operating expenses. The initial installation cost includes the purchase price of the complete system (including tower, wiring, utility interconnection or battery storage equipment, power conditioning unit, etc.) plus delivery , installation charges and professional fees.
- The major points involved in a wind energy decision, condensed into a series of the following steps:

* Evaluating energy requirements.
* Evaluating the measured efficiency of the energy and compared with the other alternative energies.
* Evaluating legal, social and environmental issues.
* Evaluating wind resources.

* Determining the wind system application.
* Buying a wind system.
* Determination the requirements for utility interconnection.
* Evaluating the wind system economics.
* Refine system design.

- In this work only seven governorates are taken in the considerations, in which there is always winds, during the year. [9]
- The study and analysis of results leading to that all the obtained histograms have the same shape distribution (concave down shape). This means that the wind energy generally increases from the first months of the year to reach its maximum value at the nearly mid months of the year then starts to decrease and reaching to its minimum value at the last three months of the year.
- From histograms of power estimation:

In Mosul the ideal period for wind generation is during the months March to August and the peak value in June as shown in Fig.(8).

In Kirkuk the optimum period is during January to July whereas the peak value is during May as shown in Fig.(9), while the power in September has higher value by comparison with those in Mosul Fig.(8). The optimum period in Nasiriyah is limited between March to October and the most useful time is in May and July as appeared in Fig.(10). The best period in Hilla is during February to October and the peak time is in June as shown in Fig.(11). This histogram is showing a uniform concave distribution along the year unless peakdown in April and May, but in Hilla the power obtained is nearly half that obtained in Nasiriyah. In Basrah the useful time for using the wind generators is from April to July and the maximum value is in April as illustrated in Fig.(12). Basrah has a very bad wind or power distribution, while it has a high peak value of (2700w). That means, the wind generator can not invested worthy only three months, which are April, June and July. Other months from January to September have a rare power greater than that obtained in Mosul. The best period in Rutba is during the period of January to August whereas the peak value is in March as shown in Fig.(13). The histogram of Rutba is showing that there is a wide period to utilize the wind energy for the electrical generation in a high rate of power. This period reaches to eight months. The annually average power estimations for the mentioned areas in Iraq are shown in Fig.(14), from which it appears that the recommended areas for the distributing wind generators in Iraq are Nasiririyah , Rutba, Hilla and Basrah respectively.

5. REFRENCES:

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الخلاصة:

تعتبر طلبات القدرة فى هذه الايام متناسبة مع الكميات المتولدة من الطاقة الكهربائية بالطرق التقليدية البخارية والحرارية.

يتضمن البحث دراسة الاحوال الجوية فى مختلف محافظات القطر العراقى لغرض الوصول الى تخصيص الاماكن الملائمة لنشر المراوح الهوائية فى القطر للحصول على اقصى قدرة ممكنة على مدار ايام السنة. وتعتبر الطاقة البديلة ذات انتشار واسع فى الايام الحالية مما يؤدى بالنتيجة الى ازياد المشاكل فى طرق انتاجها ونشرها. ويتاتى بعض هذه المشاكل من طرق ربطها بالشبكة الكهربائية وبعضها من مقاومة المجتمع لتشرها بسبب مساؤوها.

تم نشر النتائج للقدرات المنتجة فى المحافظات المختلفة وحسب قراءات الانواء الجوية على شكل بيانى (هستروكرام) لاختيار المناطق الاكثر صلاحية لنشر المراوح الهوائية فى القطر.