Can Iraq use the wind energy for power generation?

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***Abstract*— Renewable energy, including wind energy, has become a vital part of reducing air pollution and improving its quality. This paper analyses the use of small wind turbines to generate electricity in Iraqi weather conditions. The study provides an assessment of the wind system required to generate electric power for highways services such as lighting and parking. According to the results of the study, the optimal use of wind turbines for highway lighting is possible. The efficiency of the maximum wind turbine depends on the design of its blade. The wind speed recorded in Iraqi winter relatively acceptable for the proposed application.**

***Index Terms*— Alternative and sustainable energy, wind energy, Iraqi climate.**

I. Introduction

Air pollution, global warming and climate change can be considered the most important threats to humanity today and in the future. All these risks are linked to human activities, the most important of which is power generation by burning fossil fuels (coal, oil, and natural gas) to generate electricity and operate vehicles [1].

The burning of fossil fuels results in dangerous pollutants, mostly carbon oxides, nitric, and sulfur. These pollutants, in addition to non-burning hydrocarbons, are the main cause of several phenomena such as acid rain and chemical clouds. Excessive combustion of fossil fuels causes CO2 to be increased in the upper atmosphere, causing global warming, which shows an impact across the globe. This phenomenon has caused many dangers to mankind such as climate change, drought, and high ocean water [2].

The increase in the number of small and large vehicles discharged from their exhausts increased this dilemma [3]. Especially in countries that have less electricity processing hours, forcing their citizens to switch to gasoline or diesel generators to compensate for electricity shortages. These generators with poor specifications caused an environmental disaster for the citizens of these countries [4 & 5]. The worst of the air pollution risk is that the rich northern industrial countries are receiving their pollutant to the southern poor countries, which do not have the potential to fight this pollution.

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Hence the new trend of most countries of the world to clean renewable energies and green [6]. Renewable energies are characterized by being natural, without any authority over them, and therefore will not cause high or fluctuating fuel prices as the oil has done over the past years [7]. From these renewable energies, solar energy has proved its advantage against the rest energies in terms of the dynamics of its spread. It can also be used in remote areas away from the electrical grid with high efficiency [8]. The power plants that use the concentration of solar energy have proved effective and have recently spread in many countries of the world [9 &10]. The solar chimney is a clear example of the potential of solar energy to produce large amounts of electricity to cover the needs of entire cities [11 & 12]. The use of solar energy in heating water for domestic and industrial purposes has become common in most countries of the world [13 & 14]. Air heating for convenience purposes is also possible and many models have been manufactured and proven to be efficient [15]. The Trombe wall is a solar energy application that can be used to ventilate spaces or to heat rooms [16 & 17]. Besides, the solar pond proofed its efficiency in heating and cooling application as it stores huge amount of thermal energy in its layers [18 & 19]. Photovoltaic cells have spread rapidly in recent years and have succeeded in stabilizing their feet as a viable alternative to fossil fuels in the processing of electricity both in homes and in cities [20 & 21]. Perhaps the most important disadvantages of solar energy systems, especially solar cells, are it is affected by humidity [22 & 23], solar radiation intensity [24 & 25], temperature [26 & 27], and dust [28 & 29].

Wind energy is used to transform this energy into another form of energy that is easy to handle and use. Wind energy can be converted into mechanical kinetic energy, such as windmills, or the conversion of wind energy into electric power using turbines. The total wind power production in the world in 2006 was 74.223 megawatts, equivalent to 1% of the global demand for electricity. If we go into more detail, wind power generates 20% of electricity consumption in Denmark, 9% in Spain and 7% in Germany. Global wind power production quadrupled between 2000 and 2006 [31 and 32]. The rotation of wind turbines is converted into electricity using generators [33]. Scientists and engineers have had enough experience to turn wind (wind) into mechanical movement and generate electricity. That wind energy has been used since ancient times [34], used by the Pharaohs to push the boat movement in the Nile River, as used by the Chinese in the operation of windmills operating as pumps to pump groundwater. To produce electricity, wind energy is used. Large farms operate as electricity grids, and small turbines can be used to power homes in rural or remote areas away from the national grid. [36] Wind energy can be considered safe, renewable and environmentally friendly and does not produce air and ocean pollutants. [37] The world is turning to the use of renewable energy sources as a healthy alternative to reducing the consumption and burning of fossil fuels and to reducing the effects of global warming and pollution. Technological and research advances are working towards reducing the cost of renewable energy in all its forms to expand its spread and popular acceptance [39].

The main components of the wind turbine are rotating blades mounted on a pole and a generator that converts the kinetic energy of the wind into electrical energy [40]. When the wind passes on the blades, a dynamic air flow is created that causes the rotation of the blades. This rotates the generator and produces electrical energy [41]. The rotation of the blades can be used as (brakes) to regulate their turn over and stop movement if necessary [42].

Energy produced by wind turbines is affected by wind speed and turbine blade diameter [43], and wind speed increases as the turbine rises from the ground. When a windmill is designed, large numbers of these turbines accumulate in vast areas to produce the greatest amount of electricity [44].

The United States alone produces about 3 billion kilowatt-hours per year (about 1 million people per year), mostly from California's wind fields [45]. The excess electricity is usually stored in batteries and because there are times when it is low Wind speed, which makes it difficult to produce the required demand of electricity [46]. It is preferable that the user and the wind user place a diesel or solar generator as reserve at the time [47]. The best air speed makes the use of turbines (wind work) at an average annual wind speed of less than 12 miles per hour. Wind turbines can produce mechanical energy for use in many applications such as water pumping for irrigation as well as for its primary production of electric power [48].

Today there are two major designs for wind turbines: horizontal axis turbines (Haut) and vertical axis (FOT). For vertical axis wind turbines are very rare to use, and the only current plant for this type of turbine is Darius and resembles the shape of turbines manufactured here like the egg whale form [49]. Fig. 1 represents a photo of a vertical axis wind turbine.

Fig. 1: a photo of a vertical axis wind turbine

A. The VAWT column is mounted on a vertical perpendicular axis on the ground and is always aligned with the wind, unlike its horizontal axis counterparts so it will not be necessary to adjust it when the wind changes but the VAWT cannot begin to move alone [50]. It needs a push from its electrical system to start and has wires. The height of the rotor is lower and the lower height means slower winds so the VAWTs are generally less effective than the HAWTs [51]. VAWT may be used for narrow-band turbines and water pumps in remote rural areas, but use horizontal axis wind turbines (HAWTs) at a much wider range [52].

The HAWT column is horizontally parallel and parallel to the ground and requires a deflection adjustment device to stabilize itself against the wind [53]. This deviation system includes electric motors and gearboxes that move the entire rotor to the left or right in small amounts [54]. The turbine control, the rotary (mechanically or electronically) site is adjusted to accommodate the largest available amount of wind power [54]. Horizontal axis turbines use a tower to raise the core components of the turbine to a maximum height for wind speed. Z while the length is approximately 260 feet (80 meters) in the air [55]. Fig. 2 represents a photo of a horizontal axis wind turbine.

Fig. 2: a photo of a horizontal axis wind turbine

International companies have achieved, through continuous research and development, the production of highly developed wind turbines, with adjustable structures, rapid construction and dismantling [56]. Some designs of modern wind turbines produce an electric power that doubles the equivalent of two decades ago, and today there are many wind farms that produce power equal to or less than conventional power stations. [57] The total wind power production was about 40,300 megawatts at the beginning of 2004, and this amount of electricity capacity met the needs of some 19 million medium-sized European households. [58] The cost of wind power production has fallen by about 50% over the last 15 years with the development of the quality of wind turbines and consumer acceptance of this type of electricity production [59]. Currently, winds at maximum locations can compete with new coal-fired plants and in some locations can compete with gas [60].

Oman is a country lies near the Indian ocean with high potential for using wind energy in many locations cross its large area [61]. This paper aims to evaluate a smooth and easy design of a wind turbine that can be used efficiently in Omani climate conditions.

II. Experimental setup

Theoretically wind turbines are 100% efficient, but in reality it cannot reach this efficiency. Some limitations which contribute to losing efficiency are that wind conditions change all the time and are never constant. Other factors include turbulence caused by land formations, trees, and buildings. A practical location to build a wind turbine is on high ground by a coastal plain where water exists. The local wind speed is also another important factor because the power is directly proportional to the cube of the wind speed as shown in Fig. 3.

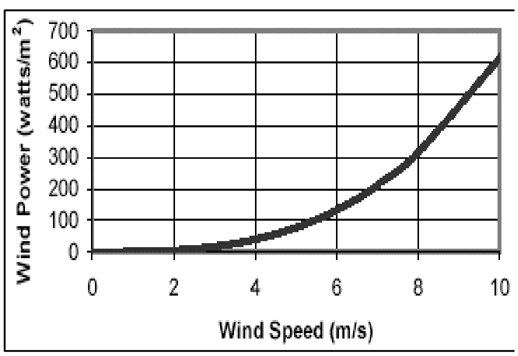


Fig. 3: Relationship between wind speed and wind power

Table 1: Wind turbine specifications

The name of the manufacturer	Marlec (UK)
Power generated	Up to 0.34 kW
Blades diameter	Variable diameters
The life span	15 years

The wind turbine is connected to a Data Acquisition system to record the wind speed 24 hours a day. The recorded wind speed is used to find the generated power by the turbine. The following equations were used for this purpose:

The area $=\pi r^2$,

Where r- is the turbine blades radius (0.8 m in this study).

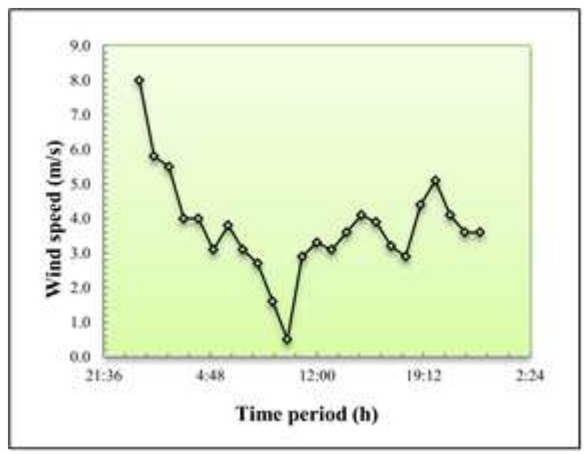
The generated power$=\frac{1}{2}*A*\rho*v^3$

Where ρ- is the air density, v- is the air velocity

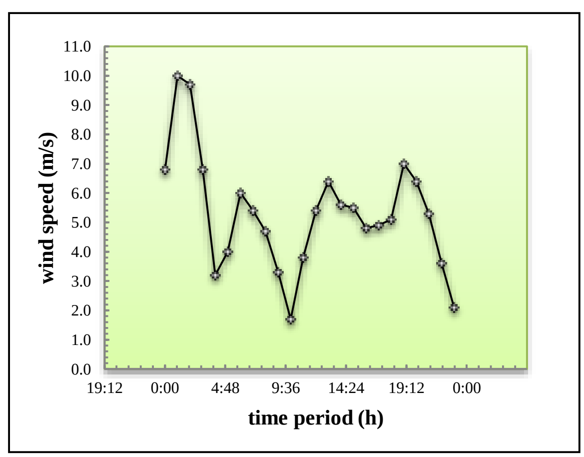
III. Results and Discussion

Fig. 4 shows the wind speed variation with time for four days in Iraqi winter season. The figures depicts that the wind speed are higher at night compared to noon hours. Besides, the wind speed reached high speed more than 10 m/s once a day while its average reached 3.825 m/s in Fig 4-A, 5.28 m/s in Fig. 4-B, 7.9 m/s in Fig. 4-C, and 4.52 m/s in Fig 4-D. The minimum wind speed reached was less than 1 m/s in three from the recorded four days. This speed fluctuation in the wind speed makes the dependence on the generated power has a risk and the use of current transformers or batteries is a must. The recorded wind speeds less than 5 m/s in average which makes the use of wind speed in large wind farms or the use of large wind turbines not economically feasible.

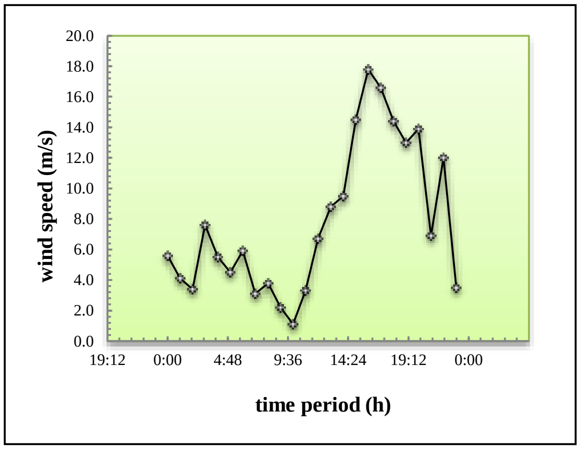
Fig. 5 represents the average wind speeds for the recorded days. The average wind speed in Iraq is low and less than 5 m/s, as the figure declares, and therefore may not benefit in the operation of wind farms, which is therefore not economically feasible. However, this speed can run small-scale turbines and produce enough electricity for the desired application of street lighting or parking, especially in remote open areas. The wind turbine produces electricity that will oscillate with the wind swing. Therefore, batteries must be used within the cycle of electricity processing to maintain a stable electrical load.



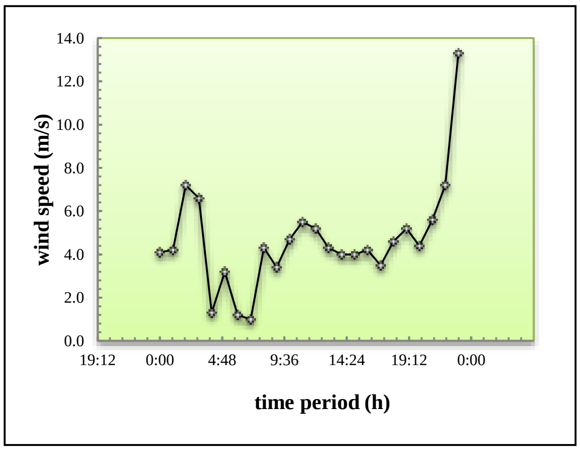
(A)



(B)



(C)



(D)

Fig. 4: recorded wind speed for four days in winter 2017

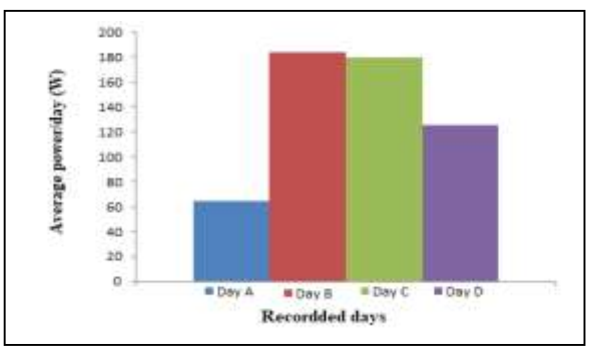


Fig. 5: the average generated power per day from the used turbine

V. Conclusions

The concept of harvesting renewable energy sources has existed for many years, and we have just begun to look at the transformation of these sources. The environmental benefits of wind power outweigh many other non-renewable energy sources. Wind farms are the main generator of wind energy, but there are also small residential wind turbines that can be used outside the grid. Different types of wind turbine configurations are selected to suit the geographical location of the land capable of use. Many factors are considered before installing wind turbines. Wind speed and direction play a dominant factor in selecting a suitable location.

The results of the study showed the possibility of using small wind turbines to work in the production of limited electric capacity. Iraq is characterized by low wind speed in general and in most parts. However, the results show that small turbines are capable of generating sufficient electrical power for street lighting or rest stops, especially in remote areas.

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