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Research Study on Wind Energy and Its Importance in Libya

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ABSTRACT

The practice of utilizing turbines or fans to transform the movement of wind into power is known as wind energy. Local electrical firms use wind energy in the form of wind turbine fields, and homes in rural areas can receive electricity from modest turbines. Not only is wind energy a renewable energy source but it's also regarded as safe. This renewable energy source doesn't release any pollutants into the atmosphere. The world is now looking to it as a fossil fuel substitute to lessen the effects of global warming. Beginning about 1940, wind power was utilized in Libya to pump water into several oases. Libya has had significant power outages over the past ten years due to many civil conflicts and a lack of routine maintenance, which has resulted in the loss of some power plants. A wind speed measurement was done to discover the wind's potential to fix this issue. According to the data, Libya has a lot of potential for wind energy. At 40 meters in height, the standard wind rate is between 6 and 7.5 m/s. It was discovered that Libya is among the nations where winds blow both frequently and regularly. The Qibli, Khamseen, and blows in the large desert are the most well-known local monsoon winds. To provide a permanent and ongoing solution to Libya's electrical outage problem, this paper highlights a portion of recent research in this area.

KEYWORDS: Wind Energy, Fan Turbine, Wind Speed Measurement, Electricity Libya.

1. INTRODUCTION

The main function if wind energy is converting the movement into a different type of energy that can be used easily [1], frequently electrical, using turbines or fans [2]. The wind movement rotates turbines is converted into electricity using electrical generators [3. Wind energy can be used in the shape of wind turbine fields for limited electricity companies or in the shape of small turbines to supply homes by electricity [4]. Wind energy is safe, and becomes a sort of renewable energy [5]. The humanity is now turned to renewable energy to take the edge off worldwide warming as another source of fossil fuels [6]. Wind energy was used in Libya to pump water into several oases starting in 1940 [7]. This energy has not been developed because windmills need some maintenance from time to time. In 2004, wind speed measurements were made to determine the wind potential [8]. Measurements showed that there is great potential for wind energy in Libya, and the average wind speed at an altitude of 40 meters ranges between 6-7.5 m/s.

It was found that Libya is one of the countries where winds blow regularly and periodically, and the well-known local monsoon winds are the tribal winds, the Khamaseen winds, and the desert winds [9]. Many studies have been conducted on wind energy and proven that, first, wind maintains the surface of the Earth temperature. It is known, while the air close to the Earth's surface heats up, its weight decreases, and thus it rises to the top and is replaced by cold air. Had it not been for this movement, the Earth's temperature would have risen. Year after year, it eventually becomes a holocaust for all living creatures that approach it, and thus life on Earth ceases to exist [10,11]. Secondly, winds are very useful in the process of transporting dust and dirt and in breaking up rocks and working to deposit them in those places where they collide, which leads to the formation of sediments that are considered to have an aesthetic appearance as a result of their formation, which forms many beautiful geometric shapes [12]. Third, the winds that move ships in the oceans or seas. This is due to the importance of air in completing the combustion process, on which the fuel used in ships depends [13].

Wind is also very useful in transferring pollen between plants. It is known that male plants produce pollen, which is responsible for pollinating female plants. If it were not for the wind, this pollen material would remain in the male plant, and thus the plants would die [14]. Winds are also beneficial in the process of precipitation. This is because when warm winds blow over the cold upper layers of the atmosphere, they condense, and thus rain falls on the Earth's surface. [15]. However, all these studies still need to be developed and kept up with the latest and most up-to-date technologies in renewable energies and wind energy, in particular, to advance electrical energy in the State of Libya and its public network.

This paper proposes a model that is applicable to any Libyan house to tackle the matter of power outages. It consists of six sections: an introduction, a description of the proposed model, a section for the proposed smart home for energy management, a section for results and discussions, a section on tracking and monitoring circuit design using Arduino Mega Board and App Inventor software, and a section on results and discussions. The conclusion is presented at the last section.

2. STUDY SYSTEM DESCRIPTION

A Dynamo turbine is a machine with an arm that is driven by a passing liquid gas such as water, gas, or air. The turbine changes the kinetic energy of the fluid into a special type of kinetic energy, which is the rotational energy that is used to move machines. The turbine delivers mechanical energy to other machines through the rotation of the rotating axis. The turbine provides power to a variety of devices, including electrical generators and pumps. Turbine-driven generators generate nearly all of the electricity used in lighting homes and operating factories. It is also used to rotate ships and is an significant component of a jet aircraft engine. Figure 1 shows the wind potential in the Libyan coastal region. It was found that Libya is one of the countries where winds blow regularly and periodically, and the well-known local monsoon winds are the tribal winds, the Khamaseen winds, and the Sahara Desert winds.

Figure (1): Dispalys the wind potential in the Libyan coastal region.

3. TYPES OF TURBINES

Turbines can be divided according to their type of function, and all turbines are driven by propulsion, reaction, or both. In a propulsion turbine, force makes the fluid move quickly when it hits the blades, and in a reaction turbine, the rotor rotates as a result of the fluid's pressure on the blades. The usual division of turbines depends on the type of fluid that moves them, and according to this division, there are four types of turbines.

3.1. Water turbines

It is propelled by water falling from a high place through a pipe or other channel. A water turbine is also called a hydraulic turbine. Figure (2. a) shows water turbines. Most water turbines, as well as hydraulic turbines, are driven by waterfalls or water stored behind dams that are used to drive electrical generators in electric power plants.

3.2. Steam turbines

It is considered a significant type of turbines that used in electric power generation plants. It operates electrical generators in most power stations and also operates ships and heavy machinery. It is also considered one of the most powerful engines in the world. Figure (2. b) shows the steam turbine.

3.3. Gas turbines

This kind has a lot of use. It can be used in jet aircraft, sea, and land transportation. Moreover it can be used in electrical power generation plants, particularly when reaching the peak hours. This turbine is characterized by its fast operation. It works on many types of fuel as shown in Figure (2. c).

3.4. Wind turbines

These turbines, known as windmills, were developed about 1,300 years ago. The first people to use it were the Pharaohs to transport sailors, and the Chinese also used it to grind grain and pump water. In the end of the 18^{th} century, windmills started to generate electrical energy, and they spread over the world. Some countries have replaced closed turbines with better efficiency. During the 1970s, the decline in oil increased the desire to use wind turbines to generate electricity. Figure (2.d) Parts of a wind turbine.

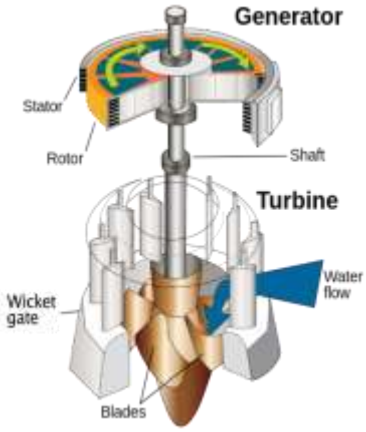

Figure (2-a) displays water turbine.

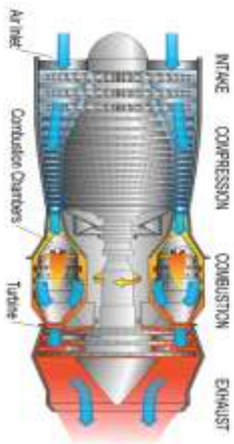

Figure (2-c) dis[lays gas turbine.

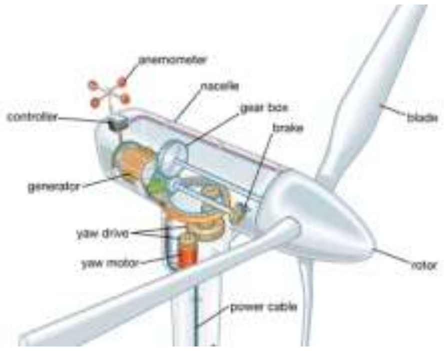

Figure (2-d) displays wind turbine.

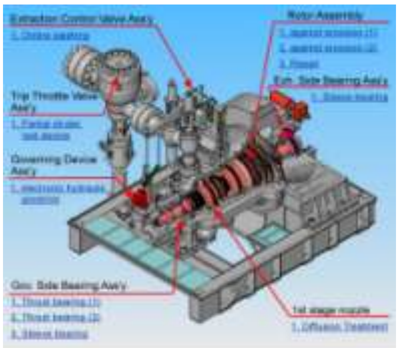

Figure (2-b) displays turbine.

Wind turbines come in three vertical and two horizontal varieties. There are many different wind turbine designs; however, some of them have not been approved because of their high cost and lack of efficiency. While there are a few different classification schemes for wind turbines, the axis of rotation is the most widely used classification scheme. It has the potential to be a vertical or horizontal axis as shown in the figure.

❖ **Horizontal turbines**

It is the most popular and widely used type of turbine because the electric generator and gearbox are positioned above the tower that carries the air, making the design somewhat complicated and costly and because the axis of rotation is parallel to the ground and the wind current in general, making the design of this type of turbine difficult. We can see the horizontal turbine in Figure (3. a). Horizontal turbines can be divided into single, double, triple, and multi-bladed categories based on the number of blades they have. The propeller with three blades is the most commonly utilized. The fans that receive wind from both the front and the back are depicted in Figure (3. b).

Figure (3-a) displays horizontal turbine.

Figure (3-d) displays fans that receive wind from the front and the other from the back.

❖ Vertical turbines

Vertical turbines rotate on a vertical axis that is perpendicular to the direction of the wind. One benefit of this system is that wind can blow from any direction, therefore, a wind-directing device of this kind can be abandoned. Additionally, the gearbox does not need to be mounted on the tower; it can be placed on the ground. Similar to horizontal turbine technology, these turbines are more cost-effective. However, one of its biggest drawbacks is that it might not be self-launching, meaning that we would need to find a way to launch it; in other words, we would need a propulsion mechanism to get things moving. This makes creating a tower for this kind of device more practically challenging. In vertical turbines, there are various varieties of rotors. Figure (4. a) shows the Darrieus turbine. As Figure (4. b) shown, it displays Savonius turbine.

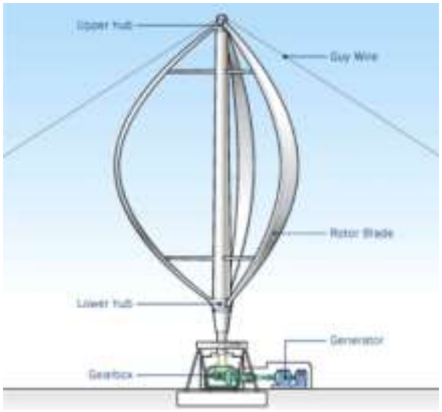

Figure (4-a) displays the Darrieus turbine

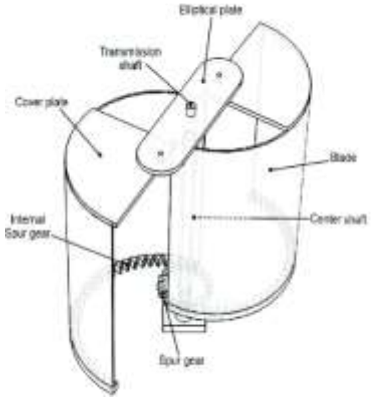

Figure (4-b) displays they Savonius turbine.

4. WIND TURBINE MODELLING

The mechanical power, power conversion, and electrical power system subsystems can all be used to characterize the electrical energy produced by a wind turbine. An essential part of harnessing wind energy and turning it into mechanical power is the rotor blade. The gearbox's ability to convert the low-speed rotor shaft into the high-speed shaft rotation required to power a generator provides the mechanical power. A power converter receives the mechanical power produced by the generator along with its torque. The electrical power is then generated by the power converter. Power is defined as energy produced per unit of time. Using the following equation (1).

$$P_a = \frac{dE}{dt} = \frac{1}{2}\left(\frac{dm}{dt}\right)v^2 = \frac{1}{2}(\rho AV)v^2 = \frac{1}{2}\rho Av^3 \qquad (1)$$

where P_a is the theoretically allowable wind power E is the wind kinetic energy; $\frac{dm}{dt}$ is the mass flow rate; v is the wind velocity; ρ is the air density; A is the area swept out by the blade. The theoretically permitted wind power is greater than the realistic amount of power (P Betz), which is ascertained as follows equation (2).

$$P_{Betz} = \frac{1}{2}\rho Av^3\, C_{p,Betz}\; \alpha\; l^2 \qquad (2)$$

where $C_{p,Betz}$ is the Betz limit dictating the theoretical limit of the power coefficient in the wind turbine; l is the blade length.

5. RESULT AND DISCUSSION

An electrical generator is a mechanical machine uses the electromagnetic induction principle to transform kinetic energy into electrical energy in the occurrence of magnetic field. Electromagnetic induction is the process of producing electrical energy when a coil revolves around a magnetic field (or a magnet around a coil). The coil, or magnet, is rotated by mechanical energy. For instance, a bicycle generator generates electrical energy to light the headlight of the bicycle by using the force of a wheel's revolution. Power plants use renewable energy sources, like wind, water, and so on. To turn the energy of the flowing water into electricity, sizable turbines are constructed.

An electromagnetic field is created by the stator coils when the rotor is rotated by a rotating shaft attached to the primary motor. This field is then transmitted to the stator coils, which then receive it and transform it into a three-phase electric current that is distributed inside the coils, creating a 120-degree angle between each side. The variation in airspeed before and after the turbine causes this to produce a regular electrical current in the shape of a wave, as seen in Figure (5).

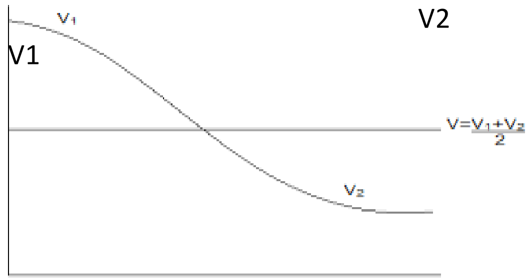

Figure (5): Shows the change in wind speed before and after the turbine.

As Figure 6 shown, the maximum capacity of the turbine is achieved according to the following relationship:

$$V2 = \left(\frac{1}{3}\right) * V$$

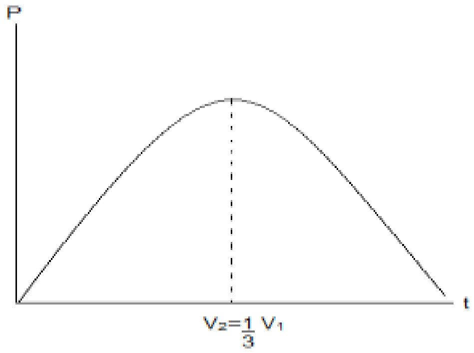

Figure (6): shows the energy change.

The energy possessed by the wind is called the kinetic energy of the air currents and is given by:

$E=1/2. m.V^2$ ………………………………………………….. (3)

The wind penetrating the wind turbine through the blades as they rotate forms a circle whose radius is the length of the blade and the area it creates is the area of the circle:

$A=\pi * r^2$ ……………………………………………………….. (4)

$E=1/2 * \rho. A. V^3$ ………………………………………….……. (5)

Therefore, the power generated by the wind turbine depends on (þ.A. V3), but the most influential factor is the wind speed (V3).

6. WIND ENERGY STUDIES AND PROJECTS IN LIBYA

For the KW 850 Siva wind turbine model, an evaluation of wind energy was carried out in the cities of Gharyan, Nalut, Masalata, and a few other cities in the eastern part of Libya. A summary of the fundamentals of wind energy and its resources is given, along with an analysis of the data that has been collected from typical weather stations. To generate the mean Bell distribution, energy density function, annual power, and annual amplitude factor, computer-generated databases were created using a 24-hour time series of wind data for the chosen sites. The wind data were then recalculated to represent the actual wind speed at axis height.

Mesalata has a good potential for wind energy because the KW 850 Siva wind turbine produced an energy equivalent to 1.27861 MWh annually (for the machine under study, the power factor was 1.275861). 17.14% of respondents think the wind source is appropriate for producing electricity. As part of the project to generate electrical energy using wind energy, which will be held in the Al-Shaafin Reserve in Masalata, the transfer of towers and the remaining wind turbine components to produce electrical energy continued after the city of Masalata was selected as a suitable area for establishing an electric power farm using wind turbines.

There were 16 towers and turbines totaling 70 meters in length. Each tower held a turbine that was attached to three 40-meter-long revolving blades that worked to move the turbine shaft in response to wind, indicating that this project would generate roughly 27 megawatts of electrical energy. to supply 40 megawatts, or 70% of the electricity used in Masalata. This project resulted from wind direction and speed measurements made by the Ministry of Electricity's Executive Center for Renewable Energy, utilizing equipment that was placed in the reserve years ago by a foreign business.

- **The wind energy** features

Everything has advantages and disadvantages, and wind energy has the following:

- It deeply conserve the environment because it reduces carbon dioxide emission rates.
- This energy is also free of pollutants associated with nuclear plants and fossil fuels.
- In addition, energy is renewable, the wind drives the turbines for free.
- It is also not affected by fluctuations in fossil fuel prices.
- While fossil fuel prices are rising around the world, the cost of generating wind energy is falling and its value is rising.
- Wind energy cannot supply the transportation sector with the energy extracted from it, which leads to the transportation sector relying on petroleum products only.
- Although wind is renewable, it is not permanent, but rather seasonal, and the wind speed is often not proportional to the required electrical energy.
- The wind turbines of this energy generate too much noise to be ignored. A single wind farm or a single loud windmill can produce such a loud noise in just twenty-four hours that it is unbearable.

7. CONCLUSIONS

In the coming years, there will be a sharp rise in the need for electrical energy due to both population growth and economic advancements. Libya is said to be in an ideal situation for employing renewable energy, particularly solar and wind energy technologies, due to its favorable geographic position. This energy presents a great opportunity and is suitable for usage in grid-connected power generation. Through field research, well-thought-out plans, and adequate funding are necessary for the quick and efficient utilization of renewable energy. After natural oil and gas, wind energy resources in particular might provide Libya with a significant portion of its energy needs and, if developed, could become a steady source of income for the country.

Finally, the most significant finding in this research work is how few colleges and other educational institutions have contributed into the field of the advancement of renewable energy technologies. The process of deploying renewable energy technology in Libya would therefore be positively impacted by the establishment of partnership platforms and the increase of strong collaboration between the power sectors and research institutions.

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