



Wind Turbines Evolution



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Table of Contents

Abstract	2
Introduction	3
Analysis	4
Conclusion	12
Recommendation	13
Literature cited	14

Table of figures and graphs

Figure (1) The energy resources in Egypt	P. (3)
Figure (2) quit revolution wind turbine	P. (5)
Graph (1) Relation between wind speed travel and power generated	P. (5)
Figure (3) Spiral drag wind turbine	P. (6)
Figure (4) difference between the general form and structure form of spiral drag	P. (6)
Graph (2) Estimated power efficiency with respect to tip speed ratio	P. (7)
Figure (5) wind spire and what happen in it	P. (7)
Figure (6) The magenn air rotor system	P. (8)
Graph (3) Relation between wind speed travel and power generated in rotor system	P. (9)
Figure (7) Ducted wind turbine	P.(10)
Figure (8) Sky serpent wind turbine	P.(10)
Graph (4) Estimated power considering electrical efficiency in sky serpent	P. (11)



Wind turbine Development

-Abstract –

Renewable energy has been derived from the earth's natural resources that are not finite or exhaustible, such as wind and sunlight. It is an alternative to the traditional energy that relies on fossil fuels, and it tends to be much less harmful to the environment. Also, renewable energy technologies produce power, heat, or mechanical energy by converting those resources either to electricity or to motive motor. Especially, Wind energy is the fastest-growing energy source in the world, with worldwide wind-generation capacity tripling in the five years leading up to 2004 also Wind-powered machines have been used by humans for centuries. Wind energy provides more than 10 % of total electricity generation. Egypt has the potential to generate up to 53 % of its electricity from renewable sources by 2030 according to a new report by the International Renewable Energy Agency. Because wind turbines are large and its wind blades average about 184 feet long, and turbine towers average almost 290 feet tall, flexible structures operating in noisy environments, also affect environmental balance by killing birds when they collide with wind turbines, There are two kinds of wind turbines horizontal axis turbines, but this kind has problems as high cost and it difficult to transport and install and they require an additional yaw control mechanism to turn the blade toward the wind. The second one is a vertical axis turbine one of the major challenges facing its technology is the dynamic stall of the blade as the angle of attack varies rapidly. And after the discussion about two kinds of them These problems can be overcome by using composite material and improvement in design including the use of aerodynamic wind tips and using modern generators, Finally, Turbines of wind energy had been very confused and essential topic for scientists and researchers.



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-Key words-

Vertical axis wind turbine (VAWTs), Horizontal axis wind turbine (VAWTs), Renewable energy, Efficiency, Ecofriendly.

-Introduction -

Fossil fuels currently supply most of the world's energy needs, however, unacceptable their long-term consequences, the supplies are likely to remain adequate for the next few generations. Scientists and policy makers must make use of this period of grace to assess alternative sources of energy and determine what is environmentally possible and acceptable promising

One of the developments that occurred in the late 20th was the emergence of wind as a source of alternative energies as in Geology (LO.1.1), directly capturing the wind energy) that is friendly to the environment. Because wind turbines are large in noisy environments,

also birds flying within wind farms can be killed when they collide with wind turbines causing environmental imbalance, in biology (lo .1.14, as food web and the effect of missing member in it) as killing kinds of living organisms can affect the other organisms. The blades of horizontal turbines are to the side of the turbines center of gravity, helping stability, which gives the turbine blades the best angle to attack, this angle makes it best control. So, the turbine collects the maximum amount of energy for the time of the day and season. Additionally, they present a myriad of control problems that if solved, could reduce the cost of wind energy. Also, the scientists think about the vertical turbines that can help solve this problem. It is safe for birds and environment. The parts of vertical one is located near the ground. It helps to decrease in materials too because it is lower in height than horizontal one.so, scientists try to make it cheaper

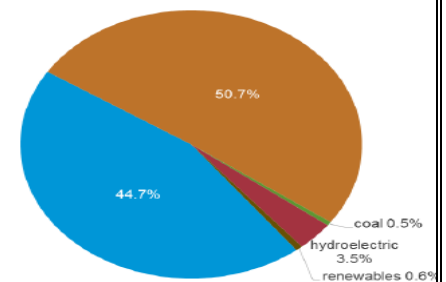


figure (1) show that the Percentage of total Egypt energy supplied by different fossil fuels and renewables in 2019



Wind turbine Development

by using composite materials as in chemistry {(LO.1.9) as composite materials contain fibers and polymer matrix }so, they are very strong material and help to decrease the cost if we add some cheap materials together. Furthermore, ecologists don't prefer using horizontal axis turbine as it effects on the ecosystem and environment, So, nowadays scientists try to modify on vertical axis wind turbine to make it more efficient in addition to trying to use other materials for making blades of turbine to increase the hardness. Scientists measure the efficiency of the turbine before and after adding these materials according to physics and the law of efficiency. As, scientists try to modify on the shape of the blades to make it quieter and eco-friendlier. So, it can be seen nowadays that there are many prior solutions differing in the shape and efficiency of blades like: Quiet Revolution, Wind Spire Wind Turbine, etc. also, scientists try to increase the revolution speed of the turbine blades as it is found in mechanics(LO.1.9,centripetal force) to increase the production of the electricity. However, modifying on generator of wind turbine has been important topic for scientists to research about because it transforms mechanical energy into electricity according to geo (LO.1.10).so, wind energy is considered one of the essential energies all over world.

-Analysis -

Hopes are high and so are the goals as several countries throughout the world, including Egypt are making substantial efforts to harness the wind energy in the best possible manner, Wind turbines convert the kinetic energy in the wind into mechanical power. A generator can convert mechanical power into electricity. Mechanical power can also be utilized directly for specific tasks like pumping water, many solutions discuss wind turbine development and how to increase the efficiency and reduce pollution like: -

* Wind spire

*Quit revolution



Wind turbine Development

*Magen air Rotor system

*Spiral drag wind turbine

*Sky serpent

*Ducted wind turbine

Quit Revolution wind turbine

According to “David L. Callies 2012”, The quiet revolution is new VAWTs are being to appear on and near buildings around the UK that take into account the engineering challenges presented by complex wind patterns. it uses three blades of variable section each sweeping through degrees to ensure the turbine delivers smooth power with no vibration from whichever direction the wind comes. this thing gives us advantages over conventional wind turbines, which are often unwelcome to their neighbors because of their visual impact, noise and vibration according to biology(lo.1.14,food web) that this noise will affect ecosystem and will kill lots of birds and animals , So this will lead to destroying the food web.

Real modeling shows that QR can produce between (20% : 40%) more energy than conventional HAWTs. As shown in figure (2).

As explained in geo (LO.1.9) energy resources and transformation , the rate at which a generator transforms electric energy is called capacity, we learned that energy power is measured by (watt) as the DC output energy that produced by QR in 31 mph (14 m/s) wind is 6.2 kw, with the British wind energy association rated power output at 24.6

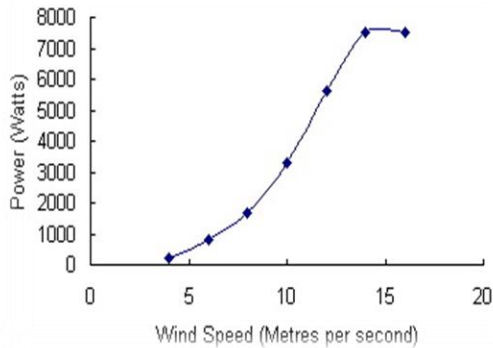


Figure (2) the Quit revolution wind turbine



Wind turbine Development

mph (11 m/s) is 3 kw DC so, power generation can begin at 10 mph (4.5 m/s), and the turbine cuts out at 36 mph (16 m/s). "INGENIA ISSUE 41 DECEMBER 2009 "



Graph (1) shows the relation between wind speed travel through Quit revolution wind turbine and the power generated.

Conventional turbines also have problems termed vortex shedding (in which pockets of fast-spinning air detach from blade and can create considerable noise). in the QR turbine, the tapered tips of its blades pass through the air more slowly than the rest of the blade and produce minimal noise. Also, this turbine doesn't need to turn to face the wind head-on when the wind direction changes.

Spiral drag wind turbine

A new type of HAWTs adopting the Archimedes spiral blade is introduced for urban-use. the design formula for the blade was derived using a variety of shape factors. The characteristics of the Archimedes wind turbine were examined using computational fluid dynamics simulations. This turbine, which is a new HAWT concept, was designed using the Archimedes spiral principles. Unlike traditional HAWTs, which use the lift force to take power from wind energy, the turbine uses both the lift and drag force. According to (Arman Safdari ET al; January 2015) Also, it can utilize the kinetics energy from wind energy. In particular,



Figure (3) General form of (VAWTs) which called Spiral drag which designed according to Archimedes principle of drag force



Wind turbine Development

according to the advantages, it will be more obvious in many circumstances, like around

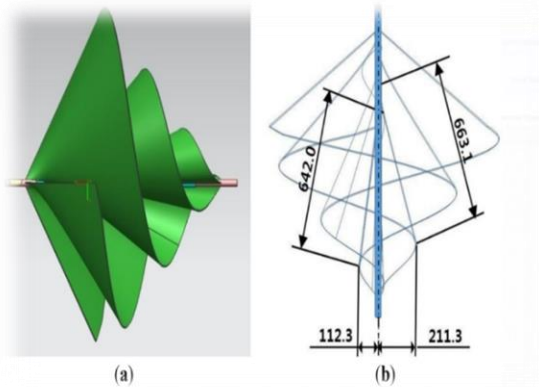


Figure (4) shows the difference between the general form and structural form of spiral drag wind turbine

buildings, wind direction in an urban environment

changes constantly but Archimedes wind turbine

follows the wind direction automatically because the yaw is passively controlled due to the drag force.

Other advantages include low noise because of the relatively low rotational speed that it was taught in

Mechanics(LO.1.9), centripetal force that say :that

rotational speed of an object rotating around an axis is

the number of turns of the object divided by time, specific as revolution per minute (rpm) or

cycles per second (cps) or....., etc. so, scientists know the angular speed of turbine by

calculating (Ω)omega($\Omega = v/2\pi r$) and they do that to make sure that the turbine is ready to be used in its usual speed

AS (Kyung Chun Kim ...Et al; 2014) said, the disadvantage of the Archimedes turbine is the

high thrust force compared to a propeller-type conventional HAWT.” In 2009, Timmer and Tote (two scientists)” carried out research to examine the potential and optimal power output of this

wind turbine. The highest efficiency measured was 12%. recently developed a design method for turbine blade and performed numerical simulations. To the best of the authors’ knowledge, there

are no reports on the characteristics of the turbine. (Ho Seong Ji, Li Qiang Et al; 2016)

Wind spire wind turbine



Wind turbine Development

(Global Energy Network Institute (GENI); 2012) Wind spire has been actively involved in different installations of VAWTs around the world.

The advantages like being Omni-directional (don't require a complex mechanism and motors to yaw the rotor). “Arlinda Huskey, Et al; 2009” VAWTs

generally function better than HAWTs in turbulent and gusty winds. HAWTs cannot efficiently harvest such winds, which cause accelerated fatigue, In VAWTs, gearbox maintenance is simpler and more efficient, as it's accessible at ground level, so that no large equipment is needed on-site. This reduces costs and impact on environment. Motor and gearbox

failures generally are significant considerations in the operation and maintenance of HAWTs both on and offshore.

(Huskey, A; Forsyth, T; June 2009) There are some disadvantages like, some designs of

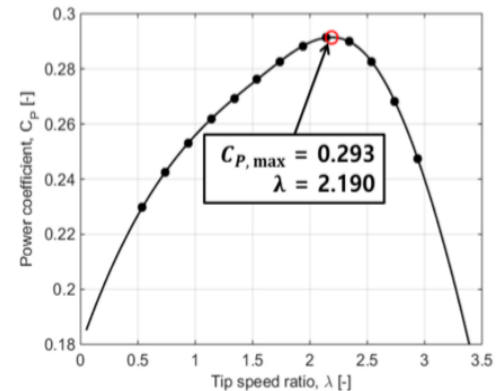


Figure (5) that show general form of wind turbine and the cycle that happened in it

VAWTs in suitable situations that can use screw pile foundations, which hugely reduces the road transport of concrete and the carbon cost of installation. Screw piles can be fully recycled at the end of their life. So, one of challenges facing VAWTs technology is the

dynamic stall of the blades as the angle of attack varies rapidly. The blades of a VAWT are fatigue-prone due to the

wide variation in applied forces during each rotation. This can be overcome by the use of modern composite materials that it was learned before in chemistry (LO.1.9). More importantly, composite materials enable structures to be designed to provide significant advantages such as



Graph (2) estimated power efficiency with respect to tip speed ratio.



Wind turbine Development

weight reduction, being a very strong material, lowering of its cost. Manu Sharma, Brian Rieger; May 2012) So, they try to use composite material while making turbine blades because it's known that some factors considered as big problems in turbines such as mechanical equipment, fatigue, corrosion resistance, weight, breaking toughness.

Also, improvements in design - including the use of wingtips that cause the spreader wing connections to have a static load. The vertically oriented blades can twist and bend during each turn, causing them to break apart.

The Magenn Air Rotor System wind turbine

(Tebibel;2018) The Magenn Air Rotor System (MARS), is a high-altitude wind turbine kept afloat by helium. Essentially, it is connected to an electrical ground station that generates renewable energy at a low cost as it learned in physics (LO.1.8, Archimedes principle) Things float in the air according to Archimedes principle that says: the buoyant force is equal to the weight of displaced air as ($F_b = \rho V g$).

also, this turbine floats in the air in the best way because it contains helium that has a lifting force of 1 gram / liter so if the turbine has 5 liters of helium, the turbine can lift 5 grams, scientists use pressure to know how much pressure that turbine will appear according to physics (LO.1.8), the System has many advantages over just using a diesel generator to provide energy solutions. Using wind and diesel power together can deliver energy at less than 20 cents / Kilowatt Hour

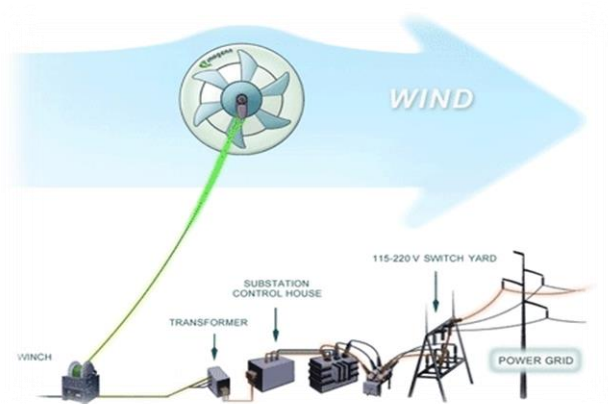


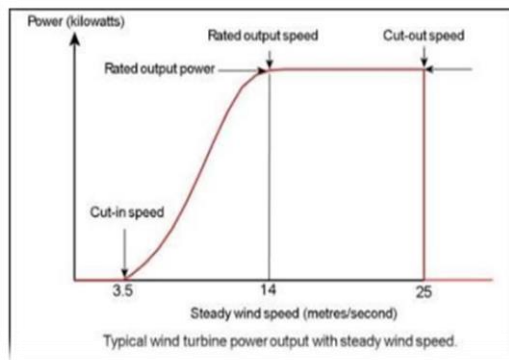
Figure (6) that show general form of rotor system turbine and the cycle that happened in it



Wind turbine Development

(kWh), whereas energy produced from just using a diesel generator costs between (25: 99) cents per kWh. it is also expensive to handle and store a diesel generator.

(Devalla, Sharma;2017) As the MARS is small, it is also very easy to set up, being deployed and redeployed quickly, Also, they are better for the environment so, many people complain that they destroy the countryside. With the MARS, as it does not impact natural views in the same



Graph (3) shows the relation between wind speed travel through Maegan rotor system and the power generated

way. It also has much lower noise emissions than other turbines and is bird and bat-friendly. Also, its low start speed and able to function in high wind speeds (it can operate in a greater variety of weather).

However, it faces many problems like,

Transportation and installation can now cost 20% of equipment costs. And stronger tower construction is

required to support the heavy blades and generator. The reflections from tall HAWTs may affect side lobes of radar installations creating signal clutter, although filtering can suppress it. more in height can make them visible across large areas, disrupting the appearance of the landscape and sometimes creating local opposition.

They require an additional yaw control mechanism to turn the blades toward the wind.

The ducted wind turbine



Wind turbine Development

According to (Christopher Norman Gaskell;2002) A research project, the ducted motor consists of a turbine inside a duct that flares at the back. They are also referred to as a diffuser augmented wind turbine. Its main advantage is that it can operate in a wide range of winds and generates a higher power per unit of rotor area.

Strong points:

It can be used in densely populated areas such as large cities. Also, it is noticeable and has little impact on the aesthetics of a building. And these turbines are avoiding together the transmission losses that come with centralized energy generation because they allow the on-site production of electricity.



Figure (7) that shows the general form of the ducted turbine

Weakness points:(Robert K. W. Dannecker ;2002) However, they cannot be used for houses. And the wind must blow in the right direction for them to work. Also, as a new model, this type of wind turbine isn't yet properly tested for efficiency.

Sky serpent wind turbine

(Yamini Sarathi ;2015) the Sky Serpent is one such project that can be fixed on a building or a nearby place and can still be used to supply a substantial amount of energy. The multiple rotors are attached to a single generator, which generates electricity. The Sky Serpent has a



Figure (8) that show the general form of the turbine



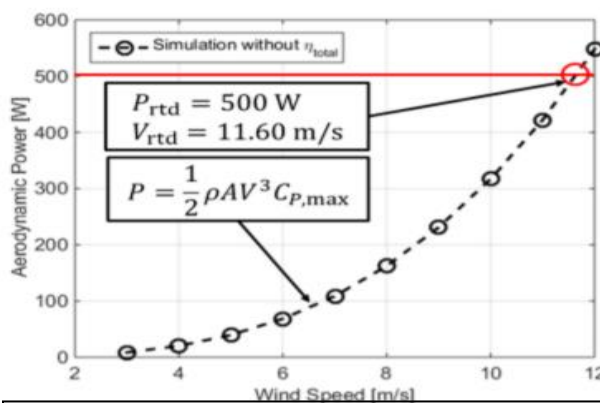
Wind turbine Development

capacity of generating power up to 3 KW. Moreover, as the construction of the system is simple with fewer materials, the maintenance required is low, Advantages of the system: -

It is 10×efficiency of the traditional wind turbines and scientists know that by using the law of efficiency that found in physics and the equation of wind power (efficiency) is given by

Energy out = $12 \times \rho A V^3 C_p$ (0.5 × density × area of circle × velocity cubic × velocity of the turbine)

Also small and inexpensive designs Again in tests the prototype was able to produce 6,000 watts in winds of 32.5 mph, Turbine as no complex gearboxes or slip rings to turn and steer the



Graph (4) estimated power output considering electrical efficiency.

turbines And it can twist and turn at

multiple angles to gain optimum power,

The blimp itself could also be covered with

solar cells- so that virtually everything is

harnessing renewable energy

Disadvantages of this system

(According to More inspiration website 2017)

Although these turbines can be used on land, the primary employment will be offshore. Moored by tethers to the sea bottom, the shaft's fulcrum will be at or very close to the water surface,

allowing maximum "twist ability". But what happens in severe storms? The super turbine could

be filled with water, and laid down onto or beneath the water's surface. But this wouldn't work

with a dirigible attached, unless that was manually untethered and stored. Also, there may be the

potential to impact adversely on passing seabirds and ships- especially in unpredictable

conditions.

So, the universal joint for its fulcrum and the flexible drive shaft have proved themselves in

smaller test models, but with that be able to successfully translate into full-scale commercial



Wind turbine Development

turbines. Finally ,after this discussion about the development of wind turbines it shows that for any organization want to make wind turbine for improvement of the economy, some many rules should be followed like use vertical one instead of the horizontal for more efficiency, and it is low in cost and need little materials and less impact for the environment also the idea of following the wind direction automatically

It's brilliant and collect a great amount of energy, using multiple wind turbines as in sky serpent wind turbine is efficient, the idea of drag force and the rule of Archimedes could work in most situations and achieve a high amount of energy.

-Conclusion-

The absolute introduced and individual limit of wind turbines have both been consistently expanding over the most recent four decades—primarily determined by the requirements for progressively sustainable power sources and furthermore continually to bring down the expense of vitality. The breeze power these days assumes significantly more significant job in the vitality gracefully framework ,To help this and other idea examines planned for evaluating seaward wind turbine innovation as in the event that somebody or any organization need to make wind turbines with less contamination and high proficiency with minimal effort there are a few models that ought to be taken consideration about:-

utilizing vertical breeze turbine as it has less commotion than customary breeze turbine and it is consider little so it is anything but difficult to arrangement. Additionally, its expense is not exactly flat turbines on account of less materials. Also, the edges between the cutting edges of wind turbines to accomplish the best proficiency like sky serpent, the most noteworthy productivity of it at the point of (30) degree. Estimating a weight is significant models that researchers care about as it estimated by the weight condition (the pressure=force/territory), the



Wind turbine Development

researchers do that to perceive what is the most noteworthy weight that the turbine will bear. in option to that they should be cautious when they pick the edge materials. Through the investigates, we wrapped up by laws, theories and our calculations that DC generator is the most proficient generator that make power by wind vitality and decline defilement

In this way, the perpetual advancement in wind turbines is the most significant factor to improve utilizing the elective vitality on the planet at a similar make the manners in which that ensure nature more.

-Recommendations-

Egypt can possibly produce up to 53 % of its power from sustainable sources by 2030 as per another report by the universal Renewable Energy Agency.

After the conversation wind vitality is significant, recommended to be utilized as it considered one of the cleanest wellsprings of vitality and doesn't cost a lot of cash. Vertical turbines are more effective than different sorts of turbines and if there is an opportunity to utilize the level it's recommended to utilize numerous numbers of sharp edges like in sky serpent turbines

DC generator is one of the most productive generators on the planet and can gather incredible measure of vitality and convert it to power. Likewise, the drag force and Archimedes principle are interesting for the issue, it's recommended to furnish turbines with sun-oriented cells to get the greatest measure of power if there should be an occurrence of non-nearness of wind.

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