An Analysis of Benefit of Wind Turbine Blade

Zeid Saleh

School of Engineering, Technology and Maritime Operations
Liverpool John Moores University
Liverpool, United Kingdom
Email. diez2004@hotmail.com

Abstract

Wind is a natural source of energy which has been used effectively over the times for mechanical purposes such as the case of Windmill and recently for electrical purposes such as wind turbines. The growing global economy and the increasing demand of ecological energy resources, helped significantly in developing new technologies to produce electricity from the wind. Over the last few decades wind turbines have evolved considerably to gain a respectful share in the green energy market. There are two types of wind turbine horizontal and vertical. The horizontal axis wind turbine and the vertical axis wind turbine could either be fixed in offshore or inshore depending on the wind force and directions. In order to take the most out of the wind energy, wind turbines blades have been designed carefully for a greater efficiency in energy capture. For instance, a small wind turbine can generate around ten kilowatts of electricity that has been designed for home use. Several studies related to the turbine theory have been carried out in order to reach an optimal
aerodynamic efficiency in different blade type's geometries. Wind power is one of the most common renewable energy sources that it has proved to be one of the most profitable energy sources both in terms of economy and ecology. The contribution of this work is to examine the benefits of using wind turbine in particular in producing more electricity and thereby save additional cost in due course.

1. Introduction

Wind power is one of the common renewable energy sources that it has proved to be one of the most profitable energy sources both in terms of economy and ecology. (Beatriz, 2010). The history states that the first windmill has existed in the 1st century B.C and it's referred to Hero of Alexandria. This windmill was used for mechanical duties such as grinding stones. (Manwell, 2011).

Fig1a illustrates the earlier windmill. Historians stated that the second windmill was built in the 9th century in the East of Iran as it shown in Fig1b. The Seistan windmill has a vertical axis rotor. It is used to grind, saw, water pumping etc. (Manwell, 2010). However, inspired from the Persian windmill, Denmark became one of the earliest European countries to obtain the technology of the windmill. (Holland, 2012)
Fig 1a: Hero’s windmill “Manwell, 2010”

Fig 1b: Seistan windmill “Manwell, Northern Europeans has then developed smocks mills while Danish engineers were testing windmill rotor and studying the blades.

In the UK, according to the guardian newspaper, the first conducted windmill test was recorded in July 1987 in Glasgow. This experimented by Professor James Blyth of Anderson’s College. He tested the first windmill for electricity generation. (Guardian, 2012).

Today, windmill electricity represents the best renewable source of energy. Cheap cost and more popular, it force many people in the world to look towards alternatives. Windmills structural components and design remains the same. A windmill has three blades which are placed on a long vertical shaft. The blades are turned by the wind to generate electricity. (Richard, 2012)

A wind turbine is defined as a machine which made up of two or three propeller-like blades called the rotor. The rotor is attached to the top of a tall tower. The wind turbine generates electricity, as the wind blows it to spins the rotor. As the rotor spins the energy, the movement of the propellers gives power to a generator.

Fig 2 shows a typical wind turbine, which is usually made of three components, nacelle, tower and the rotor. The rotor is composed of to the hub and the blades of the wind turbine.
Fig 2: Wind Power “South-Ayrshire, 2012”

The tower is supporting the nacelle box and the rotor blade. The typical tower height is between 1 and 1.5 times the rotor diameter but in any case is commonly at least 20 meters. More the tower is stiff less vibration will be produced. The new wind turbines have synchronous generator. These mean if the generator is combined with the power electric converters then it will be easier for engineers to operate the wind turbine in variables speed.

Based on their orientation of their spin axis, wind turbines can be either vertical- axis wind turbine (VAWT) or Horizontal-axis wind turbine (HAWT). For the VAWT, the orientation of the spin is parallel to the ground (refer to fix below).

Fig 3a: Different types of HAWT

For the horizontal-axis wind turbine, the tower elevates the nacelle. Thus provide sufficient space for the rotor blade rotation. The tower allows the nacelle to reach better wind condition. The rotor blades are held by the rotor hub. The nacelle holds also the generator and gearbox. The horizontal-axis wind turbine industry usually uses three-blade rotor placed in the front of the nacelle. This is known as upwind configuration.

However, the downwind configuration is a horizontal-axis wind turbine with the blade at the back. HAWT has higher wind energy conversion efficiency. (Bin Wu) Due to high tower, horizontal-axis wind turbine has access to stronger wind. Unfortunately, the installation of the tower cost a lot of money to support the heavyweigh.
wind turbine, the orientation of the spin axis is perpendicular to the ground.

Fig 3b: Different types of VAWT

For the vertical-axis wind turbine, the gearbox and generator are placed in a box of the turbine in the ground. The rotor for the VAWT can have a variety of shapes with a number of blades. Compared to the HAWT, VAWT has a lower installation cost. The maintenance is easier due to the gearbox and generator which are placed on the ground. The disadvantage is the efficiency of wind conversion is low. VAWT has a higher torque which leads to mechanical vibration.

3. Analysis and Discussion

Several reasons are used to explain the benefit to adopt the wind turbine approach. Using wind turbine allows people to save more money. Wind turbine energy is one of the most adopted renewable energy and probably the most influential energy in the world. This type of energy resources differ from others such as oil, gas and coal. However, wind turbine energy is a clean energy which is good for the environment compared to the coal which creates pollution. A part from saving money, it is important to consider that wind power energy is an efficient and sustainable energy which reduce the pollution that send to the atmosphere. It said as we reduce the need for more mining, the need for the destruction of habitats to facilitate the extraction of these
resources or the transportation of the resources. (South-Ayrshire, 2012)

Fig 4: Wind energy production “Beatriz, 2010”

Most countries in the world installed wind turbine as alternatives sources of energy. The deployment of the wind turbine energy will tackle the climate change. Fig 4 shows that the wind energy production has increased exponentially from 1995 and 2008. Fig 5 shows the wind energy capacity. It has been promoted all over the world. The two most populated countries such as India and China are now using this technology to produce large amounts of electrical energy. For fig 5, United State of America is currently the largest wind power market, followed by Germany and Spain. It is said that “In terms of growth, world wind generation capacity more than quadrupled between 2000 and 2006. Additionally, wind farms are assumed to continue their expansion, as it is expected that in the next decades’ wind energy will occupy 20% of the total annual power consumed both in Europe and USA” (Beatriz, 2010)

Fig 5: Energy production “Beatriz, 2010”
Fig 6: World wind energy increase estimation “Wind harvest, 2012”

The graph is predicting the world energy consumption using wind turbine energy. It shows that for the next twenty years it is expected to expand at 20% annual increase by 2015.

4. Conclusions and Future Work
The contribution of this work is to evaluate the use of wind tribune to produce more electricity at a low cost. Future research will investigate energy conservation using wind tribune.

References
