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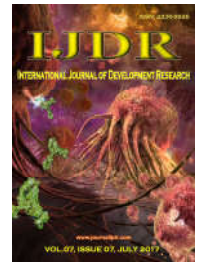
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CHALLENGES AND OPPORTUNITIES OF WIND ENERGY TECHNOLOGY

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ABSTRACT

Wind is one of the growing alternative sources of energy in the world offering solutions to the depleting fossil fuels which have continuously polluted the atmosphere by emission of the greenhouse gases. Although wind has proved to be a viable source of green energy, wind turbine machinery construction is accompanied by a lot of challenges during both construction and operation which are at times considered minor but still exhibits tangible impacts. As well, wind energy comes with a number of opportunities both socially and economically. This paper therefore focuses on the challenges and opportunities created by the construction of wind turbine for energy generation. Studies from different authors are analysed and critically reviewed with a comparison made on both the pros and cons of the wind turbine as an alternative source of green energy after which a conclusion is drawn as to why this type of energy generation is preferred to conventional energy sources.

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INTRODUCTION

Wind energy technology has become increasingly a viable electricity source which has better economic benefit to the countries which have implemented it (EWEA,2012). Wind is the cleanest source of energy which does not produce direct gaseous emissions into the environment hence it help to reduce the climate change (Evance, A *et al.*,2009).As the technology dominates more and more, people are getting employed in this sector and this reduces the unemployment rate which is a solution to the global socio-economic problems(EWEA,2012). The negative impacts of the technology on natural environment such as damage to birds, bats and loss of their habitat gives the technology a challenge as the people's perception becomes negative about its progress (Kuvlesky *et al.*, 2007).Technically, the wind turbines generate power within the rated speed which is between 4 m/s and 15 m/s but due to the intermittency of the wind speed, any wind speed below the rated minimum speed gives no power generation and above maximum rated speed results into shutting down of

the turbine with no power generation and hence this gives the technology a big challenge(Komor, 2009). This paper looks deeply on the challenges and the opportunities of the wind energy technology.

Challenges of wind energy technology

Damage to birds and bat: According to Kuvlesky *et al.* (2007), the development of wind energy technology poses a significant challenge to birds and the bat. In the research conducted at the Lower Gulf Coast of Texas in the U.S.A, the havoc was noted to be much on the migrating and resident birds. The birds' collision mortality is noted to be very high due to the fact that they get hit by the blades of the moving turbines and the wind farm structural parts. Research carried out in Europe and U.S.A in the past 20 years showed that the bird collision range per turbine per year was between 0 to 30.These collision risks are related to locating wind farms along the migrating routes of the birds or areas which are frequently visited by birds which resulted into many birds

being killed by the wind turbine blades and the farm's structures. The turbines constructed in clusters posed less damage than those constructed in long strings. In a research conducted in Canada, according to Zimmerling *et al.* (2013), the mortality rate of the birds was 8.2 ± 1.4 birds for every turbine per year in 43 sites analysed. This quantity varied between 0 and 26.9 birds per turbine per year. But according to Morrison (2006), the way wind turbines appear to the birds (height, blade tip speeds, and the presence of lighting) contribute so much to the collision risks of the birds. Morrison (2006) further attributed that specific lighting attracted specifically most of the nocturnal migrants. Kuvlesky *et al.* (2007) is not accurate to argue that cluster layout gives less danger to the birds than line lay out of the turbines since the collision of the birds depends on moving patterns of the birds. As well, if light was to attract birds at night according to Morrison (2006), then tall city buildings with lights could be the greatest cause of bird and bat mortality. Zimmerling *et al.* (2013) and all the authors do not consider any natural death which may arise to both the birds and the bat in the wind farm.

Loss of Habitat

In areas where there is a wind farm, there is tendency of the birds to avoid such areas and overcrowded the only available habitat for their survival. Birds are mostly found in grasslands which is part of the wind farm (Kuvlesky *et al.* 2007). According to Johnson *et al.* (2000), the survey carried out in areas with turbines and compared with areas without turbines registered big difference in the birds population. There were fewer birds in the wind farm areas compared to the grasslands an indication that birds had abandoned that area. A survey conducted at the Buffalo Ridge in Minnesota indicated that the population of the birds in the Conservation Reserve Program (CRP) grasslands containing turbines was significantly lower than the conserved grassland (CRP) without turbines (Leddy *et al.*, 1999). So therefore; wind farms facilitate the loss of the habitat by the birds. According to Morrison *et al.* 2001, when the research was done before the construction of the wind turbine, the song bird species population was higher than after the construction of the turbine. This is a clear indication that the existence of the wind turbine has a negative effect on the bird habitat. Although all the studies do not a certain if the displacement of the birds is due to the noise from the turbine blades, the tall structures, the vehicular movements to the site during the regular turbine checks, it is worth noting that all these are bought by wind turbine technology evading the natural bird habitat.

Intermittency /Variability of Wind

Large wind turbines produce electricity at 4m/s and reach maximum rated output at around 15m/s. The wind speed may sometimes vary and therefore the production keeps on changing at times (Komor, 2009). Unpredictability of the wind speed poses a great challenge to the consumer since during daytime, electricity demand seems to be very high and any low output gives the sector a blow compared to other sectors such as natural gas and hydroelectric power plant which can turn the power plant up or down whenever need be. This is a great challenge to the wind energy sector since wind cannot produce power anytime as per demand due to variation of wind speed it faces (Komor, 2009). According to the research done by Palutikof *et al.* (1987) between 1898 to 1954 at Southport, it was established that the annual wind speed varied between

5.5m/s to 7.3m/s. Depending on the characteristics of the wind turbine, this wind speed variation affects the electricity production since if the speed is below minimum turbine design speed, no power will be produced by the turbine and if the wind speed goes beyond the turbine maximum rated speed, there will be no energy production since the turbine is shut down which interferes with energy supply (CSE, 2011). All the authors seem to share same idea, it is evident that wind energy sector should devise a method whereby any excess energy produced can be used to pump water to a dam so that when the production goes low due to low wind speed, the water pumped in a dam can flow back at a higher pressure to drive a standby hydro turbine for continued energy production to keep to the constant energy demand. But the challenge of this is that the site of the wind farm must be near a constant water source in order to create an artificial dam.

Opportunities of wind energy technology

Clean Source of Energy

Evance, *et al.* (2009) sees wind energy technology as a source of clean energy that has no direct gaseous emissions into the environment. The carbon footprint of electricity generation is adversely reduced with this technology compared to other energy sources. Figure 1 clearly gives a comparison of the grams of carbon dioxide equivalent emissions during electricity generation by different plants and during manufacture. By producing electricity through wind power technology, the greenhouse gas emissions is greatly reduced and a clean atmosphere is achieved since there is no direct gaseous emissions into the environment (U.S. Department of Energy, 2012). Both Evance *et al.* (2009) and U.S. Department of Energy (2012) do not consider the carbon dioxide emissions during clearing of the vegetation in the farm area for the project and the decaying of the birds hit by the turbine blades which emit some gases into the atmosphere. All these contribute to the emission but at a lower level compared to the non-renewable resources which have constant emissions.

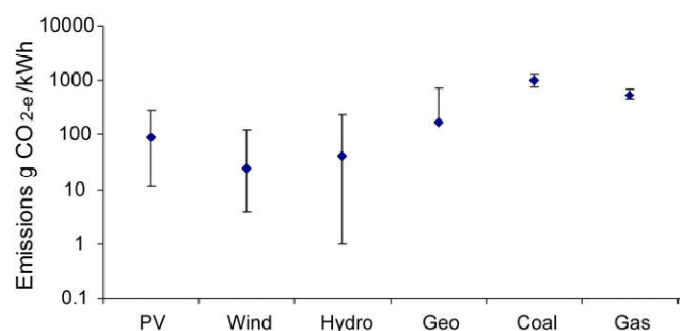


Figure 1. Carbon dioxide equivalent emissions (Evance *et al.*, 2009)

Economic boost

According to EWEA (2012), economic status of Europe was improved by the income through the wind power. The wind energy sector alone contributed €32.43 billion in 2010 both directly and indirectly to the European Union's (EU) gross domestic product (GDP) which formed 0.26% of the EU's total GDP for that year. This is a great opportunity to change the economy. The same year, tax from wind energy sector contribution also amounted to €3.59 billion which further

improved the economic status (EWEA 2012). The tax income trend is as shown on figure 2. The property tax revenue increases with the wind energy technology projects in the local communities which in turn is used to boost the local schools, parks, recreational facilities and other public amenities (Reategui and Tegen, 2008). According to the conference paper by Reategui and Tegen (2008), the Colorado six wind power projects generated about \$23.8 million in property taxes as at 2008. The projects also generate over \$2.5 million yearly as added income to farmers who leased their land to the developers. By generating electricity through wind technology, the economy of a country is well boosted through different sources of energy by providing cost effective supply of electricity to the critical economic sectors like manufacturing (U.S. Department of Energy, 2012). All the authors tend to see the economic boost of this project but as well the payback period is very wanting considering the capital input by the government and the research funding for the project. Its substantial income is realised after a very long period a fact which gives it a challenge compared to other energy sources such as hydroelectric power plants and fossil fuels.

Taxes paid by EU wind industry

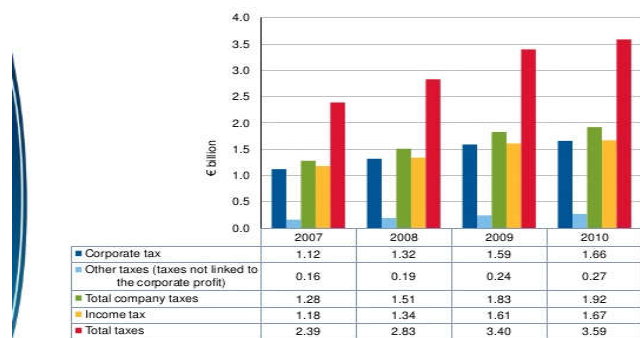


Figure 2. Taxes paid by EU wind industry (EWEA, 2012)

Employment Opportunity

A rewarding opportunity brought about by wind energy technology is the employment creation. As the advancement of wind turbines continues, more and more people are getting employed in this sector. As per EWEA (2012), in the year 2010 around 238,154 people were employed in Europe in the wind energy sector up from 230,970 and 198,647 in 2009 and 2008 respectively. During manufacture of the wind turbine parts and the transportation of the parts to the site create employment to the population.

According to Reategui and Tegen (2008), 1000 MW installed capacity of wind turbine gave 300 people permanent jobs in the state of Colorado in the rural areas while 1700 citizens were employed in full time basis during the construction phase of new projects. A research done by Sterzinger and Svrcek (2004) indicated that wind energy sector gave employment in the ratio of 70% during manufacture of the turbine parts, 17% during installation and 13% in operation and maintenance in the wind energy technology sector. Apart from the direct employment from the sectors as identified by the authors, it is worth noting that the businesses around the estate for the permanent employees like shops and hotels also create self-employment. The researchers did not consider all these in their study and hence this technology has vast employment opportunity.

Conclusion

It is very evident to note that wind energy technology has tangible advantages and can be treated as the most recommended source of energy since it helps in boosting economy, creates employment in the society and provides clean fuel to save universe from global warming menace. Its challenges are very minor just like the mortality of birds is 8.2 ± 1.4 birds per turbine per year which can be compared with natural death of birds in a year. Loss of habitat is real but do not affect birds much since they always adapt to newer environment easily. As well, variability of wind speed still stands as a critical challenge to continuous energy generation in wind energy technology but good research on the wind speed trend can save the situation before constructing a wind farm. As well, several back up technologies can help curb the situation to keep constant energy supply. With these minor challenges, the technology stands to be the best in power generation.

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