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Energy, Economic and Environmental Impact of Wind Power in Malaysia

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Abstract

Wind energy, commonly recognized as an environmentally friendly and renewable energy resource, has experienced major developments since its inception. The harnessing of energy through this resource is said to be one of the best alternatives to non-renewables like coal and fossil fuels in many countries. However, developments in wind energy have not come very far in tropical countries like Malaysia. This paper seeks to provide an overview of the possible impact wind energy could have on the local energy industry, its influence on the economy as well as the direct and indirect effects on the environment. Also, the potentiality and practicality of harnessing wind energy in Malaysia are discussed.

Keywords: *Wind Power; Energy; Economic; Environment; Renewable energy*

1. Introduction

Global industrialization, since its inception, brought with it a great need for energy. Every day, the consumption of energy grows with the advancements humanity makes, be it in terms of technology, lifestyle, preservation of culture – every task requires energy. Due to this growing need, the harvesting of energy, in all its forms, has become a controversial topic in today's world, due to a variety of reasons. Among the topics of interest include the impact on the energy industry, how the economy will be affected, as well the influence the generation of energy has on the environment. Recent debates across the globe, be it academic or political, have included substantial proof that if we continue along our current consumption trends, the planets non-renewable sources are projected to be depleted within the next 100 years[1]. Due to the fact that a majority of the world's energy comes from non-renewable sources (i.e. coal, fossil fuels, etc.), the renewable energy industry has recently garnered more attention [1-3].

Wind energy is among the aforementioned renewable energy resources. Energy is harnessed by using wind turbines that convert the kinetic energy caused by blowing winds into electrical energy [4]. Many countries like the United States, Germany, Spain and the Netherlands have begun opting for wind energy, while reducing their dependency on non-renewable sources, because of its relatively low carbon footprint as well as its potential to generate clean energy. However, despite the slow optimistic responses toward wind energy, unless enough research and effort is put into making wind energy a worthwhile resource, it will not be able to compete with the ability of fossil fuels to meet growing energy demands, seeing that nett world electricity consumption rose from 7,323.36 billion Kilowatt-hours(kWh) in 1980 to 19,396.64 billion kWh in 2011 [5].

Like most of the world, Malaysia depends on coal and fossil fuels for the generation of most of its electricity. Malaysia is divided into two, one is Peninsular Malaysia, and the other is East Malaysia, which is a part of Borneo. Due to its geological situation, Malaysia has a readily available-major renewable energy resource in its electricity portfolio – hydropower. Already, about 10.74% of the country's electricity is being

[1]Data obtained at: https://www.ecotricity.co.uk/our-green-energy/energy-independence/the-end-of-fossil-fuels [Accessed 1 Jul. 2017].

supplied by hydropower[2], which means alternative renewable sources could further reduce the dependency on coal and fossil fuels.

Given that Malaysia is a tropical country that lies in the equatorial zone, and its weather patterns are strictly regulated by the Northeast and Southwest monsoons which blow in alternating periods throughout the year [6], the region does not experience winds similar to the likes of the Great Plains or the Netherlands. The general consensus on wind patterns in Peninsular Malaysia is that the east coast experiences the greatest winds when the Northeast Monsoon hits, between November and March [4]. According to the Malaysian Meteorological Department, winds during this period range between 10 to 30 knots[3]. However, due to its irregularity, and relatively low wind speeds, wind power is very unpopular in this region, which includes Thailand, Singapore and Brunei[7].

If we are to expand Malaysia's renewable energy resources beyond hydropower, we will need to review every available energy source by evaluating specific factors to gauge the feasibility of said sources. Thus, this paper aims to provide an overview of harnessing wind energy by focusing on 3 main topics – impact on energy, impact on the economy, and the impact on the environment.

2. Energy Impact

As previously mentioned, Malaysia has two primary governing seasons, the Northeast and Southwest monsoons. During the Southwest monsoon, around June to September, the prevailing wind flow is generally low, while wind speed picks up during the Northeast monsoon. However, several studies have cited that previously recorded wind speed data in Malaysia have relied on inaccurate data due to a combination of simplistic methodologies and poor choice of surveying locations, resulting in grossly inferior estimates of wind potential [5].

2.1 Feasibility of Wind Harvesting in East and West Malaysia

Although Malaysia has an east and west that is separated by the South China Sea, both experience wind with relative similarity due to the wind behaviour in the region. Given that wind speed is a key factor in the harnessing of wind energy, only locations with high wind speed can be considered as sites for wind farms [8]. Researchers who utilised the Weibull distribution system of analysis [4, 8], coupled with other algorithms, determined that it is indeed feasible to build wind farms[4] in Malaysia, but using wind turbines specially designed for low-wind areas. It was found in 2010, that in Kudat, Sabah (East Malaysia), the most frequently occurring wind speeds ranged from 4.7 to 9.1 m/s, with 6 m/s (Fig. 1) being the median speed [8]. It was also found that Mersing (Fig. 2) and Perlis had mean wind speeds of 2.4 m/s and 2.5 m/s respectively [4]. From data obtained, these areas among others seem to be the best suited locations for potential wind farms. Other areas researched included suburbs, airports and highlands, all of which showed very low wind speeds [9].

2.2 Technology in Wind Energy

Relating to the previous subtopic, the challenges faced, with regards to harnessing wind energy in low wind speed regions, need to be addressed through the innovation of tools and instruments that cater to the need of the region. First, the type of wind turbine used would have to be different from the conventional 3-blade turbines we're used to seeing, as those require much higher wind speeds. The Horizontal Axis Wind Turbine (HAWT) and Vertical Axis Wind Turbine (VAWT) are viable options as they are suited to medium-low wind speeds in inland areas [10, 11]. Some studies have shown that some turbines have great capacity factors in low-wind speed regions, but choosing turbines solely based on its capacity factor would be a misguided decision [12]. Another issue with current technologies pertaining to wind energy is the efficiency of the turbines. Most conventional turbines used are said to have a maximum efficiency at 50% [13]. This suggests that more energy could be harnessed if the efficiency was improved.

2.3 Offshore Wind Turbines

[2] Data obtained from http://meih.st.gov.my/documents/10620/57af5e2a-7695-4618-a111-4ba0a49ba992.
[3] 1 knot = 0.514 m/s
[4] Wind farms is the site where a group of wind turbines are installed for bulk electricity generation [7].

Most of the wind analyses and research gathered for this paper surrounds inland wind. However, recently the idea of offshore wind turbines were explored, and has opened up a new world of possibilities. Erecting wind turbines offshore, where the measured wind speeds were higher than expected wind speeds [14, 15], would allow the generation of much more energy than if it were placed inland. Another perk of building a wind farm offshore is the issue of noise and sight pollution [16], which is the basis for so many complaints on inland wind farms. Due to different scenarios experienced offshore, as well as cost issues, various offshore wind turbine designs have been implemented in parts of the world. Offshore wind farms, given the spacing and higher winds, do produce more energy in aggregate compared to onshore configurations [17].

2.4 Future of Wind Energy

Malaysia, to the date this paper was written, has had no success in wind energy harvesting. The small experimental projects like the ones at Swallow Reef and Perhentian Island serve as a reminder that wind power capacity will not be very easily achieved in this region, given low wind speeds and seasonal variabilities [5]. Instead, Malaysians are advised to look at mesoscale winds instead of concentrating on macroscale winds, as it could prove to be more effective.

3. Economic Impact

Wind energy, at its current technological capacity, has seen to provide doubts to stakeholders as to whether it is a worthy investment or not. This is because wind energy systems come with a very high start-up cost, and would usually depend on large investments from the government and/or public [11]. However, once installed, the long term benefits are said to give a better return on investments as compared to coal and fossil fuels [11, 18].

3.1 Cost Factors and Possible Contribution

In order to see if the implementation of wind turbines is a worthwhile investment, some basic calculations need to be done as a preliminary assessment. The factors that should be accounted in calculations include the following [19]:

i. Cost of the individual wind turbines ~ US$1200/kW to US$1500/kW
ii. Cost of installation (onshore/offshore) ~ 30% of cost of wind turbine
iii. Acquisition / leasing of land for wind farm ~ (in the U.S. $0.113/kW-h)
iv. Operation and maintenance costs ~ 15% of capital cost
v. Wind turbine lifetime
vi. Bulk electricity generated from the turbines.

Several research papers have come up with ball park figures for these costs [19, 20], as they tend to vary with time and the advancement of technologies, as well as the country. The electrical generation potential as seen from Malaysia's neighbouring country, Thailand, shows that at offshore areas of mean wind speed between 5.5 and 6.5 m/s, assuming 1000 turbines are strategically installed at an area about the size of the Bay of Bangkok, an estimate of 6 TWh/year in AEP[5] could be generated [14]. Now, extrapolating these figures to Malaysia, going on the assumption that Malaysia's wind potential is not dissimilar to that of Thailand, and a majority of the coast line is fitted with wind turbines with a hypothetical capacity factor of 25%, about 15 TWh/year in AEP could be produced.

3.2 Plans to use Wind Power

At this point in time, only research is being done with respect to wind energy in Malaysia. Due to the country's discouraging wind speeds as well as socio-political influences [5, 21], wind energy does not look like the next best alternative energy source in Malaysia.

4. Environmental impact

There are several aspects that surround how the environment is influenced by the generation of wind energy. It has been proven that wind energy is among the cleanest energy sources with zero carbon emissions [20, 22], yet there are some aspects which are said to negatively impact the environment. This paper aims to discuss both the advantages and disadvantages of wind turbines.

4.1 Advantages of Wind Energy

There are various environmental advantages that follow the use of wind turbines to generate

[5] AEP – Annual Energy Production

electricity. Among them is that wind energy creates no harmful emissions, hence the carbon footprint from generating power can be reduced. Following the figures obtained in the previous section, if 15 TWh/year is produced from wind energy, a staggering 7000 tons of CO_2 emissions could be avoided [14]. Another advantage of wind energy is that the cost of wind energy will be less than that of coal, if we take into account the cost used in trying to offset the emissions of CO_2 and SO_2 among other substances [22]. Another viable option is the use of off-grid low-speed wind turbines in rural areas [23], because it is too costly and challenging to connect small rural villages to the national power grid. Doing this not only improves the lives of our rural counterparts, it will do so without heavily impacting the environment.

4.2 Environmental Disadvantages

There have been several discussions pertaining the detrimental effects wind farms have on the environment, and most arguments include the disturbance and destruction of ecosystems [24], be it onshore or offshore systems. Onshore systems have been said to cause noise pollution and are not visually pleasing [5, 15, 24], and also affect fauna, especially birds. Bird mortality has been shown to be caused by a few factors, including wind turbine arrangement, bird species, as well as climatic variables [25]. But the extent of destruction caused is not very far. However, offshore wind farms are a very different ball game. They not only require different support systems, a vast network of underwater cables, which could span several square kilometres, are needed in order to transport the power generated by said wind turbines [24, 26]. This could very well destroy coral reefs and the habitats of marine animals and plants. Another issue related to offshore wind turbines is the installation process. Not only would it be more costly than its onshore counterpart [26], the emissions released during the installation and decommissioning of the wind turbines would severely affect aquatic ecosystems [24]. Besides that, wind energy creates a life cycle impact because of the material it is made from (steel), and the amount of power needed during the manufacturing stage. Another complaint commonly heard is the waste of space with regards to wind farms. Due to the fact that wind farms cannot be too close to one another, a lot of space is needed, yet the land in between is not utilized to its potential.

4.2.1 Overcoming Environmental Disadvantages

Among the steps that could be taken with regards to improving our approach to the harvesting of wind energy is to plan wind farms with the environmental impacts in mind [24, 27]. This brings with it the duty to avoid protected areas and forest reserves, as well as aquatic protected zones. Another step that could be taken is to improve the manufacturing process [28]. This means, using steel from countries with stricter environmental policies [27] as well as using electricity from renewable sources to reduce the carbon emission during the manufacturing process [28, 29]. With regards to the underutilization of space, experts say the land could be used for farming and animal grazing, as it will not be affected by the wind turbines.

4.3 Summary of Malaysian Environmental Concerns

As of date, Malaysia has no legible wind farms to show the detrimental effects or the advantages that wind energy could bring to the nation. However, it should be noted that Malaysia is a country that relies heavily on ecotourism as a means of income [30]. Hence, the preservation of its forests, lands, oceans and wildlife should be given priority if there is conclusive evidence of the destructive powers of wind farms. However, it should also be noted that in Malaysia, between 1984 and 2008, the mean value of carbon dioxide emission was about 4.81 metric tons per capita, and this value will only increase with greater energy demands [31]. Hence, the country is currently committed to reducing its carbon emissions by aiming to make economic development sustainable by 2055, as well as increasing carbon tax to discourage CO_2 emitting practices [32, 33].

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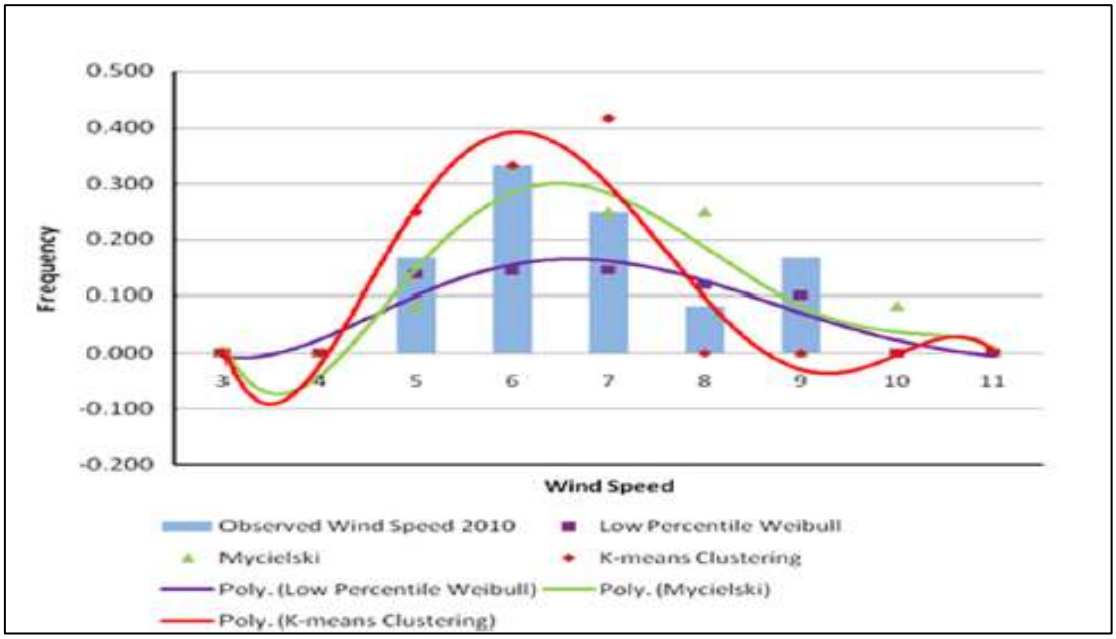

Fig. 1 Wind Speeds in 2010 in Kudat, Sabah[8].

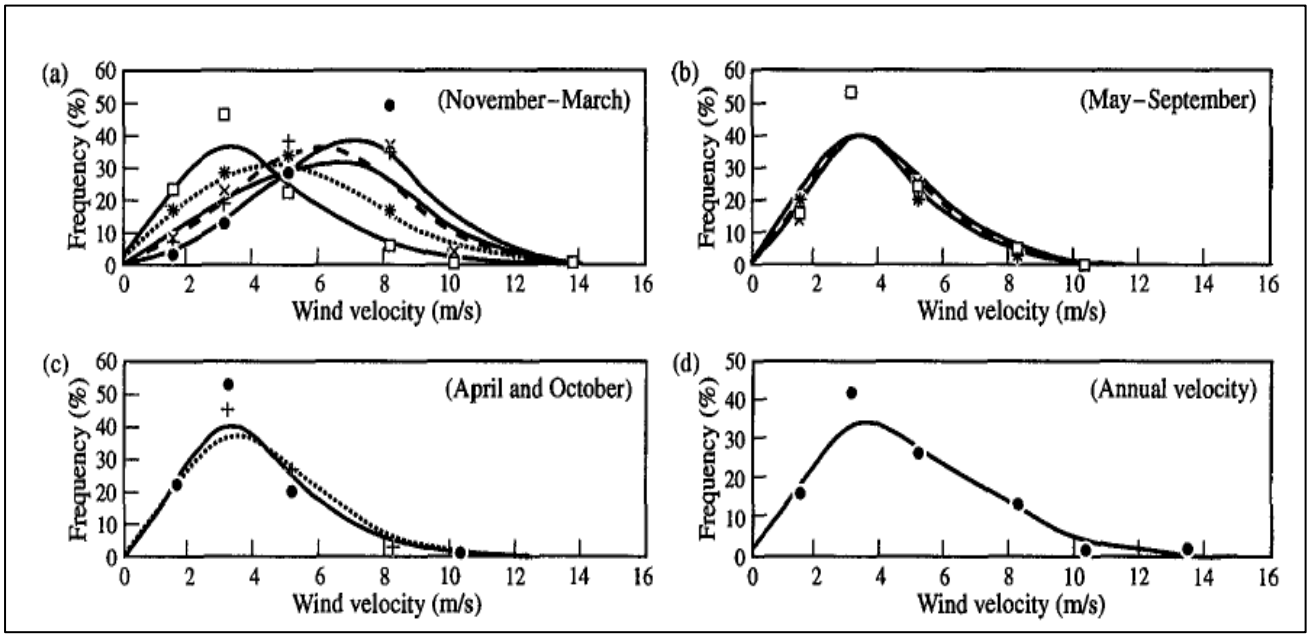

Fig. 2 Frequency distribution of wind throughout the year at Mersing, Johor [6].

5. Conclusions

Wind energy is a great renewable source of energy and its implementation around the globe would undoubtedly bring with it a great change in terms of electricity generation. Malaysia, despite having a unique challenge compared to most of the world, could one day join the ranks of countries that are utilizing wind as an important source of renewable energy. However, based on the research conducted and the knowledge of technology available at the present moment, wind energy most likely is not a pragmatic step forward in Malaysia. Due to the immense start-up cost, as well as extremely long return periods (given current efficiency rates), investors are unlikely to invest in such a source. Perhaps in the near future, where more research and innovation can cater to the needs of the region, the harvesting of wind energy could prove to be a viable source. This is not to say that renewable energy as a whole should be avoided by Malaysia, as there are many other options in renewable energy that would have a greater positive impact on Malaysia's energy, economy and environment than wind energy can at this moment.

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