

Review of Available Barriers to the Wind Energy Development Activities in the Coastal Areas of Pakistan

Zeeshan Alam Nayyar^{1,*}, Nayyer Alam Zaigham², Nadeem Mahmood³, Muhammad Saeed³, Ahmed Ali¹, Nazia Sadiq¹

Abstract:

The fossil fuels including coal, oil & gas, nuclear and other waste burning methods for power generation are the main cause of our climate to change drastically, and are contributing factor to global warming. And these conventional forms of energies are also finite and depleting with a fast pace. The alternate to this situation is the adaptation of clean, renewable forms of energies, like wind, solar, hydel, geothermal, etc. The coastal belt of Pakistan is the supposed to be the windiest part of the country, so we have a massive wind energy resource waiting to be used for the development of wind-based power plants. Despite the efforts made at provincial and central governments level and in different private sectors, the wind electricity generation capabilities and/or technologies so far couldn't be developed as it should be. This paper describes the salient natural and anthropogenic barriers against the wind energy development activities along the coastal belt of Pakistan.

Keywords: *Natural barriers, anthropogenic barriers, wind energy, Pakistan*

1. Introduction

A United Nation's panel of scientists and over 160 governments agree that "The burning of fossil fuels like coal, oil & gas, wood and other waste & agriculture leftovers are causing our climate to change drastically, contributing to global warming that exposes many millions more people to the risks of hunger, drought, flooding and diseases and produce irreversible losses of species" (UNFCCC, 2006).

The alternate of this alarming situation is to adopt clean, cheap and environment friendly forms of energy, i.e. renewable energies like wind, solar, biomass, hydel, geotherm, tidal, etc. The adaptation of renewable energy sources instead of conventional energy sources will also help to minimize the threats causing by nuclear power, a life-long

threat to the human health and to the global eco system. Among the renewable energy sources, the wind energy is proved to be the cleanest, cheapest, most environment-friendly in terms of less GHGs emission form of energy source.

There are many concerns that are related to power generation plants either by conventional or renewable energy sources, such as, no power plant is capable to generate electricity without stopping because of any unexpected outages or maintenance issue. Furthermore, renewable energy resources like wind are not available for all the time and hence power generation through it is also a question of availability and reliability. Therefore, these types of reliability factors are much difficult to deal with than the

¹ *Renewable Energy Research Group, Department of Applied Physics, University of Karachi, Pakistan*

² *GeoEnvoTech Services, Karachi, Pakistan*

³ *Department of Computer Science, University of Karachi, Pakistan*

Corresponding Email: zanayyer@uok.edu.pk

intermittency of wind energy resource. One of the main advantages of wind energy is its availability is much higher during the hotter months of the year, when the energy demand is at its peak in the countries like Pakistan. Hence, wind energy hybridizing all other available renewable energy resources in the country such as solar, biomass and wave & tidal could meet most of the electricity demand.

The coastal areas of Pakistan supposed to be the windiest part of the country, therefore we do have an unlimited and free resource to be utilized. And in the future, all or most of our electricity demand could meet from the mix of complementary renewable resources, balancing wind energy with solar, biomass, wave & tidal (Zaigham and Nayyar, 2005).

This paper describes the salient natural and anthropogenic barriers in the development of the wind energy technology against of the sincere efforts of the government.

2. Anthropogenic Barriers to the Wind Energy Development

Despite the efforts made at provincial and central governments levels and by many different private sectors, the wind energy-based power generation capabilities and/or technologies so far couldn't be developed as it should be (Kamran, 2018; Bilal et al., 2018; HDIP 2017; Nayyar et al., 2014; Nayyar, 2009; Dawood, 2002; Farooqui, 2002; Fatehally, 2002; Zaigham, 2002). Table 1 shows current grid connected wind energy-based power generation installations in Pakistan.

By a detailed overview study of the situation relevant to activities related to wind energy technological developments, it is found that there are certain barriers which could be classified as:

2.1. Lack of Institutional Coordination

Different institutions in public and private sectors are working in the field of wind energy technology without any cohesive interaction or exchange of their working outputs. Even one institute hesitates to share its data with other. It is interesting to note that focal point for the development of renewable energy technology in Pakistan is changing since last few decades very regularly which is a discouraging situation to decide the national priority. With the view to develop a strong focal point, Pakistan Council of Renewable Energy Technologies (PCRET) was created by the Government of Pakistan by merging several institutes working separately for the development of renewable energy

technologies few years back (Hassan, 2002a; Hassan, 2002b). In state of strengthening the newly developed focal point, another focal point has been created as Alternate Energy Development Board (AEDB) in 2003 (AEDB, 2019). Similarly, Ministry of Environment has their independent programs in collaboration with UNDP-GEF and UNEP.

In addition, there are other institutions at provincial and central level which are also working independently on their conceived projects. This is also very important issue to note that most of the institutions do not have adequately educated and/or trained manpower to work on the promotion and development of wind energy resource as well as technology. The status of coordination among these focal points is not very clear, rather reflects state of confusion.

Table 1: Installed Capacity of Wind Projects at the End of 2017. Source (GWEC, 2018; AEDB, 2019)

Year	Installed Capacity (MW)	Location	Annual Growth Rate (%)
2013	105.9	Jhampir, Sindh	-
2014	99.5	Jhampir and Gharo, Sindh	93.6
2015	102.8	Jhampir and Gharo, Sindh	103.3
2016	282.3	Jhampir and Gharo, Sindh	274.6
2017	248.5	Jhampir and Gharo, Sindh	88.1
2018	446.7	Jhampir and Gharo, Sindh	179.8
Total	986.6 MW		

2.2. Lack of Baseline Data Pertaining to Wind Energy Potential

For the development of wind energy generation capability, the imperative prerequisites are the assessment of wind potential in general and the site-specific baseline wind studies. With the financial support of Ministry of Science and Technology, Pakistan Meteorological Department established a network of wind masts along the coastal areas in 2001-2002 to conduct an extensive wind survey of the coastal areas to assess wind power potential at 10m and 30 m heights (Chaudri, 2002). The design of the wind mapping system indicates the lack of background knowledge of wind energy

technology. As the result, the design they could not decide adequate measuring heights of the wind layers and resulting wind potential.

2.3. Lack of Interactive Background Knowledge of Basic Wind Technology

A well-established commercial technology in developed countries does exist, which is largely unfamiliar to developing countries. Like for example, in Pakistan so-called wind farms were installed with great publicity through national media claiming sufficient generation of electricity for the need of nearby townships, which were failed after few months since the introduction of the technology was without proper study and basic knowledge (Figure 1).



Figure 1: So-called wind farm installed at Karachi Beach and failed after few weeks.

Such types of activities have created bias thinking and misperceptions about applicability, cost and reliability of the wind energy technology in Pakistan in general. On the contrary in countries where wind power has been adequately introduced its growth has been very rapid, like in the case of China, India and/or Turkey (GWEC, 2018).

2.4. Least Priority Given to Research Institutions

It is experienced that the research institutions and industrial personnel have discouraged and disallowed to release the wind and other relevant data by the public

institutions. Generally, the data sets are considered to be confidential by most of the public institutions. In some cases, huge cost has been asked from the research scholars to provide the raw data which is a great hindrance for the research scholars to continue his/her studies since they generally do not have research grant to purchase the data. This is surprising that research scholars can acquire relevant data of Pakistan from international organizations through Internet which is not available in their own country due to the non-cooperation. In developed countries research scholars are always encourage and provided all kind of technical and financial assistance to accomplish their studies, so that basic baseline and future technological trend could be modeled sustainably.

2.5. Unattractive Policy and Operational Issues

In countries where wind energy-based power generation is not practiced, important shortcomings exist in the applicable policy framework that must be redressed before such projects can be established. For instance, the variability of wind power output requires power purchase agreements and tariff regimes that take the daily and seasonal availability of the wind resource explicitly into account so that the investor can be assured of a reasonable and practical financial payback mechanism. Furthermore, the operational arrangements in acquiring suitable land leases, connecting wind power to a distribution grid, including load dispatch and balancing, backup supply, switching controls, and power quality must also be resolved at the outset to the satisfaction of both the producer and purchaser of wind-generated electricity, and experience in formulating such agreements may not be locally available (PPIB, 1998).

Albeit, some incentives have been included in the current power policy relevant to renewable energy development, which need clarifications and major updates to attract national and international investors of private sectors particularly for the development of wind energy technology on Pakistan.

3. Natural Barriers to the Wind Energy Development

For the development of the wind energy resource, only the wind-mapping through network of wind masts is not sufficient. There are number of natural hazards which can directly affect the development of wind technology if adequate consideration against their adverse effect is not given. The reports available on wind analysis/mapping do not

have a correlative study with relevance to particular natural hazard prevailing in the specific area of study.

Along the coastal belt of Pakistan, we have different trends of natural hazards. For example, the coastal areas of Sindh and Balochistan have frequent dust storms. The trend of these dust storms reflects different characteristics from one region to another (Nayyar and Zaigham, 2014). Along the coastal belt of Balochistan province, the impacted velocities of the dust storms are relatively much higher and stronger and they do carry coarser sediments (Figure 2 and Figure 3), which results in creating enormous abrasion, attrition and other physical & mechanical damages. On the contrary, along with the coastal areas of Sindh province these dust storms exhibit relatively low velocities and carry finer sediments. The main problem associated with such finer dust is that they can in-house and stick to the sensitive components of the wind machines and also to the other mechanical devices and can reduce their working life, if appropriate and suitable systems are not design under these specific prevailing climatic conditions.



Figure 2: On March 20, 2012, a giant dust storm stretched across the Arabian Sea from the coast of Oman to India. The Moderate Resolution Imaging Spectroradiometer (MODIS) on NASA's Aqua satellite took this picture the same day. This extensive plume followed days of dust-storm activity over the Arabian Peninsula including Pakistan coastal belt. Source: (Ichoku and Przyborski, 2012).

Beside the dust storms, the Sindh and Balochistan coastal belt is also prone to periodic Tropical cyclones (Figure 3 and Figure 4). Sindh coastal areas, particularly Thatta and Badin districts, have heavy and regular variable impacts of the tropical cyclones. Comparatively, Balochistan costal belt has low intensity of the cyclones in general. The maximum sustained wind speed during the cyclone period has a range

from 18 m/s to over 54 m/s and the maximum gust speed has a range from 29 m/s to over 67 m/s.

Without detailed studies relevant to these natural hazards of long-term and short-term recurrence frequency, the sustainable development of wind energy technology is not assured in Pakistan. Presently, such analysis or studies are not available in relevance to their impact on the development of wind technology as baseline study in Pakistan.



Figure 3: NASA's Terra satellite provided a visible image of Tropical Cyclone Ockhi on Dec. 4, 2017 and dust storms that were blowing over the Arabian Sea. Source: (Przyborski, 2017)



Figure 4: Tropical cyclone Nilofar in the last week of October 2014. This category 4 cyclone was a threat to the coast of Pakistan. This image was acquired by the Moderate Resolution Imaging Spectroradiometer (MODIS) on NASA's Terra satellite. Source: (Carlowicz, 2014)

4. Recommendations

- Research institutions must be encouraged for the development of baseline data and sustainable research-based model(s) for the particular technology.
- There should be politically unbiased strong focal point and sustainable mechanism of coordination among the public, private and research organizations and institutions.
- National projects on wind energy development must be prepared in consultation with the research technical committee consisting research scholars from national universities of the country.
- For the accomplishment of special national projects, like Wind Mapping of Pakistan, the research scholars should also be associated officially by the public institutions on their merit of work.
- A project is recommended for the detailed study of natural hazards relevant to the development of wind energy generation capability in Pakistan.

REFERENCES

- AEDB. Alternate Energy Development Board [Online]. Available from: <http://aedb.org/>. 2019
- Bilal H, Siwar C, Mokhtar M, Ahmed S. Recent development and sustainability of wind power sector in Pakistan. *Int J Biomass Renew* 7(1): 24-34, 2018.
- Carlowicz M. Cyclone Nilofar: Natural Hazards [Online]: NASA Earth Observatory. Available from: <https://earthobservatory.nasa.gov/NaturalHazards/view.php?id=84650>. 2014.
- Chaudri QUZ. Wind energy potential of coastal areas of Sindh & Balochistan. In: Proceedings of First National Workshop on PREGA; Islamabad, Pakistan; 19p, 2002.
- Dawood R. Karachi Port Trust Wind Farm Project: Project proposal submitted to ADB & PECRET. Karachi: Pakistan Venture Capital Limited; 2002.
- Farooqui SZ. Harnessing the Wind Energy in Pakistan. Karachi: The Daily Dawn; April 19, 2002.
- Fatehally M. Sohana Farm: Brochure. Karachi: Marin Pvt. Limited; 2002.
- GWEC. Global Wind Report: Annual Market Update 2017. Global Wind Energy Council, 72p, 2018,
- Hassan MU. Development of renewable energy technologies in Pakistan - an overview. Islamabad: PCRET; 2002a.
- Hassan MU. Formation of PCRET: Unpublished note. Islamabad: PCRET; 2002b.
- HDIP. Pakistan Energy Yearbook 2017. Ministry of Energy, Government of Pakistan. 2017.
- Ichoku C, Przyborski P. Dust Over Arabian Sea [Online]: NASA Visible Earth. Available from: <https://visibleearth.nasa.gov/view.php?id=77475>. 2012.
- Kamran M. Current status and future success of renewable energy in Pakistan. *Renew Sustain Energy Rev* 82(1): 609-617, 2018.
- Nayyar ZA, Zaigham NA, Qadeer A. Assessment of present conventional and non-conventional energy scenario of Pakistan. *Renew Sustain Energy Rev* 31: 543-453, 2014.
- Nayyar ZA, Zaigham NA. Satellite image identification of wind channels to delineate wind energy generation sites in Pakistan. *J Basic & App Sci* 10: 344-348, 2014.
- Nayyar ZA. Investigation & development of GIS linked aerodynamic wind potential models of Sindh and Balochistan coastal areas of Pakistan: Ph.D. Thesis. Karachi: University of Karachi; 2009.
- PPIB, Policy for new private independent power projects: Ministry of Water and Power. Islamabad: Government of Pakistan; 1998.
- Przyborski P. Tropical Cyclone Ockhi (03B) and dust storms in the Arabian Sea: NASA Visible Earth {Online}. Available from: <https://visibleearth.nasa.gov/view.php?id=143141>. 2017.
- UNFCCC. United Nations Framework Convention on Climate Change: Handbook. Bonn: UNFCCC; 2006.
- Zaigham NA, Nayyar ZA. Prospects of renewable energy sources in Pakistan. In: Khan HA, Qurashi MM, Hussain T, Hayee I, editors. *Renewable Energy Technologies and Sustainable Development*. Islamabad: COMSATS. 2005: p. 65-86.
- Zaigham NA. Institutional capacities & barriers relevant to REGA technology promotion in Pakistan: ADB report (draft) under PREGA TA No. 5972-REG. 2002.