

ENVIRONMENTAL BENEFITS OF WIND FARM PROJECTS IN PAKISTAN

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ABSTRACT

This paper highlights the environmental benefits that can be accrued by the installation of wind farms for power generation at potential sites in the country. Renewable energies and more significantly, wind energy is considered to be the most clean source of energy as these do not emit any green house gas during production of power. Due to current climate changes and hazards cause to the atmosphere due to emission of greenhouse gases, the trend has been set to harness renewable energy resources to discourage environmental hazardous projects and encourage commissioning of environmental friendly power projects that would result in abatement of greenhouse gases. The global wind energy industry is grooming at very fast rate and has resulted in gaining various social, technical; and environmental benefits. Considering the international trend for commission renewable energy projects it seems that it is the right time for commencement of wind farm projects in Pakistan.

Wind Energy is an environmentally superior means of generating electricity. The environmental and socio-economical assessment of the wind farm conducted in keeping with Pakistani legislation as well as national and international guidelines, reveal that wind energy is proven and commercially available and does not contribute to climate change, air and water pollution, habitat destruction, or the production of solid, toxic or nuclear wastes. Wind energy creates no significant new environmental problems. While it requires more land than conventional energy sources, the land can be used for other purposes (e.g. agriculture and recreation). Wind turbines also have a very limited impact on birds – less than a house cat or a car - and noise issues associated with wind energy production have been eliminated by advances in turbine design, and proper setbacks from residences.

The overwhelming environmental benefit of wind energy in terms of reduced emissions of atmospheric pollutants and greenhouse gases, comes at a certain environmental cost. After becoming the signatory of Kyoto protocol, venues have become available for Pakistan that can be utilized to get financial, economical and technological benefits from developed countries under the clean development mechanism (CDM). Under the umbrella of CDM there is a huge potential for the country to earn carbon credits from the carbon market and hence gain monetary benefits.

KEYWORDS

Environment, emissions, impacts, carbon credits, environmental benefits

INTRODUCTION

The regular supply of electricity could have a significant impact. Commissioning of wind farm projects would build institutional and technical capacity in Pakistan in alternative energy systems. If successful, the projects could be replicated in other areas where appropriate wind energy potential would be available. The long-term benefits of wind farms for socio-economic development and national cost savings are obvious. The challenge before Pakistan, therefore, is to continually expand its power generation and distribution infrastructure by augmenting limited public resources with substantial private sector participation and foreign direct investments, while at the same time devising a sustainable long-term growth strategy that optimizes the use of inexpensive energy choices with minimal impact on the environment. In this respect, cleaner technologies that are commercially competitive, such as gas-fired combined-cycle plants, small hydel plants, and wind power, assume increasingly important roles. Of these three, it is only wind power that has yet to receive serious attention in the country's energy plans.

Recent environmental awareness resulting particularly from the phenomenon of global warming has pushed renewable energy sources towards the top of the power generation agenda. Wind power has the greatest potential of all renewable energy resources and requires active commitments to stimulate the development and utilization of this energy source. Wind energy can provide a continuously growing contribution in the competitive energy market, contributing to climate change goals, energy diversity and security. Despite a slow start to offshore wind projects, current predictions are that future wind energy development will strongly favor the use of offshore locations to make use of higher average wind speeds, with less environmental impact. At a sufficient distance from the coast, visual intrusion is minimized and wind turbines can be larger, thus increasing the overall installed capacity per unit area. Similarly, less attention needs to be devoted to reduce turbine noise emissions offshore.

WIND ENERGY: A CLEAN SOURCE OF ENERGY

Wind energy is a 'clean' resource, as there is no carbon monoxide or other environmentally damaging emissions generated by wind energy plants. As such, the wind projects do not add to the GHG emissions in the country. As the fuel i.e. wind for the power utilized in wind farm is a clean energy resource which is neither consumed nor burnt during whole process, hence this energy resource is the most environmental friendly resource for such purpose. Wind farms only require the energy stored in the wind to rotate the blades of the wind turbine. The blades run the generator which produces power. The wind leaving the first turbine requires some distance to regain its energy that can be further utilized to run next turbine. The regaining of energy by the wind depends upon the wind density, atmospheric pressure, relative humidity and most important the prevailing ambient temperature. This is because the wind resource is called as renewable energy resource. The next turbine is sited at such a distance that wind regains its energy and strikes its blade with the same impact as in the case of previous one. Due to this fact area covered by one wind turbine is far less than the total area over which a wind farm is being installed. This renders remaining land as useable for specific purposes and developments which would not cause increase in wind shear and reduce the efficiency of the wind turbine. This all leaves the overall environmental conditions undamaged.

Wind farms do not hamper and damage the overall natural conditions. As wind is used as a source of energy and a source to run the turbine, the by-products are not of such amount that they may result in damaging any component of the environment. If the wind farm project is successful commissioned and can be replicated at other sites, it may reduce the need for thermal generation systems in coastal areas and other locations, and thus instead reduce total GHG emissions. Energy generated through wind farms is claimed to be as clean energy as no effluents and gases are emitted from such plants. This benefit of wind farms is increasing their utility and viability in the energy sector as environmental and climatic concerns of the world are acclaiming now-a-days to debar commissioning of such projects that are harmful for the environment due to recent global warming and climatic changes issues. While considering the feasibility of such projects certain issues must be considered. In

next pages, the most promising environmental benefits that are expected to be accrued from the wind farms will be discussed.

ENVIRONMENTAL IMPACTS AND MITIGATION

The sites for installation of wind farm are usually located far-off where the development infrastructure is not available and population density is too low. Though wind energy tend to be most environmental friendly source of energy and such projects have been encouraged and highly recommended by the authorities all around the world. But, in due course of their development and manifold execution, it has been experienced that wind farm projects add to environmental degradation and affects the natural habitat. Due to this fact, some considerable environmental components of the area are being studied, evaluate and environmental hazards have been determined under the scope of this project. Efforts have also been made to give the solutions for most of them.

A more detailed and thorough assessment was, however, carried out for the impacts described below.

Loss of Habitat

The wind farm of 50 MW capacity usually acquires almost 2000-acre area^[1] for the turbine towers and a 240-acre right of way for the access road. Wind farm projects do not require large civil works and hence do not the flora species of the area. Considering Gharo^[1] as proposed site, most of the plants at project sites have a wide ecological aptitude and populations large enough to ensure their genetic diversity. The removal of a small portion of vegetation will not harm the overall diversity of plant communities in the area.

The disturbance to wildlife will be minimized through management controls, such as reducing the size of the fenced area to the extent possible; training project staff to avoid killing or chasing wild animals; and minimizing noise generated by project activities.

Disturbance to Birds

Though not a significant impact, wind turbines affect birds' staging or roosting because of the noise they create, or because their location forces birds to change their migration paths. Studies indicate that wind turbines affect staging or roosting birds up to a distance of 500 m^[2]. Birds population is not much significant in the area and migratory birds also do not come in the way of the project site. Some coastal birds settle along the shoreline and passerine and other resident birds nest in forest areas. Important staging, roosting, or nesting areas, around the wind farm site will be declared off limits during the construction phase.

Avian Collisions

It has been estimated that between 100 million to well over 1 billion birds are killed annually in the United States^[3] because of collisions with human-made structures. However, wind generation facilities account for only 10,000 to 40,000^[4] of these fatalities. This indicates that avian collision mortality attributed to wind turbines is the lowest when compared to other sources of mortality, and does not appear to cause any significant population impact. It is suggested that auditory and visual stimuli would be used to warn birds of the turbines' presence.

Disturbance to Marine Life

The presence of humans during the construction phase, and the expected further influx of people because of infrastructural development in the area during the later stages of the project, may pose a threat to the area's marine life, particularly the marine turtles that breed on the beaches. The sandy beach to the west of the project site tends to host sizeable concentrations of turtles during the breeding season, at which time they will be

vulnerable to interference. In case turtle nests are found in the project area, the nesting sites will be treated as 'no-go areas'.

Waste Disposal

The main types of waste that will be generated during the construction phase of the project are waste oil, camp waste, medical waste, demolition waste, packing waste, and excess construction material. It is suggested that every effort would be made to minimize the waste generated while construction is in progress, and a special waste-minimization program would be initiated. In addition, project management would be made responsible for all waste generated by the project until its final disposal. A waste disposal site would also be developed, containing a lined landfill and a burn pit. Furthermore, an inventory of all waste generated during the project would be maintained.

Aircraft Safety

Although wind turbines can pose a safety hazard for low-flying aircraft, the Civil Aviation Authority (CAA) has a detailed code that specifies the maximum height of structures that are allowed in the vicinity of commercial airports. The proposed wind turbines would meet CAA safety standards and would not interfere with aircraft using the Karachi airport.

Interference with Telecommunication Systems

The moving blades of a wind turbine can distort electromagnetic signals. In the Gharo, Thatta area, five different sources of electromagnetic signals may be affected: the microwave communication link between Gharo and other towns of Sindh, the television rebroadcast tower in Gharo, the VHF omni-directional radio (VOR) communication link at the Karachi airport, the communication link of the coastal guards with their bases and the military radar west of the airport. The wind turbines are not expected to interfere with any of these sources of electromagnetic signals because they are situated too far away from these facilities^[5].

Land Use Conflict

The district revenue department of Gharo has declared that the area under consideration for the proposed project is the government land and has given permission to utilize it for wind power generation projects. The land near to the project site has been utilized as salt pan. Some archeological areas have also been earmarked and private owned land has also been marked out. The project site is though near to all these, but issues have already been resolved with all these stakeholders. Nevertheless, the project's footprint is only a small fraction of the total area of the land. It is, therefore, feasible for the wind farm and other land users to coexist. Moreover, once the wind farm is complete, joint development activities can also be commenced that may include plantation exercise in the area.

Employment Opportunities

The project is expected to open doors for the professionals and skilled and unskilled manpower to jump into this field. This will accommodate manpower from various fields. There is also a high expectation among the population of Gharo that the project will generate significant local employment opportunities. Skilled or unskilled labor brought in from within the Thatta, Karachi and Hyderabad districts is, therefore, likely to cause resentment in the local community, reducing opportunities for human capital development and creating tension between non-local labor and resident communities.

Accordingly, the local population will be given preference when hiring unskilled, semiskilled and skilled workers. If suitably skilled labor is not available in Gharo itself, then residents of the other districts will be given preference, followed by residents of the rest of Sindh, and then the rest of the country. Wherever feasible, local laborers will be trained to enhance their skills. No person under the age of 15 will be employed on the project.

Tourism Potential

At present, apart from a few occasional, local visitors, recreational visits to the proposed wind farm site and the beaches near it are rare. The installation of the wind farm is likely to increase visitors to the area.

Environmental Benefits

The benefits that are expected to be accrued from installation and commissioning of wind farms are discussed as below:

GHG Emissions Offset

Given that wind power is a 'clean' source of energy, its key environmental benefit is in terms of the emissions offset it provides. **Table 1** below shows the results of the calculations in terms of potentially displaced fossil fuel generation from thermal power stations.

Table 1: Emission Offsets from Proposed Wind Farm^[6]

<i>Pollutant</i>	Plant utilizing 0.28 kg of HSD to generate 1 kWh		Plant utilizing 0.62 kg of HSD to generate 1 kWh	
	<i>Offset Ton/Year</i>	<i>CO₂ Equivalent/Year</i>	<i>Offset Ton/Year</i>	<i>CO₂ Equivalent/Year</i>
NO	210.43	61,025.70	466	135,140
N ₂ O	0.383	111.07	0.85	246.50
CH ₄	0.86	19.47	1.91	43.18
CO	15.303	68.87	33.90	152.57
CO ₂	70136	70.136	155,303.33	155,303.33
SO ₂	483.33	--	1076.67	--
TOTAL		131,361.11		290,885.25

The wind farm will offset anywhere between 131,361 to 290,885 tons of carbon dioxide equivalent per year. Over a twenty-year time horizon, i.e., the assumed life of this project, the wind farm thus has the potential to offset 2.63 to 5.83 million tons of CO₂ equivalent.

Minimum intrusion to the human environment

The sites which are usually selected for such activities are located in the remote areas where no development and human environment exists. Same is the case with the present proposed project. The project site is located in far flung area where the population density is too low and development and there is no available developed infrastructure. These coast lines have not been utilized for any purpose and the government also has no plans in next twenty years to utilize this barren land for any purpose. Due to this fact intrusion to the human environment will remain negligible.

Visual impact

Though there have been questions about the visual impact and in some of the developed countries the wind farms are bearing negative impression in this sense. But, in several countries, the general masses have welcomed such projects and many have expressed that wind farms add to the aesthetical beauty of the area. This increases the attractiveness of the area and hence catches more visitors to this area, resulting in tourism and in a public place.

Increase in utility of unused barren land

As in the present case, the piece of land over which wind farms are commissioned has never been utilized for any development purpose. Also, due to complex terrain and barren land, any development and cultivation of crops is not possible. Installation of wind farms would increase the utility of this unused barren land and will result in commencing economic activity, economic and financial development and will become a business developing and earning piece of land.

Use of natural resource of energy without damaging overall environment

Wind farms do not hamper and damage the overall natural conditions. As wind is used as a source of energy and a source to run the turbine, the by-products are not of such amount that they may result in damaging any component of the environment. Wind hits the rotor blades of the turbine and transfers its kinetic energy to the mechanical energy and results in running the generator and hence, produces power. The wind leaving the first turbine requires some distance to regain its energy that can be further utilized to run next turbine. The next turbine is sited at such a distance that wind regains its energy and strikes its blade with the same impact as in the case of previous one. Due to this fact area covered by one wind turbine is far less than the total area over which a wind farm is being installed. This renders remaining land as useable for specific purposes and developments which would not cause increase in wind shear and reduce the efficiency of the wind turbine. This all leaves the overall environmental conditions undamaged.

Particulates and non GHG emissions

The wind farm will also offset between 145 to 323 tons of sulfur dioxide^[6]. The local benefits of this are obvious in the sense that the ingestion of SO₂ and particulates is harmful for human health. Sulfur dioxide also contributes to acid rain. Therefore, if a thermal power station option was exercised as opposed to the wind farm, the additional cost of mitigating the SO₂ and particulate emissions would have to be borne.

Elimination of HSD transport and storage hazard

The elimination of the need for fuel for generating electricity, such as high speed diesel (HSD), by switching to wind power will result in the elimination of the hazards associated with the transport and storage of flammable HSD and hydrocarbon contamination risks from spills.

Water conservation

Another important benefit is in terms of the elimination of cooling water requirements for the baseline case of diesel-based generation. It is estimated that nearly 353,300 m³^[7] of water will be conserved on this account in this water-deficient region if the wind farm is developed instead.

Socio-economic benefits

Socio-economic benefits have much importance in wind farm projects. As these projects require a large number of professional, technical and skilled manpower, which is usually not available in project site. This result in attracting the individuals from different parts of the country depending upon the nature of skill required. This increases the social interaction between multi-cultural individuals and comes up with a healthy and diversifying environment. Also, non-commencement of development activities in these areas has stopped the economical uplift of the dwellers. Commencement of this project in such remote site would result in generating economic activities in the locality and hence result in community uplift and poverty alleviation. Setting up of such a big project may require provision of other services like, living, health, education, communication and latest means of interaction with other parts of the country to attract professional manpower. This all would result in development of healthy community in the area.

Business development

Development of economic activities in these areas will open the doors of other economical activities in the area. Small business entities would be developed which would comprise of consumable items for the project, edibles

and non-edibles for the community that would be generated due to commissioning of this project, supply of other means of living like clothes, meals, development of housing societies, tourism, transportation and so on so forth. This all would result in business development in such area where no business activity has been generated till now.

Infrastructure development

Intrusion of the human will increase the human activities in the area which in turn will result in infrastructure development as for living as living styles may alter due to such economical and financial development. Development of infrastructure for schooling, medical treatment, dinning areas, and transportation link with other areas will become requisite. This all will result in development of the area.

Environmental consequence

Overall environmental conditions will improve and socio-economic betterment would possibly result in improving the social, economical, business, cultural and environmental status of the area.

CONCLUSION

- Depleting conventional energy resources and prevailing energy crises scenario in Pakistan requires harnessing indigenous energy resources that can supplement energy requirements and fill in the demand supply gap. Wind energy is ranked the number one in the world with a great potential of development in the future. Accomplishment of wind farm projects in Pakistan would result in acquiring full benefits of the energy resource available in the country.
- An assessment of the significance of each potential environmental impact indicates that though there are some social risks involved in implementation of such projects. But if the project incorporates all the mitigation measures as discussed before, it is anticipated that impact on the natural and socioeconomic environment of the area would remain well within acceptable limits. The project would also comply with the country's statutory requirements and standards.
- As relative environmental values are revealed in the paper, it would be possible to develop wind farms in such a way that minimizes the total social costs of the investment and which maximizes its net benefits. It is estimated methodologically that wind farms prevent environmental damages than contingent rating. Though there are some social risks are involved in implementation of such projects, but it is recommended that wind farm projects must be initiated as most significant environmental parameters reveal that monetized environmental value of wind farm projects is very high.

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