
A REVIEW STUDY ON ENVIRONMENTAL ISSUES ASSOCIATED WITH WIND ENERGY

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ABSTRACT

Regions require a complete understanding of the environmental impacts caused by wind farms. In this article, previous studies were summarized to evaluate the environmental problems created by wind farms. This paper explored available mitigation strategies for reducing these negative environmental effects. The goal of this document is to offer wind energy planners and developers with up-to-date information on environmental problems connected with wind energy development, as well as mitigation methods. Fossil fuel combustion is thought to be one of the main contributing elements towards global warming. In order to cut dependencies on fossil fuels, energy researchers, industrial professionals and policy-makers focused on renewable forms of energy. Wind energy, which is considered one of the most mature renewable energy sources, has seen tremendous growth in recent years. Many nations have shown interest in using wind power, although many are worried about the wind farms' environmental effect. The continued expansion of the wind energy sector in many areas of the globe, particularly in developing and environmentally fragile nations.

KEYWORDS: *Animals, Environmental, Energy, Noise, Wind Energy.*

1. INTRODUCTION

The use of fossil fuels is thought to be one of the main contributors to global warming. Renewable energy sources are rapidly attracting the attention of energy experts, industry professionals, and government decision makers in an attempt to decrease dependence on fossil fuels. Biomass, wind, and geothermal energy technologies are rapidly evolving and becoming more economically viable. According to the European Renewable Energy Council, renewable energy will account for about half of total world energy supply in 2040(1–3).

Wind power has seen rapid development in the last decade as one of the most mature renewable energy sources. Wind power has emerged as the preferred energy source for planners and national governments aiming to diversify energy supplies, decrease CO₂ emissions, develop new businesses, and provide new job possibilities. At the end of 2013, the total worldwide wind power installation was 318.105 GW, according to the latest Global Wind Report. Wind energy development, on the other hand, does not come without negative environmental consequences. The wind energy sector, particularly in developing nations and environmentally sensitive areas, is concerned about a lack of knowledge of these environmental effects(4–7).

The authors of this article examined possible environmental problems caused by wind farm developments, evaluated data from previous case studies, and suggested methods for mitigating these negative environmental effects. This review research informs energy sector planners and developers on how an ineffective wind farm project design may have a negative impact on the surrounding ecosystem. To prevent harm to sensitive biological systems, mitigation measures should be performed throughout the design, building, and operating stages of a wind farm(8,9).

1.1. Wind energy induced environmental issues:

Wind turbines convert wind energy into electricity or mechanical energy in a wind power facility. The density of the air, the area swept by the turbine blades, and the cube of the wind speed determine a turbine's output power. Wildlife safety, Biosystems disruption, noise, visual pollution, electromagnetic interference, and local climate change are the main environmental concerns associated with wind turbine use. These problems may be divided into three categories: ecological consequences, human impacts, and climate-related issues.

1.2. Effects on animals

1.2.1. Birds:

Wind turbines put birds at danger of death and disruption. Collisions with the spinning blades of a wind turbine may kill birds, and collisions with turbine towers, nacelles, or other structures in a wind farm, such as guy cables, power lines, and meteorological masts, can inflict fatal injuries. Despite the fact that birds have been killed by pesticides or accidents with other man-made structures, such as fossil fuel infrastructure, the negative impacts of wind farms on birds cannot be overlooked. Wind turbine towers have also been discovered to have killed uncommon birds such as golden eagles, swans, and Cantabrian Capercaillies. It's impossible to compare the death rates in these studies since the researchers employed different techniques to determine the number of birds killed. Because of differences in search area, searcher effectiveness, and predator clearance rates, an exact avian mortality rate is difficult to determine. The frequency of deadly bird accidents varies depending on where you are. Even across various sets of wind turbines at the same area, there are variances(10–12).

Disturbance, which includes habitat loss, the barrier effect, and impacts on bird nesting and feeding habits, is another detrimental consequence of wind turbines on birds. The installation of wind turbines and related equipment may result in habitat loss for local birds(13–15). Some wind turbines may also create physical obstacles that prevent birds from reaching their normal feeding and roosting areas. Noises and turbulent air currents generated by wind turbines may frighten birds away and limit their territories, affecting their feeding behavior. Birds may be harmed as a result of the construction of power lines and roads for wind farms. Prairie birds were discovered to try to stay at least 100 meters away from power wires and road building projects. Power lines and highways may also divide habitat and offer a pathway for alien species to invade.

1.2.2. Bats:

Bats are more likely to respond to moving objects than stationary ones. However, a high bat mortality rate close to wind farms has been observed. Wind turbine related bat mortalities are now affecting nearly a quarter of all bat species in the United States and Canada. Research revealed that wind turbines killed not only bats from local populations but also migratory bats. However, researchers are not in agreement about the reasons for the bat mortalities. Early studies concluded that bats were killed by the sudden pressure drop near the turbine edges, which caused the bats to suffer barotrauma and internal hemorrhaging. Barotrauma-related internal hemorrhaging was found in over 50% of the dead bats. More recent research found that impact trauma was responsible for the majority of the turbine-associated bat deaths. Other researchers proposed alternative explanations.

1.2.3. Marine species:

Marine creatures may be harmed by offshore wind turbines. Wind turbine foundations and towers are built on-site, making saltwater turbid and introducing new items to the bottom, which may harm benthic wildlife and vegetation and obstruct sunlight. Wind turbines and their scour protection may alter the distribution of fish in the area. The building of wind farms produces an

artificial reef, which has an effect on biodiversity(16–19). Fish may be harmed by the noise and electromagnetic waves produced by wind turbines. Wind farms may cause reactions among marine animals such as porpoises and seals, particularly during building operations like as pile driving. Maintenance operations on wind turbines, such as component replacement or lubrication, may cause oil or trash to leak into the surrounding saltwater, polluting it.

1.3. Deforestation and soil erosion:

Some operations, such as foundation excavation and road building, may have an impact on the surrounding bio-system during the development of a wind farm. Surface soil would be exposed to severe wind and rainfall if surface plants were removed, resulting in soil erosion. Construction site wastewater and oil may leak into the ground soil, causing severe environmental issues. Grasslands, moorlands, and semi-deserts, which have abundant wind resources, usually have poor eco-systems with little bio-diversity. Heavy equipment construction may disrupt the local Eco balance, and recuperation of the local ecosystem may take a long period. Excavation should include human work as much as feasible, according to a Chinese wind turbine building guideline, in order to reduce the disruption caused by the heavy machinery. Trees and grasses should also be replaced as soon as feasible following construction, according to the regulation.

1.4. Visual impact:

When a number of factors converge, such as distance from the turbine, operating hours, and interactions with the sunlight, shadow flicker, an effect produced by the movement of the turbine blades through the sunlight, creates a human impact(20–22). Aside from the flickering shadows, the poor visual effect of wind farms on landscapes is another issue that contributes to public mistrust of the wind energy sector. People's attitudes about wind turbines may be favorable or negative depending on their sense of the environment's oneness, their personal feelings about the impact of wind turbines on the landscape, and their overall attitude toward the wind energy sector. Some may see wind turbines as machines that are transforming a beautiful landscape into an industrial setting, while others may see them as a helpful option to minimize the negative environmental effects of conventional energy. It's tough to assess the aesthetic effect of a wind farm. Thayer and Freeman used a poll to conduct a subjective research. The findings revealed that a wind farm has a greater effect on individuals who live nearby and are more acquainted with the natural environment. The majority of people prefer to view neutral-toned wind turbines that are bigger in size but have a low utility quantity. According to other polls, the population is generally supportive of wind power and the renewable energy sector. Most local people, however, may be opposed to the building of a new wind farm near them, even if they understand the benefits to society. This resistance to development initiatives in the neighborhood.

1.5. Limiting the effects on birds and bats

Several methods may be explored to minimize bird deaths. Construction operations should be limited to non-breeding times to minimize the detrimental impacts of bird disturbance. Improvements in structural design were also helpful in lowering avian mortality. Enlarging the blades and reducing the rotational speed of wind turbines, for example, may reduce the number of birds killed. One of the reasons birds crash with turbine towers is the effect of wind turbines on their eyesight.

1.6. Reducing influence on marine environment and climate

The rotor-generated turbulences should be minimized to lessen the meteorological effects of wind farms. Turbulence may be minimized and hydro-meteorological effects can be managed through better rotor and blade designs, as well as appropriate turbine spacing and pattern design. It is also recommended that wind farms be built in areas with plentiful wind energy and low frictional dissipation. Wind energy will be collected instead of being lost due to friction. The goal of this

approach is to make wind farms more efficient.

1.7. Noise reduction

Improved blade design is the key to reducing wind turbine noise. During the blade design process, a balance between noise emission and energy output should be investigated. The aerodynamic noise may be substantially reduced if the blades are designed properly. Upwind turbines may also help with noise reduction at low frequencies. During operation, the insulations within the turbine towers may effectively reduce mechanical noise. Compared to conventional industrial gearboxes, customized gearboxes for wind turbines produce less noise. To guarantee strength, prolong the equipment's lifespan, and muffle noise, the steel wheels of the unique gearbox feature semi-soft and flexible cores with hard surfaces. Direct-drive wind turbines, which do not need a gearbox or a high-speed mechanical component, are quieter.

1.8. Mitigating visual impact

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2. DISCUSSION

One answer to the global energy crisis is renewable energy. Renewable energy also has positive social consequences, such as diversifying energy supplies, expanding regional and rural development possibilities, and generating domestic industry and job opportunities. Renewable energy, on the other hand, may cause environmental problems in a habitat or a community. Despite the fact that the environmental effect of wind turbines is still a contentious issue, it should not be overlooked. When wind energy becomes one of the primary energy sources, minor problems now may have severe consequences in the future(23). More scientific research on the possible environmental effects of wind farms are required, as demonstrated in this review study. The economic, social, environmental, biological, and ecological impacts of wind energy development and associated infrastructure building projects should be assessed. To minimize the environmental impacts of wind farm infrastructure development and operation, appropriate measures should be put in place. To guarantee that projects are built in a manner that avoids, minimizes, and mitigates environmental effects, developers, planners, and government officials must collect and convey full information to the public.

3. CONCLUSION

The study examined previously available information on the wind power industry's environmental effects and possible mitigating strategies. Several observations are made based on the conversations. In the literature, various rates of bird and bat mortality have been recorded as a result of wind turbines. Turbine types, a wind farm's topography, bird/bat species, meteorological conditions, and a variety of other factors all influence the death rate. Although it is unclear how much of an impact offshore wind farms have on the marine environment, care should be used when placing offshore wind turbines near important sea mammal habitats. Wind turbines are still not subject to strict bio-system protection regulations in many countries. Environmental impact studies are often the responsibility of the developer. To completely comprehend the effects of wind farms on local ecological systems, further study is required.

For many years, wind turbine noise has been researched, and many standards have been published in various nations and areas. Following appropriate noise restrictions and distance requirements established from those scientific research is one acceptable way to reducing wind turbine noise nuisance. In contrast to thorough study on other noise sources, such as traffic noise, there is a scarcity of reliable data and quantitative scientific studies on wind farm sounds. Through field measurements and theoretical studies, further study is needed to get a better understanding of wind farm sounds. The aesthetic effect of wind farms on the landscape is a personal choice. To assist address, the issues, social studies and technological advancements may be utilized. Despite the fact that various research varies on the meteorological effect and electromagnetic interference of wind farms, large-scale wind farms do cause issues for regional climate and communication services. As a result, during the wind farm planning stage, mitigating technologies and actions at various sizes should be considered.

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