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Investigating the Environment Impacts of the Wind Farms.

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ABSTRACT

This paper investigates the environmental impacts of wind farms. In this paper, many aspects such as land and water usage, wildfire and habitat and public health are studied. This paper shows that wind farms have a significant effect on the environment and human life.

Keywords: Environmental Impacts, Wind Farms, Land Usage, Water Usage, Agriculture

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INTRODUCTION

Wind farms have been recently developed in electric power systems as reviewable and sustainable energy resources. In this regard, wind farms have been widely studied in electric power systems [1-4]. Paper [5] states that due to the increasing deterioration of environmental problem, multi-objective Economic Emission Dispatch (EED) problem has become one of the active research areas in recent years. Meanwhile, the renewable energy such as wind energy is an important approach to reduce pollution emissions, as well as the dependence on fossil fuels. In paper [5], a newly developed optimization technique, called Multi-Objective Evolutionary Algorithm based on Decomposition (MOEA/D), has been applied to optimize the cost and emission of wind–thermal power system. MOEA/D provides a simple but efficient framework which decomposes a Multi-objective Optimization Problem (MOP) into a number of scalar optimization sub-problems and optimizes them simultaneously. The stochastic nature of wind power is modeled by Weibull probability distribution function and the uncertainty of wind power is considered as system constraints with stochastic variables. To validate the effectiveness of the MOEA/D method, it is first applied to solve the traditional EED problem of standard IEEE 30-bus 6-generator system as the benchmark. Then, the effect of wind power penetration on cost and emission is analyzed by MOEA/D in a 6-generator system and a 40-generator system with wind farms based on the proposed EED model. A comparative analysis with other similar optimization methods reveals that the MOEA/D method is able to generate better performance in terms of both solution quality and computational efficiency. Paper [6] explains that with the increasing penetration of wind power generation into the power system, it is required to comprehensively analyze its impact on power system stability. The present paper analyzes the impact of wind power penetration by doubly fed induction generator (DFIG) on power system oscillations for two-area interconnected power system. The aspects of inter-area oscillations which may affect the operation and behaviour of the power systems are analyzed with and without the wind power penetration. Eigenvalue analysis is carried out to investigate the small signal behavior of the test system and the participation factors have been determined to identify the participation of the states in the variation of different mode shapes. The penetration of DFIG in a test system results in an oscillatory instability, which can be stabilized with the coordinated operation of automatic voltage regulator (AVR) and power system stabilizer (PSS) equipped on synchronous generators. Also, the variations in oscillatory modes are presented to observe the damping performance of the test system at different wind power penetration level. In paper [2], interval arithmetic (IA) is used for taking into account the uncertainties of the active power produced by a wind turbine generating system (WTGS) in the power flow computation of a balanced radial distribution system. The effectiveness of the proposed method has been investigated by comparing the results obtained by this method with those obtained by Monte Carlo simulation (MCS) technique on two different balanced radial distribution systems. It has been found that the results obtained by these two methods (IA and MCS) are very close to each other while the computation time required by IA based method is significantly less than that required by MCS.

Current paper investigates the environmental impacts of wind farms such as land usage, water usage, wildfire and habitat, public health. It is shown that wind farms have a significant effect on the environment and human life.

Environmental impacts of wind farms

Wind energy is one of the cleanest and most sustainable energy resources to produce electricity without pollution. Wind is also abundant, inexhaustible, and affordable, which makes it a viable and large-scale alternative to fossil fuels. Despite its vast potential, there are a variety of environmental impacts associated with wind power generation that should be recognized and mitigated.

Effect on power grid

Utility-scale wind farms must have access to transmission lines to transport energy. The wind farm developer may be obliged to install extra equipment or control systems in the wind farm to meet the technical standards set by the operator of a transmission line. The company or person that develops the wind farm can then sell the power on the grid through the transmission lines and ultimately chooses whether to hold on to the rights or sell the farm or parts of it to big business like GE, for example.

Land usage

The land use impact of wind power facilities varies substantially depending on the site: wind turbines placed in flat areas typically use more land than those located in hilly areas. However, wind turbines do not occupy all of this land; they must be spaced approximately 5 to 10 rotor diameters apart (a rotor diameter is the diameter of the wind turbine blades). Thus, the turbines themselves and the surrounding infrastructure (including roads and transmission lines) occupy a small portion of the total area of a wind facility. A survey by the National Renewable Energy Laboratory of large wind facilities in the United States found that they use between 30 and 141 acres per megawatt of power output capacity (a typical new utility-scale wind turbine is about 2 megawatts). However, less than 1 acre per megawatt is disturbed permanently and less than 3.5 acres per megawatt are disturbed temporarily during construction. The remainder of the land can be used for a variety of other productive purposes, including livestock grazing, agriculture, highways, and hiking trails. Alternatively, wind facilities can be sited on brownfields (abandoned or underused industrial land) or other commercial and industrial locations, which significantly reduces concerns about land use. Offshore wind facilities, which are currently not in operation in the United States but may become more common, require larger amounts of space because the turbines and blades are bigger than their land-based counterparts. Depending on their location, such offshore installations may compete with a variety of other ocean activities, such as fishing, recreational activities, sand and gravel extraction, oil and gas extraction, navigation, and aquaculture. Employing best practices in planning and siting can help minimize potential land use impacts of offshore and land-based wind projects.

Wildlife and habitat

The impact of wind turbines on wildlife, most notably on birds and bats, has been widely document and studied. A recent National Wind Coordinating Committee (NWCC) review of peer-reviewed research found evidence of bird and bat deaths from collisions with wind turbines and due to changes in air pressure caused by the spinning turbines, as well as from habitat disruption. The NWCC concluded that these impacts are relatively low and do not pose a threat to species populations. Additionally, research into wildlife behavior and advances in wind turbine technology have helped to reduce bird and bat deaths. For example, wildlife biologists have found that bats are most active when wind speeds are low. Using this information, the Bats and Wind Energy Cooperative concluded that keeping wind turbines motionless during times of low wind speeds could reduce bat deaths by more than half without significantly affecting power production. Other wildlife impacts can be mitigated through better siting of wind turbines. The U.S. Fish and Wildlife Services has played a leadership role in this effort by convening an advisory group including representatives from industry, state and tribal governments, and nonprofit organizations that made comprehensive recommendations on appropriate wind farm siting and best management practices. Offshore wind turbines can have similar impacts on marine birds, but as with onshore wind turbines, the bird deaths associated with offshore wind are minimal. Wind farms located offshore will also impact fish and other marine wildlife. Some studies suggest that turbines may actually increase fish populations by acting as artificial reefs. The impact will vary from site to site, and therefore proper research and monitoring systems are needed for each offshore wind facility.

Human health

A 2007 report by the U.S. National Research Council noted that noise produced by wind turbines is generally not a major concern for humans beyond a half-mile or so. Low-frequency vibration and its effects on humans are not well understood and sensitivity to such vibration resulting from wind-turbine noise is highly variable among humans. There are opposing views on this subject, and more research needs to be done on the effects of low-frequency noise on humans. In a 2009 report about "Rural Wind Farms", a Standing Committee of the Parliament of New South Wales, Australia, recommended a minimum setback of two kilometres between wind turbines and neighbouring houses (which can be waived by the affected neighbour) as a precautionary approach. Sound and visual impact are the two main public health and community concerns associated with operating wind turbines. Most of the sound generated by wind turbines is aerodynamic, caused by the movement of turbine blades through the air. There is also mechanical sound generated by the turbine itself. Overall sound levels depend on turbine design and wind speed. Some people living close to wind facilities have complained about sound and vibration issues, but industry and government-sponsored studies in Canada and Australia have found that these issues do not adversely impact public health. However, it is important for wind turbine developers to take these community concerns seriously by following "good neighbor” best practices for siting turbines and initiating open dialogue with affected community members. Additionally, technological advances, such as minimizing blade surface imperfections and using sound-absorbent materials can reduce wind turbine noise. Under certain lighting conditions, wind turbines can create an effect known as shadow flicker. This annoyance can be minimized with careful siting, planting trees or installing window awnings, or curtailing wind turbine operations when certain lighting conditions exist. The Federal Aviation Administration (FAA) requires that large wind turbines, like all structures over 200 feet high, have white or red lights for aviation safety. However, the FAA recently determined that as long as there are no gaps in lighting greater than a half-mile, it is not necessary to light each tower in a multi-turbine wind project. Daytime lighting is unnecessary as long as the turbines are painted white. When it comes to aesthetics, wind turbines can elicit strong reactions. To some people, they are graceful sculptures; to others, they are eyesores that compromise the natural landscape. Whether a community is willing to accept an altered skyline in return for cleaner power should be decided in an open public dialogue.

Water Use

There is no water impact associated with the operation of wind turbines. As in all manufacturing processes, some water is used to manufacture steel and cement for wind turbines.

Ground radar interference

Wind farms can interfere with ground radar systems used for defense, weather and air traffic control. The large, rapidly moving blades of the turbines can return signals to the radar that can be mistaken as an aircraft or weather pattern. Actual aircraft and weather patterns around wind farms can be accurately detected, as there is no fundamental physical constraint preventing that. But ageing radar infrastructure is significantly challenged with the task. The US military is using wind turbines on some bases, including Barstow near the radar test facility.

Life-Cycle Global Warming Emissions

While there are no global warming emissions associated with operating wind turbines, there are emissions associated with other stages of a wind turbine’s life-cycle, including materials production, materials transportation, on-site construction and assembly, operation and maintenance, and decommissioning and dismantlement. Estimates of total global warming emissions depend on a number of factors, including wind speed, percent of time the wind is blowing, and the material composition of the wind turbine. Most estimates of wind turbine life-cycle global warming emissions are between 0.02 and 0.04 pounds of carbon dioxide equivalent per kilowatt-hour. To put this into context, estimates of life-cycle global warming emissions for natural gas generated electricity are between 0.6 and 2 pounds of carbon dioxide equivalent per kilowatt-hour and estimates for coal-generated electricity are 1.4 and 3.6 pounds of carbon dioxide equivalent per kilowatt-hour.

Mitigation

Permanent problem solving include Non-Initiation Window to hide the turbines while still tracking aircraft over the wind farm, and a similar method mitigates the false returns. England's Newcastle Airport is using a short-term mitigation; to "blank" the turbines on the radar map with a software patch.[104] Wind turbine blades using stealth technology are being developed to mitigate radar reflection problems for aviation. As well as stealth wind farms, the future development of infill radar systems could filter out the turbine interference. In early 2011, the U.S. government awarded a program to build a radar/wind turbine analysis tool. This tool will allow developers to predict the impact of a wind farm on a radar system before construction, thus allowing rearrangement of the turbines or even the entire wind farm to avoid negative impacts on the radar system. A mobile radar system, the Lockheed Martin TPS-77, has shown in recent tests that it can distinguish between aircraft and wind turbines, and more than 170 TPS-77 radars are in use around the world. In Britain, the Lockheed Martin TPS-77 will be delivered and installed in November 2011 at Trimingham in Norfolk, removing military objections to a series of offshore wind farms in the North Sea. A second TPS-77 is to be installed in the Scottish Borders, overcoming objections to a 48-turbine wind farm at fall ago.

Agriculture

It has been shown that in the immediate vicinity of wind farms, the climate is cooler during the day and slightly warmer during the night than the surrounding areas. This effect is due to the turbulence generated by the blades. The analysis carried out on corn and soybean crops in the central areas of the United States has noted that the microclimate generated by wind turbines improves crops as it prevents the spring and autumn frosts, and it reduces the action of pathogenic fungi that grow on the leaves. Even at the height of summer heat, the lowering of 2.5–3 degrees above the crops due to turbulence caused by the blades, can make a difference for the cultivation of corn.

CONCLUSIONS

This paper addressed the environmental impacts of wind farm such as land usage, water usage, wildfire and habitat and public health. Results of investigation showed that wind farms have a significant effect on the environment and human life.

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