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Greener energy: Issues and challenges for Pakistan—wind power prospective

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ABSTRACT

Energy is one of the essential inputs for economic development and industrialization. A reliable supply of energy is essential to maintain and to improve human being's living conditions. The management of energy sources, rational utilization of energy, and renewable energy source usages are vital. Among the renewable energy sources wind energy is currently viewed as one of the most significant, fastest growing, and commercially attractive source to generate electrical energy because of the mature and cost effective energy conversation technology. Developing a utility-scale wind project is a complicated and time-consuming process which involves developers, landowners, utilities, the public and various local authorities. This article discusses the past, the present and the future of wind energy use in Pakistan. The efforts for the utilization of wind energy in the country are presented as well, along with barriers in its development. It is concluded that the potential exists, but significant efforts are needed to effectively make use of this cheap renewable energy source.

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1. Introduction and background

Rising concern about the effect of greenhouse gas (GHG) emissions on climate change is pushing national governments and the international community to achieve sustainable development in an economy that is less dependent on carbon emitting activities (the vision that is usually termed a "low-carbon society" (LCS)). Since the utilization of energy resources is the main source of GHG emissions, restructuring current energy systems in order to incorporate low-carbon energy technologies is essential for the realization of the LCS vision. Energy policies promoting the penetration of these technologies must view the role of energy in society as a system composed of several energy resources, conversion technologies and energy demand sectors [1].

To address these concerns to some extent, global communities are trying to find and implement different energy saving strategies, technology, and alternative sources of energy for different sectors that rely on energy produced from different sources. In that regard development of wind energy is anticipated to play a significant role to meet future energy demand which can reduce environmental pollution to a certain extent [2]. Wind turbines, both large and small, produce electricity for utilities and home owners and remote villages. When wind turbines are grouped together, they are referred to as "wind farms". Wind farms comprise the turbines themselves, plus roads for site access, buildings (if any) and the grid connection point. In fact over the last ten years wind energy is the world's fastest growing energy source with an average annual growth rate of 31.1% [3]. It is predicted that wind energy will provide 5% of the world's energy in 2020 [4].

Windmills have been used for at least 3000 years, mainly for grinding grain or pumping water; while in sailing ships the wind has been an essential source of power. In fact, the word mill is derived from the Latin word for a machine used for grinding grain. From medieval times, horizontal axis windmills were an integral part of the rural economy and only fell into disuse with the advent of cheap fossil-fuelled stationary engines and then the spread of rural electrification [5,6].

In the beginning, the primary motivation for basically all the research in wind-power was to strengthen the mechanization of agriculture through local-made electricity. With the electrification of the industrialized world, however, the role of wind-power decreased. It was not able to compete with the fossil-burning power stations, which showed to be far more competitive in providing electrical power on a large scale. Lack of fossil fuels during World War I and later World War II created an awareness of the great dependence on fossil fuels and gave wind-power renewed attention. The prices for wind-powered electricity were still not competitive and politically nuclear power was given more attention and hence more research funds.

It was the oil crises in the 1970s creating the supply-problems and price fluctuations on fossil fuels when wind-power once again was put on the agenda. In many countries in the 1970s a new era for wind power started and spurred the development of a global industry which today is characterized by relatively few but very large wind-turbine manufacturers -primarily from Denmark, Germany, Spain, China, India and the US.

During 1973–1986, the commercial wind turbine market evolved from domestic and agricultural applications of small machines in the 1 kW to 25 kW size range to utility interconnected wind farm applications of intermediate-scale machines of 50 kW to 600 kW [7,8]. However medium to large grid-connected wind turbine generators are particularly becoming the most important and fastest growing form of electricity generation. They attract interest as one of the most cost-effective ways to generate electricity from renewable energy resources [9]. Indeed, this renewable energy ranks second after hydroelectric in terms of installed capacity and rapid growth [10]. New markets are emerging and existing markets are expanding. Jacobson and Delucchi [11] ranked several long-term energy systems with respect to their impacts on global warming, air pollution, water supply, land use, wildlife, thermal pollution, water–chemical pollution and nuclear weapons proliferation. The ranking of electricity options, starting with the highest, included: wind power, concentrated solar, geothermal, tidal, solar photovoltaic, wave, and hydroelectric power, all of which are powered by wind, water, or sunlight (WWS). The study also found that battery-electric vehicles and hydrogen fuel-cell vehicles recharged by WWS options would largely eliminate pollution from the transportation sector. Jacobson and Delucchi [11] also concluded that coal with carbon capture, corn ethanol, cellulosic ethanol, and nuclear power were all moderately or significantly worse than WWS options with respect to environmental and land use impacts. Jacobson and Delucchi [12] outlined a large-scale plan to power the world for all purposes with WWS (no biofuels, nuclear power, or coal with carbon capture). The study found that it was technically feasible to power the world with WWS by 2030 but such a conversion would almost certainly take longer due to the difficulty in implementing all necessary policies. Same study also suggests converting to a WWS energy infrastructure will reduce 2030 world power demand by 30%, primarily due to the efficiency of electricity compared with internal combustion. The amount of wind power plussolar power available in likely developable locations over land outside of Antarctica exceeds projected world power demand by more than an order of magnitude. Jacobson and Delucchi [13] concluded that barriers to a 100% conversion to WWS power worldwide are primarily social and political, not technological or even economical.

Globally, 1700 TW (Trillion Watts) of wind energy are available over the world's land plus ocean surfaces at 100 m if all wind at all speeds were used to power wind turbines however, the wind power over land is around 72–170 TW in locations over land and near shore where the wind speed is 7 m/s or faster (the speed necessary for cost-competitive wind energy) [14,15]. Over half of this power is in locations that could practically be developed. This vast potential can be exploited to produce electricity on both community and wind farm scales. Applications other than electricity production, such as water pumping, also have vast applications. The maturity of wind energy is high because it has been used since olden times in many economic activities [16].

Wind-generated electricity contributed over 1% of global demand for the first time in 2007, when installed capacity grew to 94 GW [17]. The worldwide wind capacity reached 254 GW by the end of June 2012. European Union has set a binding target of a 20% renewable energy contribution by 2020, which equates to 34% of electricity production. It is estimated that wind energy could contribute one-third of this production [18]. In American Chemical Society's 240th National Meeting Walter Kohn, who shared the 1998 Nobel Prize in Chemistry noted that continuous research and development of alternative energy could soon lead to a new era in human history in which two renewable sources, solar and wind, will become Earth's dominant contributor of energy [19]. According to findings from the International Scientific Congress "Climate Change: Global Risks, Challenges & Decisions." Renewable energy is essential to modern society—reducing harmful emissions from fossil fuels and making us more self-sufficient. Most of the technologies needed to shift the world from fossil fuel to cleanrenewable energy. Implementing that technology requires overcoming obstacles in planning and politics. With adequate financial and political support, renewable energy technologies like wind and photovoltaic could supply 40% of the world's electricity by