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# Potential wind power generation in the State of Kuwait

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**Abstract**

The wind characteristics of six locations in the State of Kuwait have been assessed. The annual average wind speed for the considered sites ranged from 3.7 to 5.5 m/s and a mean wind power density from 80 to 167 W/m$^2$ at standard height of 10 m. The Weibull parameters and power density of each station have been determined using Weibull distribution. The wind data at heights 15, 20, 25 and 30 m were obtained by extrapolation of the 10 m data using the Power-Law. The potential wind energy at different heights was estimated using Weibull parameters. Maximum power density is found at 30 m height which varies between 130 and 275 W/m$^2$ with 70% increase from the standard height indicating fairly potential wind energy especially in the northern part of the country. The highest potential wind power was found during the summer season which is the peak demand season of electricity in Kuwait.


*Keywords:* Wind energy; Weibull distribution; Wind data in Kuwait

## 1. Introduction

The worldwide concern and environmental awareness of air quality created a move towards pollution free energy production such as solar and wind energies. Wind is an abundant resource available in nature that could be utilized by mechanically converting wind power to electricity using wind turbines.

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Kuwait is one of the well-known oil countries in the world. More than 20% of Kuwait's oil is consumed within the country by five power plants, three oil refineries and many other petroleum and petrochemical industries. The heavy consumption of fossil fuels significantly affects the level of air pollution over residential areas nearby industrial activities.

The rise of air quality related problems world wide raises strong questions about alternative sources that are cleaner than the conventional ones even though practical and economically viable to use. Wind energy was used heavily in desert regions mainly to pull up ground water for human and animal use. In Kuwait, the first windmill was built in the early 1900s on desert water well known as Ben Shlash Windmill about 70 km Northwest of Kuwait City [11]. Since that time there were no record of further practical use of wind energy in Kuwait and the interest in further development of this technology was diminished by the exploration of oil in the late 1930s.

During the last three decades, robust urban development and the widespread expansion of industrial and residential areas have resulted in high demand of power. The demand was almost doubled during the last 10 years from 4120 MW in 1993–7250 MW in 2002. According to the Kuwait ministry of Energy [16], 70% of the electricity consumed to air conditioning the interior environment at schools, houses, offices and shopping centres especially during the long summer season starting from May to October (Fig. 1). Knowing that the least energy consumption over the year is in the month of February, Fig. 2, the heating, ventilation and air-conditioning (HVAC) consume nearly 45% of the annual production [18].

Moreover, the five main power plants in Kuwait, Subbya, Doha west, Doha east, Shaiba and Az Zour are the main sources of sulfur dioxide ($SO_2$) and nitrogen oxides ($NO_x$) in the country. Az Zour power plant that consist of eight steam turbine units consuming 281.34 t/h of fuel that emit 1563 and 480.3 g/s of $SO_2$ and $NO_x$, respectively [19].

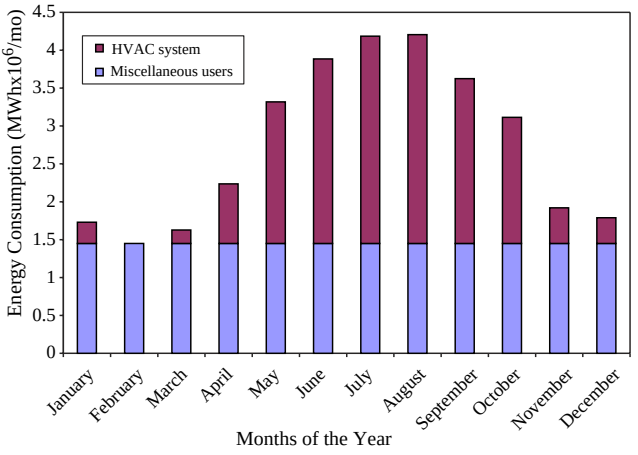


Fig. 1. Monthly energy consumption in Kuwait for year 2002.