Different Models of Wind Speed Prediction; A Comprehensive Review

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Abstract— The energy crisis witnessed in the early seventies is a serious problem that had happened in the universe. Hence, induction of renewable energy into electrical power generation mix can serve as an alternative source to cater for the limited reserve of fossil fuels. Wind energy is promising and has emerged as one of the safest, cleanest and fastest growing renewable energy in the recent years. The bottleneck of this type of emission free energy is the variability, stochastic, unpredictable and complex nature of the wind speed. To harness the energy content in a wind efficiently, it's of utmost importance to accurately predict wind speed and energy with minimum accepted errors for security and economics of wind power utilization. For this reason, it becomes necessary to appraise different types of models used in the wind energy forecast. This paper present review of available wind speeds and power prediction models and discuss their applications and current developments. Moreover, the survey also highlights an overview strength and weakness of these models.

Index Terms— Wind, Wind Energy, Wind Speed, Wind Power, Prediction Model.

1 Introduction

Burning of fossil based fuels such as: coal, oil and gas for generation of electricity is associated with many challenges like greenhouse gasses. Indeed, when these gases are released to the environment, its effects climate and hence increase global warming directly or indirectly.

Industrial development and population growth have increased the energy demand globally. Hence, the current scenario of energy resources is insufficient to meet the present energy demand. Hike increase in oil and gas prices, shortage of reserves witnessed in the past few decades made renewable energy option gaining more attraction and recognition. Additionally, renewable resources such as solar, hydro, biomass and wind are the natural sources of energy and a major competitor of the current trend of energy based on hydrocarbons that have limited reserves. Among the existing renewable, wind energy is the most effective and prosperous in the near future but the availability of wind resources varies depend on the location.

Wind energy naturally exists anywhere in the world and is considered as a clean and efficient source of energy generation that will sustain and maintain the environment. In this regards, wind energy will play an important role in the economic activities, electricity generation and emission control.

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The dilemma of this type of energy is the intermittent and the stochastic nature of wind speed. It is well known that, there is a non-linear relationship between wind speed and power output of wind turbines, for this reason a small fraction deviation of wind speed will lead to a large error output of wind driving systems [1-2]. Hence, it is of utmost important to predict an accurate and precise wind speed values.

This paper provides a recent review of wind speed and power prediction models previously presented in a literature and discuss the strengths and weakness of each model. The rest of the paper is structured as follows. Section 2 present time scale concerning different wind speed prediction horizons. An overview of wind speed predictions is presented in section 3. Wind speed/power is presented in section 4. The different prediction model applied in the scientific literatures discussed in section 5. Discussion and concluding remarks are run down in sections 6 and 7.

2 Wind Speed Prediction Horizons

Research works on wind speed/power prediction vary depending on the prediction period. Different time scale horizons have been reported in many scientific literatures. The time scales pertaining to wind speed predictions are in range from minutes to days. A detailed review conducted by [3-4], reported that the wind speed forecasting techniques can be grouped into very short, short, medium and long term methods as shown in table 1.

- **Very short-range forecasting**: This technique is used to forecast wind speed/power values from a few seconds to thirty minutes ahead. Its main application for electricity market clearing and regulatory actions.
- **Short-range forecasting:** The main purpose of short term wind speed prediction is to dispatch power output of wind turbines to meet customer need within a