WIND SPEED ANALYSIS AND ENERGY CALCULATION BASED ON MIXTURE DISTRIBUTIONS IN NARAKKALIYA, SRI LANKA

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Wind resource is important part of the utilization of renewable energy. For effectively estimate the wind energy potential for a given area, a variety of probability density functions (pdf) are available in literature. The Weibull, Lognormal and Gamma distribution functions have been widely used in the literature to model the wind speed data. But when the distribution has two humps these conventional distribution functions are not suitable. Since Narakkalliya is affected by two monsoons in varying degrees which shows a bi-model behavior, this study is focused on examine the applicability of Mixture Weibull distribution, Mixture Lognormal and Weibull distribution and Mixture Gamma and Weibull distribution to model Wind Speed Frequency Data (WSFD) and calculate energy production of Narakkaliya wind turbine using Power curve data and most suitable mixture distribution and compare with energy production calculated by Weibull distribution.

This analysis has been carried out for Narakkalliya for hourly average wind speed data obtained for the year 2001 at 40m mast height. The Wind Speed Frequency data (WSFD) was calculated using hourly average wind speed data. Frequency distribution was calculated for range of wind speed from 0-18.5 m/s. Width of the wind speed frequency bin was selected as 1 m/s and bin range was specified as 0.5-1.5, 1.5-2.5 etc. up to 18.5 m/s.

Parameters for Weibull distribution, lognormal distribution, Gamma distribution, Mixture Weibull distribution Mixture Lognormal and Weibull distribution and Mixture Gamma and Weibull distribution were calculated using Maximum Likelihood Method. The performance of all distributions in describing wind regime was compared. This study has shown that the when describing bimodal behavior, the accuracy drops considerably in using Weibull, Lognormal and Gamma approximation because these distributions can't describe bimodal behavior. The goodness of fit of the distributions was compared using K-S error, Chisquare test, RMSE and R^2 test. Mixture Weibull distribution has the lowest error followed by Mixture Lognormal and Weibull distribution. If R^2 error is considered, Mixture Weibull has a value very close to 1.0, confirming its superiority in performance followed by Mixture Lognormal and Weibull Distribution.

Power curve data for Narakkalliya wind turbine was used for energy calculation and energy calculation was done for Weibull and Mixture Weibull distribution for the comparison purposes. According to the analysis Mixture Weibull estimates 83.2% of actual energy while Weibull estimate 75.9% of actual.