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WIND ANALYSIS AND ESTIMATION OF WIND ENERGY POTENTIAL IN ERBIL (HAWLER) GOVERNORATE

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Abstract

In this thesis, routine wind data (speed and direction) recorded at six agro/meteorological stations within Erbil(Hawler) governorate were collected and analyzed. The stations are [Makhmur(2004), Khabat(1986), Ankawa(2004), Shaqlawa(2001), Degala(2002) and Koya(2002)]. The data were recorded at 2meters and 10 meters above ground level, using manual, automatic and full automatic anemometers. The recorded data were extrapolated to 10m and 50m height through careful selection of height extrapolation formula.

Monthly and annual mean wind speeds for each location were calculated. The results are all shown in both tabulated and graphical forms. It was found that the mean monthly wind speed varies from minimum value 0.71 m/sec in April at Degala to maximum value 6.29 m/sec in April at Shaqlawa at 10m elevation, with annual means ranging from 0.98m/sec to 4.44m/sec at the same locations mentioned above.

Also, monthly and annual mean wind speeds for each location at 50 meters height were calculated. The results which were found, showed that the mean monthly wind speed varies from 1.21 m/sec in April at Degala to about 10.69 m/sec in April at Shaqlawa at 50m elevation, with annual means ranging from 1.69m/sec to 7.65m/sec at the same locations mentioned above.

The mean monthly power exponent factor (α_p) of the power laws model ranged from o.32 to 0.39 with an overall annual mean of 0.34.These values agree well with universal standards.

The frequency distribution of wind speeds were also studied by fitting the well known Wiebull distribution function. The results showed that this function is fitted to the wind data reasonably at Erbil Governorate. The shape and scale parameters of Weibull distribution are determined by using least square approach and Weibull

probability distribution functions. The results are all shown and carefully analyzed. The selected wind data thereafter are used to determine the quantity of wind power and its potential energy monthly and annually for each location under consideration.

The annual wind power densities estimated from wind speeds at 10 meters height are 90.05, 14.75, 17.35, 120.58, 1.06, and 92.221 W/m^2 for Makhmur, Khabat, Ankawa, Shaqlawa, Degala and Koya, respectively, while the corresponding values of wind power densities from winds at 50 meters height are 458.72, 80.95, 89.24, 617.44, 5.45, and 473.05 W/m^2,respectively. The annual wind energy densities are 788.85 for Makhmur, 129.18 for Khabat, 151.98 for Ankawa, 1056.27 for Shaqlawa, 9.27 for Degala, and 807.85 KW/year/$m^2$for Koya at 10m, and 4018.37, 709.09, 781.72, 5408.77, 47.78, and 4143.95 KW/year/m^2 at 50m height, respectively.

The generated wind power in all sites were also determined using 4, 50, 100 and 1000KW wind machine models and compared with hourly annual electricity demand in the study area and the results of the investigation are promising.