

Wind Resource Database of South Korea KIER-Wind DataTM

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ABSTRACT: In order to support the development of wind farms in Korea, a wind resource database for Korea has been established using a meteor-statistical analysis of KIER (Korea Institute of Energy Research) met-mast measurements and KMA (Korea Meteorological Administration) weather data. The analysis included wind statistics, tower shading, an exposure category classification using satellite images, the effect of atmospheric stability on the wind profile exponent, and a correlation matrix of wind speed to gain an understanding of the meteorological correlation between long-term weather observation stations and short-term met-mast measurements. The wind resource database, referred to as KIER-WindDataTM, is to be provided as an add-on to Google EarthTM, which is expected to be utilized as a guideline for the selection of an appropriate reference site for long-term correction in the next wind farm development project.

Keywords: wind resource database, meteor-statistical analysis

1. INTRODUCTION

Korea, due to its industrial structure based on heavy industry, is the world's 10th gross energy consumer and 4th largest importer of petroleum. Nevertheless, 97% of Korea's energy requirements are reliant on imports. Considering these situations, it is now very urgent to readdressing renewable energy R&DD, including wind energy [1].

Conversely, the private commercial development of wind farms is still at an early stage, with only two private inland wind farms currently in operation: Kangwon wind farm (98MW) and Youngduk wind farm (40MW).

For the wind resource investigation, wind data should be measured for at least a year by installing met-masts in the area of the expected wind farm development [2]. Because such observational data include

inevitable uncertainty factors due to long-term secular change and weather variance of meteorological parameters, long-term correction is required for long-term wind farm operation, such as for the wind power generation business [3]. Also, if the local climatology representation and synoptic climatology linkage are not analyzed, it is difficult to identify the uniqueness of an observation period.

According to the previous investigations on domestic wind resources, it is difficult to verify local representation, investigate long-term corrections and the effects of met-mast shading, etc. When such data are used in wind resource assessments, the expected uncertainty would be very great, and if the weather of the measured period was not that of an average year, an error can have a direct effect on the success or failure of a wind farm business.

Baring this in mind, in order to provide direct assistance and guideline to a wind resource assessment and feasibility survey for the development of a wind farm, while broadening the understanding of the Korean wind environment, which is classified as complex terrain and Monsoon climatology, the wind resource database, referred to as KIER-WindDataTM, has been established using a meteor-statistical analysis of wind resource measurement data, which had previously been considered idle data unless it could be made into a database using a systematic and integrated assessment. The main purpose of this research was to provide the reference point selection criteria for the long-term correction required during a wind resource assessment.

2. WIND DATA

Owing to the complex terrain and complicated Monsoon climatology of Korea, the wind data obtained from weather observation stations, which are mostly located within urban or valley areas at ground level, would not be applicable to a wind resource assessment. Moreover, European style wind resource assessments, which assume relatively flat terrain, would not be appropriate for Korea, a mountainous country; therefore, a wind resource assessment method suitable for this situation is necessary.

KIER has carried out wind resource measurements at about 100 sites in Korea. The uncertainty level of the wind resource assessment state is in the following order [4]; micro-siting in complex terrain (25%), height extrapolation of wind speed (20%), long-term correction (7%). This research focused on providing correctly analyzed data and useful guidelines for minimizing the uncertainty of a wind resource assessment, i.e., long-term correction and height extrapolation of wind speed, and so forth.

3. ANALYSIS METHODS & RESULTS

The meteor-statistical analysis methods employed in this research were as follows:

(1) The observation data of KMA and KIER were collected, and for wind resource measurement data, the pre-treatment by eliminating abnormal data and irregular events such as a typhoon were performed according to the meteorological data quality control methods of KMA.

(2) For wind resource assessments, met-masts should be installed at representative sites of local climate areas for prospective wind farm developments so that short-term observations of duration of at least one year, including seasonal variations, could be performed. Therefore, for the wind resource assessment of an operational period of at least 20 years in the future, a long-term correction must be performed. In order to provide guidelines for long-term corrections, a correlation analysis, using time-series wind speed data between reference observation sites, was performed to prepare a wind speed correlation matrix composed of cross-correlation factors between in-situ measurement sites.

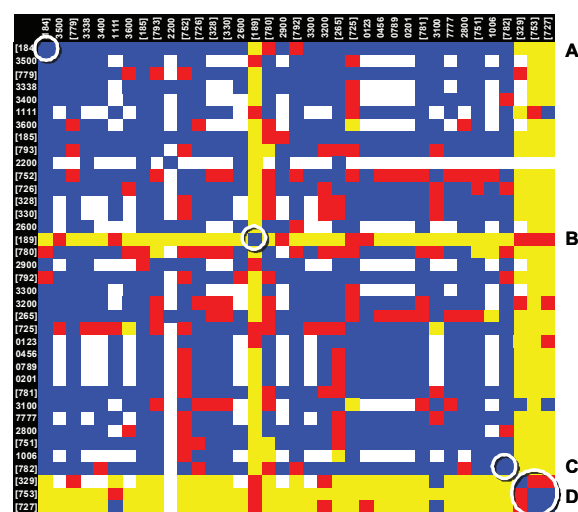


Figure 1: Wind speed correlation matrix to assist in reference site selection for long-term correction (■: >0.6 , ■: $0.3 \sim 0.6$, ■: <0.3 , □: ND).

(3) The ground-level climatology is supposed to have meteorological correlation with the upper-air climatology (or synoptic climatology) unless the local climatology derived from complex terrain or structure is dominant. Consequently, it is worth while testing meteorological dependency between the ground-level measurement and upper-air measurement observed with a radio-sonde to confirm whether climatology at the ground-level incorporates the synoptic climatology or is independent to local wind system.

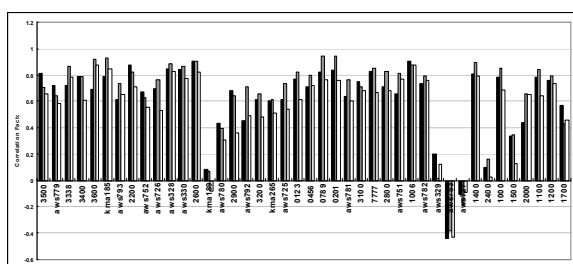


Figure 2: Correlation between upper-air (synoptic) data and ground-level in-situ measurements.

(4) In spite of the neutral atmospheric condition takes about 40% of occurrence in reality, neutral atmosphere has been simply assumed during wind resource assessments so far – stable or unstable atmospheric effects has been neglected because it was not easy to take into account especially in wind-speed height extrapolation [5].

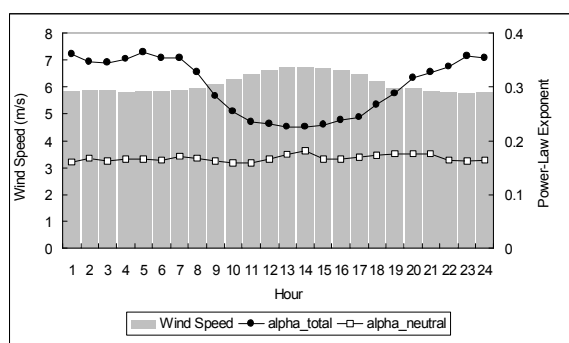


Figure 3: Diurnal variations in the wind speed and wind profile exponents (over-all and neutral atmospheric conditions).

Accordingly, by separate interpretation of neutrally stratified atmosphere situations,

the change in the vertical profile of wind speed due to atmospheric stability has been investigated.

(5) Most observations are made by met-masts installed only up to heights less than that of the hub of a wind turbine due to technological and economical limitations. Therefore, for the height extrapolation of wind speed, the wind speed at the hub height must be calculated. As reference materials for deriving accurate wind profile exponents, the surface roughness and exposure category analysis of the area surrounding a met-mast site using high resolution satellite images, as well as tower shading effect analysis have been established.

(6) While measuring wind speed using a met-mast, the met-mast is located upwind of the anemometer in the measurement plane, which creates tower shading. Because the tower shading error (two downward/upward peaks in Figure 4) in the wind speed measurement can be 2.5% or greater, corrections are necessary.

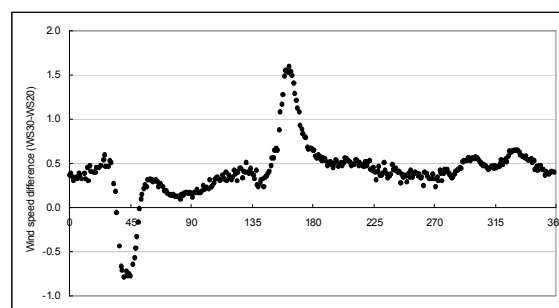


Figure 4: Detection of the tower shading effects by analyzing the wind speed difference between anemometers mounted at different heights on the met-mast.

The wind resource database, KIER-WindDataTM is expected to provide reference data and interpretation guidelines for wind farm developers when performing the feasibility assessments required by the wind power business. As demonstrated in Figure 5, KIER-WindDataTM is to be provided as add-on file for Google EarthTM which is a public software and provides

good quality satellite images and geographical information such as coordinates, etc. Therefore, it is anticipating that a practical usability of KIER-WindDataTM would be greatly enhanced.

4. CONCLUSIONS

Wind energy, which is the ultimate energy source among renewable energy in terms of economic feasibility, should lead to the propagation of renewable energy to achieve the dissemination target of 5% of the Korean national electricity demand from renewable sources by 2011.

Therefore, the wind resource database has attempted to support the wind power business by providing reference materials and analytical guidelines to considerably reduce the uncertainty of wind resource assessments, such as a wind speed correlation matrix, for selecting reference points for long-term corrections, exposure category analysis for wind speed height extrapolation and atmosphere stability analysis, etc.

ACKNOWLEDGEMENT

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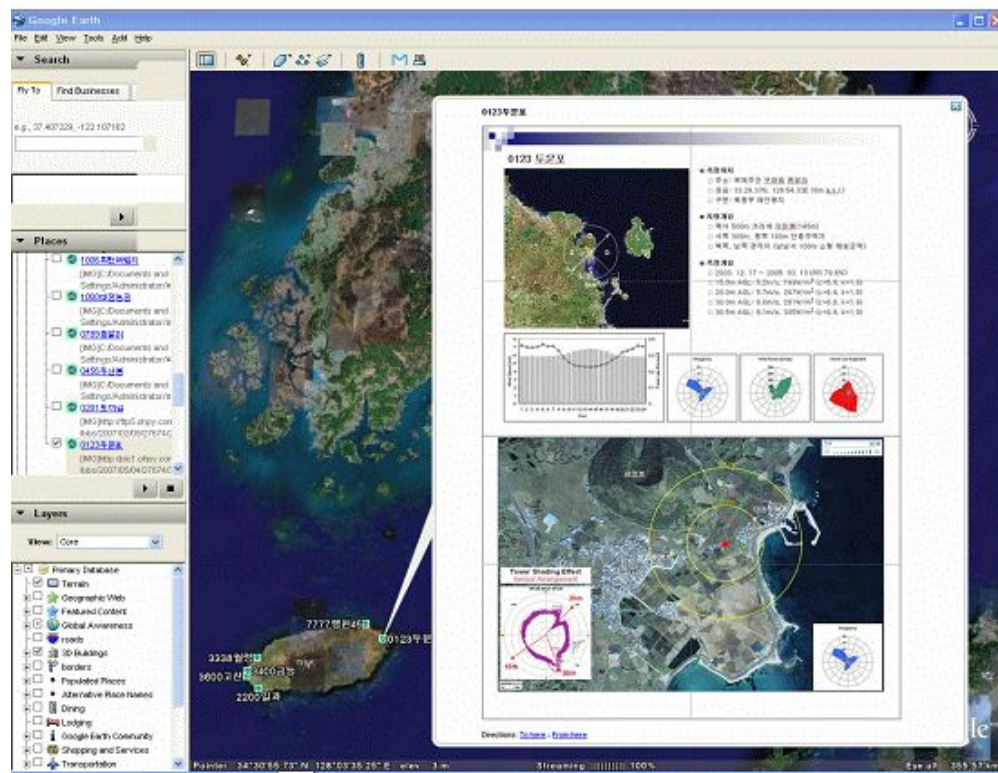


Figure 5: Screenshot of the wind resource database displayed in Google Earth™.