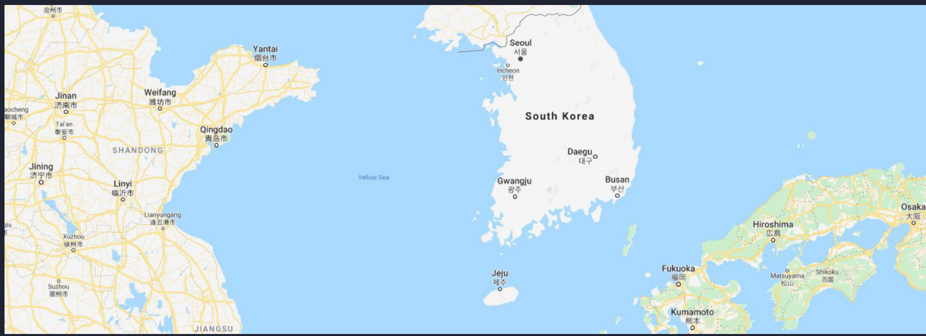
CASE STUDY 10

Wind direction measurement according to IEC.61.400.12.1

Korea



Leading Korean wind developer TQD Energia Co. Ltd uses the Geovane Metmast (Geovane MM) to get rid of offsets in their wind direction measurements. For this specific project TQD Energia Co. Ltd. detected a misalignment of the wind vanes with respect to True North of 14 degrees. The economic consequences of a wind farm layout that would have been based on wrong wind direction measurements, have been calculated to be 5.1 million euros.

Customer profile

TQD Energia Co. Ltd is an independent South Korean wind energy developer with a portfolio of over 1 GW and currently involved in four different wind farm projects, each with a power capacity between 40 MW and 100 MV. Its Chairman, Moises Lee, is also a member of the Korean Wind Energy Industry Association.

Introduction

On January 14th 2020 the installation of a 80-meter measurement tower was carried out in complex terrain in the Hwasun region (South Korea). In order to measure the wind direction, two Thies Compact TMR wind vanes were installed at 78 m and 58 m respectively. The wind vane installed at 58 m was equipped with a Geovane Metmast (Geovane MM) from Kintech Engineering.

RESULTS

This case study summarizes how TQD Energia Co. was able to identify a 14-degree misalignment in their wind vane measurements and how this misalignment was detected with the use of the Geovane Metmast.

To outline the importance of correct wind direction measurements, the economic impact by having used the incorrect wind direction measurements was calculated.

Had TQD Energia not used the Geovane Metmast, the “false” wind rose would have:

- Overestimated the benefits by 254650 euros per year.
- Overestimated the benefits by 5.1 million euros over the lifetime of the wind farm (20 years).

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THE CHALLENGE

The traditional approach to the installation of wind vanes involves several difficulties:

- The metallic met mast structure distorts the Earth's magnetic field when trying to orientate the wind vanes using a magnetic compass. In addition to such distortion, getting to know the precise magnetic declination for the specific installation site and the impossibility to detect the presence of certain minerals underground add even more uncertainty.
- Complex orography and vegetation preclude the possibility of moving far away enough to obtain the orientation of the booms either by means of GPS or a compass equipped with telescopic sight.
- Cultural and language barriers while dealing with local installation crews with no previous fieldwork experience installing meteorological met masts hinders the implementation of complicated orientation procedures.
- Harsh local weather conditions and remote hard-to-access location makes maintenance visits expensive and preferably avoidable.

THE SOLUTION

Using the Geovane MM designed and manufactured by Kintech Engineering for the precise measurement of the True North and the cancellation of the mounting offset of wind vanes.

Benefits

- Drastic reduction in the uncertainty of the wind direction measurement.
- Site-to-site consistency throughout countries and regardless of the local installation team.
- Easy to install. No need for on-site orientation of the wind vane.
- Direct interfacing with all data-loggers used for wind measurements.
- No need to worry about the met mast twisting or sensor booms bending, altering the wind direction measurements over time.
- The raw data of the wind vane is still available: no electrical interfacing between the wind vane and the Geovane.
- Zero maintenance costs.

LOOKING INTO THE CASE STUDY

Met mast installation instructions

The following instructions were given to the met mast installation company:

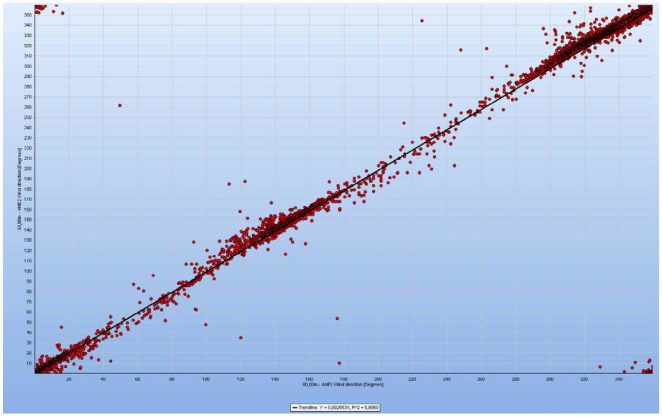
1. The boom for wind vane #1 should be installed at 78m above ground level and oriented to 30° with respect to True North. The zero of the wind vane (its "North mark") must be referenced to the boom and face the met mast structure, so that the wind vane is oriented to 30° + 180° = 210°.
2. The boom for wind vane #2 should be installed at 58m above ground level and oriented to 30° with respect to True North. The zero of the wind vane (its "North mark") must be referenced to the boom and face the met mast structure, so that the wind vane is oriented to 30° + 180° = 210°.

Note for wind vane #2.
Wind vane #2 will be supplied with a Geovane Metmast already coupled to it. Since the wind vane and Geovane Metmast has been pre-aligned by Kintech Engineering the unit (wind vane + Geovane Metmast) is therefore installed as a single unit. The output from the wind vane and the Geovane Metmast are connected to the respective channels of the data logger used.

The data

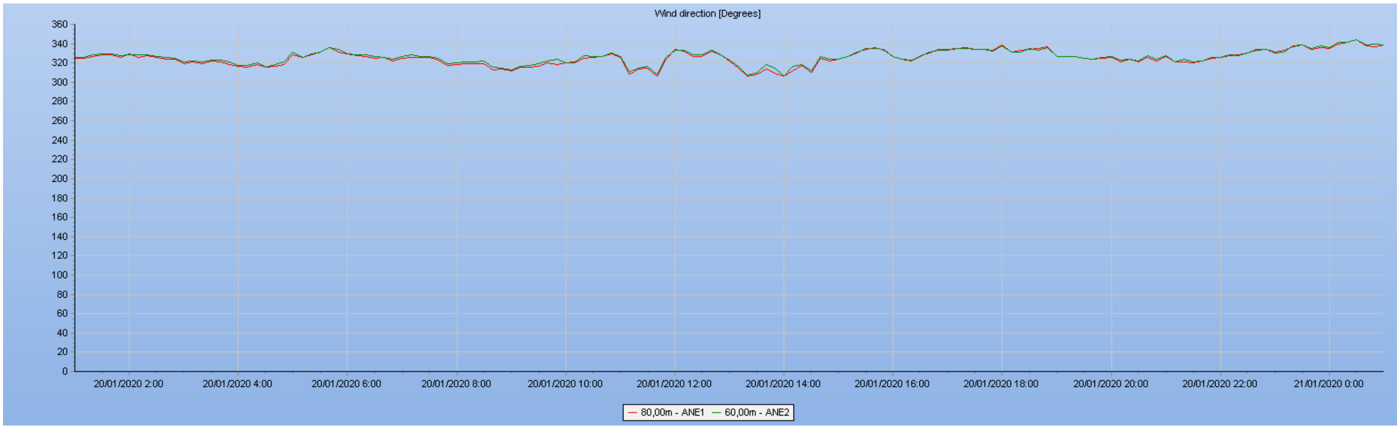
After a measurement period of 10 days, the data collected from the Geovane and the wind vanes are analyzed in order to draw the first conclusions.

Linear correlation between wind vanes:



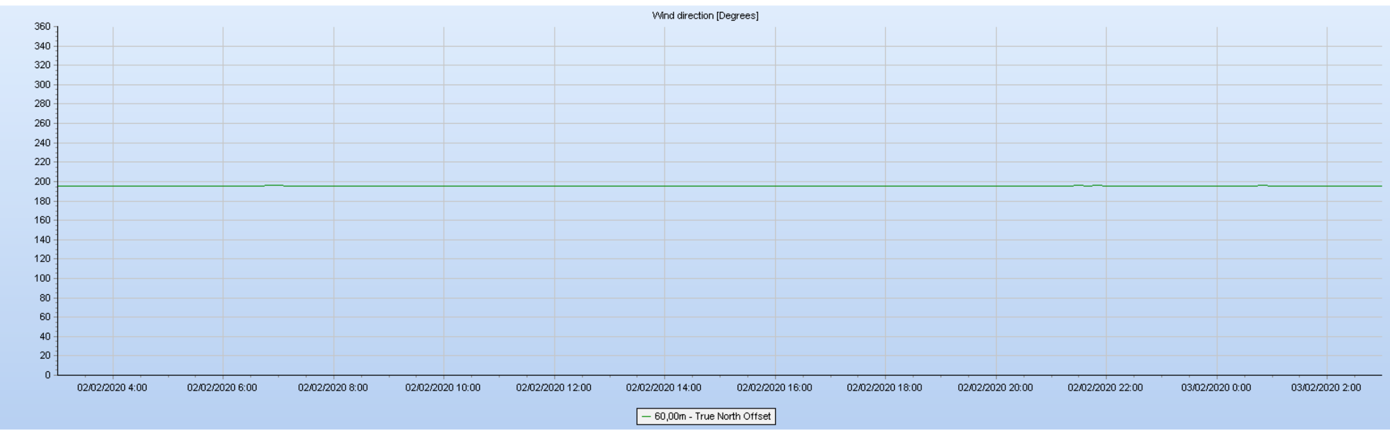
The linear correlation between the data from both wind vanes (unfiltered) allows us to verify that both transducers work correctly.

If we look at the 10-min data we see that there is no offset between wind vanes.



The absence of differences between the measurements of the two wind vanes may lead us to mistakenly think that the wind direction measurements are correct.

Once we have confirmed that the two wind vanes follow the same trend and measure practically identically, we turn to see the orientation data that the Geovane has been providing for this period.



The Geovane has been measuring an orientation of 195.8° from True North (geographic orientation). This means that the "North mark" of the wind vanes are not actually oriented to 210º, as indicated in the installation report, but to 196°. Thanks to the Geovane, the wind direction data can now easily be corrected and the wind analyst can carry out the correct wind farm layout knowing the true wind direction.

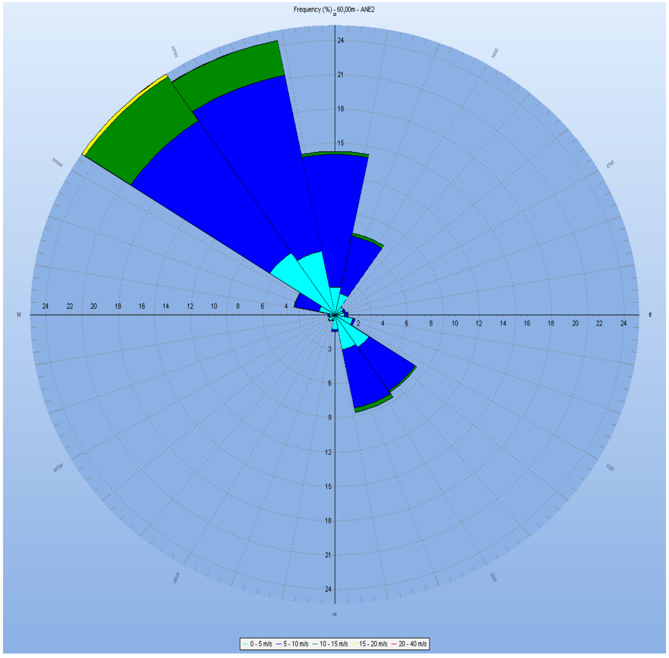
Two wind roses are shown here below:

On the left, the wind rose generated with the data collected from wind vane #2. This wind rose is wrongfully displacing the wind directions 14 degrees towards the north.

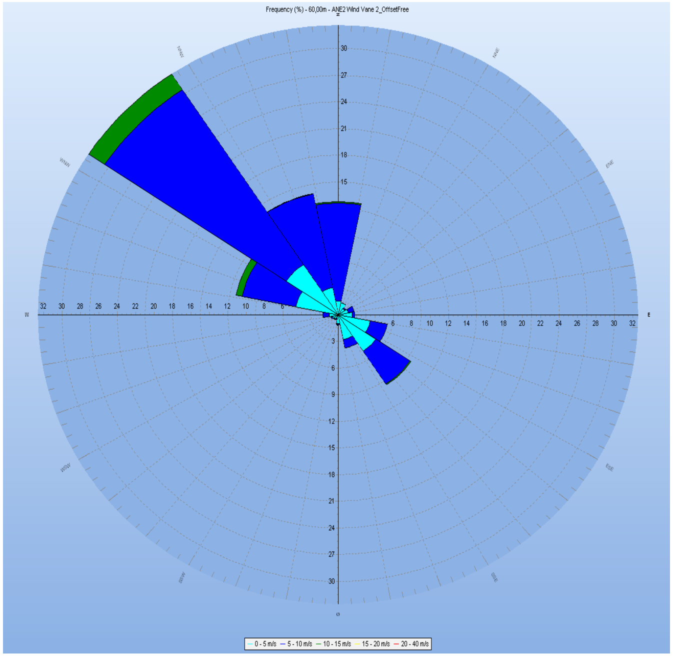
On the right, the authentic wind rose. This wind rose is generated after applying the True North from the Geovane to the raw wind direction data.

Important takeaway:

The wind rose on the left would have been considered correct if the Geovane MM had not been used in this project. The economic consequences of this are covered later in this case study.



Wrong wind rose (no Geovane)



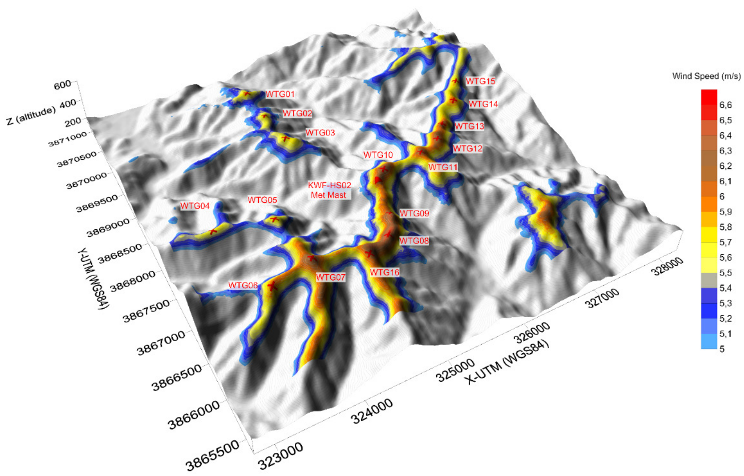
Real wind rose (corrected according to the Geovane data)

MICROSITING

In order to evaluate the economic benefits of using Geovane, the micrositing of the wind farm will be carried out assuming that no data from the Geovane is available. This is, with only the data from the wind vanes and the installation reports. Later on, the energy production will be calculated with the Geovane-corrected wind rose to assess the impact that the offset in the wind direction measurements would have had if no Geovane would have been used in the wind resource assessment campaign.

About the micrositing:

- According to the raw wind vane data and the installation reports, the prevailing wind direction would be between 315°and 337.5° (between the Northwest, NW; and the North-Northwest, NNW).
- With the data recorded by the anemometer at 80 meters high, a wind resource map is calculated using WindPRO (WAsP) and those areas in which the resource is optimal for the location of a wind turbine are determined.
- A wind turbine model is selected at random, in this case the Vestas V136 with 3.45 MW of unit power at 112 meters of hub height.
- The placement of the wind turbines within the available area is carried out keeping a minimum distance of seven times the diameter of the rotor (7D) in the supposed prevailing wind directions (previously indicated), and three times the diameter of the rotor (3D) perpendicular to the prevailing wind direction.



The final result is a micrositing of 16 wind turbines with a total power to evaluate of 55.2 MW.

Following with our example of a micrositing carried out based upon the false wind rose, the energy production is calculated for both the false and the true wind rose using the PARK module integrated within the tools that WindPRO features:

	Gross AEP (MWh/year)	Wake Losses (%)	NET AEP (MWh/year)	Capacity Factor (%)
False wind rose	192286.1	4.19	184229.7	38.10
True wind rose	190651.6	4.51	182053.2	37.65

AVOIDED CONSEQUENCES

The following summarizes what could have been the consequences of a 14-degree misalignment in the wind direction measurements for this specific project of 55.2 MW.

Underperformance

- Over-estimation of Annual Energy Production (AEP) of 2176.5 MWh.
- Increase of wake losses by 0.32%.

Wind turbine fatigue

The greater the wake, the greater the turbulence and therefore the probability of structural damage in the wind turbines increases.
Greater maintenance costs throughout the useful life of the wind farm.

Economic losses

Taking into account that during 2019 the average price of wind-generated energy in South Korea was 117€/MWh, the micrositing carried out based upon the false wind rose would have:

- Overestimated the economic benefits by 254650 euros per year.
- Overestimated the economic benefits by 5.1 million euros over the lifetime of the wind farm (20 years).

Moises Lee, Director of TQD Energia Co. Ltd

"The Geovane has allowed us to detect and correct an offset of 14 degrees in our wind direction measurements that would otherwise have been impossible to detect.

We always install two wind vanes and we were actually considering installing a third one, but after using the Geovane Metmast we have realized that the fact that there is no offset between the wind vanes themselves on a single met mast in no ways means either of the wind vanes are measuring correctly and therefore adding more wind vanes does not solve the problem. Instead, from now on, we will equip one of the wind vanes with Geovane."

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