PO.106

Interannual variability of the wind resource over Europe: overview and evolution over time

Marion Jude, Manuel Demazeux
Eoltech

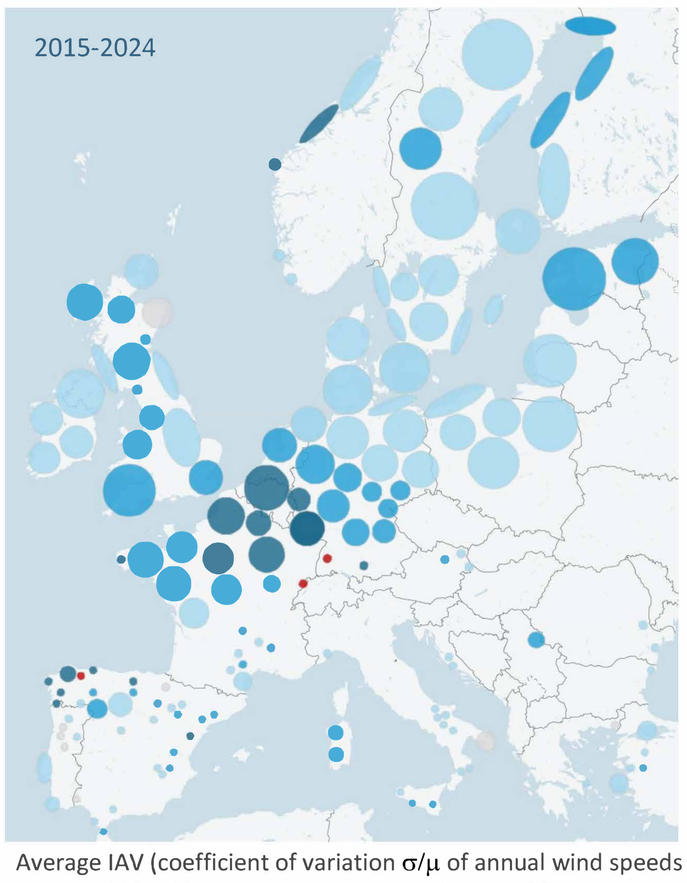
The IAV of wind speeds at hub height is usually overestimated by assuming a Gaussian distribution with a σ of 6%. But should we revisit this assumption?

CONTEXT AND METHOD

The objective of the study is to assess the Inter Annual Variability (IAV) of wind speeds over the main areas of wind power development across Europe, as well as the evolution of this variability over the past 20 years. The analysis leans on ERA5 wind data (100m high wind speeds) associated with 163 regional areas covering over 95% of the currently operating onshore wind farms in Europe. Each of these regional areas corresponds to irec index predefined regions i.e., areas with a consistent evolution of the wind resource over time (similar time variability within each area). Therefore, small regions correspond to locations with a very local wind regime (i.e. high probability of variation over short distances), whereas big regions reflect the fact that the wind regime is similar on large areas.

The interannual variability of wind speeds is one of the key points of the evaluation of the uncertainty linked to long-term prediction in the framework of energy yield assessments. Analysing this parameter allows to question the default value that could be usually considered and thus could help refine the process on a case-by-case approach.

IAV OVER THE PAST 10 YEARS



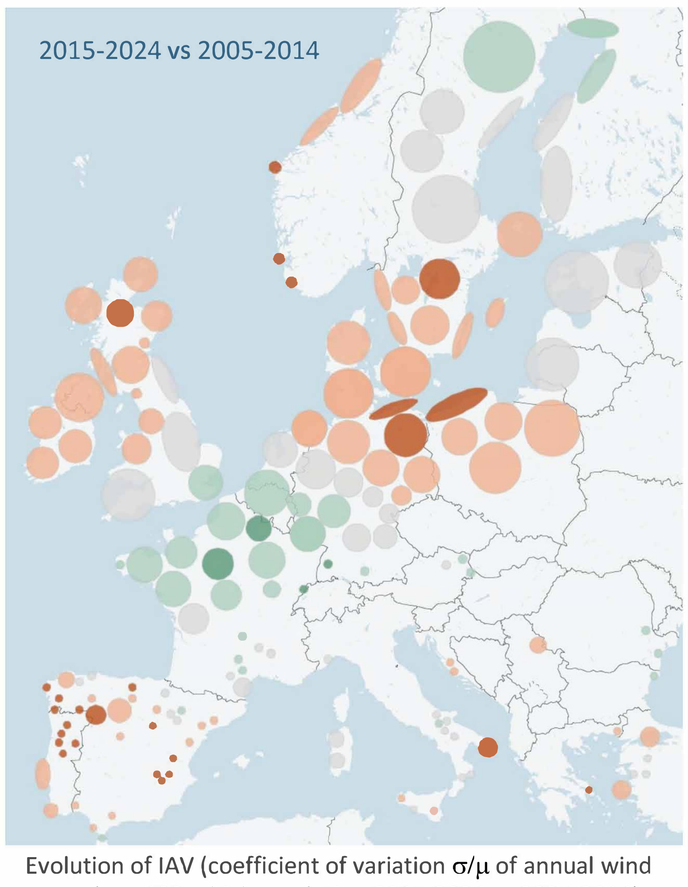
Average IAV (coefficient of variation σ/μ of annual wind speeds at 100m high, average value over the past 20 years)

2% 3% 4% 5% ≥6%

For most of the studied regions (98% of them), the observed value σ/μ is below 6% and actually ranges between 3% and 4% for half of the studied regions.

On a global scale, the 3 to 4% value was found for most areas of wind farm development worldwide, and 2 to 3% is even observed in numerous areas (NorthEastern part of the USA, South Africa or Japan).

EVOLUTION BETWEEN TWO DECADES



Evolution of IAV (coefficient of variation σ/μ of annual wind speeds at 100m high, evolution 2015-2024 vs 2005-2014)

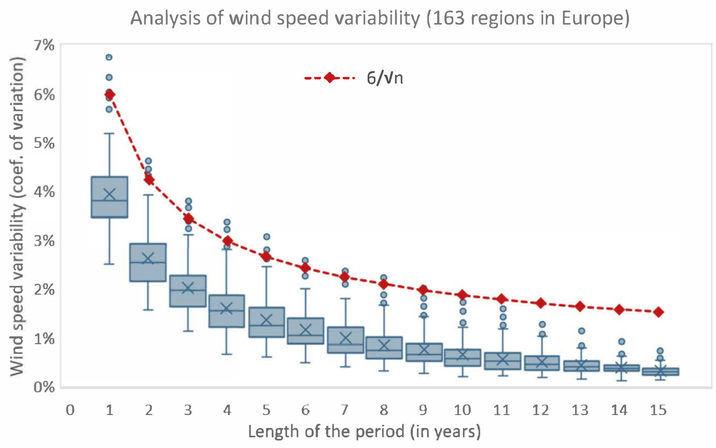
-2% -1% Stable +1% +2%

The interannual variability has increased for most regions in France and has globally decreased in the UK, around the Baltic sea and for most regions in Spain and Portugal.

The median σ/μ value is lower on the most recent decade compared to the previous one (3.4% vs 4.0%). However, even on the decade 2005-2014, it remains below 6% for 93% of the regions.

SO, WHAT ABOUT 6/√n?

The figure below presents the distribution of the coefficients of variation of the wind speeds for the 163 regions, depending on the length of the period considered. The 6/√n model is also displayed on the figure (default assumption for uncertainty on long-term prediction linked to wind resource variability).



Based on ERA5 reanalysis data at 100m high, the 6/√n model seems globally quite conservative, except for a few regions where periods below 8 years are considered. For a 10-year duration, a median value of 0.6% is observed on the sample of 163 regions whereas the 6/√n leads to a value of 1.9%. The coefficient of variation is even below 1.4% for 97% of the regions, and below 1% for 87% of the regions.

CONCLUSIONS

As a reminder, the present analysis leans on wind speeds issued from ERA5 reanalyses data at 100m high and a cross checking with on-site measured data would be interesting. With a few rare exceptions, we find that a σ of 6% overestimates the actual wind speed variability close to hub height. Consequently, the uncertainty on resource variability based on the 6/√n seems quite conservative. For a 10-year period, an uncertainty of ±1.5% could be relevant as it is slightly higher than the variability observed and thus should cover a risk of evolution on the next decade. Regarding longer periods (i.e. >15 years), the traditional model assuming a decrease of uncertainty as the duration of the period increases should be questioned in a context of climate change: is it really less uncertain to consider 15 or 20 years than 10 years from now?

Wind EUROPE ANNUAL EVENT 2025 COPENHAGEN 8-10 APRIL

windeurope.org/annual2025
#windeurope2025

Watch this presentation

Download the poster