Improving a probabilistic icing risk forecast system for wind farm operation

Rémi Dupont[1, 2]

1. Valemo, Bègles, NOUVELLE-AQUITAINE, France

2. Meteo france, Toulouse

The installed cumulative wind capacity in regions prone to icing conditions across Europe, North America and Asia was around 119 GW at the end of 2020 and will reach 163 GW for 2025 [1]. But icing may significantly influence energy production. Instrument and turbine manufacturers may have cold climate solutions available that decrease production losses due to icing and increase safety. However, these solutions are expensive and not 100% effective. To address this issue, VALEMO, a French company specialized in the operation, maintenance and supervision of renewable energy farms, participates in collaboration with Météo-France and the National Centre for Meteorological Research (CNRM) in the development of an icing forecast model on wind turbine blades: WIRE (Winter Risks for Energy). Initially dedicated to the ice and snow accretion forecast on power cables [2], WIRE was extended to icing forecast on wind turbine blades. The accretion model used in WIRE is based on state of the art accretion modelling, in particular on Makkonen's work [3]. WIRE uses atmospheric fields of the AROME ensemble prediction forecast (PEAROME) as input parameters in order to develop a probabilistic forecast of snow and ice accretion on power cables and wind turbine blades. Icing accretion risk maps are produced daily and updated 4 times a day. In 2020, a melting module has been integrated in WIRE to forecast icing event from beginning to end. Snow accretion forecast has been accurately evaluated on power cable thanks to an experimental campaign led on a Météo-France test site. Results were encouraging with a good detection rate of 80% and a false alarm rate around 7,5% during the winter 2019/2020 [4]. The melting module has also been evaluated and a good agreement with the observation data has been observed, with a good representation of the melting diurnal cycle. However, accretion and melting modelling on wind turbine blades need to be further validated with observation data from wind farm operators. A thesis started in autumn 2021 aims at improving icing forecast abilities for wind farms operation. The AROME model, as many others, is known to underestimate the liquid water content in cold clouds, the simulated cloud phase transitions to ice too often and too fast. The main objective is to improve the whole system, focusing first on the AROME model, to improve AROME's ability to predict supercooled liquid water, then adapting/improving the WIRE system taking advantage of the improved AROME outputs, and eventually developing a real probabilistic forecasting chain, accounting for uncertainties in all components of the system. Thus, this tool could help wind farm operators to determinate the best strategy to limit mechanical loads due to ice accretion and optimize wind turbines restart when the ice has completely melted.

1. [1] : IEA Wind TCP Task 19 – Cold Climate wind market study 2020-2025
2. [2] : Bouilloud. L, Forecasting of winter phenomena impacting the energy sector
3. [3] : Makkonen. L, 2000, Models for the growth of rime, glaze, icicles and wet snow on structures
4. [4] : Dupont. R, 2020, Modélisation de l'accrétion de givre sur les pales d'éoliennes.