Development of a DLR solution based on data calibration from weather stations

The climate change, the network aging and the development of renewable energies have prompt the French TSO, RTE, to invest more and more on flexible solutions for line ratings.
Dynamic Line Ratings (DLR) are now currently used at RTE to increase the power flow of its lines and get more operational efficiency as well as limit investment compared to transmission line construction or retrofit projects. Several technologies exist and have been tested in the last few years. It appears that getting conservative line rating values with few equipment on a given line is a major challenge.

DLR from weather stations

In 2018, an experimentation was done in the South West of France in order to calculate the cable temperature next to a specific structure with different kind of technologies: thermocouple temperature sensor (used as reference), DLR sensor, global weather data and weather station. The result of this experimentation concludes that the weather station was the most accurate to calculate the cable temperature and thus, ampacity of that particular section. What is more, it showed that weather data correction thanks to the weather station has significantly reduced errors on the ampacity calculation.

Since then, a second experimentation has been launched to check if it would be possible to extend dynamic line rating calculation for an entire line from weather forecast beforehand calibrated with several weather stations installed all along the power line during at least two years.

A two years data acquisition from local weather stations

In December 2021, three power lines localized in the same area (North of France) have been selected to install twenty weather stations, fixed directly on the structure, under the phase cables. The correct spacing between devices is for now unknown, that is why it has been decided to have at least one weather station every five kilometers.

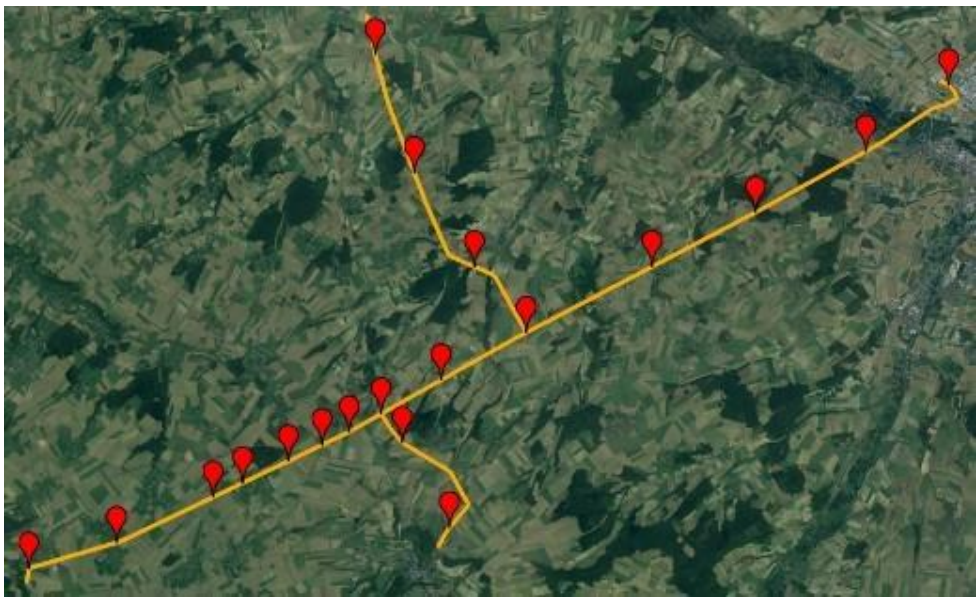

Figure 1: location of the weather stations

Each weather station is equipped with anemometer, temperature and solar radiation sensors in order to measure weather data each minute during two years. Data is transmitted by the 4G network.

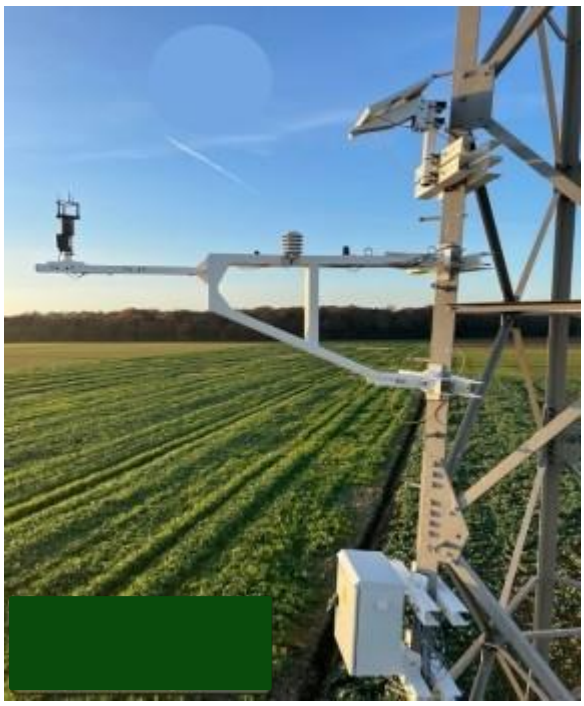

Figure 2: weather station fixed on a structure

Ampacity calibration and validation of the solution

After two years, the stations will be removed and a machine learning on the data acquired will be done in order to calibrate the ampacity calculated from the weather forecast and sharpen the forecast model in real time. These will be used to calculate every five minutes dynamic line ratings used by operations. The true challenge will be to find on one hand the correct method to calculate higher ampacities than the current Static Line Ratings (SLR) when the weather conditions are favorable; and on the other hand, to be conservative enough to almost never have risky situations. The wind measures will probably be the key to have a satisfactory result.

To check if the calibration is efficient enough, the ampacities calculated from the weather forecast will be compared to values determined by DLR sensors already installed on these power lines. Topographic surveys can be used to complete the validation. First results are expected in 2024.

An analysis will be done on the minimum distance required between two weather stations in order to control the uncertainty on line ratings values.

Besides having more accurate weather forecast and ampacities calculation, one of the most interesting vantage of this solution is that the weather stations can be used for other power lines after the two years data acquisition. That turns this new solution very economic for reasonably gains on line ratings in real time.

To raise profitability, the weather stations could be used to calculate immediately after the installation dynamic line rating in real time during the two years data acquisition phase.