Anemos.Rulez: Prediction of severe ramp events

- Accurate prediction of severe ramp events
- High configurability to meet end users ramp definition
- Export of Warnings and alerts in XML and RSS
- Set up for TSOs SONI, EirGrid and PPC
- Cut-off event predictions

Motivation

The increasing penetration of unscheduled fluctuations due to wind power production presents a major challenge to ensuring grid stability for the coming years. In recent years, this challenge has been tackled partly by the development of tools for accurate wind power prediction (wpp). The focus of this work was to forecast the power production with a minimized average statistical error (e.g. mean absolute error or root mean square error).

Under high penetration conditions, achieving a low average prediction error is not sufficient to ensure grid stability. Single extreme events, such as a ramp event caused by a rapid in- or decrease in the average wind speed (see figure 1), or cut-off events due to very high wind speeds can temporarily lead to very high prediction errors, which severely endanger the grid stability. An increasing share of wind power in the grid even increases the frequency and impact of these events significantly. Today, therefore the prediction of extreme events has to be given attention to ensure grid stability.

Ramp prediction with Anemos.Rulez

With Anemos.Rulez, Overspeed developed a flexible module for the prediction of extreme events. The definition of a ramp event can be very different for each transmission operator due to different characteristics of their technical and business environment. Therefore Anemos.Rulez offers a high configurability to meet the customers needs and allows on-line editing of its configuration by the end user. Anemos.Rulez detects extreme events and issues alarms for upcoming events. Based on the latest weather predictions and wind farm information predictions are calculated with a wpp model specialised for extreme events. Upcoming events are notified by an alarm, e.g. as XML or via RSS.

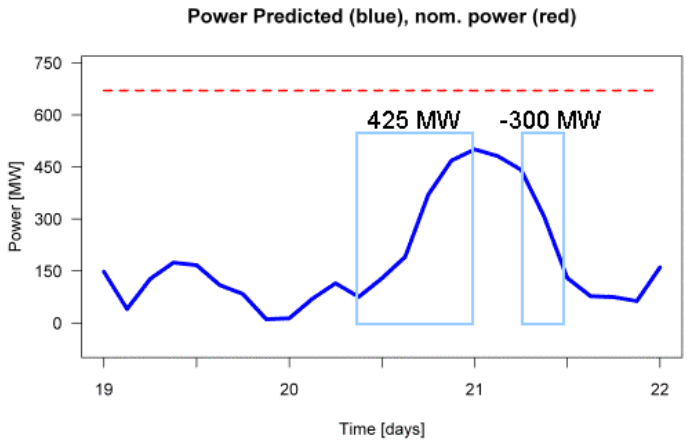

Figure 1: Prediction of two upcoming ramps by Anemos.Rulez with an expected power increase of 425 MW and decrease of 300 MW

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Ramp events

Ramp events are specified by a threshold and time frame. For the detection of extreme events Anemos.Rulez analyses the latest wpp time series. Figure 2 illustrates the approach for the ramp detection. Within a sliding time window min-max values of the time series are determined and the expected change is checked against the specified ramp threshold. If the threshold is exceeded, an alarm will be issued.

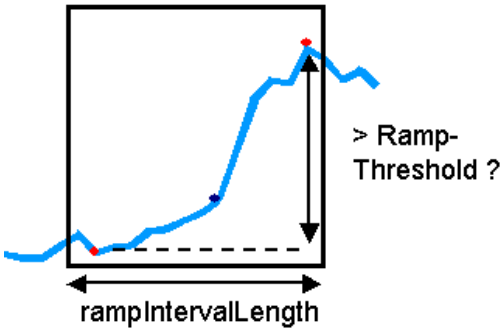

Figure 2: Example of a ramp event detected by Anemos.Rulez. The parameters applied for the detection are the change of power (=RampThreshold) within a given time frame (=rampIntervalLength).

Accuracy

Anemos.Rulez has been developed and evaluated within the SafeWind project. The module has been set up for several wind farms and aggregations in Ireland (SONI and EirGrid) and Greece (PPC). The evaluation target was to forecast the severest ramps (50 - 100 per year). The predictions have been evaluated by calculating the forecast accuracy and ramp capture. Figure 3 shows some results of the SONI test case. Anemos.Rulez runs operationally since 2011 for the Australian market operator AEMO.

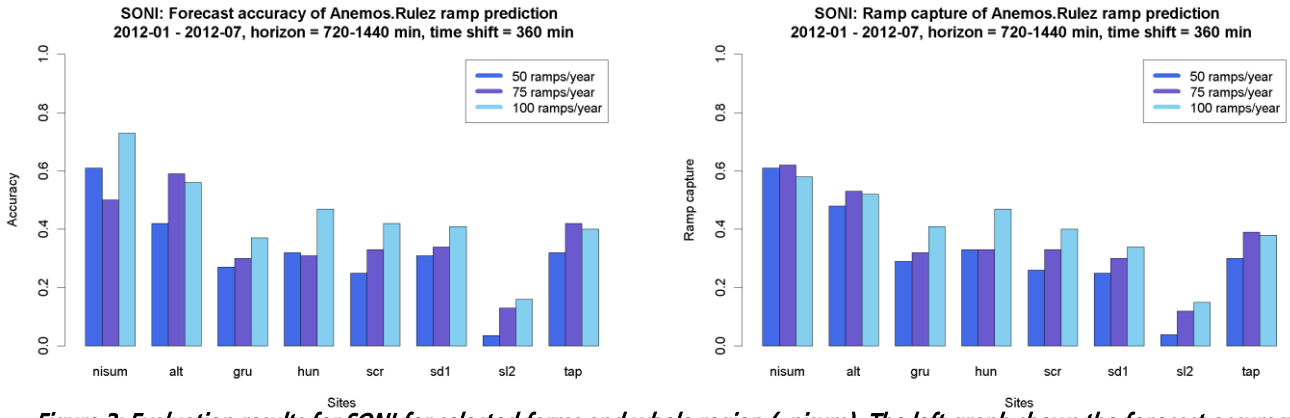

Figure 3: Evaluation results for SONI for selected farms and whole region (=nisum). The left graph shows the forecast accuracy of the predictions (= share of correct forecasts). The right graph shows the ramp capture of the predictions (= share of predicted ramps).

Further work

Currently a module for the prediction of cut-off events based on wind speed and gust predictions is developed. To further improve the ramp predictions methods from computational intelligence will be evaluated.

Related publications

H.-P. Waldl, P. Brandt: „Anemos.Rulez: Extreme and ramp event alarming to support stability of energy grids “, proceedings of the Deutsche Windenergie-Konferenz (DEWEK), Bremen, 2010

H.-P. Waldl und P. Brandt: "Anemos.Rulez: Rule Based Extreme Event Prediction and Alarming to Support the Integration of Wind Power", International Conference on Intelligent System Application to Power Systems (ISAP), Crete, 2011