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Anemos.Rulez: Extreme Event Prediction and Alarming to Support Stability of Energy Grids

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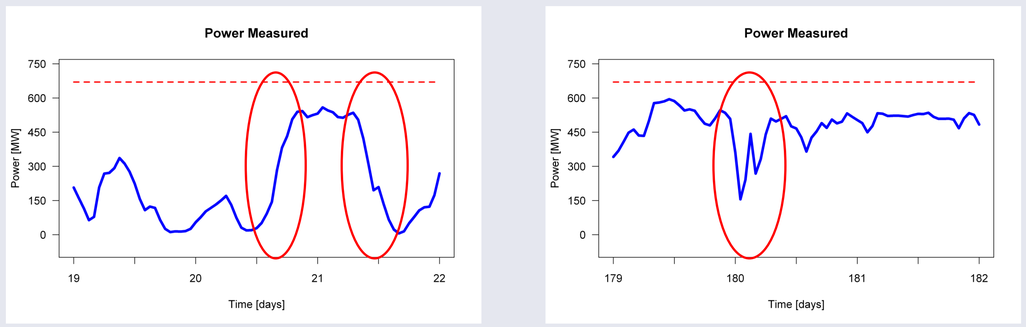
Abstract

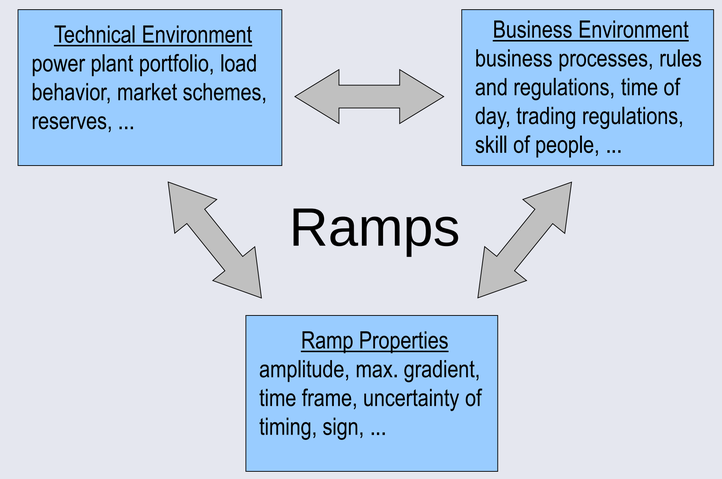
Due to the increasing, world-wide penetration of wind energy, it has become necessary to complement daily, operational wind power predictions by providing alarms for extreme events such as a sharp increase in wind power production or cut-off events. As there can be no universal definition for ramps caused by extreme events, we describe algorithms and parameters for their definition and factors that influence these parameters. A tool for extreme event predictions, Anemos.Rulez, will be presented, including evaluation results from an application test case.



Ramp events causing rapid changes in the power production due to changes of the weather conditions (left) and cut-offs (right).

How to define a ramp?

The types of events requiring special attention depend on the technical and business environment of the TSO:

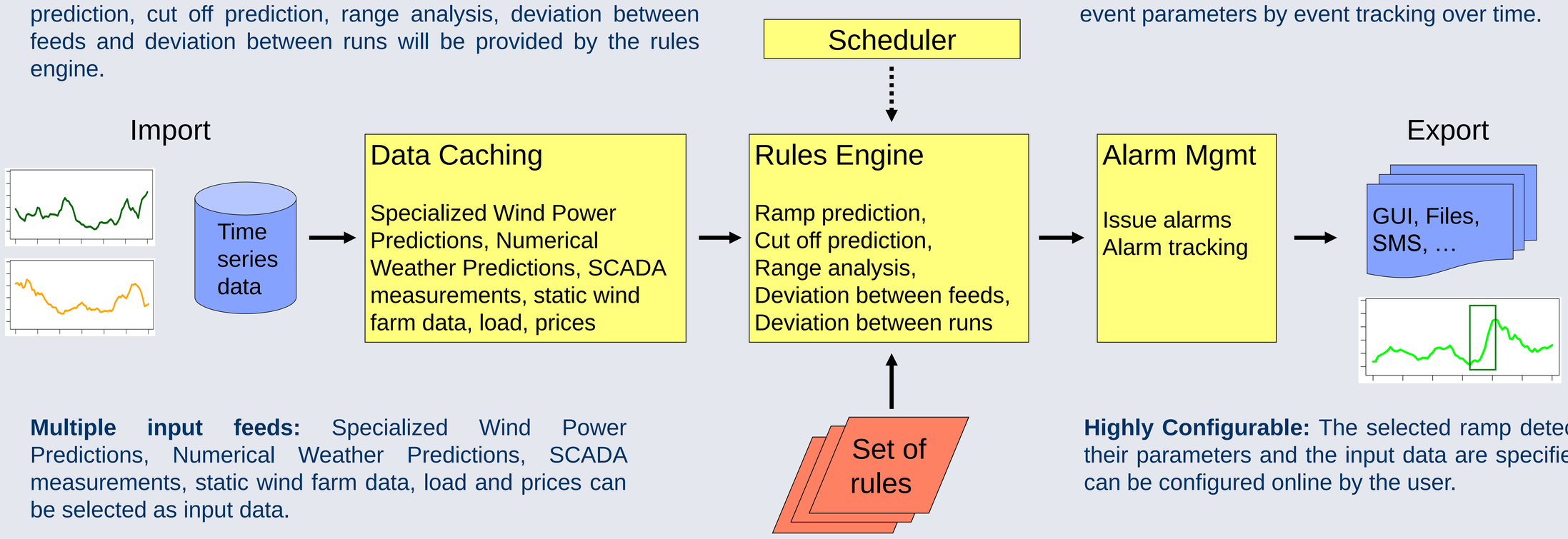


→ Each TSO and application has an individual definition of extreme events.

Anemos.Rulez: Rule-based tool for extreme event prediction and alarming

Variety of methods for extreme event prediction: Ramp prediction, cut off prediction, range analysis, deviation between feeds and deviation between runs will be provided by the rules engine.

Alarm management: Issuing of alarms and updating of event parameters by event tracking over time.



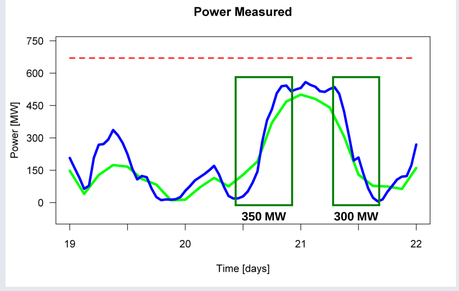
Multiple input feeds: Specialized Wind Power Predictions, Numerical Weather Predictions, SCADA measurements, static wind farm data, load and prices can be selected as input data.

Highly Configurable: The selected ramp detection methods, their parameters and the input data are specified in rules that can be configured online by the user.

Results

Evaluations of the ramp prediction for a region in Northern Ireland with different wind power prediction models as input.

WPP model	NWP model for WPP	Hits	Misses	False forecasts
Model 1	Skiron	19	12	10
Model 2	BMO	11	20	22
Model 3	BMO	12	19	16



→ The selection of the Wind Power Prediction (WPP) model and the Numerical Weather Prediction (NWP) model strongly influence the accuracy results.

Current Wind Power Prediction models are optimized for low **average** errors. The RMSE optimization therefore acts to decrease the amplitude of the predicted values, which however is of special interest of the extreme event prediction.

→ Providing a Wind Power Prediction model optimized for extreme events will further improve the prediction accuracy.

Conclusions and Outlook

Conclusions:

- Prediction of extreme events is needed to ensure future grid stability.
- Definition of extreme events differ for each practical application.
- Highly configurable tool is needed.
- Various detection methods and parameters are needed to cover different types of extreme events.
- A wind power prediction model specialized for extreme events will improve the extreme event prediction accuracy.

Outlook:

- Additional detection methods will be implemented (e.g. specialized cut-off predictions).
- Investigate advanced data mining methods for ramp prediction such as support vector mashines.