WEPROG High-speed
Shut-down warning system
for extreme events

PRESENTATION
ESIG Forecasting Workshop
2018
St. Paul, MN, USA

WEPROG
Weather & Energy Prognoses

About **WEPROG**

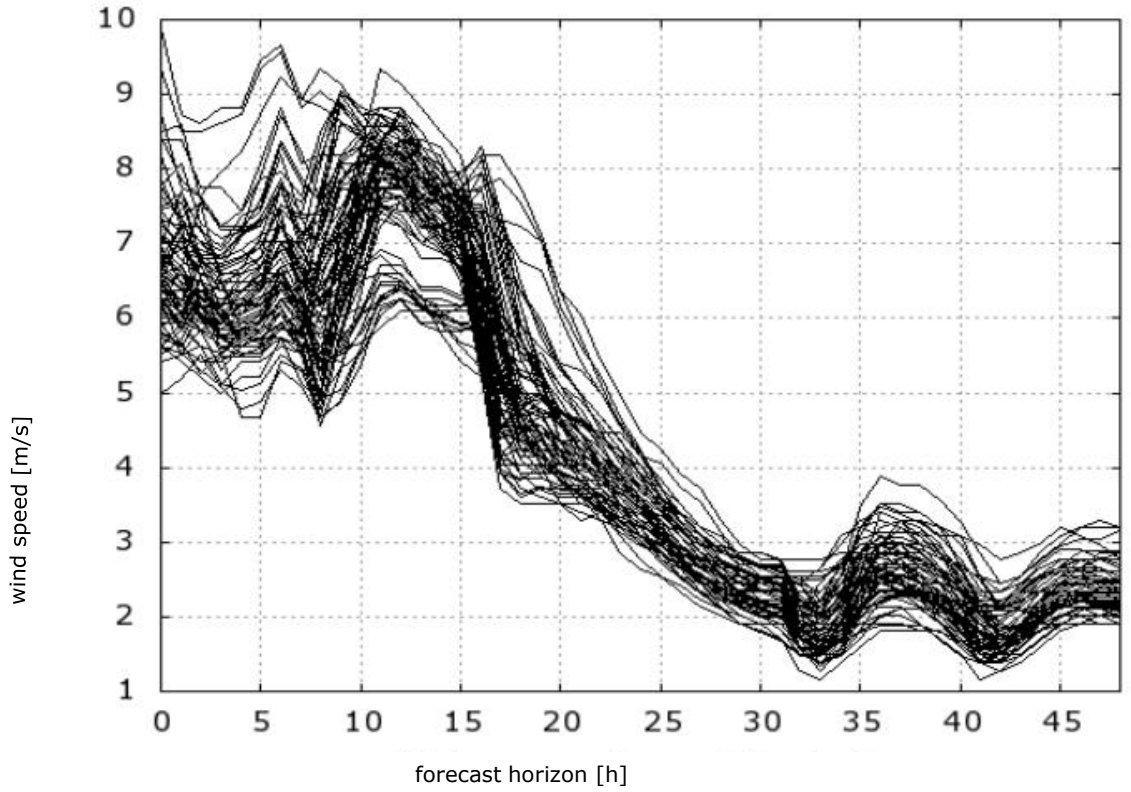
First comr … Europe in 2003!

WEPROG's … oses.

We provide … ncy & sustainability from the u…

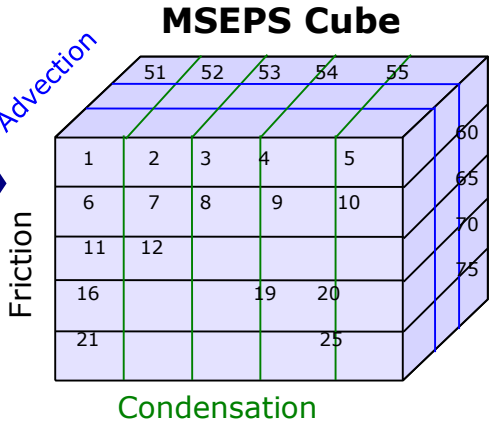
WEPROG o… 3 countries for **maximum… s production.**

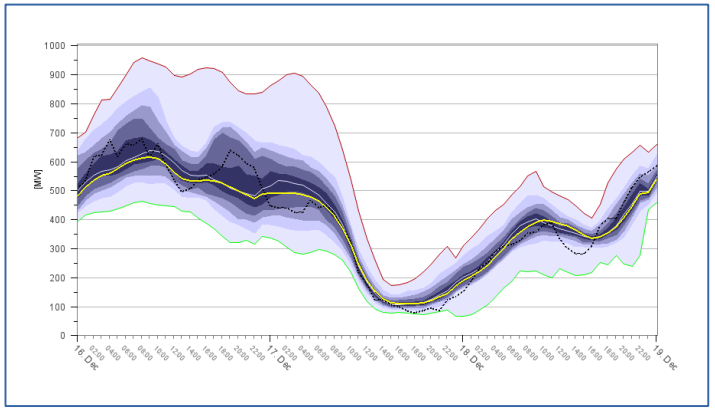
Real-time … up to 180 … .2,18 UTC and



…tic weather, wind & …olar power forecasts

Global Analysis (State Estimate)





When the penetration level increases....

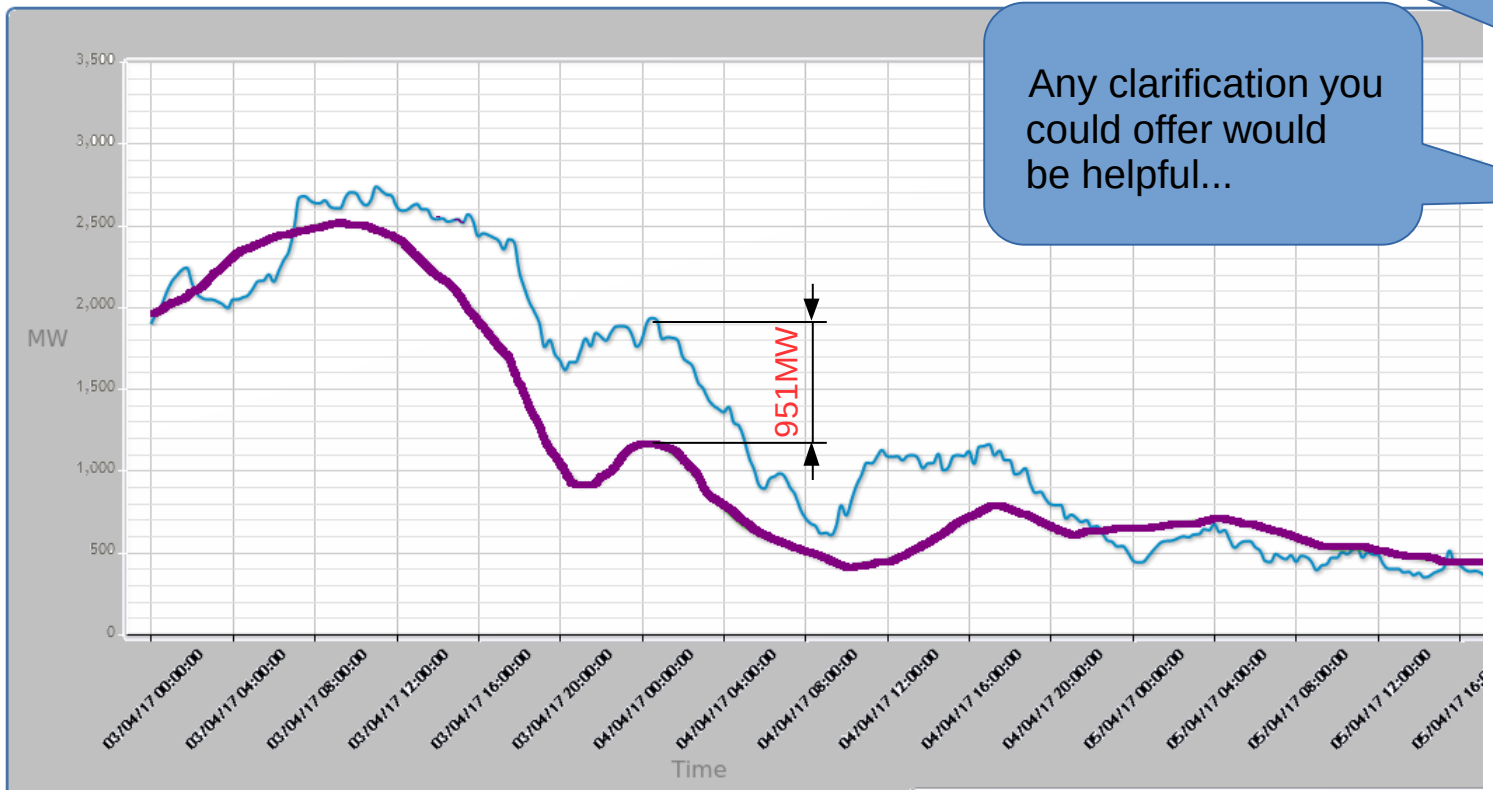
... deteministic information becomes insufficent...

Questions from an operator working with 1 forecast...

What was the weather Situation at the time and would this have caused the error?

Does the actual value lie within the confidence bands of your model?

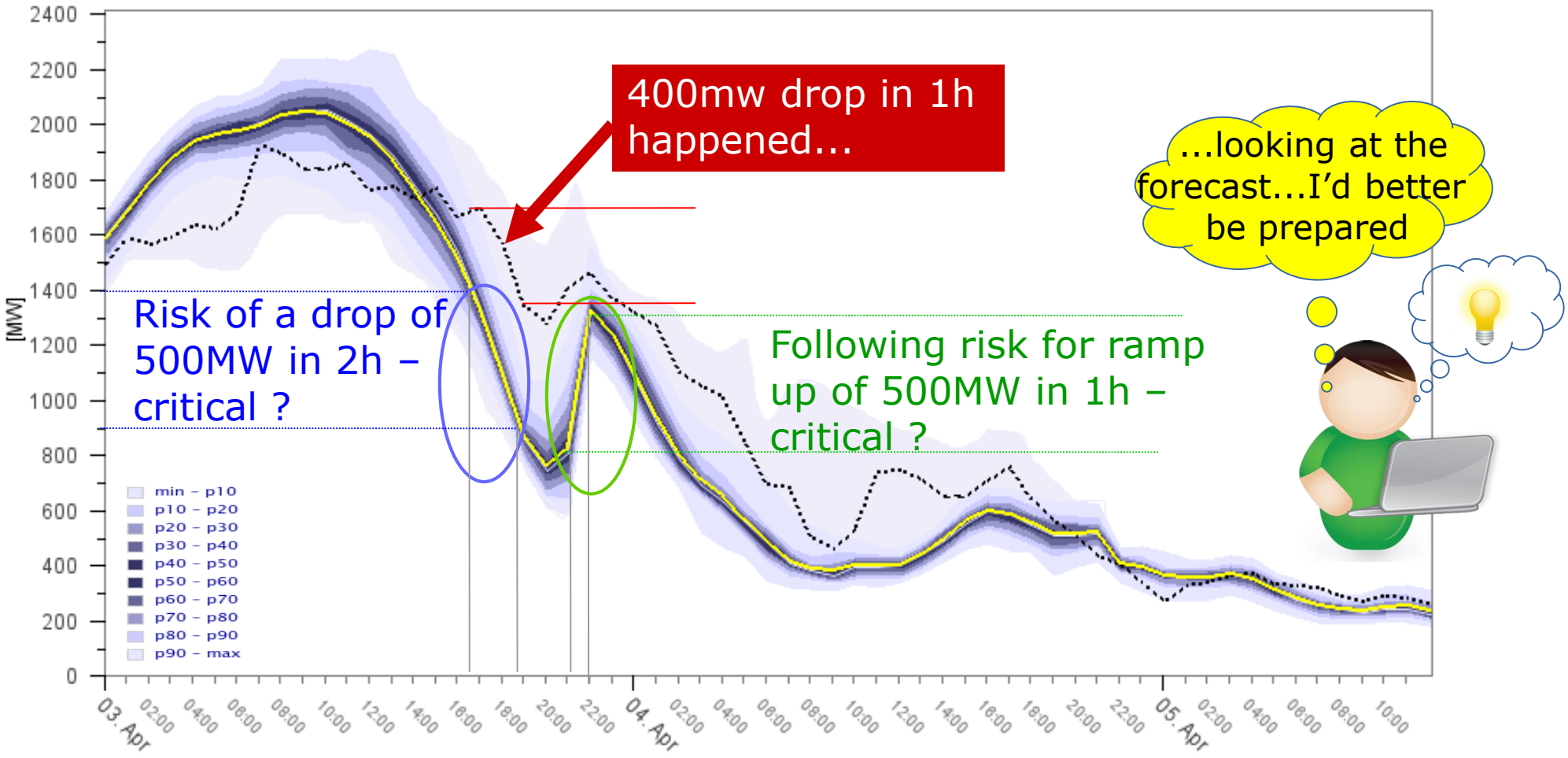
Any clarification you could offer would be helpful...



Forecast off with 950MW over-prediction at 22 hours in a grid with 4500MW peak demand

Knowing risks in advance from uncertainty forecasts provides confidence and security

- high uncertainty in the evening with low demand!
- possible extreme event with large forecast error



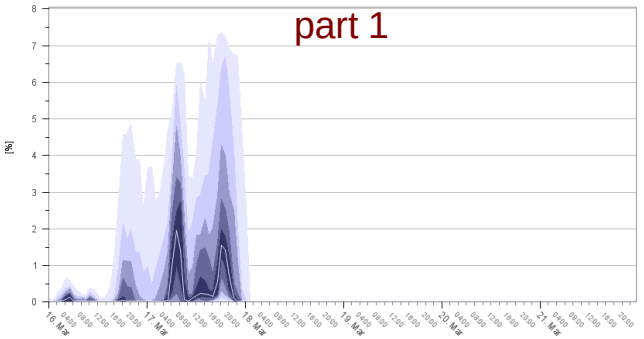
Warning System: 3-component Module (MSEPS-HSSDA)

WEPROGs warning system contains 3 components:

(1) **Probability of the expected cut-off capacity**
In cooperation with the end-user the system critical part of the capacity will be determinded (e.g. 30% of the capacity)

(1) **Accumulated part of the expected cut-off capacity**
This component provides the accumulated cut-off probability of the expected temporal shortage of capacity and ramps

(1) **Table of the information of** (1) and (2) for the more detailed analysis and action planning



Probabilities of the expected cut-off capacity

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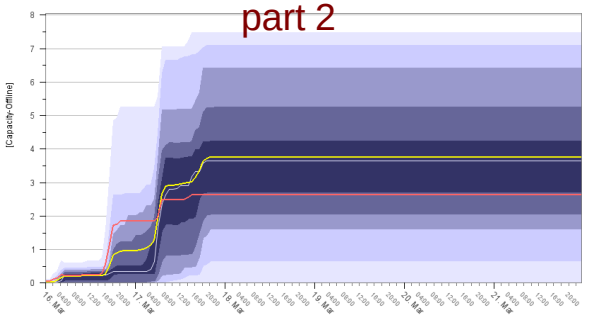

Accumulated probability of the cut-off capacity and long-term shortage of capacity

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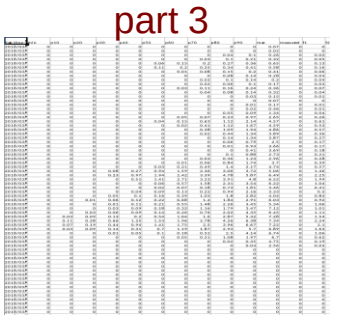


Table with detailed information of part 1+2

High speed shutdown events Setup

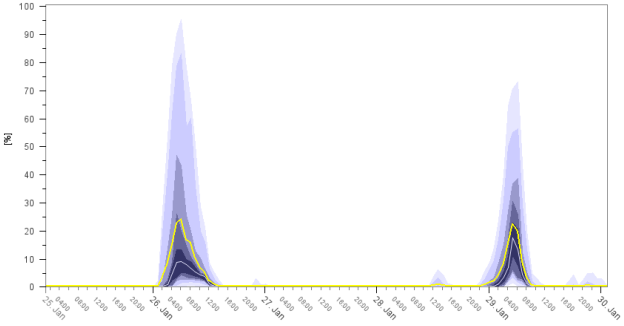
Communication is crucial for the interpretation of the probability for a certain event to take place

The information needs to be visually accessible and easy to interpret
--→ the operators need to be able to “read” probabilities !!!

Establish Guide lines
+
Training and Analysis

Warning examples...

10% probability of a 50% high-speed shut-down
5% probability of 90% shutdown
90% probability of a 10% shutdown



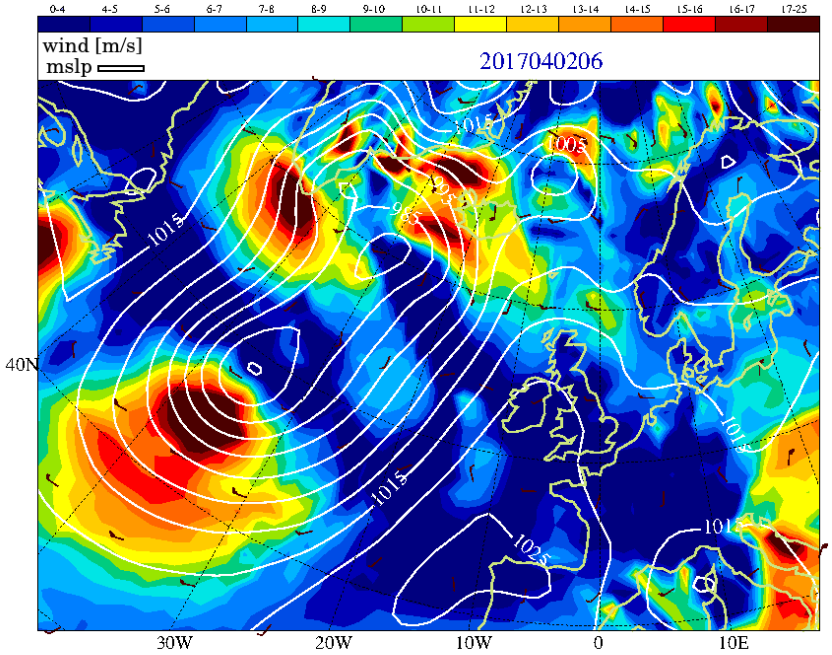
BACKGROUND INFORMATION OF EIRGRID GROUP

Wind Generation in Ireland

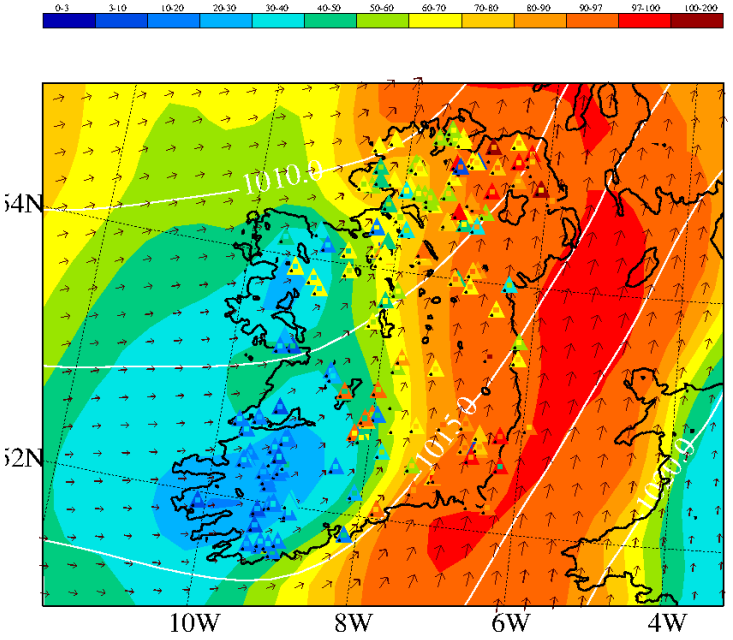
- **High penetration of wind** (all-time peak demand 5000MW)
  Installed MEC > 3600 MW (All Island) | MEC >2800 MW (Ireland)

Challenges:

Weather



Wind Parks Distribution

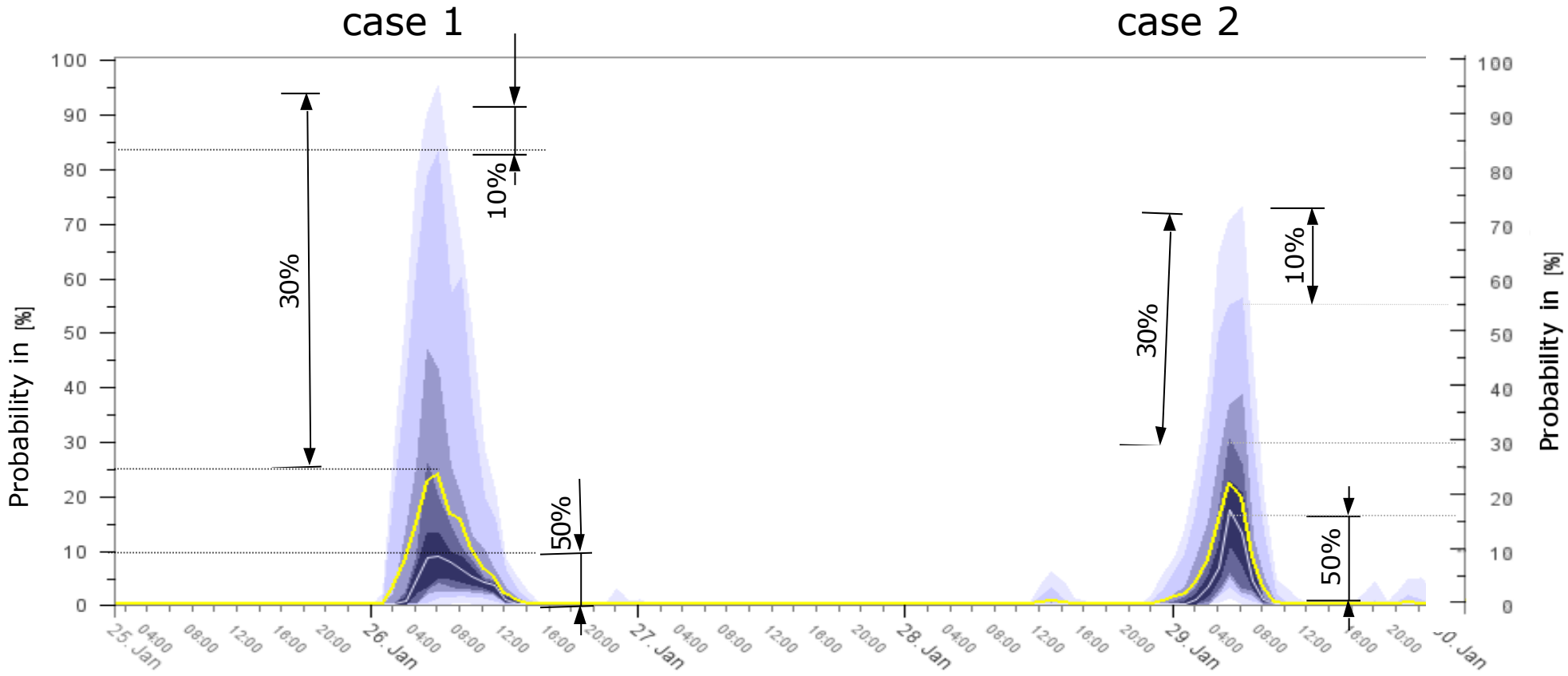


Electric grid

Statistics winter 2017-2018: 20 cases
(October 2017-April 2018) 42 warnings

High speed shutdown events

Definitionof the critical amount of cut-off is crucial for the interpretation of the probability for a certain event to take place



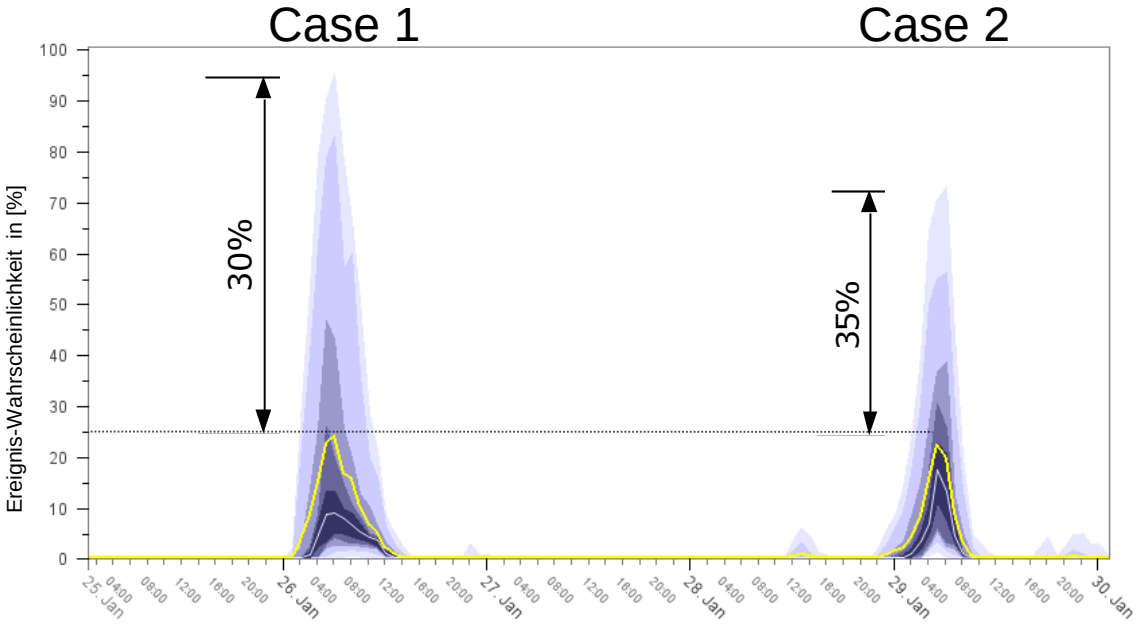
The dilemma: ….interpretation of and action plan from the information …

Examples for case 1:
10% probability of >84% cut-off
30% probability of >25% cut-off
50% probability of >10% cut-off
90% probability of ~5% cut-off

Examples for case 2:
10% probability of >55% cut-off
30% probability of >30% cut-off
50% probability of >16% cut-off
90% probability of ~5% cut-off

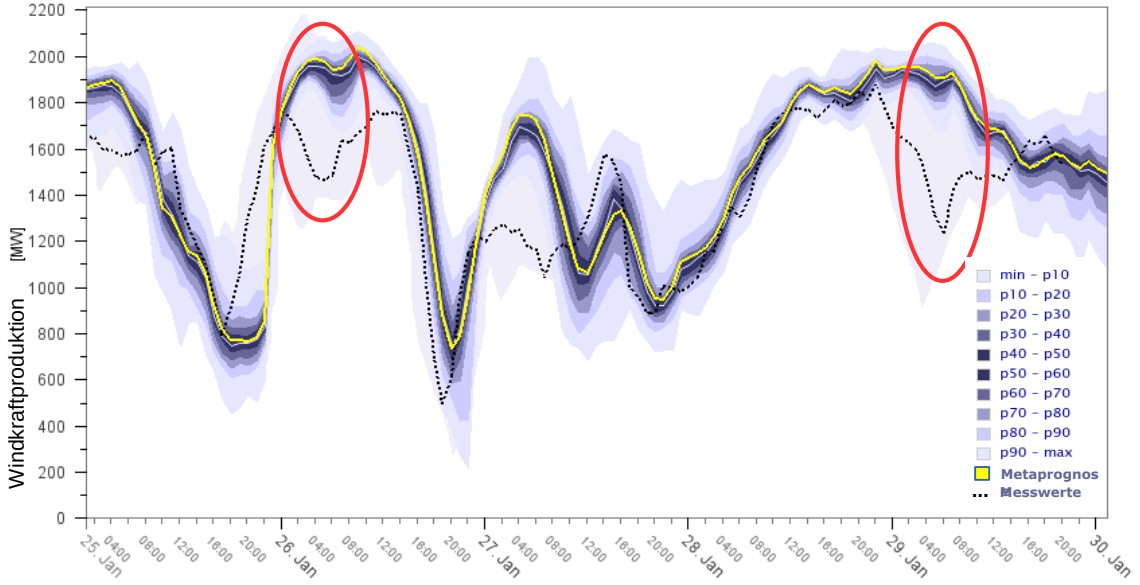
Example: Shutdown in 2 consecutive high-speed events

Definition for Alarm: warning at shut-down risk > 25% of production over 2 run cycles



Care 1:
30% Probability of >25% Cut-off
(P90-P60)

Fall 2:
35% Probability of >25% Cut-off
(P90-P55)

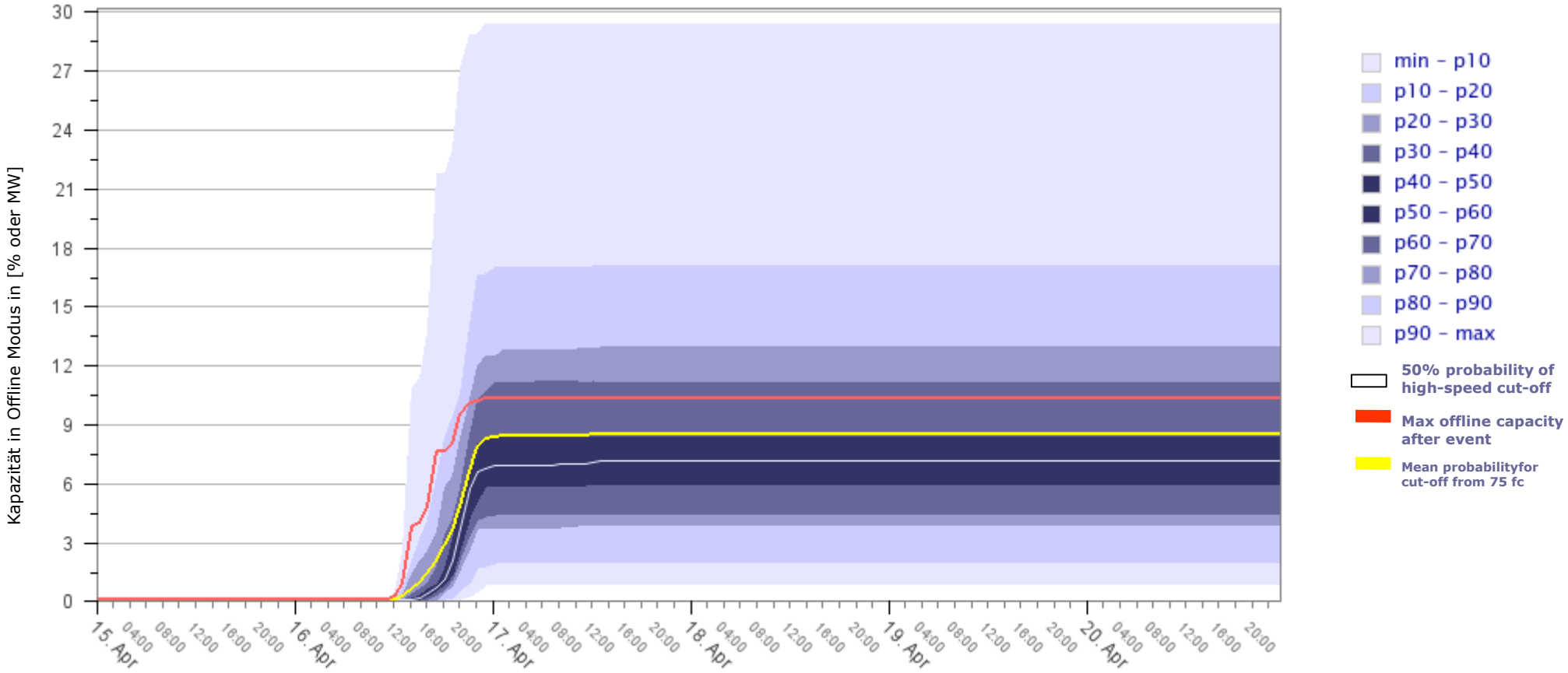


Result of actual cut-off scenario:

Case 1: 25% peak cut-off

Case 2: 35% peak cut-off

1. Enhancement: Temporal Accumulation of shut-down capacity



Main information made visible:

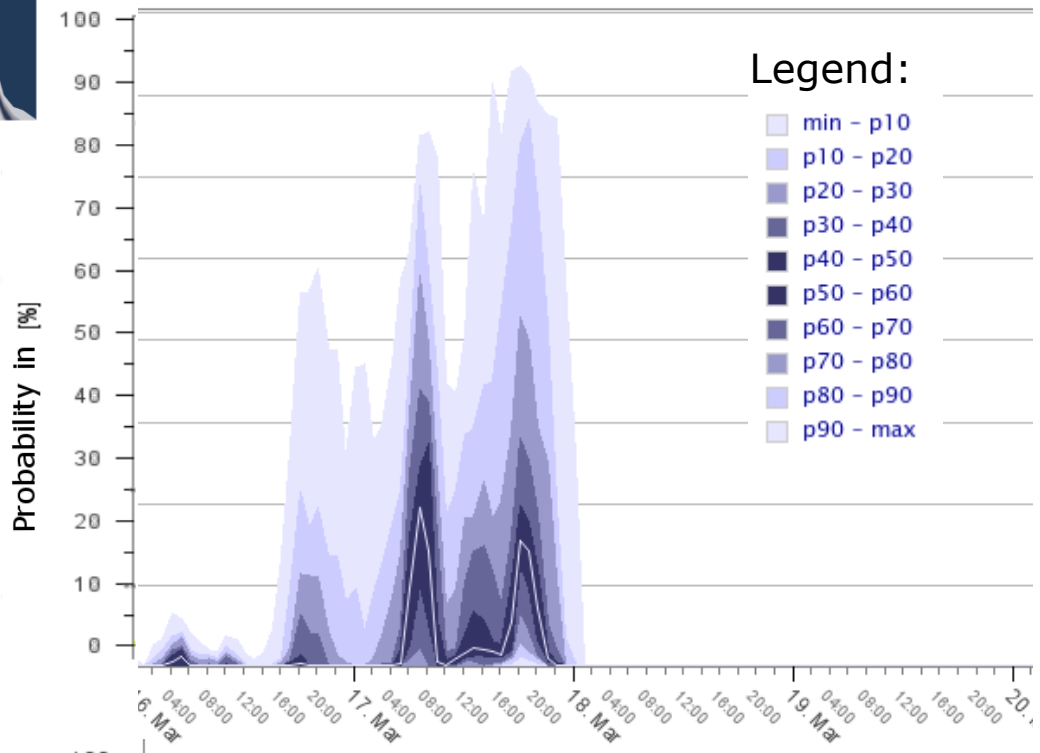
1) Accumulated capacity of a high-speed event in probability space

1) Ramp effect can be seen clearly and is part of the warning

1) Maximum-Minimum provides required reserve capacity

A typical cut-off event over 2 days

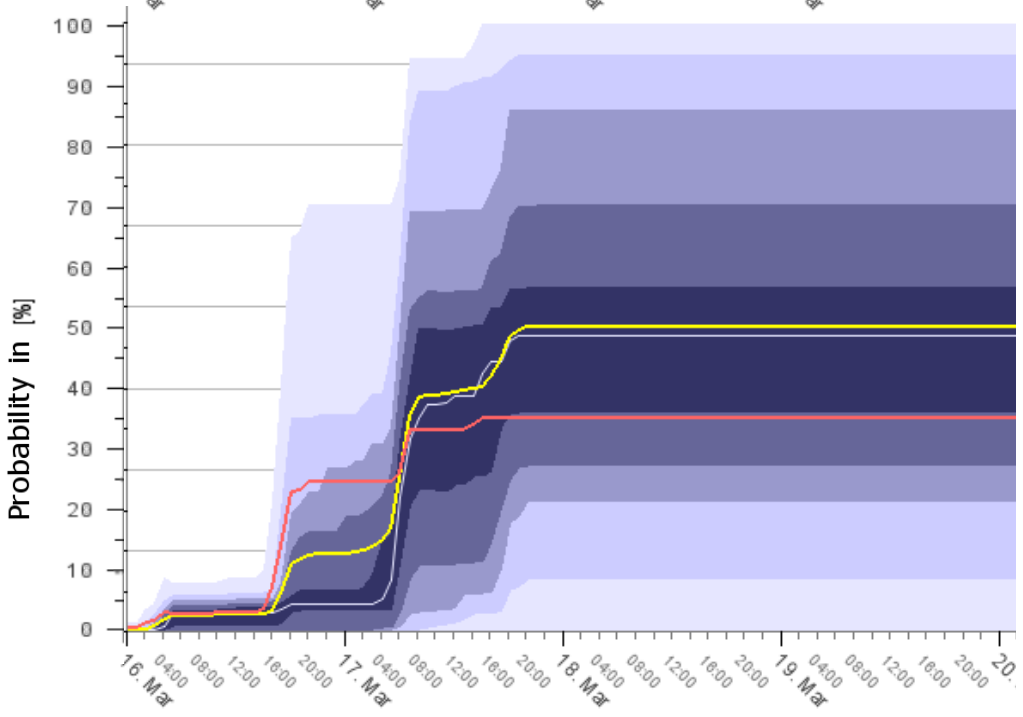
Probability of cut-off



Amplitude important for:

- max reserve requirement
- risk for max shortage
- rist for max overflow
- risk for congestion

Accumulated cut-off Probability



Temporal Acummulation important for:

- amount of required reserve
- length of event
- ramps up- and down

max. unavailable capacity

mean cut-off probability

High speed shutdown events
- how to build up a warning system -

Communication is crucial for the alerts to be taken serious when required !

The frequency of alert generation need to be adjusted to:

- ☐ lead time of the alert
- ☐ change of severity level since previous alert
- ☐ initial week day
- ☐ valid week day
- ☐ time of day
- ☐ severity of the event computed from a ramp-rate
- ☐ the actions required
- ☐ the need and possibility to call back and/or revert actions

Strategy of alert issuing:

- issue every alert according to a simple scheme (e.g. probability exceeding 10% for more than 2 subsequent forecasts)
- reduce the amount of alerts to prevent that critical alerts are not accidentally overlooked (observe before an alarm is issued...)

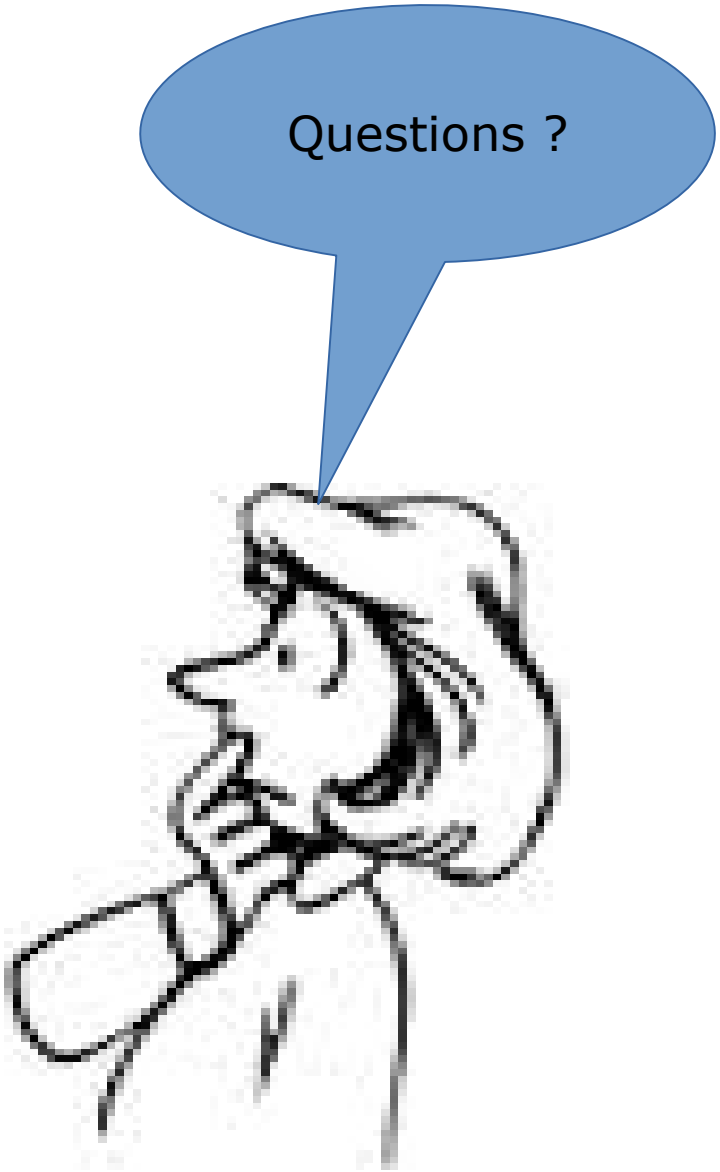
Uncertainty forecasts in the High-speed Shutdown warning system creates value for the user

- Automatic filtering of unpredictable weather phenomena
- Limits double punishment and thereby volatility and consequently risk
- Allows the end user to strategically prepare for the increased risk
- Faster interpretation of conditions with a suitable presentation
- Increased forecast confidence by bridging models and measurements
- Flexible decision making with various objective formulae
- Forecast uncertainty without use of historical measurements

Thank you for your attention …

Overcoming barriers…

Speek with us to find a solution
to your cut-off and ramp situations…



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