



Forecasting Reserve



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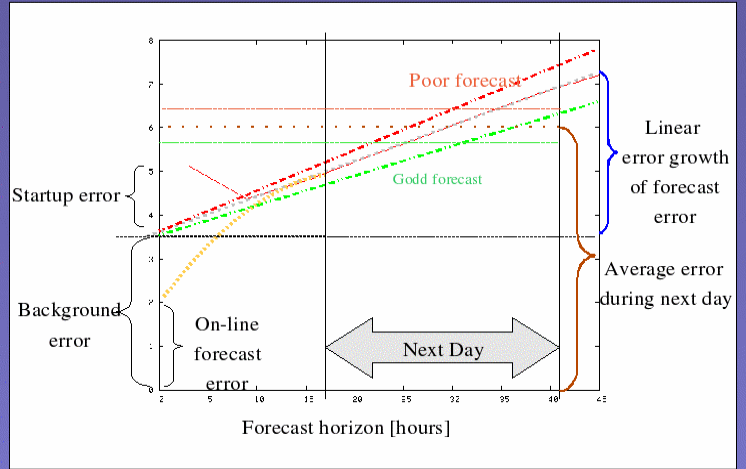
The average forecast error over a forecast horizon can be regarded as a sum of

- The Linear error growth of the weather forecast (1)
- A partly weather dependent background error (2)

The background error comprises all error sources other than the synoptic scale weather forecast error. A typical example, as shown to the right, has 2/3 background error and 1/3 linear error growth. The background error may be as much as 4/5 on single wind farms.

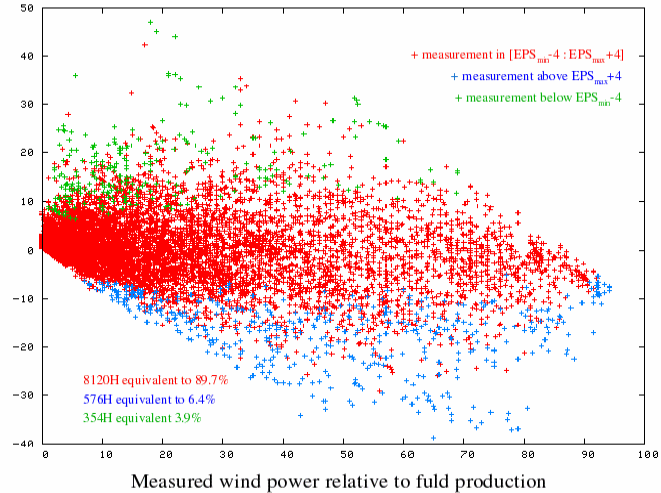
From (1) and (2) we can derive that there is no simple way to eliminate the wind power forecast error.

The background error will normally be balanced as if it was a prediction error of the demand.



Hourly Wind Power Forecast Error With the MS-EPS Ensemble Single Forecast

The Error is shown as Forecast - Measurement - Everything 06UTC forecast - Day ahead verified



Verification of the uncertainty forecast (DK-west for 1 year's data):

- Each symbol represent one hour in the year
- Red symbols represent measurements within the ensemble spread
- Green symbols represent unpredicted over predictions
- Blue symbols represent unpredicted under predictions
- All symbols above the x-axis are over predictions, but the red lie within the ensemble spread
- All symbols under the x-axis are under predictions, but the red lie within the ensemble spread
- All in all 89% of the hours were within the predicted error range

Relationship between Forecasted wind power and expected Reserve Direction

Forecasted Production	Competition on reserve	Recommended forecast choice	Ramp direction
Low	Good for ramping down	EPS minimum	down ↓
Average	Good on up and down ramping	Best forecast	down & up ↓↑
High	Good for ramping up	EPS maximum	up ↑

The average forecast error during the next day is the upper limit for the reserve requirement from wind power. Part of this error needs to be covered by automatic ancillary services, because the variation is too fast to allow trading on the market.

The average daily error covers significant variations on hourly basis, which is the important time scale for the wind power reserve market.

The two main questions are:

1. Is the error predictable and how far ahead is it predictable ?

- => The error is 90% predictable in the forecast range 12-72 hours
- => There is small increase in the uncertainty with forecast horizon
- => The major uncertainty variations change with the type of weather

2. Can the wind power forecast error be used commercially ?

- => Yes, in combination with predictions for the applied storage system
- => Forecasts for the overall market and the end-user's own storage are required
- => Ensemble predictions give an objective basis for evaluation of the competition level on the market

Ramp Forecast Sample

Min + Max (black): optimization for grid security

STDV (blue): optimization for trading

