

ECMWF's Ensemble Prediction System in probabilistic Wind Power Forecasting

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Outline

>Wind Power Forecasts in the power supply system

>Wind power forecast model based on Principle Component Regression

Conclusions

Applying ECMWF's Ensemble Prediction System



be predictable for save grid integration

Example: January to March 2004. Germany, hourly values

Germany: 19024 Turbines. 21.3 GW (as of 30.06.2007)







Example: Powergrams of Wind Power Forecast (Day+1 to Day+3)

end user: TSO, DSO, wind farm operator, energy trader



Wind Power Forecast Model using Principle Component Regression (PCR)

- 1. Weight (squared) forecasted wind speed field with installed wind power capacity
- 2. Compute main patterns of wind power generation with PCA
- 3. Multivariate regression of principle components with historic wind power



- Physical meaning of the eigenvectors can be explained with associated sea surface pressure/wind fields
- Simple & robust approach that is very fast and excellent for use with EPS



Applying EPS Forecasts to the PCR Wind Power Model

50 forecast members available from ECMWF (50km resolution)
 evaluation period Apr 2006 - Mar2007, lead time +72h
 Model level of EPS forecast runs are not archived, use 10m wind speed forecasts
 <u>Training of the PCR wind power model:</u>

PCA of EPS control forecast to determine patterns of wind power generation
Regression coefficients are determined from the last 90 days and are updated every 15 days

Application of EPS forecasts:

- Computation of principle components for each member
- Estimate wind power generation with stored regression coefficients



Wind power forecast with high confidence



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Time series of fc(P=90%) and deterministic wind power





Reliability Diagram for Day +3

(Apr 2006-Mar 2007)

over many cases the forecast prob. should equal the observed prob. (<u>Reliability</u>)
 the forecast system shall have <u>Resolution</u>



 Brier score combines Reliability and Resolution measure: =1 no skill =0 perfect det. forecast



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ROC curve

ROC curve is plot of Hits against false alarms for a range of forecast probabilities





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Event: wind power >8.4GW





Ensemble Mean vs deterministic forecast (80m)

(Apr 2006-Mar 2007)



- EPS mean has same skill than 80m deterministic forecast
- 10m wind speeds are insufficient to represent wind speeds at hub height (~80m) due to atmospheric stability



Summary

PCR Model is robust (does not need extras like orography, surface roughness, turbine characteristics), but only spatial distribution

- >PCR Model is very fast \rightarrow excellent for EPS application
- 10m EPS winds are not ideal, model level fields will be used (1 year of data is now available)

Probabilistic skill scores are encouraging that EPS forecasts will have a value in Wind Power Forecasting, decision making models must be developed now

Higher temporal resolution is needed (<3h)</p>



