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Smoothing of Variability and Forecast Error in Europe's Wind Power production

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The current perspective of the European Wind Energy Association states that around 400 GW of installed wind power capacity (250 GW onshore and 150 GW offshore) will supply 30% of Europe's electricity consumption in 2030. Clear communication with all stakeholders and detailed results of simulation studies of the future power supply system are necessary concerning the optimal investment in infrastructure for large-scale wind power integration.

Within the framework of the EU-project SafeWind, we present various results of a simulation study that bases on (on&offshore) modeling of wind power forecasts and wind power feed-in for Europe. Wind speed data in hubheight of a mesoscale model with 7km horizontal resolution provided by the German Weather Service has been utilized to compute wind power forecasts up to 72h ahead. The wind speed analyses of the German Weather Service have been used to compute the actual feed-in of wind power for each of the 140000 grid boxes. The data base consists of the years 2007-2010 and provides stable statistics on wind power production and forecast errors induced by uncertainty in the Numerical Weather Prediction (NWP) model.

It is well known, that distributed generation reduces the variability and the short-term forecast error of wind power considerably. This effect is studied systematically with the described modeling system. Several metrics (like correlation, temporal gradient reduction, etc.) are defined to characterize the effectiveness (or ability) of each grid point (as a potential wind farm site) to lower the overall variability of wind power in an European power system. Furthermore special interest is given to those grid points that show small wind power forecast errors and that balance forecast errors very well with surrounding grid points.

The cross-correlation and other metrics for smoothing of wind power production and of forecast errors are visualized on a geographic map. Hence, favorable sites can be spotted immediately. It is found that the cross-correlation of wind power production is higher in longitudinal direction than in zonal direction due to the prevailing westerly flow in Europe. This means, for example, that North-South transmission of wind power is more efficient to reduce variability. As a side result it is seen that the saisonal dependency of wind power smoothing is relatively pronounced. During summer wind power smoothing and also wind power forecast error reduction is much stronger than during winter. More local weather phenomena led to less correlation of wind speeds in summer.

The demonstrated results are preliminary works to look intensively for wind sites in Europe that are superior to other sites, as they lower wind power variability and wind power forecast errors more effectively than reference sites (with the same wind resource). Thus, those sites can be proposed for preferential deployment as less grid infrastructure and storage (or backup power) is required to ensure a stable power supply system.