AKE 13: Fluctuating Electricity Supply: Modelling of Generation, Backup and Storage (joint Session AKE / DY / SOE)

Time: Wednesday 15:00–16:30 Location: A 151

Invited Talk AKE 13.1 Wed 15:00 A 151

Fluctuations from photovoltaic and wind power systems — •Detlev Heinemann[1], Gerald Lohmann[1], Mohammed Reza Rahimi Tabar[2], and Mehrnaz Anvari[2] — [1]Universität Oldenburg, Institut für Physik, AG Energiemeteorologie & ForWind — [2]Universität Oldenburg, Institut für Physik, AG TWiSt & ForWind

Solar and wind resources vary considerably in time and space, and changes in their magnitude are almost immediately translated into output power variations of wind and solar power plants. Analyzing the stochastic properties of wind and solar resources in different temporal and spatial scales is therefore a necessary step towards a proper representation of these contributions to large scale power systems.

This presentation describes known stochastic properties of wind and solar resources as well as reports on current studies of (i) their conditional probability distribution functions in different time lags and (ii) increment statistics of large-scale wind and solar production.

Conditional distribution functions show severe deviations from Gaussian statistics and possess positive skewness, while the risk of flickering events in both wind and solar generally increases with parameters as wind speed and solar elevation, respectively. Spatial averaging significantly influences this behavior. The comparison of wind and solar power fluctuations is strongly affected by the presence of a deterministic contribution in the solar part. Applying a detrending approach for the solar data results in an significant improvement of the solar increment statistics.

AKE 13.2 Wed 15:30 A 151

Facing Europe: Revised wind power upscaling algorithms — •Bruno Schyska, Lüder von Bremen, and Alexander Kies — University Oldenburg - ForWind, Oldenburg, Germany

In the wind energy sector, upscaling models are used to estimate the total wind energy production within a certain region from a small number of reference sites. Each reference site is considered to be representative for a certain sub-region. Upscaling models therefore include selection schemes for the reference sites as well as statistical, partly non-linear, models to estimate the energy production in the sub-regions. Until now, upscaling models are mainly used on country level. For larger areas such as Europe no operational model and no research model exist.

In this study, revised upscaling models for the estimation of near real-time wind energy production in Europe are presented. These models include different approaches for the estimation of the energy production in the sub-regions as well as different selection schemes for the reference sites using cluster analyses. Cluster analyses are based on wind speed data from the MERRA reanalysis data set as well as on the geographical distribution of installed wind energy capacities in Europe. From the comparison, the selection scheme, which requires the minimal number of reference sites, is selected for long-term investigations of the wind energy production in Europe.

AKE 13.3 Wed 15:45 A 151

Backup flexibility classes in complex renewable energy networks — •David Schlachtberger[1], Sarah Becker[1], Stefan Schramm[1], and Martin Greiner[2] — [1]Frankfurt Institute for Advanced Studies, Uni Frankfurt, Frankfurt am Main, Germany — [2]Department of Engineering, Aarhus University, Aarhus, Denmark

How large will be the demand for more flexible backup plants in an European power system with an increasing share of fluctuating renewable energies? We use eight years of high resolution weather-based wind and solar power generation data to split the backup systems required to cover the residual load into three flexibility classes for daily, weekly, and seasonal time-scales. They are distinguished by the maximum rates of change of their power output. We find that a large fraction of seasonally and weekly flexible backup systems can no longer be reasonably integrated above a penetration of renewables of around 50% and 90% of the mean load, respectively. We also find that the total required backup capacity can only be reduced if countries share their excess generation and backup power.

AKE 13.4 Wed 16:00 A 151

Dimensioning the Minimal Storage Needs in Renewable Power Systems — •Stefan Weitemeyer, David Kleinhans, and Carsten Agert — NEXT ENERGY · EWE Research Centre for Energy Technology at the University of Oldenburg, Germany

Integrating a high share of electricity from non-dispatchable Renewable Energy Sources (RES) in a power supply system is a challenging task; it will likely require large-scale installations of costly storage capacities.

We present a modelling approach to investigate which storage characteristics are most adequate for scenarios with high shares of RES. Adapted from an optimization approach, the model allows to systematically study the influence of important storage parameters (size, efficiency, power) on the integration of RES. In particular, the implications of simultaneously using multiple storage classes in combination with fossil back-up power plants can be investigated.

Applying our model to data for Germany, our simulations show how an extensive integration of RES requires different storage characteristics during different phases of the pathway towards a 100% RES scenario. The results also imply that a balance between installing storage capacities and additional generation capacities is required.

AKE 13.5 Wed 16:15 A 151

The temporal development of storage needs in the European energy transition — •Alexander Kies, Lüder von Bremen, and Bruno Schyska — ForWind, Universität Oldenburg, Oldenburg

Europe is on the way towards a highly renewable energy system. In 2012 23.5% of the gross electricity consumption in the EU-28 was produced from renewable sources. This share is expected to increase further up to very high penetration levels close to 100% in the next decades. To ensure reliability and stability of the power system several solutions to the generation-load-mismatch problem have been proposed like over-installation of renewables, transmission capacity extensions and the use of storages. In this work we investigate the development of storage needs in 34 European countries for different transmission grid scenarios until 2050. A large weather data set with a spatial resolution of 7 x 7 km and a hourly temporal resolution covering Europe is used to model the fluctuating feed-in from the renewables, i.e. wind, photovoltaics, hydro, concentrated solar power and wave. Additionally the controllable renewable generation types biomass and geothermal were considered. Starting from the renewable shares in the year 2012 we model the increase in renewable capacities in a linear and a logistic way until levels of 100% in 2050 for different transmission grid scenarios and calculate the storage needs for every year. The remaining generation shares to cover the load are assumed to come from conventional generation. We show that storage needs are unlikely to grow rapidly until 2030, but thereafter are of high importance. However, this process can be slowed down considerably by transmission grid extensions.