DY 12: Energy systems

Time: Monday 15:00–16:00 Location: H47

DY 12.1 Mon 15:00 H47

Bridging KM-like power systems and real decentralized grids — Katrin Schmietendorf[1], •Oliver Kamps[2], and Joachim Peinke[1] — [1]ForWind, Universität Oldenburg, Germany — [2]CeNoS, Universität Münster, Germany

Kuramoto-like models describing networks of synchronous machines allow for the investigation of basic mechanisms of power grid stability and the interplay between dynamics and topology from the viewpoint of self-organized synchronization. Several key issues of modern power systems are concerned with the integration of fluctuating renewables into decentralized grids. To address these questions, some model extensions have to be implemented before-hand.

In the course of ongoing decentralization, small and medium renewable generating units are progressively being connected to the low and medium voltage level where, in contrast to the previous studies on the extra-high voltage transmission grid, transfer losses can not be neglected. Furthermore, in particular solar power is fed into the grid via inverters, whose behaviour is different from generators with inertia. Hence, the network of synchronous machines has to be complemented by simple units mimicking inverter characteristics. In addition, we introduce a simple local voltage regulator, which may support the system in keeping tolerance bounds.

We discuss the impact of transmission losses and voltage regulation on the dynamics and stability of both a small two-machine component and a complex power grid and we present a how-to for the implementation of inverter units.

DY 12.2 Mon 15:15 H47

Cascading Failures in AC Electricity Grids — •Martin Rohden, Samyak Tamrakar, Daniel Jung, and Stefan Kettemann — Department of Physics and Earth Sciences, Jacobs University Bremen, 28759 Bremen

The severity of power grid failures is often measured by the number of affected consumers. Data from real-world power grids show that the probability to disconnect more than a certain number of consumers often decays like a power law [1]. Here we are using an oscillatory power grid model [2] to model cascading failures, induced by the failure of single transmission lines. We analyse the effect of different cascading failures by counting the number of affected consumers for both artificial regular topologies and the topology of the German power grid. We show that depending on parameter values different distributions of disconnected consumers can be found. Furthermore we analyse the effect of different cluster sizes of generators and consumers and determine the vulnerability of small and large clusters against cascading failures.

[1]: I. Dobson et al., Chaos **17**, 026173 (2007)
[2]: M. Rohden et al., Chaos **24**, 013123 (2014)

DY 12.3 Mon 15:30 H47

Long-range Response in AC Electricity Grids — •Daniel Jung and Stefan Kettemann — Department of Physics & Earth Sciences, Focus Area Health, Jacobs University Bremen, 28759 Bremen, Germany.

The transition towards renewable energy sources (RES) leads naturally to a decentralized and fluctuating production of electrical power. Furthermore, it is well known not only among grid operators that local changes to the grid topology – regardless if intentional or accidental – can have global effects on the flow of power within the entire network [1]. Thus it can be expected that ensuring stable grid operation becomes more challenging with an increasing share of RES. In a model-based ansatz focussing on decentral power production, the impact of single-line additions on the long-range response of DC electricity grids has recently been studied numerically [2]. By solving the real part of the static AC load flow equations, we conduct a similar investigation for AC grids. For intermediate distances in a regular 2D grid, we find a power law behavior for the change of power flow as a function of distance to the disturbance. Furthermore, the power exponent saturates in the limit of large system sizes. We also compare the results of the regular 2D grid topology to a model topology of the German transmission grid.

[1] D. Witthaut and M. Timme, Eur. Phys. J. B **86**, 377 (2013).
[2] D. Labavić, R. Suciu, H. Meyer-Ortmanns, and S. Kettemann, Eur. Phys. J. Spec. Top. **223**, 2517 (2014), arXiv:arXiv:1406.4699v1.

DY 12.4 Mon 15:45 H47

Model order reduction for network based whole energy systems — •Frank Hellmann — Potsdam Institute for Climate Impact Research

I will discuss recent work on applying non-linear model order reduction techniques to power system models. The aim of this work is to obtain models that are simple enough that methods which were previously only available for conceptual models can be applied in practice. To do so we develop reduction methods that make use of and preserve the network structure of the system under consideration.