SOE 5: Energy Systems / Power Grids (joint session DY/SOE)

Time: Monday 12:00–13:00 Location: BH-N 128

SOE 5.1 Mon 12:00 BH-N 128

Energy recuperation system for skip trucks — •Robin Masser, Karsten Schwalbe, and Karl Heinz Hoffmann — Chemnitz University of Technology, Chemnitz, Germany

When braking with conventional brake discs, kinetic energy is converted into heat that is released to the environment. The reduction of the energy made unusable in this process has been in the focus of research during the last decades. Following this goal, our work aims to reduce the fuel consumption of commercial vehicles, in particular of skip trucks. Therefore, a module consisting of a hydraulic pump driven by the cardan shaft and a bladder accumulator is installed to store and reuse energy. The stored energy may then be used to operate auxiliary units, to support the thermal management and as additional propulsion. This system consisting of the hydraulic components, the cooling circuit as well as pressure and heat losses is modeled applying endoreversible thermodynamics. Based on this model, system parameters and control strategies can be optimized in terms of power and efficiency. The resulting fuel and operational cost savings are estimated evaluating recorded urban driving data.

SOE 5.2 Mon 12:15 BH-N 128

Scaling of transmission capacities in coarse-grained renewable electricity networks — •Mirko Schäfer[1], Simon Bugge Siggaard[2], Kun Zhu[1], Chris Risager Poulsen[2], and Martin Greiner[1] — [1]Department of Engineering, Aarhus University, Denmark — [2]Department of Physics and Astronomy, Aarhus University, Denmark

Network models of large-scale electricity systems feature only a limited spatial resolution, either due to lack of data or in order to reduce the complexity of the problem with respect to numerical calculations. In such cases, both the network topology, the load and the generation patterns below a given spatial scale are aggregated into representative nodes. This coarse-graining affects power flows and thus the resulting transmission needs of the system. We derive analytical scaling laws for measures of network transmission capacity and cost in coarse-grained renewable electricity networks. For the cost measure only a very weak scaling with the spatial resolution of the system is found. The analytical results are shown to describe the scaling of the transmission infrastructure measures for a simplified, but data-driven and spatially detailed model of the European electricity system with a high share of fluctuating renewable generation.

SOE 5.3 Mon 12:30 BH-N 128

Frequency fluctuations and dynamically induced cascading failures in power grids — •Benjamin Schäfer[1,2], Dirk Witthaut[3,4], Christian Beck[5], Kazuyuki Aihara[6], Marc Timme[1,2], and Vito Latora[5,7] — [1]Chair for Network Dynamics, Center for Advancing Electronics Dresden (cfaed) and Institute for Theoretical Physics, Technical University of Dresden, 01062 Dresden, Germany — [2]Network Dynamics, Max Planck Institute for Dynamics and Self-Organization (MPIDS), 37077 Göttingen, Germany — [3]Forschungszentrum Jülich, Institute for Energy and Climate Research - Systems Analysis and Technology Evaluation (IEK-STE), 52428 Jülich, Germany — [4]Institute for Theoretical Physics, University of Cologne, 50937 Köln, Germany — [5]School of Mathematical Sciences, Queen Mary University of London, London E1 4NS, United Kingdom — [6]Institute of Industrial Science, The University of Tokyo, Meguro-ku, Tokyo, Japan — [7]Dipartimento di Fisica ed Astronomia, Università di Catania and INFN, I-95123 Catania, Italy

Reliable functioning of infrastructure networks is essential for our modern society. Cascading failures are the cause of most large-scale network outages while small fluctuations dominate the grid on a daily basis. In this talk, we demonstrate the importance of transient dynamics when investigating cascades in power grids. Furthermore, we analyze power grid frequency fluctuations based on measurements from several continents, explaining heavy tails and revealing the impact of trading.

SOE 5.4 Mon 12:45 BH-N 128

Flow-tracing and nodal cost allocation in a heterogeneous highly renewable European electricity network — Bo Tranberg[1], Leon Schwenk-Nebbe[2], Mirko Schäfer[1], Jonas Hörsch[3], and •Martin Greiner[1] — [1]Department of Engineering, Aarhus University — [2]DONG Energy — [3]Frankfurt Institute for Advanced Studies

For a cost efficient design of a future renewable European electricity system, the placement of renewable generation capacity will seek to exploit locations with good resource quality, that is for instance onshore wind in countries bordering the North Sea and solar PV in South European countries. Regions with less favorable renewable generation conditions benefit from this remote capacity by importing the respective electricity as power flows through the transmission grid. The resulting intricate pattern of imports and exports represents a challenge for the analysis of system costs on the level of individual countries. Using a flow-tracing technique, we introduce flow-based nodal levelized costs of electricity (LCOE) which allow to incorporate capital and operational costs associated with the usage of generation capacity located outside the respective country under consideration. This concept and a complementary allocation of transmission infrastructure costs is applied to a simplified model of an interconnected highly renewable European electricity system. We observe that cooperation between the European countries in a heterogeneous system layout does not only reduce the system-wide LCOE, but also the flow-based nodal LCOEs for every country individually.