SOE 13: Energy Networks (joint session SOE/DY)

Time: Wednesday 12:45–13:15 Location: H11

SOE 13.1 Wed 12:45 H11

Revealing drivers and risks for power grid frequency stability with explainable AI — •Benjamin Schäfer[1], Johannes Kruse[2,3], and Dirk Witthaut[2,3] — [1]Institute for Automation and Applied Informatics, Karlsruhe Institute of Technology, Eggenstein-Leopoldshafen, Germany — [2]Forschungszentrum Jülich, Institute for Energy and Climate Research-Systems Analysis and Technology Evaluation (IEK-STE), Jülich, Germany — [3]Institute for Theoretical Physics, University of Cologne, Köln, Germany

The transition to a sustainable energy system is challenging for the operation and stability of electric power systems as power generation becomes increasingly uncertain, grid loads increase, and their dynamical properties fundamentally change. At the same time, operational data are available at an unprecedented level of detail, enabling new methods of monitoring and control. To fully harness these data, advanced methods from machine learning must be used.

Here, we present explainable artificial intelligence (XAI) as a tool to quantify, predict, and explain essential aspects of power system operation and stability in three major European synchronous areas. We focus on the power grid frequency, which measures the balance of generation and load and thus provides the central observable for control and balancing. Combining XAI with domain knowledge, we identify the main drivers and stability risks, while our model and open dataset may enable further XAI research on power systems.

SOE 13.2 Wed 13:00 H11

Cascading Failures and Critical Infrastructures in Future Renewable Power Systems — Franz Kaiser[1,2], Johannes Kruse[1,2], •Philipp C. Böttcher[1], Martha Maria Frysztacki[3], Tom Brown[3,4], and Dirk Witthaut[1,2] — [1]IEK-STE Forschungszentrum Jülich, Jülich, Germany — [2]THP Uni Köln, Köln, Germany — [3]KIT-IAI, Karlsruhe, Germany — [4]Institut für Energietechnik TU Berlin, Berlin, Germany

The world's power systems are undergoing a rapid transformation, shifting away from carbon-intensive power generation to renewable power sources. As a result, there is a growing importance of long-distance power transmission, while the intrinsic system inertia provided by thermal power plants decreases. This poses several challenges to the system such as accelerated dynamics and thus a higher control effort for transmission system operators. These developments make power grids more vulnerable to cascading failures, which may result in a splitting of the grid and eventually in a large-scale blackout. While large blackouts are rare but devastating events, several smaller splits were observed in recent years.

In this work, we use the state of the art open energy system model PyPSA to generate future energy systems and assess the risk of cascading failures and systems splits in the European power grid for different carbon reduction targets. We determine the likelihood of dangerous splits and discuss mitigation strategies.