SOE 9: Energy and Environment

Time: Tuesday 11:15–12:45 Location: H 0110

SOE 9.1 Tue 11:15 H 0110

Stylized facts and fluctuations in future power markets — •Stefan Börries and Stefan Bornholdt — Institut für Theoretische Physik, Universität Bremen

In terms of an enlarged integration of so-called renewable energy resources the structure of the corresponding power market as well as the grid design are expected to underly fundamental changes. Load fluctuations caused by power generation replace the former base load. In order to dampen these fluctuations, new pricing schemes are discussed to adapt consumers consumption to varying supply levels.

We investigate a model based on the minority game [1] to simulate effects of a dynamic pricing structure while incorporating the main characteristics of power markets: the limited storability of power [2] and a constant requirement for energy consumption. In this regard large load fluctuations occur and the corresponding market shows aspects of stylized facts known from financial markets [3], jeopardizing the security of power supply.

[1] D. Challet, Y. -C. Zhang, Physica A 246, 407 (1997).

[2] R. Weron, B. Przybylowicz, Physica A 283 (2000) 462.

[3] P. Gopikrishnan, V. Plerou, L. A. N. Amaral, M. Meyer, H. E. Stanley, Phys. Rev. E 60, R6271 (1999).

SOE 9.2 Tue 11:30 H 0110

Topology and Stability in Power Grids — •Peter J. Menck[1,2], Naoya Fujiwara[1], Jobst Heitzig[1], and Jürgen Kurths[1,2] — [1]Potsdam-Institut für Klimafolgenforschung, Potsdam, Deutschland — [2]Institut für Physik, Humboldt-Universität zu Berlin, Berlin, Deutschland

In recent years there has been growing interest in applying Complex Network Theory to energy transmission networks, or power grids. Several studies focused on the interplay between topology and vulnerability, in many cases regarding the nodes' properties as static. In contrast to this, we employ a dynamic alternating-current model of the nodes that allows us to explore the influence of topology on features of the operating state of the grid (which is a synchronous state). The model, called swing equation model, has been widely used in the engineering community to gain qualitative understanding of how a power grid works. We believe that its combination with Complex Network Theory will lead to new insights. In our numerical investigations we place particular emphasis on the relation between topology of the network and stability of the operating state. Therefore first of all we specify a concept of stability we consider suitable to power grids. Questions we then address include: Which topological properties are beneficial to stability? Which are detrimental?

SOE 9.3 Tue 11:45 H 0110

Empirical distributions for firms' energy consumption and energy saving behaviour — •Patrick Plötz and Tobias Fleiter — Fraunhofer-Institut für System- und Innovationsforschung ISI, Breslauer Straße 48, 76139 Karlsruhe

A simple and often cost-effective way to reduce energy consumption and green house gas emissions is a more efficient use of energy. It is generally assumed that firms of different size behave differently when adopting energy-efficiency measures. A few studies have tried to identify a net effect of firm size and other firm characteristics. However, detailed empirical results of the influence of firm size on adoption of energy efficiency measures are still missing. Here, we study empirical distributions of firm size and adoption rates and how these interact. We identify general empirical trends by using data from different countries and industry branches. Thus, a more detailed picture of the adoption behaviour of firms of different size is obtained including the large diversity that prevails among firms and that dominates firms' adoption decision. This is a first step towards a more realistic consideration of diversity among firms and needed for building complex models of firm behaviour and interaction. The revealed broad empirical trends have consequences for the future design of models and policies to understand and influence the adoption of energy efficiency measures in industry.

SOE 9.4 Tue 12:00 H 0110

On the Predictability of El Niño by Climate Networks — •Josef Ludescher[1], Avi Gozolchiani[2], Mikhail Bogachev[1], Shlomo Havlin[2], and Armin Bunde[1] — [1]Institut für Theoretische Physik III, Justus Liebig Universität Gießen, 35392 Gießen, Germany — [2]Minerva Center and Department of Physics, Bal Ilan University, Ramat Gan, Israel

We construct and analyze climate networks based on gridded observational data starting 1948. The grid sites form the nodes of the network and links represent cooperative behavior between these nodes. We define the link weight as the strength of the crosscorrelation between the time series at the nodes, which can be temperature, pressure, wind data etc. We find that the surface air temperature links that connect the El Niño basin with the rest of the equatorial Pacific are the most sensitive for El Niño and show that the network strength of this area, defined as the sum of the link weights, in most cases precedes the El Niño Index by several months. We use ROC analysis to show that most El Niño events and non-events can be predicted in the preceding year.

SOE 9.5 Tue 12:15 H 0110

Applying Stochastic Small-Scale Damage Functions to German Winter Storms — •Boris Prahl[1], Diego Rybski[1], Jürgen Kropp[1], Olaf Burghoff[3], and Held Hermann[1,2] — [1]Potsdam Institute for Climate Impact Research (PIK), Potsdam, Germany — [2]University of Hamburg, Germany — [3]Gesamverband der Deutschen Versicherungswirtschaft (GDV), Berlin, Germany

Analyzing insurance loss data we derive stochastic storm damage functions for residential buildings. On district scale we find power law relations between daily loss and maximum wind speed, spanning more than 4 orders of magnitude. The estimated power law exponents for 439 German districts typically range from 8 to 11 and are considerably larger than previously published exponents. In addition, we find correlations among the parameters and socio-demographic data which we employ in a simplified parametrization of the damage function with just 2 independent parameters. The Monte Carlo method is used to generate loss estimates and confidence bounds of daily and annual storm damages for Germany. Our approach reproduces the annual progression of winter storm losses and enables to estimate daily losses over several orders of magnitude.

SOE 9.6 Tue 12:30 H 0110

The influence of sea level rise on coastal flood damages — •Markus Boettle, Diego Rybski, and Jürgen P. Kropp — Potsdam Institute for Climate Impact Research (PIK), Germany

The estimation of costs due to climate change and the identification of possible adaptation measures are of particular interest at coastal regions threatend by sea level rise. In terms of cost-benefit analysis one wants to quantify how efficient adaptation measures are and when their investments are amortized. Thus, reliable damage estimations, especially in the context of rising mean sea levels, are needed. We propose a probabilistic framework and study the general effect of sea level rise and changing variability of extreme events on coastal flood damages. Surprisingly simple relations describing the interplay between mean sea levels and economic losses are found. Moreover, taking into account protection measures, which may reduce the impacts from moderate flooding (e.g. by sea dikes), we obtain further expressions for the decay of damages if a predefined protection level is supposed. Applying the approach to the city of Copenhagen, our general results can be confirmed and a steeper increase of expected damages than the rise of mean sea levels is found. Our findings have important implications for the estimation of future damages and therefore for the allocation of adaptation funds.