

**SYEE 1: Symposium Energy Meets Economy: Dynamics and Statistics of Future Energy Systems**

Time: Wednesday 15:00–17:45

Location: HSZ 02

**Invited Talk** SYEE 1.1 Wed 15:00 HSZ 02**Smart Grids - From incentives to coupled markets** — ●RUDOLF SOLLACHER — Siemens AG, Corporate Technology, Munich, Germany

Future energy systems must meet the challenges introduced by an increasing portion of distributed renewable power generation. This talk describes the main challenges and presents current and future solutions. A special focus will be on market based approaches.

**Invited Talk** SYEE 1.2 Wed 15:30 HSZ 02**Energy and the economy** — ●REINER KÜMMEL — Institut für Theoretische Physik und Astrophysik, Universität Würzburg, Am Hubland, D-97074 Würzburg

Energy conversion and entropy production determine the growth of wealth in industrialized economies. Novel econometric analyses have revealed energy as a production factor whose output elasticity, which measures its economic weight, is much larger than its share in total factor cost, while for labor just the opposite is true. Although this result is at variance with neoclassical economic theory, it is compatible with the standard maximization of profit or time-integrated utility, if one takes technological constraints on capital, labor, and energy into account.

**Invited Talk** SYEE 1.3 Wed 16:00 HSZ 02**Planetary constraints to energy supply and the economy** — ●OLIVER RICHTERS — Universität Oldenburg, Institut für Chemie und Biologie des Meeres, Theoretische Physik / Komplexe Systeme — Vereinigung für Ökologische Ökonomie

The “great transformation” towards a future proof economy depends on the provision of a sustainable energy supply. Different planetary boundaries restrict the phase space of possible technical and societal solutions. Solar energy or nuclear fusion appear to be the solution for the radical reduction of greenhouse gas emissions, disregarding that other problem areas persist: First, the excessive installation of photovoltaics enters into competition with other kind of land use and therefore may lead to land system change and accelerate biodiversity loss. Second, the low entropy of solar radiation is the basis for life on earth and its harvesting for human activity reduces the energy available for biological and meteorological processes. Jointly, though renewables can’t run out of stock, the energy throughput is constrained by the speed of regeneration. Third, even nuclear fusion or other sun-independent energy supply cause global warming simply by thermal pollution, as every human activity finally ends up as heat. On the whole, this poses relevant limitations to world energy consumption and possible future energy systems. The realisation of a sustainable

energy supply will stop the excessive growth of energy throughput, putting relevant constraints to economic growth, so that it will probably come to an end. An insight is given into the significance this development has for finance, economics, social security and the people on earth.

**- 15 minutes break -****Invited Talk** SYEE 1.4 Wed 16:45 HSZ 02**Identifying critical infrastructures in complex supply networks** — ●DIRK WITTHAUT — Institut für Energie- und Klimaforschung, Forschungszentrum Jülich — Institut für theoretische Physik, Universität zu Köln — Max-Planck-Institut für Dynamik und Selbstorganisation

Transmission line failures can induce large-scale outages in power grids and other complex supply networks, causing potentially huge economic losses. Yet, how to determine which lines are particularly sensitive to inducing larger-scale outages is currently not well understood. In this talk I will discuss how the topological redundancy of a transmission line limits dynamical network robustness and allows to reliably identify critical infrastructures. I derive criteria to predict the dynamic stability of power grids based on the networks topology and the static loads prior to line failure. As both criteria are available before any outage from the state of normal operation, they may support network planning and real-time monitoring of grid operation.

**Invited Talk** SYEE 1.5 Wed 17:15 HSZ 02**Short time fluctuations of renewable energies** — ●JOACHIM PEINKE, M. REZA RAHIMI TABAR, PATRICK MILAN, and MATTHIAS WÄCHTER — Institut für Physik und ForWind, Universität Oldenburg, Germany

Wind and solar energy, the main renewable energies on which the modern sustainable electrical power supply will be based, are characterized by a high volatility. News report frequently on a new challenge for the energy management to handle these new sources. For a better understanding of their impact on the electrical power system it is essential to know in more details the nature of the power fluctuations of wind and solar energy.

In our contribution we present results from an analysis of wind and solar power. We show that the turbulent features of the weather can be seen in the power output of such systems. We will mainly focus on the characterization and modeling of these power systems with advanced stochastic tools. Concerning the extreme event statistics, we show evidence that solar power is more volatile than wind power.