

**Stefan Pfenninger: Keeping the lights on in winter: managing the variability of solar and wind power**

If average global warming is to be contained below 2°C, greenhouse gas emissions from the energy sector must be eliminated by mid-century. The rapid cost decrease of wind and solar photovoltaics (PV) opens a pathway to achieve this. However, their substantial variability in space and time remains a serious problem. Power storage — for example with batteries, whose costs are also in swift decline — can balance hourly and diurnal fluctuations. Yet in temperate regions like Europe, balancing monthly and seasonal variability, in particular of solar power, would require vast amounts of storage. This is a key reason why the feasibility of a power supply relying on solar and wind technologies is still in doubt. In this talk I will describe examples from my past, ongoing and future research examining variability at different scales, exploring technical and policy options to construct a stable renewable energy system based on an understanding of this variability. This work involves innovations in the simulation of solar and wind generation, in energy system analysis methods, and their application, which are possible through collaboration with other fields like meteorology and policy research. An energy system powered by variable wind and solar generation seems possible. Realising it requires a paradigm shift away from full control over electricity generation to a system designed around managing the natural variability of wind and solar power.