



## **The challenges of a transition to a fully renewable power system under climatic extreme events**

Christian Mikovits (1), Johann Baumgartner (1), Johannes Schmidt (1), Elisabeth Wetterlund (2,3)

(1) Institute for Sustainable Economic Development, University of Natural Resources and Life Science, Vienna, Austria, (2) Energy Engineering, Division of Energy Science, Luleå University of Technology, Luleå, Sweden, (3) International Institute for Applied Systems Analysis (IIASA), Laxenburg, Austria

Climate agreements, the urge of independence from fossil fuels, and the disembarkation of nuclear energy are driving the switch from conventional power systems to renewable power systems. Hence, this is an inevitable, but challenging task. This transition calls for a thorough modelling and analysis of long-term time series of variable renewable energy (VRE) generation and electricity demand (load) at a high resolution to provide important insights into the feasibility of fully renewable power systems. Especially frequency and duration of extreme production events in fully renewable power systems is of significant relevance, as critics warn that periods of persistent low VRE generation might threaten grid stability and exceed the balancing capabilities of current power systems.

Our work presents a case study for Sweden determining the variable costs of thermal backup generation from biomass in a fully renewable energy system, neglecting possible import opportunities. We additionally analyse the frequency and duration of extreme production events in a fully renewable power system and the risk of loss-of-load, and consequently provide important insights into the vulnerability of such a system. Due to the high share of hydropower and associated storage, Sweden is well prepared to replace its nuclear generation by wind power. Nevertheless, in certain years extended cold periods with low wind power generation stress the system, and additional thermal backup capacity is therefore necessary to be able to guarantee security of supply even under very adverse climatic conditions.