Modelling of Energy System Transition towards Very High Levels of Sustainability in Global-Local Resolution

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The targets of the Paris Agreement and the Sustainable Development Goals of United Nations require a fast rebalancing of anthropogenic activities within the biophysical limits of our planet Earth. A major aspect is the full defossilisation of the energy system comprising all sectors: Power, Heat, Transportation and Industry (in particular cement, steel, chemical and desalination), and respecting ecological and societal limits, such as biomass availability and infrastructure acceptance, but still for least societal cost. Energy system transition modeling is required in full hourly resolution due to the intermittent nature of the dominant energy resources of the arising energy system: solar and wind energy. Recent research indicates that a fast energy transition in the power sector is technically possible, while reducing the total system cost, stark declining greenhouse gas emissions and creating new jobs – based on results in global-local resolution. First results for the other energy sectors indicate comparable results for all energy sectors due to a high electrification of the whole energy system using battery electric vehicles, power-to-heat/fuels/chemicals technologies and seawater reverse osmosis desalination for sustainably addressing water demand. The latter is a stark function of phasing out thermal power plants and a drastic increase of irrigation efficiency. The Paris Agreement will most likely require negative emission technologies, which will imply new and large-scale research questions in the field of land use, water management and related energy demand.