ClimEx – Final Symposium – 7 May 2019 Parallel Workshops	
Session D	**Climate Change, Climate Extremes and Energy Transition / Renewable Energy**
Key Questions	• What are the direct and indirect impacts of climate change and the energy transition on renewable energy generation? (hydro, combination hydro, wind & solar, biomass) • What are the impacts of climate change on the electricity demand? (heating, cooling, electrification of traffic) • How do changes in water availability affect the energy sector? • Is energy infrastructure at risk due to extreme events?
Key Findings	• **Main findings:** o Higher temperatures affect seasonal energy consumption & demand o Emphasis on electric vehicles will increase overall demand o Operation of equipment has and will change for hydro power o Water availability may affect hydro power generation and thermal generation cooling o Extreme hydrological and high wind events put infrastructure at risk o Vegetation management might need revision o Higher temperatures decrease power line efficiency • **Implications:** o Hydrological regime changes and their impacts of hydropower are of concern, particularly with respect to hydropower's role in grid regulation of highly volatile wind & solar generation. o Low flow conditions that impair thermal generation need to be understood. o Risks to (renewable) energy infrastructure from flood, wind and forest fires need to be evaluated. o Potential changes in demand due to increasing temperatures need to be assessed, ideally in combination with losses due to less efficient transmission. o Impacts of climate change on vegetation growth rates need to be explored. o Biofuel production may be affected by drought. o Assessment / modeling of energy sector specific issues is required to well establish climate-energy nexus links. o Various technical implications, risks and solutions need to be explored through a climate lens.

	• **Research needs:** o Interfacing of energy sector models (generation, demand, ..)and hydro-climatological variables is needed o Transition of grid regulator “hydropower”: ▪ Role of reservoirs vs run of river vs pump storage ▪ Operation of hydro facilities in a conventional energy system vs a renewable system that is more climate dependent ▪ Consequences and requirements for equipment that is operated at higher frequency (weirs, gates, runners, …) ▪ Explore variability of wind & sun at different time scales o Risk and opportunity of the integration of renewable energy sources at different spatial scales (“Deckungsgrad”) ▪ Grid voltage & frequency fluctuations due to volatile renewable energy sources at local, regional, continental scale ▪ Analysis of potential changes by sector (hydro, wind, solar) ▪ Integrated assessment of renewables and conventional energy sources o Understand the changes in demand due to increased temperatures o Role and requirements of storage; storage options.

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