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Alpine hydropower in a low carbon economy: Assessing the local implication of global policies

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In the global transition towards a more efficient and low-carbon economy, renewable energy plays a major role in displacing fossil fuels, meeting global energy demand while reducing carbon dioxide emissions. In Europe, Variable Renewable Sources (VRS), such as wind and solar power sources, are becoming a relevant share of the generation portfolios in many countries. Beside the indisputable social and environmental advantages of VRS, on the short medium term the VRS-induced lowering energy prices and increasing price's volatility might challenge traditional power sources and, among them, hydropower production, because of smaller incomes and higher maintenance costs associated to a more flexible operation of power systems.
In this study, we focus on the Swiss hydropower sector analysing how different low-carbon targets and strategies established at the Swiss and European level might affect energy price formation and thus impact – through hydropower operation – water availability and ecosystems services at the catchment scale.
We combine a hydrological model to simulate future water availability and an electricity market model to simulate future evolution of energy prices based on official Swiss and European energy roadmaps and CO_2 price trends in the European Union. We use Multi-Objective optimization techniques to design alternative hydropower reservoir operation strategies, aiming to maximise the hydropower companies' income or to provide reliable energy supply with respect to the energy demand. This integrated model allows analysing to which extent global low-carbon policies impact reservoir operation at the local scale, and to gain insight on how to prioritise compensation measures and/or adaptation strategies to mitigate the impact of VRS on hydropower companies in increasingly water constrained settings. Numerical results are shown for a real-world case study in the Swiss Alps.