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Hydropower revenues under the threat of climate change: Case studies from Europe

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Climate change jeopardizes the future of hydropower across the world. Precipitation patterns evolve, glacier retreat affects sedimentation, and rising temperatures perturb both the water cycle and the energy-price seasonality. The energy sector also faces an energy turnaround. The growing penetration of intermittent wind and solar energy increases supply variability, thus price volatility. These trends raise concerns about the future profitability of traditional hydropower.
This work quantifies these impacts with an integrated, transferable, and parsimonious model. It integrates a semi-distributed hydrological with hydropower management models to translate climate change and energy scenarios into future energy generation and revenue. We simulated nine future streamflow scenarios for an Italian and a Swiss case study. These inputs fueled a hydropower management model, which maximizes revenue accordingly to five Italian and twenty-eight Swiss electricity prices scenarios. The simulations couple both types of scenario for the period 2016-2045. This time horizon especially matters for current decisions in climate and energy policy.
Results show that variations of climate regime adversely influence the hydroelectric production. Climate change will modify the seasonality of inflows and volumes that are exploitable for hydropower generation. However, smart hydropower management could mitigate revenue losses. This research represents a toolkit for dam operators and decision makers to assess future generation capacity in a warming climate.

Key words: Climate Change, Hydropower, Electricity Market, Water-Energy Nexus, Modelling