An assessment of the impact of environmental constraints on utilization of Norwegian hydropower flexibility for integration of wind and solar power

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ABSTRACT: Utilization of hydropower flexibility carries an important environmental dilemma. Reservoir hydropower is a renewable energy source, generally with low GHG emissions, that can help balance the variability of wind and solar power and thus help achieve decarbonization of power systems. However, if the water flows depend solely on the power grid needs, potentially following hydropeaking patterns, it can lead to severe disruptions to downstream ecosystems and communities. Restrictions on water flows, referred to as environmental constraints, are therefore implemented. In Norway, these environmental constraints might become stricter in the upcoming years for the sake of preservation of the local environment. Meanwhile, the Norwegian hydropower flexibility has an important role in enabling a higher share of renewables with the ongoing energy transition. This study aims at quantifying the impact of environmental constraints on the capacity of Norwegian hydropower to balance variability of wind and solar power in the Nordic power system. Simulations are carried over this power system with the FanSi model developed by SINTEF. Based on detailed modelling of the Nordic and surrounding countries, the model uses a rolling horizon scheme to optimize economic dispatch in a stochastic environment. A sensitivity analysis is performed on the type and stringency of the environmental constraints. Special attention is also given to differentiating the impacts of these constraints when applied to hydropower reservoirs and plants with different technical characteristics. The variations in hydropower flexibility are observed through changes in the price patterns and resource utilization, as well as recourse to other dispatchable technologies, such as batteries and gas power plants. In order to maximize the climate change mitigation role of Norwegian hydropower while minimizing threats to biodiversity, careful selection of the type, location and level of environmental constraints applying to the power plants will be crucial.