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Integration of small run-of-river and solar power: The hydrological regime prediction/assessment accuracy

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The possibility to achieved a high integration of climate related energies (i.e. run-of-river-, wind- and solar-energies) depends on the possibility to balance the potentially large deviations between the related intermittent productions and the variable demand using storage facilities such as water storage in accumulation dams. These deviations depend obviously on how energy sources co-fluctuate in time among themselves and with the demand as well. Balancing hydropower system design as well as their operational planning requires the estimation of these co-fluctuations, resulting from both, space and time weather structures/patterns and watershed features (e.g. area, altitude range, geological basement . . .).

The co-fluctuations between intermittent energy sources can be estimated from observed time series when available or from time series obtained from simulation models when not or when different contexts have to be considered (e.g. climate change and/or intermittent energy development). The simulation models were classically developed and evaluated for the prediction of each energy source individually. The ability of the models to simulate relevant levels of co-fluctuations is however to our knowledge not really considered. This issue is however critical and should also require thorough attention.

This work focuses on run-of-river and solar- power interaction assessment. The study area is located in Italy where run-of-river power plants, mainly located on small river tributaries, represent almost 43 % of the hydropower production with only 27 % of the installed hydro-capacity (in 2011). Solar power generation is available from observed time series at different locations over the region but there is no systematic measurement of water discharges over the considered river tributaries and discharges have to be reconstituted from simulations. The absence of discharge measures makes also impossible to calibrate hydrological model at each power plant location. We thus analyzed how water discharge prediction accuracy controls the assessment quality of run-of-river- and solar-power interaction. We especially sought over which hydro-meteorological context a simple prediction method of water discharge is able to produce pertinent run-of-river and solar power interaction assessment. We considered three degrees of complexity to estimate water discharges: i) model-based estimation using calibrated parameters over the watershed, ii) model-based estimation using parameters from nearby watershed and then iii) a scaling law. This work has been performed for a set of watersheds over a climate transect going from the Alpine crests to the Veneto plains in the north eastern part of Italy, where observed run-of-river power generations present different degrees of complementarities with solar power.

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