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Modeling the climate dependency of the run-of-river based hydro power generation using machine learning techniques: an application to French, Portuguese and Spanish cases.

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A big challenge of sustainable power systems is to integrate climate variability into the operational and long term planning processes. This issue is addressed in the CLIM2POWER European project. Its overall goal is to provide improved guidance to power systems' stakeholders by combining high resolution weather forecasts and enhanced energy system model.

In this work, we are interested in the modeling of the run-of-river based hydro power generation in function of climate variables (precipitations, snowfall and air temperature). Translating time series of meteorological forecasts into time series of run-of-river based hydro power generation is not an easy task as it is necessary to capture the complex relationship between the availability of water and the generation of electricity. Indeed, this kind of hydro power generation is limited by the flow of the river in which the power plants are located. Moreover, the water flow is a nonlinear function of the weather variables and the physical characteristics of the river basins. Finally, the impact of the weather variables on the runoff may occur with a certain delay, whose determination depends on physically based phenomena (e.g., melting snow–local temperature).

Our main goal is to formalize a model which is able to predict the daily national run-of-river hydro power generation based on the impact of weather variables such as precipitation, snow fall and air temperature of some climate regions of European countries. At this aim, several well-established regression algorithms based on machine learning (ML) techniques are used and compared in terms of correlation coefficient, adjusted coefficient of determination, mean absolute and mean square percentage errors. We compare the performance of five ML algorithms and select the models with the highest accuracy. Our preliminary experiment show that the algorithms based on ensemble of trees and the artificial neural networks perform quite well in most of the evaluative criteria. We also show that the obtained models are quite stable and can be applied also for the long term prediction of the hydro power generation.

An additional output of our model is the corresponding modeling error, which measures the model ability in reproducing observed data. Based on the analysis of this error, we also design a stochastic model capable of reproducing the variability of the observed capacity factor along the years.

In this work, we focus on three case studies: France, Portugal and Spain.