Assessment of ancillary services contribution of a Kaplan turbine using different advanced technologies

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Abstract. With the decarbonization of the electric power networks, a massive integration of non-dispatchable Renewable Energy Sources drastically changes the grid balancing. Hydroelectric Power Plants already significantly support electricity power system flexibility with innovative solutions such as variable speed units, fast frequency control, fast generating to pumping modes transition, high ramping rate, inertia emulation, etc. However, the choice of technology is specific to the hydropower plant and requires in-depth studies to quantify the ancillary services contribution.

In the framework of XFLEX HYDRO H2020 European research project, 7 demonstrators were analysed and different technologies were compared to extend the ancillary services contribution. Among these demonstrators, one of the four Kaplan units of Vogelgrun Run-of-River (RoR) power plant has been selected to be hybridized with a small size battery. In this particular case, the Battery Energy Storage System (BESS) works in tandem with the hydro unit, thanks to a joint control algorithm, and optimizes the ancillary services contribution of the power plant. To assess the interest of this technology, a 1D SIMSEN model of this RoR power plant was created and validated with site-measurement. A particular attention was paid to the modelling of the existing turbine governor combining the control of the flow of the Rhine river and the frequency Containment Reserve (FCR).

This article presents a comparison of 3 different technologies applicable for this RoR power plant: i) fixed speed technology used as a reference case, ii) variable speed technology and iii) Hydro Battery Hybrid (HBH) technology. The methodology consists in extending the 1D SIMSEN simulation model to the different technologies and assess the different ancillary services contribution, such as the Frequency Containment Reserve (FCR), the Fast Frequency Response (FFR) and the black start capability. This analysis is a contribution to the so-called Ancillary Service Matrix (ASM) presenting the ability to deliver the different ancillary services combined with the applicable technologies. The results are available as a public deliverable of the XFLEX HYDRO H2020 European research project.