

# **Economic viability of pumped-storage power plants participating in the secondary regulation service**

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**Abstract—** This paper analyses the economic viability of twelve pumped-storage hydropower plants equipped with different fixed-speed and variable-speed units and with and without considering hydraulic short-circuit operation. The analysed plants are assumed to participate in the day-ahead energy market and in the secondary regulation service of the Iberian power system. A deterministic day-ahead energy and reserve scheduling model is used to estimate the maximum theoretical income of the plants assuming perfect information of the next day prices, the residual demand curves of the secondary regulation reserve market and the percentages of the real-time use of the committed reserves. An estimate of the minimum theoretical pay-back period is obtained from the maximum theoretical income as a result of the scheduling model. Results indicate that the economic viability with and without variable speed units and operating or not in hydraulic short-circuit mode is not discarded if the plants also participate in the secondary regulation service, and that the minimum theoretical pay-back periods can be reduced significantly when the plant is equipped with variable speed units and/or operates in hydraulic short-circuit mode. In addition, the maximum theoretical income obtained with the used optimization model and the proposed pumped-storage hydropower plants are significantly higher than the real income obtained by plants that are currently operating in the Iberian system.

**Index Terms—** Pumped storage plant; Secondary regulation service; Variable speed technology; Hydraulic short-circuit operation; Economic viability

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