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# Risk-averse profit-based optimal scheduling of a hydro-chain in the day-ahead electricity market

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**Abstract-**

**This paper presents a profit-based model for short-term hydro scheduling adapted to pool-based electricity markets. The objective is to determine a feasible and realistic operation of a set of coupled hydro units belonging to a small or medium-size hydroelectric company in order to build the generation bids for the next 24 hourly periods. The company is assumed to be price-taker, and therefore, market prices are considered exogenous variables and modeled via scenarios generated by an Input/Output Hidden Markov Model (IOHMM). In order to be protected against low prices scenarios, two different risk-aversion criteria are introduced in the model: a minimum profit constraint and a minimum conditional Value-at-Risk (CVaR) requirement, which can be formulated linearly in the context of the optimization problem. In order to ensure a feasible operation, the model takes into account a very detailed representation of the generating units, which includes forbidden discharge intervals, spatial–temporal constraints among cascaded reservoirs, etc. The non-linear relationship among the electrical power, the net-head and the turbine water discharge is treated by means of an under-relaxed iterative procedure where net-heads are successively update until convergence is reached. During each algorithm stage, previous iterations’ information is used to build the input–output curves. This way, the hydro scheduling problem can be formulated as a MILP optimization problem, where unit-commitment decisions are modeled by means of binary variables. The model has been successfully applied to a real-size example case, which is also presented in this paper.**

**Index Terms- Hydroelectric power generation; Mixed integer linear programming; Short-term hydro scheduling; Day-ahead energy markets; Profit maximization; Risk-ave**

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