

# **Long-term optimal allocation of hydro generation for a price-maker company in a competitive market: latest developments and a stochastic dual dynamic programming approach**

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## **Abstract-**

Since the liberalisation of the power industry, there has been a large amount of literature on the determination of optimal bidding decisions for price-maker energy producers. The vast majority of the work developed so far has focused on short-term horizons and may be viewed as successful approaches for systems whose operation is generally deterministic. In the case of price-maker hydro plants with significant storage capacity, however, the solution of the strategic bidding problem is more subtle. The reason is that hydro reservoirs allow the bidder to postpone energy production if future prices are expected to be higher than the current price. This demands the management of an energy-constrained resource and determines a time-coupling characteristic to the problem, implying that the bidding strategy should ideally take into account the following stages and consider the stochasticity of inflows. These aspects characterise the strategic bidding for price-maker hydro agents as a multi-stage stochastic programming problem, with significant computational challenges. The objective of this work is to present a new methodology for the strategic bidding problem of a price-maker hydropower-based company, taking into account several hydro plants, time-coupling and stochastic inflow scenarios. The proposed approach considers a deterministic residual demand curve and is based on stochastic dual dynamic programming (SDDP), which has been successfully applied to the least-cost hydrothermal scheduling problem. Since the technique requires the problem to be concave, a piecewise linear approximation of the expected future benefit function is proposed. The application of the methodology is exemplified with a real case study based on the hydrothermal system of El Salvador.

**Index Terms-** dynamic programming; hydroelectric power stations; power markets; stochastic processes;

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