Stochastic control with state constraints of a photovoltaic plant with batteries.

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Abstract:

The ongoing clean energy transition suffers from geopolitical tensions and volatile energy markets. This issue, together with the rising demand for energy, makes necessary the employment of affordable and reliable energy supplies, [1], [2]. In order to achieve the desired transition, both renewable energies and storage have become key factors. In particular, the combination of solar photovoltaic sources with batteries provides a short-term flexible solution for electricity markets despite the uncertain nature of the renewable resource.

In this work, we develop a technique for electricity producers to determine optimal offers in day-ahead electricity market auctions and to control the renewable power plant in real time. For these purposes, we make use of mathematical modelling and stochastic control theory. Specifically, a system of stochastic differential equations is presented for the modelling of a photovoltaic power plant with storage in conjunction with the price of electricity, [4], [6]. Later, a stochastic optimal control problem with state constraints is introduced. Then, we make use of the Fokker-Planck equation, [7], which allows us to equivalently formulate the optimal control problem for stochastic ordinary differential equations as an optimal control problem for deterministic partial differential equations. Finally, the optimality conditions are deduced, which involve the Hamilton-Jacobi-Bellman equation, [8], [3]. A similar work for a wind power plant has been recently published in [5].

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