Design and management of a smart grid under uncertainties

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A micro grid is an isolated network composed by a group of loads and productions often including renewable like photovoltaic. In this kind of systems, the uncertainty both on load and renewable production is high and can be mitigated by including batteries in the micro grid. Thermal production is also used as backup solution. This kind of systems have been considered for example in [1] and [2] in which authors show the importance of optimizing the strategy of the battering using stochastic control versus a deterministic strategy.

The aim of the project is to extend the micro grid model considered in [2] by including a delay constraint in the thermal production asset. This was considered by [3] in the case of an operator who manages its thermal plant with respect to his forecast of demand and renewable production but who is connected to a more global network and as such can trade on the exchange markets. Because of this delay constraints in the thermal asset, it can happen that the production could not match the load at some time. In this project, the objective function of the operator will then be to minimize the costs of operation subject to a probability constraint on the quantity of load which may not be served. These stochastic target problems with controlled losses have been studied in [4]. The project will also analyze the optimal design in terms of the capacity of the thermal plant and of the capacity of the battery with respect to the probability of failure tolerated on the microgrid. Numeric implementations can use the open source library StOpt (`https://gitlab.com/stochastic-control/StOpt`).

[1] Pierre Haessig. "Dimensionnement et gestion d'un stockage d'énergie pour l'atténuation des incertitudes de production éolienne", PhD, ENS Cachan, 2014.
[2] B. Heymann, J.-F. Bonnans, G. Jiménez, F. Silva, "A Stochastic Continuous Time Model for Microgrid Energy Management", European Control Conference (ECC), Aalborg, Denmark, June 29 - July 1, 2016.
[3] R. Aïd, P. Gruet, H. Pham, "An optimal trading problem in intraday electricity markets", Mathematical and Financial Economics. vol. 10, pp. 49-85, 2016.
[4] B. Bouchard, R. Elie and N. Touzi, "Stochastic Target Problems with Controlled Loss", SIAM Journal on Control and Optimization, 48, 5, pp. 3123-3150.

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