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Ana Busic **(Inria)**

Title: "Optimizing mean-field dynamics for flexible loads control in power systems"

Abstract:

Matching power supply and demand used to be relatively straightforward, with large and controllable power plants on the one hand, and demand that was relatively easy to predict on the other. In recent years, there has been a significant increase in renewable power generation. The drawback of the inexpensive energy from the wind and the sun is its uncontrollable intermittence and volatility, such as ramps with the setting sun or a gust of wind. Controllable generators manage supply-demand balance of power today, but this is becoming increasingly costly with increasing penetration of renewable energy, due to the need to compensate for the missed opportunity cost the power plants are facing while operating at a lower set-point to be able to ramp up and down more aggressively than in the past. At the same time, the rapid development of "smart technologies" (e.g. Linky meter and the connected appliances) open new possibilities for innovation on the demand side.

There is an enormous flexibility potential in the power consumption of the majority of electric loads (e.g. thermal loads such as water heaters, air-conditioners and refrigerators; electric vehicles etc.). Their power consumption can be shifted in time to some extent without any significant impact to the consumer needs.

Since the 1980's, mean-field models have been used as a tool for analysis of distributed control of flexible loads. This talk surveys recent work on the optimization of mean-field dynamics. The focus is on a Kullback-Leibler-Quadratic (KLQ) optimal control formulation for the Demand Dispatch problem, i.e. creating virtual energy storage from flexible electric loads. The grid balancing authority simply broadcasts the desired aggregate power consumption target signal, and the population of loads ramps power consumption up and down to accurately track the signal.