# Statistical and mean field game methods for the modeling and control of aggregate electric water heating loads

Roland Malhame*†[1,2]

[1]Ecole Polytechnique de Montréal (EPM) – Campus de l'Université de Montréal 2500, chemin de Polytechnique Montréal (Québec) H3T 1J4, Canada

[2]Groupe d'études et de recherche en analyse des décisions (GERAD) – HEC Montréal 3000, chemin de la Côte-Sainte-Catherine Montréal (Québec) Canada H3T 2A7, Canada

**Abstract**

Increasing penetration levels of intermittent renewable energy sources (wind and solar) have created new stresses on the stability of electric power systems. Indeed, these sources are essentially uncontrollable, and only partially predictable, thus making it more difficult to maintain the balance between electricity generation and electricity demand. While the traditional business model has been one where customers were free to impose their loads, and utility had to deliver the electricity, there is an increasing consensus that the customer demand should from now on be at least partially shaped in response to power availability. This can be achieved either through weather sensitive pricing, or demand dispatch approaches coupled with financial incentives, both made possible by the improved telecommunications infrastructure of modern smart grids.

In the context of demand dispatch, electric loads associated with energy storage are particularly interesting to aim at, because they could be partially deferred or anticipated in response to market prices or renewable energy expected availability. Electric water heating , EWH, loads are of special interest since, if properly managed, they can be aggregated into a fast responding virtual battery to help mitigate the impact of renewable energy fluctuations with little impact on customer comfort. In this talk, we review a class of aggregate thermostat- controlled EWH modeling methods based on statistical mechanics inspired approaches. Also, we show how prescriptive mean field game theory can be used to robustly tune their collective response to piecewise constant signals of energy increase or decrease sent by either a utility or a load aggregator operating on the energy market.

This is joint work with Arman Kizilkale.

*Speaker

†Corresponding author: