A Bilevel Approach to Determine New Energy Service Prices

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In this work, we model and solve an energy pricing problem (EPP) for residential Demand Side Management. To shift part of the load from peak periods to off-peak ones, an energy provider offers new services to consumers. The objective of EPP is to determine prices of these new services to maximize the Energy provider's profit, defined as the difference between services revenues and production costs, explicitly taking into account the behaviour and the invoice of the consumers. The production cost is defined as an increasing function of consumption. Thus higher revenues for EDF may be reached with smaller prices if these prices induce consumption shifting from peak periods to off-peak periods.

One of the challenges of EPP is to properly model customers' behaviour when choosing energy services. We assume that customers minimize their disutility function. This is the sum of the monetary costs and unwillingness to change consumption habits. Of course the second term may differ according to the sets of customers. In fact two main factors influence domestic consumption: the type of appliances used (heating or not, cooler or not, ..) and the willingness of the customers to change their consumption. Thus, in our model, customers are divided into categories (regarding their contracts with the energy provider) and segments regarding their reluctance to change their behaviour.

We propose several bilevel models to represent the hierarchical decision making process between the energy provider (the leader) and the consumers (the follower). Both decision variables (resp. objective functions) of the leader and the follower are continuous (resp. bilinear). Through a linearization scheme, the bilevel models are reformulated as mixed integer models and solved using CPLEX or any other off-the-shelf solver. Numerical results are given and discussed.