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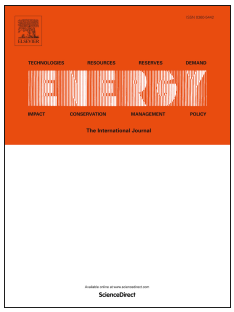

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ACCEPTED MANUSCRIPT

Optimal Contracts of Energy Mix in a Retail Market under Asymmetric Information

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Abstract

Co-generation plants have become mainstream energy production facilities at the demand side owing to their high efficiency and flexibility in operation. During the transition to more integrated energy supply, trading of energy mix will become an important issue, where a retailer is expected to play a more active role. This paper discusses the design of retailer's optimal contract with asymmetric information. Bilateral relationship between retailer and consumers can be described as an information game and is characterized by package contracts based on publicly observable information only. First, a mathematical model for the optimal contract design problem involving two coupled energy markets is established. Then, an equivalent reduced model is obtained by several certified lemmas and theorems. Consumer behaviors behind each reduction step are revealed. Thereafter, the market equilibrium is characterized with a proof of existence, revealing the impact of asymmetric information on the retailer's strategy. An illustrative example with locational marginal price based heat-power market is presented. Case studies confirm the theoretical analysis and show that our model can promote retailer's profit. The impact of several factors, such as the probability and reservation utility level, has been tested, providing fundamental insights into strategic behavior in multi-energy market under asymmetric information.

Keywords: Asymmetric information game; energy mix; package contract; retail market.

Nomenclature

Indexes, Sets, and Symbols

i	Index of consumers
w	Index of buses in energy network 1
v	Index of nodes in energy network 2
$\mathcal{N}$	Set of consumer types
$\mathcal{C}$	Set of package contracts
$\mathcal{P}$	consumer's distribution
$\hat{\Xi}$	Optimal solution of retailer's contract design problem under symmetric information
Ξ^*	Optimal solution of retailer's decision-making problem under asymmetric information
$\Xi^{*'}$	Optimal solution of retailer's decision-making problem under countervailing incentive
φ_p, φ_h	Functions depict the relationship between energy consumption and energy prices
$\Gamma(.)$	Risk preference function

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