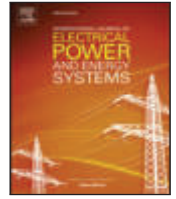




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Multi-step optimization of the purchasing options of power retailers to feed their portfolios of consumers[☆]

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ABSTRACT

The liberalization of the retail market of electricity increased the tariff choice of end-use consumers. Retailers compete in the retail market for customers, obtaining private portfolios of end-use consumers to manage. Retailers buy electricity at wholesale markets to feed their customers' demands. They can use spot, derivatives, and bilateral markets to acquire the energy they need. The increasing levels of variable renewable energy sources trading at spot markets, increase the price volatility of these markets. To hedge against the volatility of spot prices, retailers may negotiate standard physical or financial bilateral contracts at derivatives markets. Alternatively, they can also negotiate private bilateral contracts. This article addresses the optimization of the retailers purchasing options, to increase their risk-return ratio from electricity markets, and offer more competitive tariffs to consumers. Considering the risk attitude of retailers, they use a multi-step purchasing model composed of a multi-level risk-return optimization and a decision support system. The article presents an agent-based study considering a retailer with a portfolio of 312 real-world consumers. Risk-seeking and risk-neutral retailers obtained a return up to 38%, less than 7% of the optimal return. However, risk-neutral retailers are subject to four times higher risk in their returns than risk-seeking retailers. The results support the conclusion that wholesale markets of electricity are more favourable to risk-seeking retailers, considering their real returns.

1. Introduction

The deregulation of the electricity supply industry has brought full competition to both wholesale and retail markets (see, e.g., [1,2]).

A wholesale market is a market where competing generators offer their electricity output to demand-side players [3]. Market participants can trade electricity in three key (sub-)markets [4]: spot, derivatives, and non-organized bilateral markets. Spot markets include mainly day-ahead (DAM) and intraday or real-time markets, where participants can submit bids involving prices and quantities of electricity (as well as some other complex conditions) [5]. Derivatives markets allow players to sign standardized bilateral contracts to hedge against spot price volatility. They include forwards, futures, options, and swaps (or contracts for differences). Non-organized bilateral markets allow players to privately negotiate the terms and conditions of tailored bilateral contracts, typically covering the delivery of large amounts of energy over long periods (months to years). As Balance Responsible Parties (BRPs), the trades agreed by all players on these markets, lead to a programmed dispatch that they have to comply with, to avoid the payment of penalties. Unbalances between supply and demand may affect the security of the power system because of frequency

deviations (normally there is a threshold of 1%), which are solved by the balancing reserves. These reserves are traded at the balancing markets, and their costs are paid by the BRPs that deviate from their dispatch schedules [6].

A retail market exists when customers can choose their suppliers from competing power retailers [7]. Retailers buy energy from wholesale markets and sell it to end-use consumers (end-users). They usually try to attract as many customers as possible, signing bilateral contracts with them, and thus defining non-optimal portfolios (in terms of risk and return). In other words, retailers usually pursue a "business as usual strategy", meaning that they offer high tariffs to clients, which are equal for customers with similar consumption patterns. Also, they often consider a high risk premium, making the energy part of the tariff (retail price) substantially larger than the (wholesale) spot price [8,9]. The risk premium depends on their attitude towards risk. Generally speaking, three attitudes towards risk are often discussed in the literature: risk-averse, risk-neutral, and risk-seeking. The risk attitude is also known as risk preference or aversion. Risk-averse retailers tend to define stable portfolios and consider "small" risk premiums, allowing them to propose "reduced" tariffs to consumers. Retailers with more

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