

# **A fundamental analysis on the implementation and development of virtual natural gas hubs**

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**Abstract—** The ongoing gas market liberalization in Europe has brought up a new competitive environment in which shippers (i.e., companies that are responsible for conveying gas from producers to consumers) must adapt their behavior to the changing conditions. The development of gas virtual hubs increases market interactions among shippers, but the oligopolistic market structure may give room for strategic behavior. The market is in addition segmented by type of customer. Each shipper maximizes its profit by supplying gas to households, businesses and industries (conventional customers), participating in the electricity market, trading in the global LNG spot market and interacting with the rest of shippers in a virtual hub. During the hub implementation and development, the following questions arise: How do shippers behave at the different levels of hub maturity? And, to what extent does the implementation of virtual hubs in entry-exit systems diminish the barriers to entry of new market players, provides more flexibility and fosters competition?

With this aim, the decision-making process of the different shippers is simulated under different market structures, representing four stages of the market liberalization process at different levels of hub maturity. First, the proto-liberalization case includes the global LNG spot market which is represented as a perfectly competitive market, the electricity market which is represented as an oligopoly, and the conventional demand which is assumed to be captive (i.e., monopolized). Second, a hub is implemented, which provides transparency and reduces information costs by revealing the gas price. Third, switching rates are expected to grow as consumers have access to a transparent gas price; hence, the conventional demand is no longer considered as captive. Fourth, wholesale (procurement) and retail activities are unbundled, and a wholesale market is established where the retailers presumably buy gas from the shippers; thereby wholesale and retail activities acquire importance and market transactions (i.e., liquidity) increase. From the simulation and the analysis of the different market equilibria, the following conclusions emerge. First, with the introduction of the virtual hub, the marginal cost of all shippers reaches a unique value, i.e., the transparent gas hub price. Second, the aggregated profit of the shippers is increasing even when anticompetitive behavior is not explicitly represented, due to the flexibility gained by shippers with the hub. Accordingly, and third, the hub is a necessary, but not sufficient, condition to increase competition. The entry of new players is critical and discouraging market regulations or the anticompetitive behavior of a highly concentrated market may not facilitate it.

**Index Terms—** Natural gas virtual hubs, market liberalization, entry-exit access system, mathematical modeling

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