The visible hand: ensuring optimal investment in electric power generation

By Thomas-Olivier Léautier, Toulouse School of Economics

An essential objective of the restructuring of the electric power industry in the 1990s was to "push to the market" decisions and risks associated with investment in power generation, i.e., to have market forces, not bureaucrats, determine how much investment is required, and to have investors, not rate-payers, bear the risks of excess capacity, construction cost overruns and delays.

However, since the early 2000s, generation adequacy has become an issue of concern for policy makers, power System Operators (SOs), and economists. It would appear that, contrary to the initial belief, the "market" does not necessarily deliver the adequate level of generation capacity. Britain, that pioneered the restructuring of the electricity industry in 1990, constitutes a recent and striking example: the energy regulator warned that if the winter 2015/2016 is very cold, involuntary curtailment of customers may occur.

Operating and regulatory practices aimed at preventing the exercise of market power are often considered to be the primary cause of this "market failure". The theory of peak-load pricing, developed by Marcel Boiteux in the late 1940s, suggests that high prices during a few hours per year are required to finance the optimal capacity. However, in most jurisdictions SOs impose *de jure* or *de facto* price caps, which deprive producers of these high prices. This revenue loss, called "missing money", is considered an important driver of underinvestment in generation.

Therefore, SOs and policy makers worldwide have designed and implemented a variety of mechanisms to correct this apparent "market failure". For example, most US power markets have adopted highly structured and prescriptive physical certificates markets, and many European countries are considering, designing or implementing capacity mechanisms. These mechanisms are extremely complex, hence expensive to set up and run. Furthermore, they constitute a partial reversion towards central planning, which restructuring precisely attempted to eliminate: using a centralized system reliability model, the SO sets a generation capacity target, and organizes its procurement. Risk of overcapacity is borne by consumers, while risk of cost overrun is borne by investors.

This article is the first I am aware of to undertake a rigorous economic analysis of the various mechanisms implemented by SOs to restore investment. If markets were perfect, they would lead to optimal investment. Therefore, an imperfection is required to explain departure from this optimum. This article considers that competition among producers is imperfect, both in the spot and investment markets, and that policy makers attempt to curb market power by imposing price caps.

In that setting, the analysis yields three main findings. First, this article examines the equilibrium of markets where energy and forward physical installed capacity certificates are separately exchanged. This is the case for example in the Northeast of the United States: 3 to 5 years ahead, the SO procures from producers physical capacity certificates (usually 15 to 20% higher than anticipated peak load to protect against supply and demand fluctuations). The cost of these purchases is then passed on to customers. The analysis shows that the SO must impose a "no short sale" requirement, i.e., require producers to sell less certificates than have installed capacity (or to build as much capacity as they have sold certificates). If she does not, strategic underinvestment occurs. If she does, a physical capacity certificates market restores investment incentives: the resulting capacity installed is optimal. For a given price cap, social welfare is thus

maximized. However, producers' profits are higher than the imperfect competition outcome without the capacity market. Numerical illustration suggests the additional rent from the capacity market ranges between 10 to 16% of the investment cost. This finding explains why producers are favorable to capacity markets being setup.

Second, this article analyzes the equilibrium of another form of forward markets, where producers are required to sell, through the SO, financial call options to customers, covering all the demand up to a certain level at a given strike price. Option sellers pay customers the difference between the actual spot energy price and the strike price.

The analysis proves that options sale reduces but does not eliminate market power. Installed capacity is higher with options sale than without, but still lower than socially optimal. To ensure optimal investment, the SO must again impose a "no short sale" requirement. If she does, financial reliability options and physical capacity certificates with the "no short sale" conditions are proven to be equivalent. Reliability options thus also sur-remunerate strategic underinvestment.

Finally, this article examines an "energy cum operating reserves market". SOs procure operating reserves to protect against an unplanned generation outage. It has been proposed the SO balances supply against demand for energy *and* operating reserves. Producers should receive additional revenues since: (i) the resulting power price is higher than when the SO balances supply against demand for energy alone, and (ii) capacity providing operating reserves – but no energy – is remunerated. This additional revenue is expected to resolve the missing money problem, hence restores investment incentives. However, the analysis shows this intuition is invalid: since these additional revenues are already accounted for in the determination of the installed capacity, the situation is isomorphic to standard peak-load pricing.

Each of these three mechanisms is examined individually in this article, while they may be implemented jointly in practice. For example, most US markets have a physical certificate mechanism and co-procurement of energy and operating reserves.

The analysis yields clear policy recommendations. If policy makers and the SO are confident a market is sufficiently competitive, as may be the case in Texas, there is no need to impose a price cap and set up a forward capacity market (physical or financial), which are complex and costly to administer. Imposing a very high price cap, set to the best estimate of the Value of Lost Load (VoLL) or setting an energy cum operating reserves market" are simple to set up and, if the VoLL used is close enough to the real VoLL, cause limited distortion compared to the optimum.

On the other-hand, policy makers may determine that generation is insufficiently competitive in their jurisdiction. This may be the case in European markets, where in most markets less than 10 generation companies actually compete. This may also be the case where congestion on the transmission grid separates the market in smaller submarkets, and producers may be able to exert local market power. Then, policy makers should set up a forward capacity market as an interim measure while removing barriers to competition. Since financial reliability options provide better incentives than physical capacity certificates, they should be preferred.