Cécile Bazart , Corinne Chaton and Marie-Laure Guillerminet

OPTIMAL DESIGN OF ELECTRICITY GENERATION INDUSTRY UNDER DEREGULATION AND SUPPORT TO RENEWABLE ENERGIES

Cécile Bazart: Laser, Université Montpellier 1, Espace Richter, Avenue de la Mer, B.P. 9606, 34054 Montpellier Cedex 1,Montpellier, France.
Phone: +33-4-67-15-83-32, Fax: +33-4-67-15-84-04, e-mail : cecile.bazart@univ-montp1.fr
Corinne Chaton: CABREE, University of Alberta, Alberta, Canada, e-mail: Corinne.chaton@edf.fr
Marie-Laure Guillerminet: Research Unit Sustainability and Global Change, Hamburg University and Centre for Marine and Atmospheric Science, Hamburg, Germany, e-mail: ml_guillerminet@yahoo.fr

Overview

This paper deals with the decision to invest in power generation units under deregulation and gas emission constraints. Considering the construction lag of various generation technologies and the degree of opening to competition, the analysis focuses on both short and long term. We thus take into account: the evolution of deregulation, the ability for an entrant to finance heavy investments in generation (nuclear, windmills), increasing environmental constraint and the information structure of this type of problem. Under such assumptions we provide a model of optimal expansion and investment planning for the French power market. The aim of the Paper is then to estimate what the French incumbent investment decisions would be in the future. We thus determine the future equilibrium conditions (price) and capital investment decisions for the actors. Additionally, we question the future role of nuclear power to supply base load demand in the French case.

Methods

For simplifying purposes we consider a duopoly: an incumbent, an entrant. In the deregulation context, the incumbent supplies power at regulated tariff to non eligible customers. At the same time, an entrant competes to supply eligible consumers, or industrial customers, at market price. Then, the progressive opening of the market introduces uncertainty on demand and additional uncertainty results of shifts in fuel prices and availability rates of plants. Also the environmental target (Kyoto protocol) will lie as an additional constraint on investment choices.

We assume that the market is structured to prompt entry, that is, release programs are implemented to allow entry without any previous investment in generation capacities. The entrant then benefits of a supply of power resources, at constant (even if negotiated) price, from the incumbent at first stage. It could nevertheless build its own generation capacities for the future. Moreover, we assume the entrant to be a gas supplier, already operating on another market. It thus has an access to gas, via long-term contracts, without uncertainty. On the other hand all other actors (incumbent here) face a growing uncertainty in fuel prices.

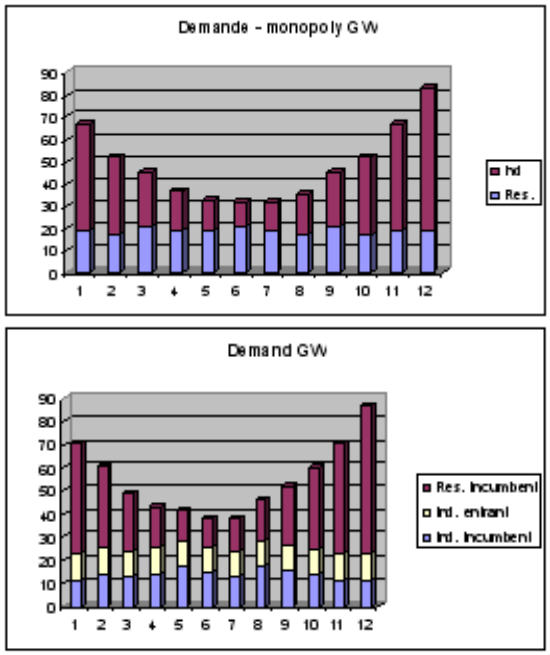
Using a multi period model (short/medium/long term); programmed with the GAMS software, we represent the improvements in competition on the market and its effect on the structure of the generation park. The periods are organized as follow 2003-2006-2015-(2020) with 12 infra periods. Each type of consumer (residential/industrial) as got his own demand. Non residential become are eligible in period 1 whereas residential consumers become eligible only in period 2. On the supply side we face a Cournot duopoly each actor

aiming at maximizing its profit. Each producer can use various technologies characterized by different availability factors and time construction lags. Then the structure of costs of alternative generation options would be reflected in prices. Then by maximizing the Net Present Value under constraint, we analyze future market equilibrium conditions and investment decisions under several scenarios.

Results

Our first results deal with: 1/ a static case monopoly versus duopoly 2/ the dynamic case with 4 scenarios corresponding to various levels of demand and fuel prices.

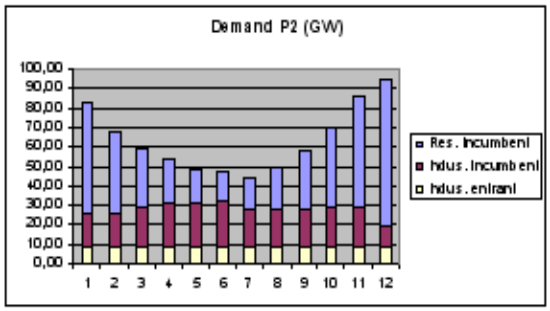
Static case:.

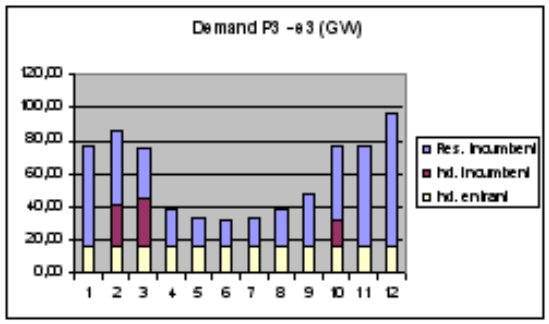


These results are in line with the theory: duopoly prices decrease compared to the monopoly case and demand is increased (428Twh to 480 Twh). The entrant provides part of the demand and invests in Nuclear power plants (10.79 Gw); Small Hydro units (1.87) on the other hand the incumbent invests in Small hydro units (0.14GW).

Dynamic case:

Uncertainty is introduced on demand and fuel prices this results in 4 cases: e1 low demand and fuel prices; e2 low demand but high prices; e3 high demand but low prices; e4 high demand and high prices. We add two assumptions: No nuclear decommissioning; Investment constraints for hydraulic.





The first graph shows that in period 2 the entrant provides par of the industrial demand, again total demand increases compared to period 1 from 581 TWh to 754 Twh. In Period 3 considering the more favorable scenario that is a high demand low / fuel price, the entrant provides the majority of the industrial demand.

Conclusion

We are actually working on the dynamic case introducing the emission constraint, release measures… With a renewable target our first results show that investments incumbents and entrant will invest in CCGT, Biomass and Wind energies. We will also aim at comparing two alternative supporting systems for investments in renewable that are the guaranteed price system and the green certificate system.