***AUCTION DESIGN FOR PROCUREMENT OF FLEXIBLE POWER***

**Daniel Monte**

University of Turin

+39 331 150 2966

[daniel.monte@fgv.br](mailto:daniel.monte@fgv.br)

**Pedro Ozenda**

Duke University

+55 21 999 952 535

[pedroozenda@hotmail.com](mailto:pedroozenda@hotmail.com)

**Richard Lee Hochstetler**

Instituto Acende Brasil

+55 11 964 290 578

[richard@acendebrasil.com.br](mailto:richard@acendebrasil.com.br)

**Rodrigo Moita**

University of São Paulo

+55 11 982 701 989

[rodmoita@usp.br](mailto:rodmoita@usp.br)

**Sara Boro**

CTG Brasil

+55 11 963 699 666

[sara.boro@ctgbr.com.br](mailto:sara.boro@ctgbr.com.br)

**Overview**

The procurement of power supply to meet future load is complex because it requires a combination of various power supply attributes. With the growing share of variable generation, power systems must ensure a proper mix of power resources to be able to meet the net load profile. Together power suppliers must be able to meet: (i) total projected consumption over a particular period (MWh/year), (ii) peak demand (MW), and (iii) load ramping requirements (i.e., capacity to increase or decrease supply at a certain rate MW/minute).

Designing an auction to procure a particular mix of these various attributes is complex because each power source (i.e. generation technology) presents a different combination of attributes. Thus, one of the main challenges is to design an auction that is able to coordinate the procurement of new power plants so that aggregate supply meets the demand of each of the power system required attributes at least cost.

**Methods**

The first step to effectively procure power resources to meet future needs is product delineation. One must diagnose what are the attributes that are expected to become scarce in the electric power system in coming years. Based on this analysis, one can identify how products should be defined.

The second step is to determine how to best procure the supply of the chosen products. The auction theory literature provides guidance on how to structure auctions to meet the challenges of interdependent pricing of multiple products. The acquisition of a particular combination of power supply attributes to meet system needs from different suppliers –each of which offers a bundle of the various attributes in fixed proportions– is analogous to the procurement of products with complementarities, since the producer can only optimally price each product (attribute) when the price of the other products are known.

To overcome this difficulty, the recommendation is to auction all products (attributes) in a single combinatorial auction. This enables producers to submit bids for different combinations of the various products.

Auction theory points out there are tradeoffs that must be considered. The “VCG Auction” (Vickery-Clarke-Groves Auction) provides the incentives for players to bid based on their true preferences, which ensures an efficient allocation, as a Vickery Auction (Second-Price Auction) does in the context of a single good. However, this auction may not be desirable from a distributive perspective, because it results in large rents to the agents (producers that actively participate in the auction as bidders). These large rents make the auction unattractive to the principal (buyer) that commissions the auction to purchase the products. In this context, a hybrid auction design is generally better suited. By sequentially combining two different auction designs, one can achieve the selection of the producers that are apt to supply the required combination of attributes at least cost, while obtaining a lower price for the buyers. The auction design that is most used in this context is the Combinatorial Clock Auction.

**Results**

Brazil’s future power supply needs can be appropriately met with the procurement of three products:

* reliability options,
* peak-demand capacity, and
* flexible capacity.

The proposed auction design to implement the acquisition of these three products is a Combinatorial Clock Auction, composed of two-stages:

* in the first stage, a Decreasing-Price Clock Auction is employed to adjust prices of the various products to a level at which the quantities supplied of each product are slightly larger than the quantities one desires to acquire; and
* in the second stage, Sealed-Bid Auction is employed, in which each producer submits a single price-discount bid for their bundle of products.

The auctioneer then chooses the combination of bundles that meet the demand for the various products at least cost.

**Conclusions**

The power supply resources required to meet future load can be achieved by market mechanisms, given proper product delineation and the adoption of an adequate auction design.

**References**

Ausubel, L. e Baranov, O. (2014). Market design and the evolution of the combinatorial clock auction. *American Economic Review* 104(5):446–451.

Clarke, E. (1971). Multipart pricing of public goods. Public Choice, 11:17–33.

Cramton *et al.* (2004). *Combinatorial Auctions*. Cambridge: MIT Press.

Cramton, P.; A. Ockenfels, and S. Stoft (2013). Capacity market fundamentals. *Economics of Energy & Environmental Policy*, 2(2):27–46.

Empresa de Pesquisa Energética (2021a). Metodologia de Quantificação dos Requisitos de Lastro de Produção e Capacidade. Nota Técnica EPE/DEE/133/2021-r0. Brasília: EPE

Empresa de Pesquisa Energética (2021b). Metodologia de Referência para a Quantificação da Contribuição da Oferta: Lastro de Produção e Capacidade. Nota Técnica EPE/DEE/134/2021-r0. Brasília: EPE

Empresa de Pesquisa Energética (2021c). Precariedade de limite de oferta e mecanismo para cobertura de exposições. Nota Técnica EPE/DEE/135/2021-r1. Brasília: EPE

Goeree, J. e Holt, C. (2010). Hierarchical package bidding: A paper pencil combinatorial auction. *Games and Economic Behavior*, 70(1).

Groves, T. (1973). Incentives in teams. Econometrica, 41(4):617–631.

Hochstetler, R.; R. Moita e D. Monte (2017). Capacity Markets in Hydro-Intermittent Dominated Systems. Rio de Janeiro: Encontro Latino-Americano de Economia da Energia – ELAEE.

Hochstetler (coord.) (2019). *Reflexões sobre uma Arquitetura de Mercado para o Setor Elétrico Brasileiro*. Rio de Janeiro: Synergia Editora.

Hogan, W. (2013). Electricity scarcity pricing through operating reserves*. Economics of Energy Environmental Policy*, 2(2):65–86.

Scheffel, T., Ziegler, G. e Bichler, M. (2012). On the impact of package selection in combinatorial auctions: an experimental study in the context of spectrum auction design. *Experimental Economics*, 15:667–692.

Vickrey, W. (1961). Counterspeculation, auctions, and competitive sealed tenders. Journal of Finance, 16:8–37.