Alireza Abbasy[1], Reinier A. C. van der Veen[1], Rudi A. Hakvoort[1]

COORDINATION OF TIMING OF RESERVE CAPACITY AND DAY-AHEAD ELECTRICITY MARKETS

[1] Delft University of Technology, the Netherlands, +31 (0)15 27 82040, a.abbasy@tudelft.nl

OVERVIEW

The typical wholesale electricity markets, mainly Day-Ahead (DA) and Intra-day (ID), are not the only marketplaces within the broad context of restructured market-based power systems. Due to the unique technical characteristics of electricity (as a product), several services are needed for secure and reliable operation of the grid, mainly known as Ancillary Services. One critical category of these services is different types of reserves that need to be available in order to balance supply and demand in real-time; also known as balancing services. The providers of these services are generators (and in some cases, willing consumers) who offer some part of their available capacity as reserves to the system operator, who is responsible for system security. Thus, Reserve Capacity (RC) markets are created.The complicating factor in design of these reserve capacity markets is that generators have the opportunity to offer their free capacity in DA and ID markets *or* in reserve capacity markets. In other words, these different markets compete with each other for attracting bids. Therefore, design of reserve capacity markets can not be done in isolation from other electricity markets. This paper focuses on coordination of timing of reserve capacity markets and DA markets and it studies the effect of alternative clearance sequences of DA and RC markets. Three cases are defined: Case A represents simultaneous clearance, in Case B first the RC market is cleared and then the DA market, and in Case C the DA market is first and the RC market is cleared afterwards. Using an intuitive argument, the authors in [1] explicitly mention that in order to avoid low liquidity and higher prices, the RC market must be closed before the DA market, and it is confirmed by [2] that to ensure that the system operator has the reserves to maintain system security, the RC market should be first. However, the issue of the sequence of these two markets is still an open question. The objective of this study is to see how these different possible designs can influence the behaviour of bidders in the two markets, using market clearing prices and volumes of offered capacity in each market as the main indicators.

METHODS

A simulation model is built in MATLAB using the agent-based modeling concept. Each agent is a generator who has to decide on its bids in the RC and DA markets, and the bids consist of a volume (in MW) and a price (in €/MWh for the DA market and in €/MW/hour for the RC market). We have defined two types of agents: Risk-averse agents who do not try to influence the market clearing price by increasing their bid price, and Risk-prone agents who do try to increase the market price by increasing their bid prices. In each round of the simulation, each agent decides on its offered volumes and prices for the next round by adapting its current bids, using the market information of the last round. In addition to the bid price, each agent adapts its offered capacities in the two markets (for the next round) by comparing its individual relative profits in the two markets and shifting some capacity (depending on the size of the difference in profit) from the less profitable to the more profitable market.

RESULTS

The data list of the generation units in Germany is used in this model: 262 units (different types) with different operating costs [3]. It is assumed that each generator bids separately, regardless of whether or not the owner is the same company. In the following results, the demand of the DA market is 74000 MW (peak load in Germany) and the demand in the RC market is 6000 MW (sum of the demand for secondary and tertiary control in Germany). Figure 1 shows the market clearance prices (for each round) of the DA market and the RC market for the 3 cases. As can be seen, in terms of the DA market, case A results in the highest market price which originates from lack of the possibility of capacity substitution between the two markets; non-selected bids in one market can not be transferred to the other market so the corresponding non-selected capacity is lost (not used). However in the RC market, case B has the highest market price because of the considerable Lost Opportunity Cost (LOC) component that will be added to the bid prices of generators in the RC market because of the sequence of market clearance; the capacity offered in the first market (RC in case B) comes with a price high enough for the bidder to insure that no possible profit is missed in the second market (by offering that capacity in the first market). Another interesting outcome is that in case C the RC market price goes down to zero. In case C, the RC market is the second so there is no LOC component in the bids of generators and in the RC market there is no operating cost either (in contrast to the DA market). Presence of a high-enough level of competition will push the bid prices down to zero (actually to the level of fixed costs which have been neglected here). As another critical indicator, the offered capacity in the RC market for cases A, B and C are around 18000, 14000, and 35000 MW, respectively. Thus, in case C (in which the RC market is the second market) the highest capacity is offered.

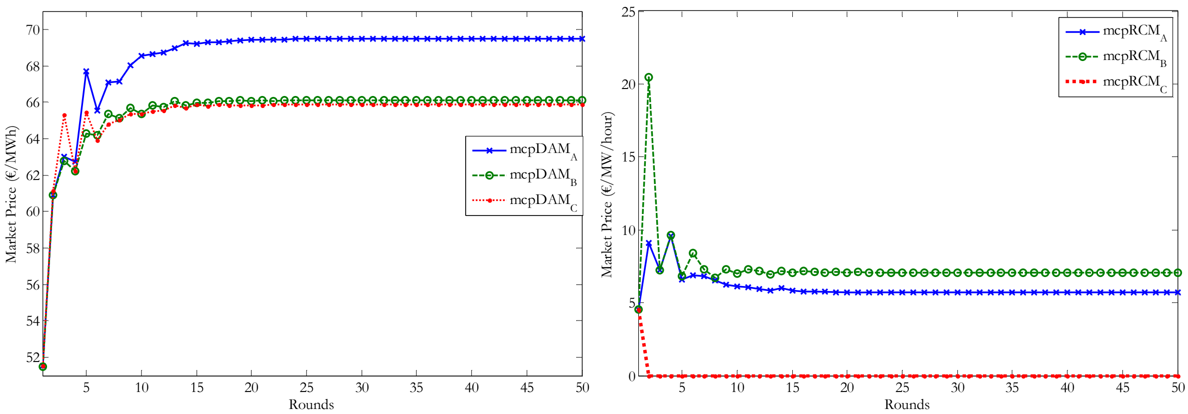

Fig. 1. Market clearing prices (MCP) of the DA market (left) and the RC market (right) for the three cases

CONCLUSIONS

Coordination of timing of the RC and DA markets plays a decisive role in the offered capacities and the market clearing prices, by changing the behavior of generators who bid in the two markets. In contrast to the intuitively expected outcome, the results of the analysis show that Case C leads to the lowest market prices, especially the RC market price, and highest offered capacity in the RC market, which is highly desirable from a system security perspective.

REFERENCES

1. Riedel, S., Weigt H., (2007). German electricity reserve markets. Electricity markets working paper No. EM-20.
2. Union of the Electricity Industry – EURELECTRIC (2008). Towards market integration of reserves & balancing markets. Eurelectric position paper.
3. Thermal power plant cost data from the project "Balance management" (2007-11), Sintef, Norway.