

# 31761 - Renewables in Electricity Markets

## Exercise session 3: Intra-day and balancing markets

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The aim of this exercise session is to appraise and better understand the basic structure of electricity markets, and most particularly its intra-day and balancing mechanisms. The session relies on Modules 1-3 of the course.

### Problem 1: Setting up our own balancing market

This Problem builds on Exercise sessions 1 and 2 which focused on day-ahead markets. Especially, we assume that the day-ahead market was cleared following Problem 4 (of Exercise session 1), i.e., based on the list of supply and demand offers described in Problems 2 and 3 (of Exercise session 1), respectively.

Before actual operation, a list of market players who can provide balancing services for that time unit is gathered. To simplify things, all of these players already participated in the day-ahead electricity market. Only generators (not demand) are ready to provide balancing. These include:

Supplier name	Supplier id.	Up. quant. [MWh]	Up. Price [€]	Down. quant. [MWh]	Down. Price [€]
FlexiGas	G <sub>1</sub>	15	80	-	-
RoskildeCHP	G <sub>4</sub>	5	50	15	15
BlueWater	G <sub>5</sub>	20	35	20	5

- 1.1 What is the generation schedule for these generators after the market clearing of Problem 4 (in Exercise Session 1)? Please re-calculate their revenues after day-ahead market clearing.
- 1.2 Draw the supply curve corresponding to these balancing offers.
- 1.3 Nuke 22 has a problem with its cooling system, yielding a shortage of 22MWh in comparison with the amount contracted through the day-ahead market. What is the resulting demand for our balancing market? Add this demand curve to your previous drawing.
- 1.4 What is the resulting balancing price, and who will provide the balancing service? How many MWh and in which direction?
- 1.5 Calculate the revenues and payments for all participants in this balancing market. Deduce the combined revenues, considering both day-ahead and balancing markets.
- 1.6 Go again through points 2.3-2.5 now considering that it is CleanCharge that needs 10 MWh more than in the original day-ahead contract.

### Problem 2: One-price vs. two-price imbalance settlements

This Problem is a follow-up of Problem 1 (hence similarly building on Exercise Session 1). We therefore still assume that the day-ahead market was cleared following Problem 4, i.e., based on the list of supply and demand offers described in Problems 2 and 3, respectively. The list of players who can provide balancing services for that time unit was given in Problem 1.

Quite a few market participants are not able to meet their contracts, and will then induce imbalances. The full list includes:

Participant name	Participant id.	Deviation [MWh]
ShinyPower	G <sub>3</sub>	+5
WeLovePower	D <sub>1</sub>	+8
Nuke22	G <sub>2</sub>	+10

In the above table, a deviation of +10 MWh means that the market participant (*i*) generates 10 MWh than his contract if being a supplier, or (*ii*) consumes 10 MWh more than his contract if on the demand side. We now aim at performing the imbalance settlement following both one-price and two-price

systems.

- 2.1 Assess the overall system imbalance resulting from this individual imbalances. Will the system need upward or downward regulation?
- 2.2 Which are the units whose imbalance are putting the system off-balance, and which are (involuntarily) helping the system getting back to balance?
- 2.3 Clear the balancing market as in Problem 2. Determine the balancing price and the schedule of the generator(s) involved in balancing.
- 2.4 What is the difference between the one-price and two-price imbalance settlements?
- 2.5 Calculate revenues and payments for the 3 market participants in imbalance, and for the generator(s) providing balancing under a one-price settlement.
- 2.6 Calculate revenues and payments for the 3 market participants in imbalance, and for the generator(s) providing balancing under a two-price settlement. Compare with the outcome of 3.5.
- 2.7 Let us imagine that these 3 market participants in imbalance could have known about their real consumption/supply before the day-ahead market settlement. Adapt the list of offers of Exercise Session 1 and clear the day-ahead market. Deduce the revenues and payments of these 3 market participants. Would they have been better off in that case?

### **Problem 3: Analysis of the balancing situation for a given day based on data**

For this Problem, we aim at understanding the balancing situation for a given day based on the data publicly available on the NordPool website. The webpages of interest are that for [day-ahead prices](#) and that for [regulation prices](#). Let us focus on the market area DK1, for the case of 21 January 2018.

- 3.1 Extract day-ahead and regulation prices (“Price up” and “Price down”) to have them on a piece of paper, or a file to import in Matlab/R/Excel/etc. What do these prices mean?
- 3.2 Are these prices always equal or not?
- 3.3 Find example hours for each of the 3 potential balancing situations (up, down and no-regulation).
- 3.4 Do you expect the price for upregulation to be higher/lower than the day-ahead price? Explain why?
- 3.4 Same questions for the downregulation price.
- 3.5 Have a look at some other days in January to see how often the various balancing situations occur, and how different prices can be.