Energy Markets

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Exercise session 4: Ancillary service markets

The aim of this exercise session is to appraise and better understand the basic structure of electricity markets, and most particularly its ancillary service markets and mechanisms.

Problem 1: Participation in the primary reserve market

This problem focuses on the primary reserve market. The table below gathers the technical data needed to solve the problem.

Supplier Name	Supplier id.	Up. Quant. [MW]	Up. Price [€/MW]	Down. Quant. [MW]	Down. Price [€/MW]	Time response [s]
Flexigas	G_1	15	80	15	92	22
Nuke22	G_2	10	35	10	35	40
RoskildeCHP	G_3	5	50	15	62	20
BlueWater	G_4	7	13	5	12	15
Darkcoal	G_5	8	64	5	41	35

1.1 What is the common name of the payment for generators' availability to participate in the provision of ancillary services?

1.2 What is the common term used for some ancillary services to define that an energy payment is not considered for that service?

1.3 Identify the suppliers that meet the technical requirements for providing primary reserves.

1.4 What is the total amount of capacity able to participate in the primary reserve market (i.e., which of the participants actually qualify)?

1.5 Determine the revenues for all participants in this market, considering that the up and down requirements established by the TSO is 25 MW.

1.6 Assuming now that all suppliers in the Table above are able to participate in the primary reserve market, re-determine the revenues of all participants for the same up and down requirements established by the TSO.

Problem 2: Revenues from the secondary reserve market

For the secondary reserve market, the remuneration mechanism is based on bilateral contracts between the TSO and suppliers, for their availability, plus a premium for energy provision.

Let us assume that the supplier "FlexiGas" is qualified to provide secondary reserve services. The agreement with the TSO establishes that it may provide 20 MW (in both up and down directions) at 60 €/MW. In addition, the spot market was cleared at 143 €/MWh. The balancing price may vary in the following questions.

2.1 Determine the revenue of "FlexiGas" in case it is asked to provide an upward regulation service (energy fully delivered), with balancing price of 179 €/MWh.

2.2 Re-determine that revenue if there is a need for down regulation instead (also with energy fully provided), with a balancing price of 12 €/MWh.

2.3 Re-determine 2.1. and 2.2 assuming that the balancing market price is 299 €/MWh in the upward regulation case, and 107 €/MWh in the downward regulation case.

Problem 3: Tertiary reserve market: clearing and revenues

Remember that the market mechanism for payment of suppliers of tertiary reserves comprises both a capacity payment based on uniform pricing and energy payment based on the balancing price. The Table below gathers the capacity offers of the various participants in the tertiary reserve market. Energy payments are obtained a posteriori when these participants are activated eventually.

Supplier Name	Supplier id.	Up. Quant. [MW]	Up. Price [€/MW]	Down. Quant. [MW]	Down. Price [€/MW]
Flexigas	G_1	25	36	20	48
Nuke22	G_2	20	18	10	42
RoskildeCHP	G_3	15	42	20	36
BlueWater	G_4	17	30	25	18
Darkcoal	G_5	18	24	15	30

3.1 Draw the supply curves and identify the suppliers that are scheduled to provide the service, considering that the service requirement for up and down regulation is of 50 MW.

3.2 Determine the revenue for each supplier for up regulation (service fully provided) considering upward regulating price of 24 €/MWh.

3.3 Determine the revenue for each supplier for down regulation (service fully provided) considering downward regulating price of 21 €/MWh. (tip: considers negative energy deviation as a positive value)

3.4 Calculate the revenues for 3.2. and 3.3 considering that only half of the service requirement was used in the system.