Module 3 – Intra-day and Balancing Markets

3.5 One-price vs. two-price settlement

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The one-price imbalance settlement

Basic properties:

<table>
<thead>
<tr>
<th>$\Delta P &gt; 0$</th>
<th>$\Delta P \sim 0$</th>
<th>$\Delta P &lt; 0$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\lambda^B &gt; \lambda^S$</td>
<td>$\lambda^B = \lambda^S$</td>
<td>$\lambda^B &lt; \lambda^S$</td>
</tr>
</tbody>
</table>

Consequences on settlement for those dispatched through the day-ahead market:

- $\Delta P > 0$:
  - Generator $i$ producing less than scheduled must buy $\hat{y}_i^G - y_i^G$ at price $\lambda^B$
  - Demand $j$ consuming more than scheduled must buy $\hat{y}_j^D - y_j^D$ at price $\lambda^B$
  - Generator $i$ producing more than scheduled must sell $y_i^G - \hat{y}_i^G$ at price $\lambda^B$
  - Demand $j$ consuming less than scheduled must sell $y_j^D - \hat{y}_j^D$ at price $\lambda^B$

- $\Delta P < 0$: ... basically, the same type of reasoning

- Meanwhile, balancing generators simply sell or buy at price $\lambda^B$
Example case 1: Outage of $G_5$

“Even though scheduled, the unit $G_5$ of KøbenhavnCHP will be down during that hour, and the operator could not get a match in the intra-day market…”

- All others are producing and consuming as planned.
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- All others are producing and consuming as planned.
- For the **balancing auction**, one has:
  - $\Delta P = 60 \text{ MWh}$ (since demand is higher than generation by 60 MWh for that hour)
  - $\lambda^B = 45 \text{ €/MWh}$
  - Scheduled balancing generators: $B_1$ and $B_2$ (only 30 MWh upward)
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● The **settlement** leads to:

  ● $G_5$ paying $60 \times 45 = 2700$ €
  
  ● $B_1(/{G_3})$ and $B_2$ each receiving $30 \times 45 = 1350$ €
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- Considering both day-ahead and balancing stages:
  - $G_5$ receives $60 \times 37.5 = 2250$ €, and has to pay $60 \times 45 = 2700$ €... That is a loss of 450 €(!)
  - $B_1$ ($/G_3$) receives $200 \times 37.5 = 7500$ € (day-ahead) and $30 \times 45 = 1350$ € at the balancing stage
Example case 2: Wind forecast errors

“For both wind farms $G_1$ and $G_2$ (operated by RT® and WeTrustInWind), the actual generation is not equal to that foreseen when clearing the day-ahead market, i.e.”

- for $G_1$: $\hat{y}_1^G = 50$ MWh but actual generation is $y_1^G = 30$ MWh
- for $G_2$: $\hat{y}_2^G = 120$ MWh but actual generation is $y_2^G = 155$ MWh

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For the balancing auction, one has:

- $\Delta P = -15$ MWh (since generation is higher than demand by 15 MWh for that hour)
- $\lambda^B = 35$ €/MWh
- Scheduled balancing generators: $B_1$ (only 15 MWh downward)
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- $\lambda^B = 35 \, €/MWh$
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The settlement leads to:
- $G_1$ paying $20 \times 35 = 700 \, €$
- $G_2$ receiving $35 \times 35 = 1225 \, €$
- $B_1$ paying $15 \times 35 = 525 \, €$

Considering both day-ahead and balancing stages:
- $G_1$ receives $50 \times 37.5 = 1875 \, €$, then pays $20 \times 35 = 700 \, €$ - Gives $1175 \, €$
- $G_2$ receives $120 \times 37.5 = 4500 \, €$, then receives again $35 \times 35 = 1225 \, €$ - Gives $5775 \, €$
- $B_1 (\text{or } G_3)$ receives $200 \times 37.5 = 7500 \, €$, then pays $15 \times 35 = 525 \, €$ - Gives $7175 \, €$
Comments on the one-price balancing markets

- The total payment/revenue of day-ahead market participants for deviations from schedule equals the revenue/payment of the balancing generators.

- Regarding deviations:
  
  - if one's own deviation contributes to setting the system off-balance (e.g., generator overproduce while there is too much power overall), this leads to a loss.

  - but...

  - if one's own deviation is of the helping the system go back to balance (e.g., generator overproduce while there is a lack of power overall), this leads to extra profit(!)

- What could be the consequences?

- And, how could we fix that?
The two-price imbalance settlement

Basic properties: (well, the same for market clearing)

$$\Delta P > 0 \quad \Delta P \sim 0 \quad \Delta P < 0$$

$$\lambda^B > \lambda^S \quad \lambda^B = \lambda^S \quad \lambda^B < \lambda^S$$

Settlement is rethought:

→ those putting the system off-balance are to be penalized
→ those supporting the system (unintentionally) will not get extra rewards

- $\Delta P > 0$:
  - Generator $i$ producing less than scheduled must buy $\hat{y}_i^G - y_i^G$ at price $\lambda^B$
  - Demand $j$ consuming more than scheduled must buy $\hat{y}_j^D - y_j^D$ at price $\lambda^B$
  - Generator $i$ producing more than scheduled must sell $y_i^G - \hat{y}_i^G$ at price $\lambda^S$
  - Demand $j$ consuming less than scheduled must sell $y_j^D - \hat{y}_j^D$ at price $\lambda^S$

- $\Delta P < 0$: ... basically, the opposite type of reasoning

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- $\lambda^B = 35$ €/MWh (while day-ahead price is $\lambda^S = 37.5$ €/MWh)
- Scheduled balancing generators: $B_1$ (only 15 MWh downward)

The settlement leads to:

- $G_1$ paying $20 \times 37.5 = 750$ € (instead of 700 € in the one-price case)
- $G_2$ receiving $35 \times 35 = 1225$ €
- $B_1$ ($/G_3$) paying $15 \times 35 = 525$ €

Considering both day-ahead and balancing stages:

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- $B_1$ ($/G_3$) receives $200 \times 37.5 = 7500$ €, then pays $15 \times 35 = 525$ € - Gives 7175 €
Use the self-assessment quizz to check your understanding!