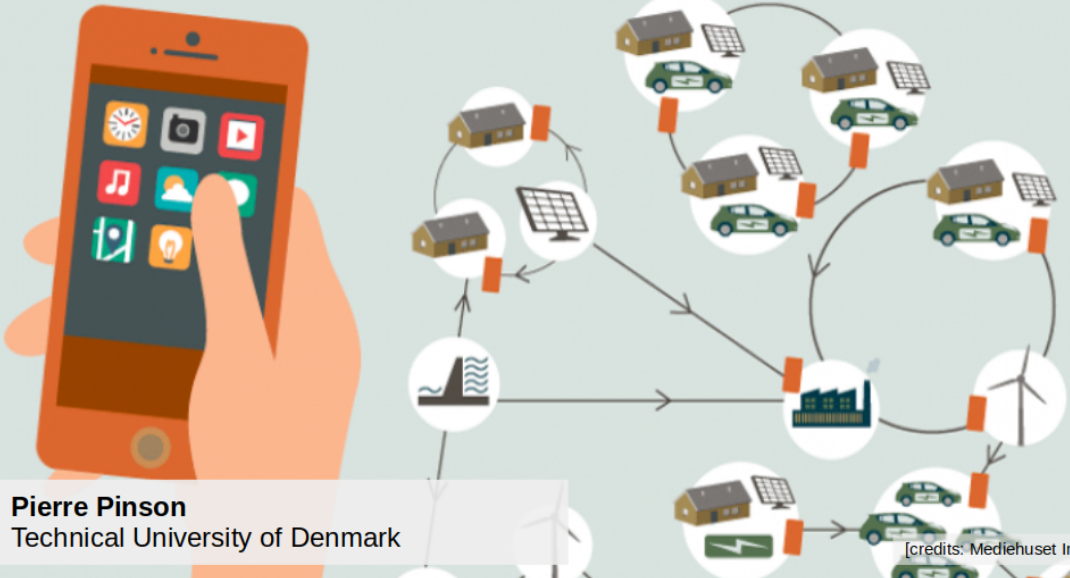
Module 3 – Intra-day and Balancing Markets

3.2 Intra-day market



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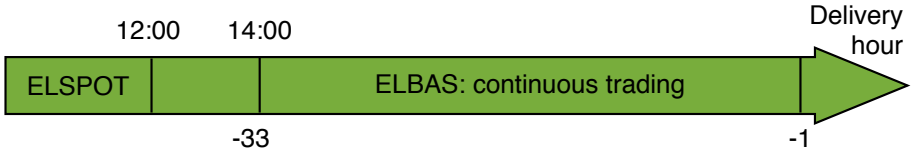
[credits: Mediehuset Ingeniøren]

Overview

- While the day-ahead market is
  - a pool,
  - based on an auction mechanism,
- the intraday market is based on **bilateral contracts**, even though handled through a central platform.
- Some reasons for that:
  - less players,
  - less liquidity,
  - the need for *corrective actions* may highly vary depending upon how new information disclosure occurs between day-ahead market clearing and actual operation...
- Organization: leaning towards *electronic trading* (introduced in a previous lecture)



[source: Nord Pool Group]

Simple example of bilateral trading: portfolio

- Let us introduce the portfolio of ROGUE TRADING® (abbreviated RT®):

Unit id.	Type	Nominal capacity	Flexibility	Marginal Cost (€/MWh)
N1	Nuclear	500	−−	30
Bm1	Biomass	70	+	60
Bm2	Biomass	45	++	70
W1	Wind	120	−−	0

- Flexibility summarizes the impact of operational constraints (i.e., minimum up and down time, ramping, minimum operating point, etc.)

- How to optimally trade with this portfolio based on bilateral contracts?

[Note: Example inspired by *Kirschen and Strbac (2004). Fundamentals of Power System Economics* (Sect. 3.4)]

Simple example... Existing contracts

- *Here and now*: 5th February, 13:00 - *Delivery period*: 6th of February, 11:00-12:00
- Existing contracts are:

Type	Buyer	Seller	Amount (MWh)	Price (€/MWh)
Long term (5 years)	QualiWatt	RT®	30	12
Long term (5 years)	IntelliWatt	RT®	200	35
Future (1-3 months)	RT®	DirtyPower	30	20
Future (1-3 months)	EVcharge	RT®	150	40
Future (1-3 months)	El4You	RT®	40	43

- RT® should generate: 390 MWh
- Prices are low... RT® should avoid using units Bm1 and Bm2
- Predicted wind power generation: 60 MWh for that hour
- Consequently, N1 is to generate 330 MWh

Simple example... Change of plan

- Update in the wind forecast - only 20 MWh to be generated... that means compensating for 40 MWh
- Nuclear is not flexible enough to adapt in time and Bm1 is down
- **Should Bm2 be used?** see the updated stacks of bids and offers:

Time	Buy/Sell	Id.	Amount (MWh)	Price (€/MWh)
1 March 2016, 11:00-12:00	Buy	D1	10	55
1 March 2016, 11:00-12:00	Buy	D2	50	50
1 March 2016, 11:00-12:00	Buy	D3	120	35
1 March 2016, 11:00-12:00	Buy	D4	80	27.5
1 March 2016, 11:00-12:00	Sell	G1	15	80
1 March 2016, 11:00-12:00	Sell	G2	55	65
1 March 2016, 11:00-12:00	Sell	G3	90	47
1 March 2016, 11:00-12:00	Sell	G4	40	45
1 March 2016, 11:00-12:00	Sell	G5	100	37

- *What would you do?*

Simple example... Option 1

- Instead of having to produce 40 MWh at a marginal cost of 70 €/MWh...

Time	Buy/Sell	Id.	Amount (MWh)	Price (€/MWh)
1 March 2016, 11:00-12:00	Buy	D1	10	55
1 March 2016, 11:00-12:00	Buy	D2	50	50
1 March 2016, 11:00-12:00	Buy	D3	120	35
1 March 2016, 11:00-12:00	Buy	D4	80	27.5
1 March 2016, 11:00-12:00	Sell	G1	15	80
1 March 2016, 11:00-12:00	Sell	G2	55	65
1 March 2016, 11:00-12:00	Sell	G3	90	47
1 March 2016, 11:00-12:00	Sell	G4	40	45
1 March 2016, 11:00-12:00	Sell	G5	100	37

- Let's just pick G4! (*we hit that offer...*)
- **Cost:** $45 \times 40 = 1800$ €

Simple example... Option 2

- Instead of having to produce 40 MWh at a marginal cost of 70 €/MWh...

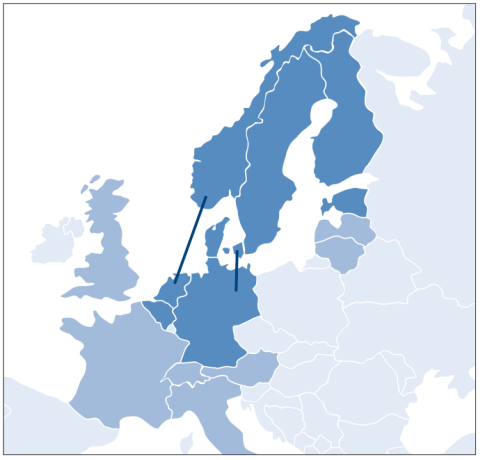
Time	Buy/Sell	Id.	Amount (MWh)	Price (€/MWh)
1 March 2016, 11:00-12:00	Buy	D1	10	55
1 March 2016, 11:00-12:00	Buy	D2	50	50
1 March 2016, 11:00-12:00	Buy	D3	120	35
1 March 2016, 11:00-12:00	Buy	D4	80	27.5
1 March 2016, 11:00-12:00	Sell	G1	15	80
1 March 2016, 11:00-12:00	Sell	G2	55	65
1 March 2016, 11:00-12:00	Sell	G3	90	47
1 March 2016, 11:00-12:00	Sell	G4	40	45
1 March 2016, 11:00-12:00	Sell	G5	100	37

- Let's play a bit more and combine G3 and D2!
- **Cost/benefit analysis:**

$$\left.\begin{array}{rl} \text{Cost:} & 90 \times 47 = 4230€ \\ \text{Income:} & 50 \times 50 = 2500€ \end{array}\right\} \text{ Total Cost: } 4230 - 2500 = 1730€$$

- *Do you have a better one?*

The example of Elbas (Nord Pool)



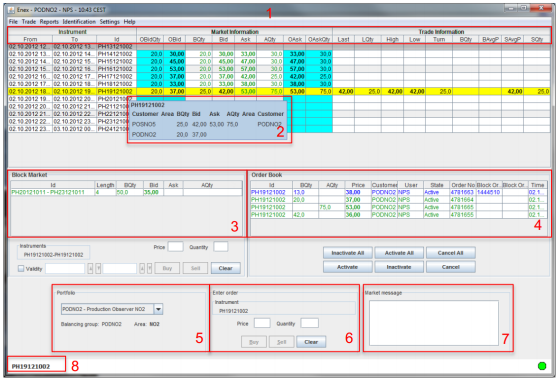
- Elbas areas, including licenced areas
- Additional countries with Elbas members
- Interconnectors with implicit Elbas capacity out of Nord Pool Spot area

[source: Nord Pool Spot]

- **Elbas**: **El**ectricity **B**alance **A**djustment **S**ystem
- Centrally operated by Nord Pool, for internal and cross-border trading (upon availability of transmission capacity)
- Products: {Energy, Price}, for a given time unit or block bids (up to 3 successive time units)
- Gate closure (closing of trading opportunities before operations):
  - **2 hours** for Norway,
  - **1 hour** for Denmark, Sweden, Finland, Estonia,
  - **30 minutes** for interconnector to Germany (Kontek cable)
  - **5 minutes** in Belgium and the Netherlands (!!)

[See: Elbas User Guide - https://www.nordpoolspot.com/globalassets/download-center/intraday/intraday-user-guide.pdf]

Matching algorithm



[source: Nord Pool Spot]

And in the future: XBID

- All players use a web-based Java application serving as a GUI
- All offers can be declared there
- Every time a new offer is entered, the information given to all players is updated
- The key information is the set of "Ask/Bid" prices

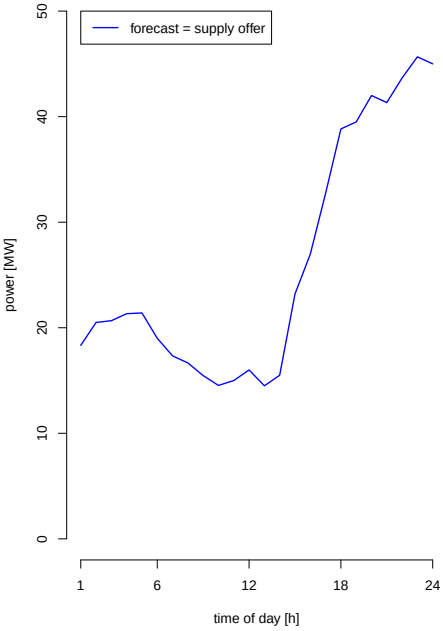
  Bid price: at which you would buy
  Ask price: for which you are ready to sell

- Participants just "hit" offers they are willing to accept...

[See: Elbas User Guide - https://www.nordpoolspot.com/globalassets/download-center/intraday/intraday-user-guide.pdf]

A practical example

- **WeTrustInWind** operates a wind farm with 50MW nominal capacity

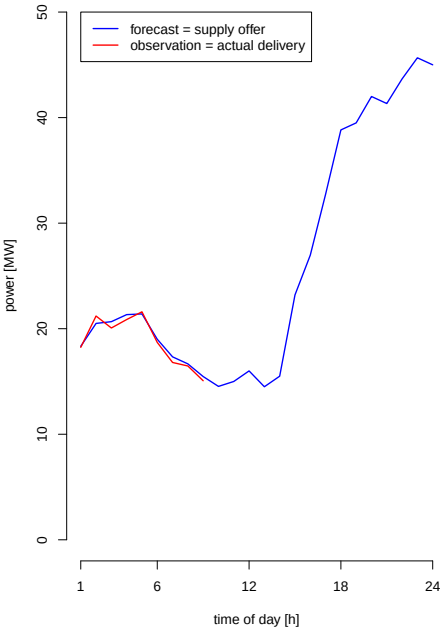


- Set of accepted supply offers from the day-ahead market (**12.03.2014 - 14:00**):

Time unit	MWh	€/MWh
...	...	...
18:00-19:00	40.1	45
19:00-20:00	41.0	57
20:00-21:00	42.3	72
21:00-22:00	45.6	75
22:00-23:00	46.5	73
...	...	...

Delivery day: 13.03.2014 - 9:00

- How does the situation look like?



Schedule:

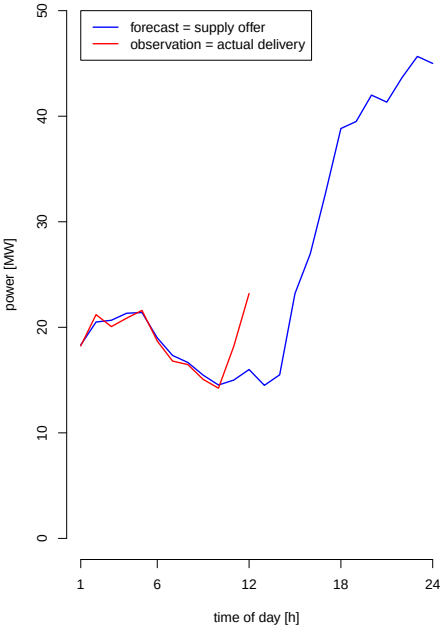
Time unit	MWh	€/MWh
...	...	...
18:00-19:00	40.1	45
19:00-20:00	41.0	57
20:00-21:00	42.3	72
21:00-22:00	45.6	75
22:00-23:00	46.5	73
...	...	...

Offers on our Elbas screen:

Time unit	buy/sell	MWh	€/MWh
...	...	...	...
18:00-19:00	sell	5.5	25
20:00-21:00	sell	20.3	13
20:00-21:00	buy	8.2	5
22:00-23:00	sell	12.5	23
...	...	...	...

Delivery day: 13.03.2014 - 12:00

- Hitting any offer?



Schedule:

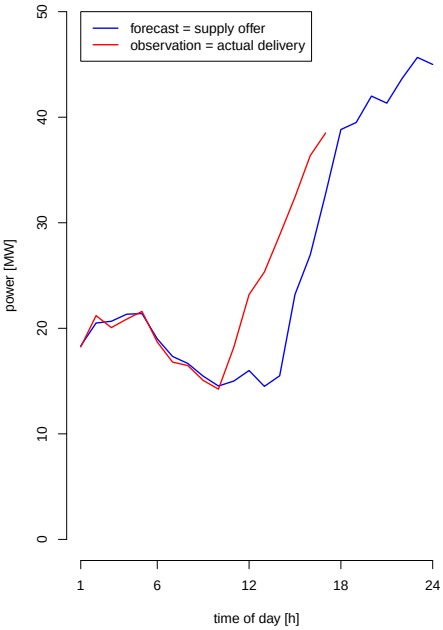
Time unit	MWh	€/MWh
...	...	...
18:00-19:00	40.1	45
19:00-20:00	41.0	57
20:00-21:00	42.3	72
21:00-22:00	45.6	75
22:00-23:00	46.5	73
...	...	...

Offers on our Elbas screen:

Time unit	buy/sell	MWh	€/MWh
...	...	...	...
18:00-19:00	sell	5.5	30
20:00-21:00	sell	20.3	18
20:00-21:00	buy	8.2	7
22:00-23:00	sell	12.5	27
...	...	...	...

Delivery day: 13.03.2014 - 17:00

- Hitting any offer?



Schedule:

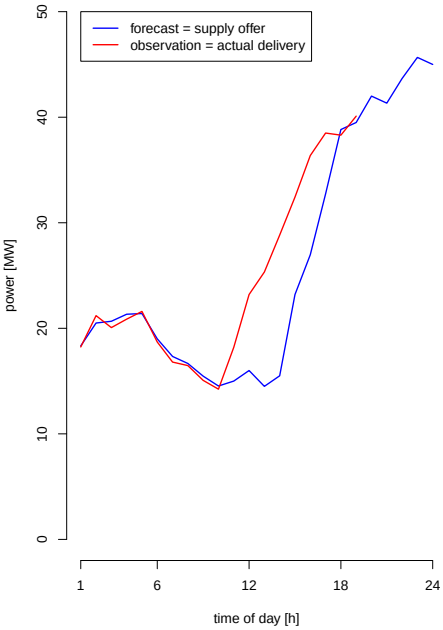
Time unit	MWh	€/MWh
...	...	...
18:00-19:00	40.1	45
19:00-20:00	41.0	57
20:00-21:00	42.3	72
21:00-22:00	45.6	75
22:00-23:00	46.5	73
...	...	...

Offers on our Elbas screen:

Time unit	buy/sell	MWh	€/MWh
...	...	...	...
18:00-19:00	sell	10	72
20:00-21:00	sell	20.3	58
20:00-21:00	buy	8.2	7
22:00-23:00	sell	12.5	27
...	...	...	...

Delivery day: 13.03.2014 - 19:00

- Hitting any offer?



Schedule:

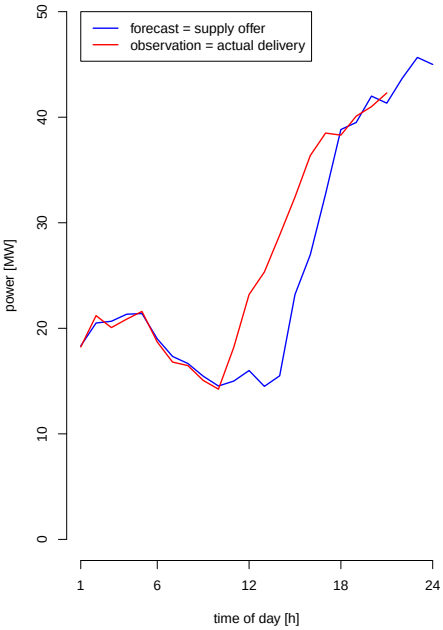
Time unit	MWh	€/MWh
...	...	...
18:00-19:00	40.1	45
19:00-20:00	41.0	57
20:00-21:00	42.3	72
21:00-22:00	45.6	75
22:00-23:00	46.5	73
...	...	...

Offers on our Elbas screen:

Time unit	buy/sell	MWh	€/MWh
...	...	...	...
20:00-21:00	sell	20.3	65
20:00-21:00	sell	4	32
20:00-21:00	buy	8.2	9
22:00-23:00	sell	12.5	47
...	...	...	...

Delivery day: 13.03.2014 - 21:00

- Hitting any offer?



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Offers on our Elbas screen:

Time unit	buy/sell	MWh	€/MWh
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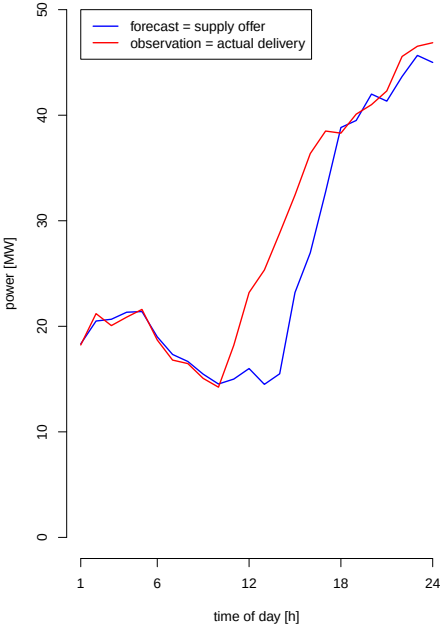
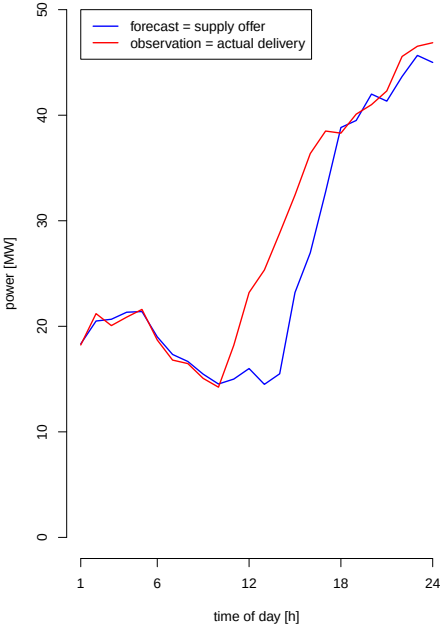
22:00-23:00	sell	12.5	47
22:00-23:00	buy	7.2	35
22:00-23:00	sell	5.3	80
22:00-23:00	sell	28.5	32
...	...	...	...

End of the day (13.03.2014): Conclusions



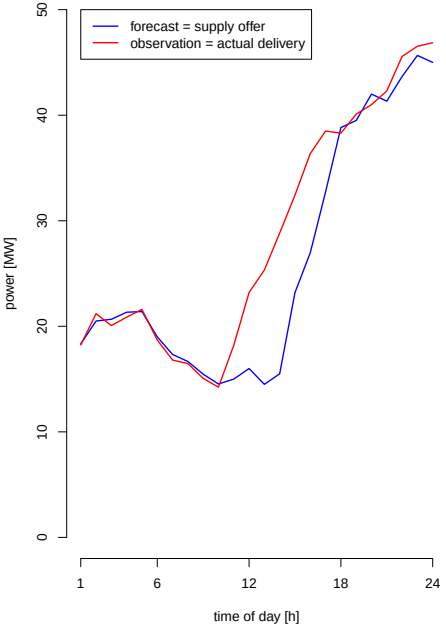
- It may be difficult to foresee the actual imbalance that would need to be fixed, eventually

End of the day (13.03.2014): Conclusions



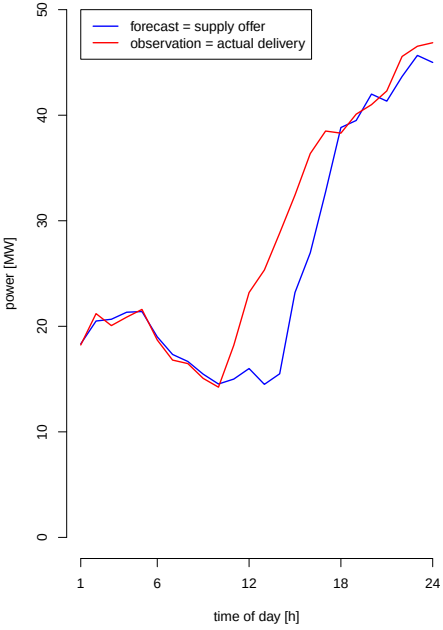
- It may be difficult to foresee the actual imbalance that would need to be fixed, eventually
- Decision-making in such adjustment markets can be
  - complex
  - and possibly stressful!

End of the day (13.03.2014): Conclusions



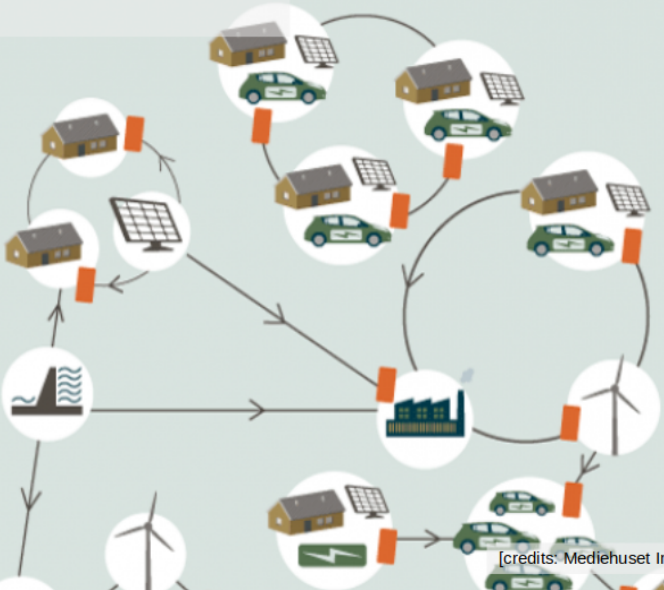
- It may be difficult to foresee the actual imbalance that would need to be fixed, eventually
- Decision-making in such adjustment markets can be
  - complex
  - and possibly stressful!
- One may clearly want to have more information than what we did in this example:
  - how the quantities and prices may develop in the intra-day market?
  - what do we expect to happen in the balancing market?

End of the day (13.03.2014): Conclusions



- It may be difficult to foresee the actual imbalance that would need to be fixed, eventually
- Decision-making in such adjustment markets can be
  - complex
  - and possibly stressful!
- One may clearly want to have more information than what we did in this example:
  - how the quantities and prices may develop in the intra-day market?
  - what do we expect to happen in the balancing market?
- A practical consequence is that, in general, volumes and liquidity in such intra-day markets are low...

Use the self-assessment quizz to check your understanding!



[credits: Mediehuset Ingeniøren]