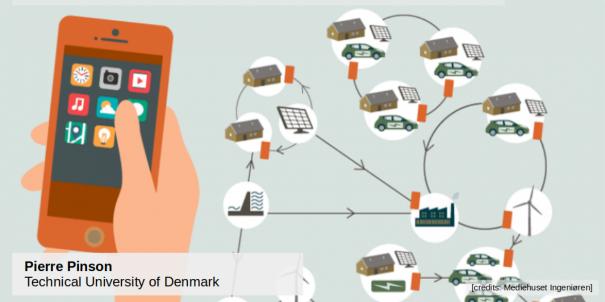
Module 3 – Intra-day and Balancing Markets

3.2 Intra-day market



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 $Rogue\ Trading^{(R)}$ (abbreviated $RT^{(R)}$):

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:

Туре	Buyer	Seller	Amount (MWh)	Price (€/MWh)
Long term (5 years)	QualiWatt	$\mathrm{RT}^{ ext{ ext{ ext{ ext{ ext{ ext{ ext{ ext$	30	12
Long term (5 years)	IntelliWatt	RT^{\circledR}	200	35
Future (1-3 months)	$\mathrm{RT}^{ exttt{ exttt{R}}}$	DirtyPower	30	20
Future (1-3 months)	EV charge	RT^{\circledR}	150	40
Future (1-3 months)	El4You	RT^{\circledR}	40	43

- ullet RT[®] should generate: 390 MWh
- ullet Prices are low... $RT^{\hbox{\scriptsize $(\!\!\!\ \, \!\!\!)}}$ 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	ld.	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	ld.	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:** 45×40 = 1800 €

Simple example... Option 2



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

Time	Buy/Sell	ld.	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:

Cost:
$$90 \times 47 = 4230$$
€
Income: $50 \times 50 = 2500$ €
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

- Elbas: Electricity Balance Adjustment System
- 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]

[source: Nord Pool Spot] 8/17

Matching algorithm



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[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

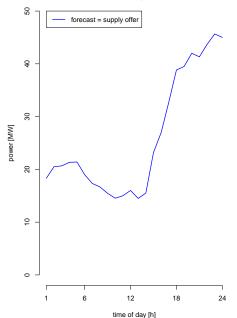
 Participants just "hit" offers they are willing to accept...

[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

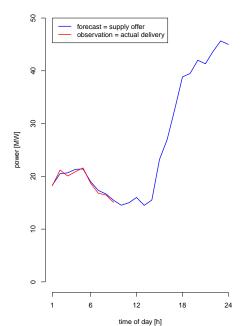


 Set of accepted supply offers from the day-ahead market (12.03.2014 - 14:00):

	Time unit	MWh	€/MWh
1	.8:00-19:00	40.1	45
1	9:00-20:00	41.0	57
2	20:00-21:00	42.3	72
2	21:00-22:00	45.6	75
2	22:00-23:00	46.5	73
			•••

Delivery day: 13.03.2014 - 9:00

• How does the situation look like?





Schedule:

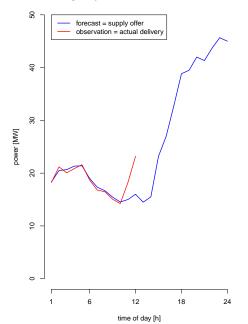
Time unit	MWh	€/MWh
18:00-19:00	40.1	45
19:00-20:00	41.0	57
20:00-21:00	42.3	72
21:00-22:00	45.6	75
22:00-23:00	46.5	73

	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
- 1				

Delivery day: 13.03.2014 - 12:00

DTU

• Hitting any offer?



Schedule:

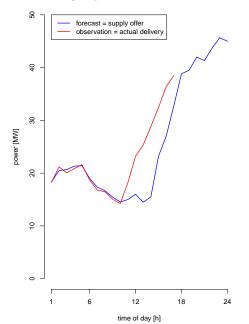
Time unit	MWh	€/MWh
18:00-19:00	40.1	45
19:00-20:00	41.0	57
20:00-21:00	42.3	72
21:00-22:00	45.6	75
22:00-23:00	46.5	73

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

DTU

• Hitting any offer?



Schedule:

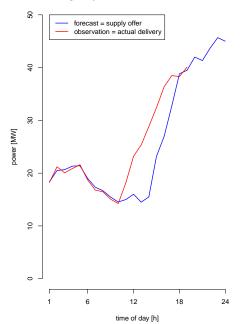
Time unit	MWh	€/MWh
18:00-19:00	40.1	45
19:00-20:00	41.0	57
20:00-21:00	42.3	72
21:00-22:00	45.6	75
22:00-23:00	46.5	73

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

DTU

• Hitting any offer?



Schedule:

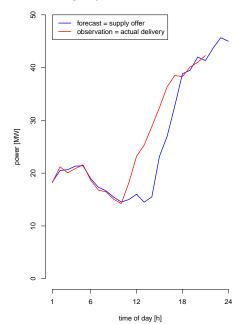
Time unit	MWh	€/MWh
18:00-19:00	40.1	45
19:00-20:00	41.0	57
20:00-21:00	42.3	72
21:00-22:00	45.6	75
22:00-23:00	46.5	73

dWh €/	′MWh
20.3	65
4	32
8.2	9
12.5	47
	20.3 4 8.2

Delivery day: 13.03.2014 - 21:00

DTU

• Hitting any offer?

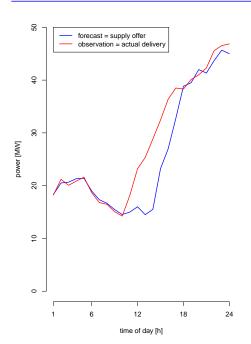


Schedule:

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

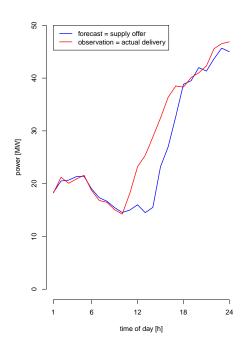
Time unit	buy/sell	MWh	€/MWh
•••			
22:00-23:00	sell	12.5	47
22:00-23:00	buy	7.2	35
22:00-23:00	sell	5.3	80
22:00-23:00	sell	28.5	32





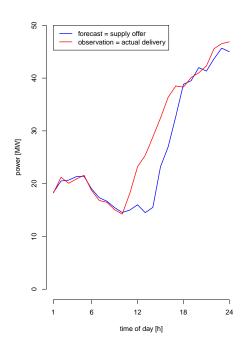
• It may be difficult to foresee the actual imbalance that would need to be fixed, eventually





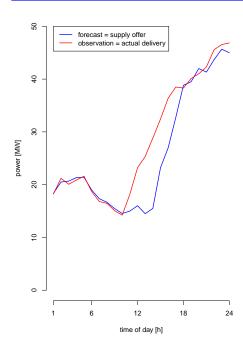
- It may be difficult to foresee the actual imbalance that would need to be fixed, eventually
- Decision-making in such adjustment markets can be
 - complex
 - and possibly stressful!





- 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?





- 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!

