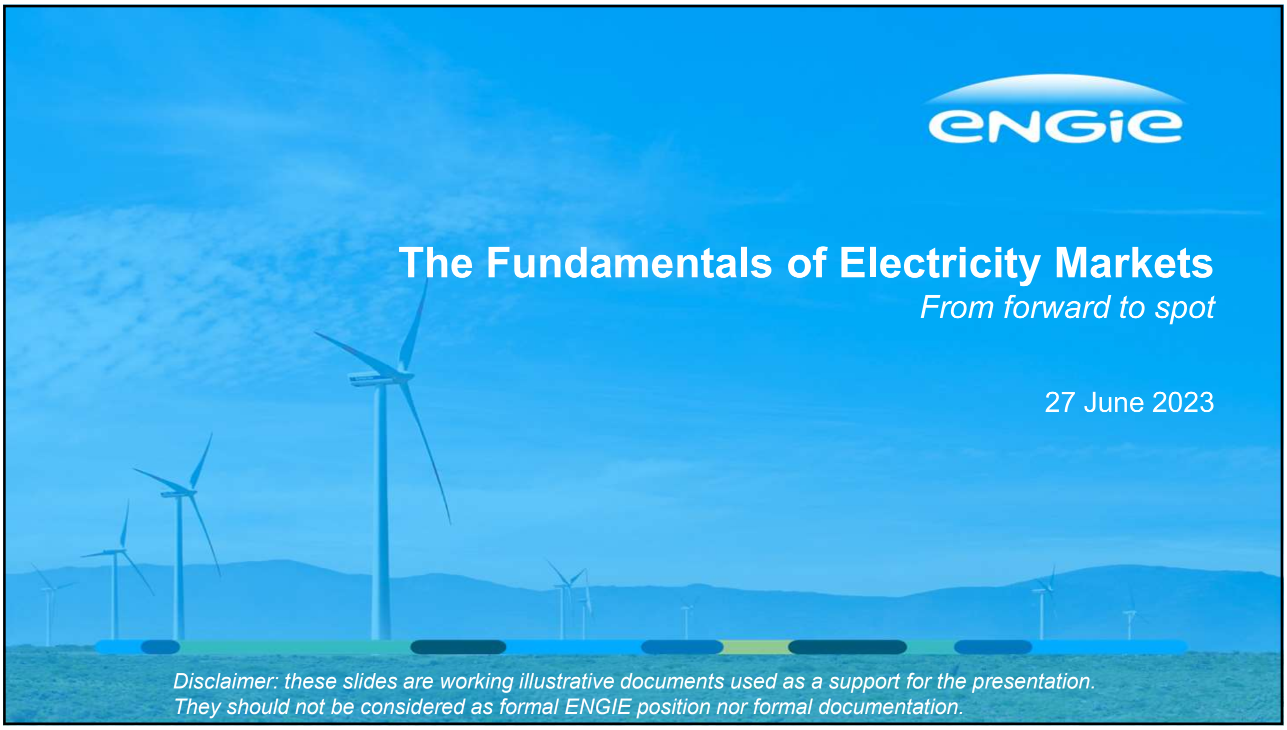

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AGENDA

1. Introduction & Key Concepts
2. Day Ahead, Intraday and Balancing
3. Forward
4. Hedging

2

3

Why ?

Fundamentally, energy supply is an engineering challenge. Good market design should give **economic incentives** to **align economics to physics in the short term and physics to economics in the long term**

Target model: a pan-European electricity market

Physically, we are interconnected and interdependent
But almost everything else has yet to follow this physical reality

Which benefit for the global welfare ?

Increase efficiency
Increase robustness and liquidity
Integrate new technologies and facilitate the energy transition

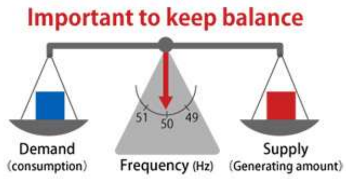
Why do we want it as market participant ?

Managing cross-border portfolios
New buying and selling opportunities
Facilitate the integration of new technologies

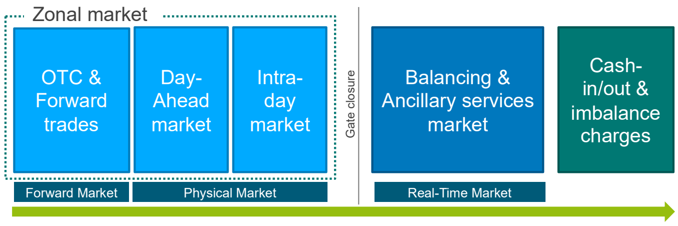
4

Market price: expectation about future real-time price

- Market is based on **supply-demand equilibrium** => each equilibrium point corresponds to a **market price**. There is an equilibrium point (= **imbalance settlement price**) at each period of time (ISP) = **imbalance settlement period**



- All actions undertaken by market parties in forward, day-ahead and intraday are based on the **expectation** of this equilibrium point



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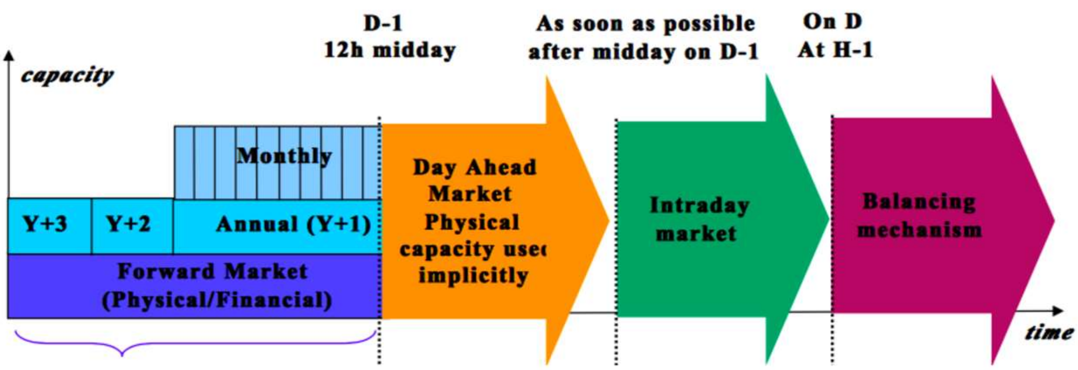
Market time frames



Source: European Commission

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7

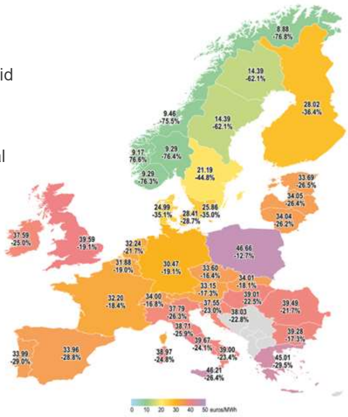
Day-Ahead market

Average annual DA electricity price in European Bidding Zones - 2017

Price coupling region (DA)

1. **Zonal market**
   - Bidding Zone = geographical zone in which traders can buy/sell electricity without having to take into account grid constraints. Between 2 zones, traders have to consider availability of transmission capacity:
   - For the market: "one country = one price = one electrical node"
   - Not true in reality => TSO to manage the grid

2. **In Day-Ahead, one common auction**
   - Electricity market prices are based on a supply-demand equilibrium
   - One auction to determine the price for each zone



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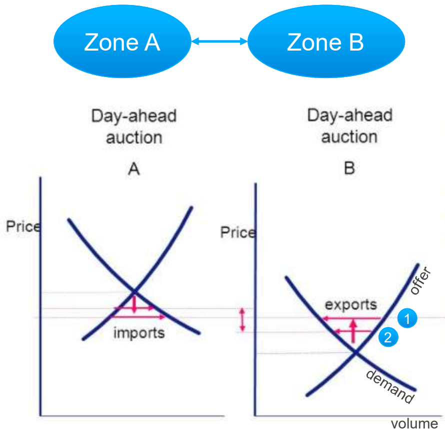
Day-Ahead Auction
Market Coupling

The Day-Ahead Process **merges capacity (transport) and energy**

1. Trader bids for energy (bids and offers) in each zone to the Power Exchange
2. TSOs provide the available capacity between each zone
3. The energy bids and offers in the different zones is then matched, depending on the availability of capacity

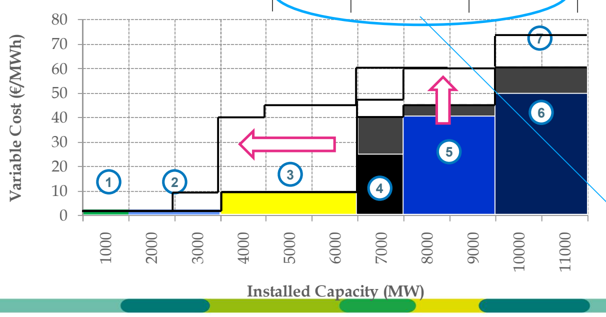
- If no congestion (ie: enough capacity): no price difference between A and B (1)
- If congestion (ie: not enough capacity allocated to the market), a price difference between A and B appears (2)



Building the merit order

- In the **merit order** units are **ranked according to their marginal cost of production.**

	(1)	(2)	(3)	(4)	(5)	(6)
Technology	**Wind**	**Hydro**	**Nuclear**	**Coal ST**	**CCGT**	**GT**
Installed capacity [MW]	1000	2000	3000	1000	2000	2000
Variable cost [€/MWh]	0	0	10	25	40	50
(7) **CO2 cost [€/MWh]**	0	0	0	15	5	10
Total Variable cost [€/MWh]	**0**	**0**	**10**	**40**	**45**	**60**



The merit order can shift:

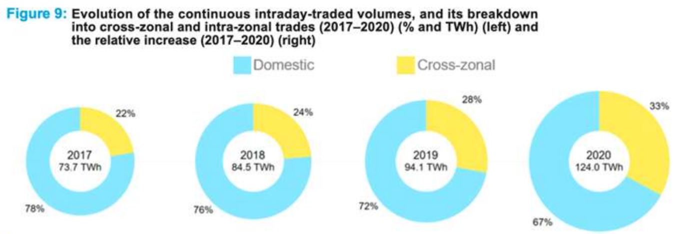
(a) **Horizontally:** due to technical outages, and unavailabilities

(b) **Vertically:** due to commodity price fluctuations

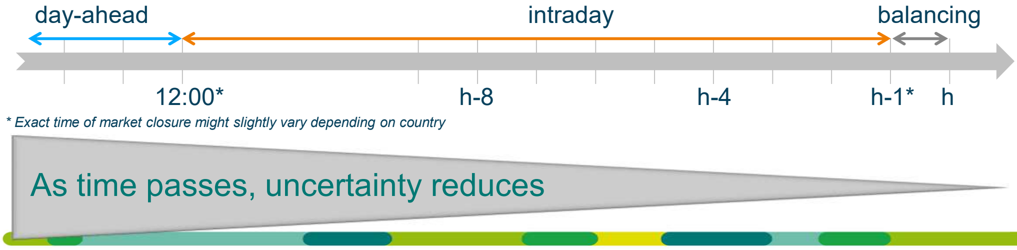
Renewables & NUC may also be offered at a negative price

Day-Ahead versus Intraday

- **Day ahead market:** considered the market giving the reference price in Europe
  - Link to nomination and scheduling process historically happening in D-1
  - But... the real price signal for market participants is the imbalance price!
- **Intraday market:** considered the market to optimise/correct positions close to real time
  - Intraday market liquidity increases, product granularity closer to ISP and ability to trade closer to real time!



Source: ACER calculation based on NEMOs data.

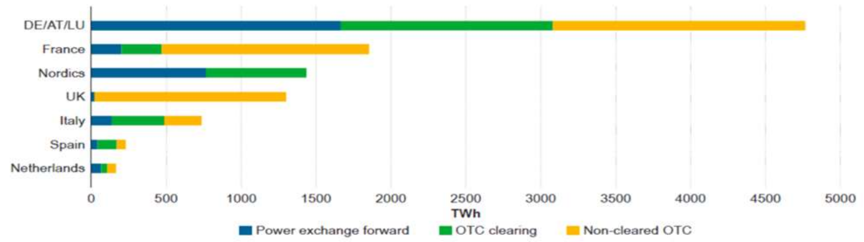


* Exact time of market closure might slightly vary depending on country

Is the forward market important ?

- Volumes traded in forward represent +/- 10 times more than the volume traded in the short term market (Day-Ahead and Intraday)

Figure 17: Forward market trading volumes per type in the largest European forward markets – 2016 (TWh)



Source: European Power Trading 2017 report, © Prospex Research Ltd, March 2017.

Source: ACER MMR 2018
Note: updated chart not available in ACER MMR, but trend is confirmed. E.g. EEX mentionned 4400 TWh traded in fwd vs 600 TWh in DA and ID

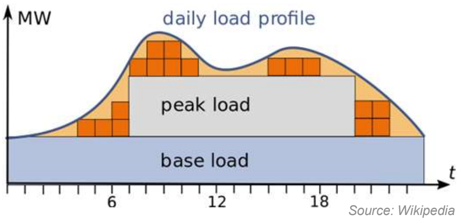
Market instruments: spot, forward, future

- **Spot** contract: an agreement to buy or sell an asset today, for a certain price.
  - ✓ In the case of, for example, gas and electricity, this typically means day-ahead.
- **Forward** contract: an agreement to buy or sell an asset at a specific moment in time, for a predetermined price.
  - ✓ Normally traded over-the-counter (OTC); a deal between two institutions
- **Future** contract: an agreement to buy or sell an asset at a specific moment in time, for a predetermined price.
  - ✓ Normally traded on an exchange; the exchange is the counterparty for both participants.

Forward products for electricity

What can you trade in each zone ?

- Daily products: D+1, D+2
- Weekly products: W+1, W+2, W+3
- Monthly products: M+1, M+2, M+3
- Quarterly products: Q+1, Q+2, Q+3
- Yearly products: Cal+1, +2, +3



Source: Wikipedia

Base-load vs. Peak-load

	Germany Baseload*					France Baseload*				
	Qty	Bid	Ask	Qty	Last	Qty	Bid	Ask	Qty	Last
Tue 28/03/23					113.50					123.00
Wed 29/03/23	15	110.00	112.50	25	112.00	5	109.50	115.00	25	
Thu 30/03/23	9	66.00	78.00	25		25	70.00	84.00	25	
WkEnd 01-02/04/23	15	74.50	75.00	25	74.50	15	78.50	79.50	25	78.25
WkEnd 08-09/04/23	25	66.00	82.00	25		25	73.00	85.00	25	
Wk14-23	25	103.00	104.00	25	103.50	15	111.00	112.75	25	112.00
Wk15-23	10	99.05	101.00	5	100.25	10	107.50	110.00	25	
Apr-23	1	103.98	103.90	3	103.80	2	112.30	112.65	3	112.25
May-23	1	106.08	106.00	2	106.00	2	111.00	111.74	1	112.25
Jun-23	1	114.98	114.90	5	115.00	5	120.00	124.25	2	
Q223	1	108.27	108.25	2	108.25	1	114.75	116.29	1	
Q323	1	121.80	122.06	1	122.00	1	130.75	132.00	2	131.00
Q423	5*	143.75	143.75	1	143.80	1	262.00	266.75	1	265.00
Q124	1*	150.25	150.54	1	150.00	2	355.00	359.50	1	357.00
Q224	1	119.50	119.79	1*	121.00	1	113.75	116.25	1	116.00
Q324	1	123.75	124.00	1	124.00	2	117.00	121.50	1	120.00
Q424	1	140.25	140.53	1*	141.00	1	182.75	186.27	1	186.00
Q125	1	142.00	143.78	1		1	160.00			
2024	1*	133.42	133.50	1	133.38	1	194.60	195.00	1	194.50
2025	1	114.00	114.85	2	114.50	1	125.00	128.00	1	128.00
2026	1	103.80	105.60	1	104.00	1	106.80	113.35	1	
2027	1	96.30	99.60	1				105.00	1	

	Holland Baseload*					Belgium Baseload*				
	Qty	Bid	Ask	Qty	Last	Qty	Bid	Ask	Qty	Last
Tue 28/03/23										
Wed 29/03/23	25	100.00	125.00	25		25	104.50	125.00	25	
Thu 30/03/23	25	50.00				25	65.000	94.000	25	
WkEnd 01-02/04/23	15	78.00	87.00	25		25	74.00	89.500	25	
WkEnd 08-09/04/23										
Wk14-23	25	105.00	110.50	25		25	106.00	114.75	25	
Wk15-23	25	100.00	111.00	5		25	97.50	115.00	25	
Apr-23	1	105.60	106.00	4*	107.50	1	110.00	110.50	5	110.50
May-23	1	103.09	103.75	2	104.00	1	106.84	109.50	5	
Jun-23	1	111.33	112.90	5		1	112.83	119.38	1	
Q223	1	106.75	107.55	2*	107.50	2	110.00	112.00	1	
Q323	2	115.00	116.25	1	116.00	5	116.00	119.25	1	
Q423	5	134.50	136.75	1		1*	137.75	141.75	1	
Q124	5*	139.00	141.04	1		1	140.00	145.00	2	
Q224	1	96.500	125.00	1		1	96.500	112.00	1	
Q324	1	100.00	129.00	1		1	100.00	116.00	1	
Q424	1	112.25	138.00	1		1	122.25	133.00	1	
Q125										
2024	1	121.25	123.50	1		1	120.00	122.00	1	125.00
2025	1	111.50	115.35	2		1	115.50	123.85	1	
2026	2*	100.00	110.00	2*		1	100.75	107.00	2	
2027						1	88.50	115.00	1	

	Germany Peaks*					France Peaks*				
	Qty	Bid	Ask	Qty	Last	Qty	Bid	Ask	Qty	Last
Tue 28/03/23					115.00					120.00
Wed 29/03/23	1	50.00						157.50	25	
Thu 30/03/23								153.00	25	
WkEnd 01-02/04/23										
WkEnd 08-09/04/23										
Wk14-23	25	110.50	113.00	25	111.00	5	110.00	122.00	25	
Wk15-23	5	102.00	106.00	5	105.00	25	107.00	120.00	5	
Apr-23	5	109.00	110.00	5	110.00	25	120.00	122.00	5	
May-23	5	107.00	111.00	5	110.00	2	115.00	122.50	5	
Jun-23	5	120.00	122.00	4	123.00	3*	133.29	148.00	5	
Q223	5	112.01	114.42	4	114.50	3*	126.00	129.00	1	
Q323	1	138.25	139.20	1	139.20	3	150.00	177.77	2*	
Q423	2	181.50	182.50	7	181.50	1	425.00	480.00	3*	
Q124	1*	183.10	186.00	1		5	550.00	650.00	5	
Q224	1	120.70	147.00	1						
Q324	1	129.10	155.00	1						
Q424	1	164.10	190.00	1				325.00	3	
Q125						5	260.00	315.00	5	
2024	1	163.00	164.00	4	163.00	1	280.00	314.00	1	
2025	1*	145.50	145.50	5	145.50	1	190.00	210.00	1	
2026	1	125.00	132.00	1		1	140.00			
2027										

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Market liquidity & traded volumes

- Market **liquidity** reflects the ability to buy or sell an asset without causing a significant movement in the market price of that asset.
  - In less liquid markets we expect the bid-ask spreads to be wider than in more liquid markets. The bid-ask spread represents transaction cost.
- The German electricity market, for example, is relatively liquid market, especially compared to the Dutch or Belgium electricity market.
- Where liquidity is limited, there is a greater risk that it may not be possible to close a position at a favorable price.
- Short term products are in general more liquid than long term products.

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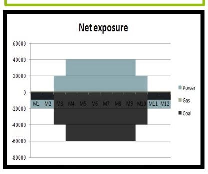
From a physical portfolio …

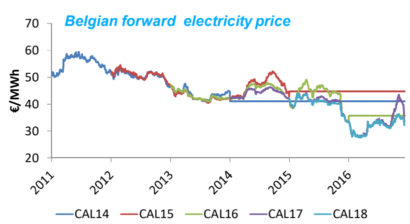
… to hedging strategies

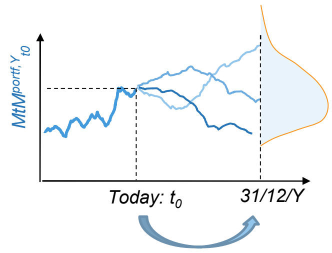
1. Risk Mapping: - Forecast (A) - Position modelling (B)	2. Definition of Hedging Strategy (C)	3. Execute Strategy



1. Risk mapping

- A portfolio of assets is **by definition "risky" ->** what is "risk" for a portfolio manager ?
  - Uncertainty on future revenues generated by the assets in the portfolio (power plants, procurement contracts, ...)
  - Different kind of risks:
    - ✓ price risk,
    - ✓ volume risk,
    - ✓ regulatory risk,
    - ✓ counterparty risk





- How to tackle price risk ?
  - First step is to accurately **forecast the positions** of each asset and contract (A)
  - Second step when trying to mitigate risks is to **identify** and classify/organize the risk factors (B)
  - To mitigate the price and volume risks, market participants can then perform **hedging** actions (C)

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(A) Forecast: key principles

Fleet information

FWD Prices

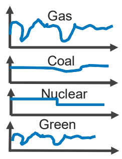
Constraints

Techical constraints (Revision planning, max power, ….)
Contractual constraints (reserves, fuel contracts,..)

Fleet information, market prices and constraints are used as input for the optimization model

OPTIMIZATION MODEL

The output of the model is the forecasted production and fuel consumption which maximizes S-P (cashflow), while respecting the constraints



Maintenance planning
Choosing the best moment to place a maintenance (while respecting the technical constraints) is also a possibility to optimize S-P results

Forecasting exercise: to be done for all contracts (industrial and residential customers) and assets (power plants including RES, storage, …)

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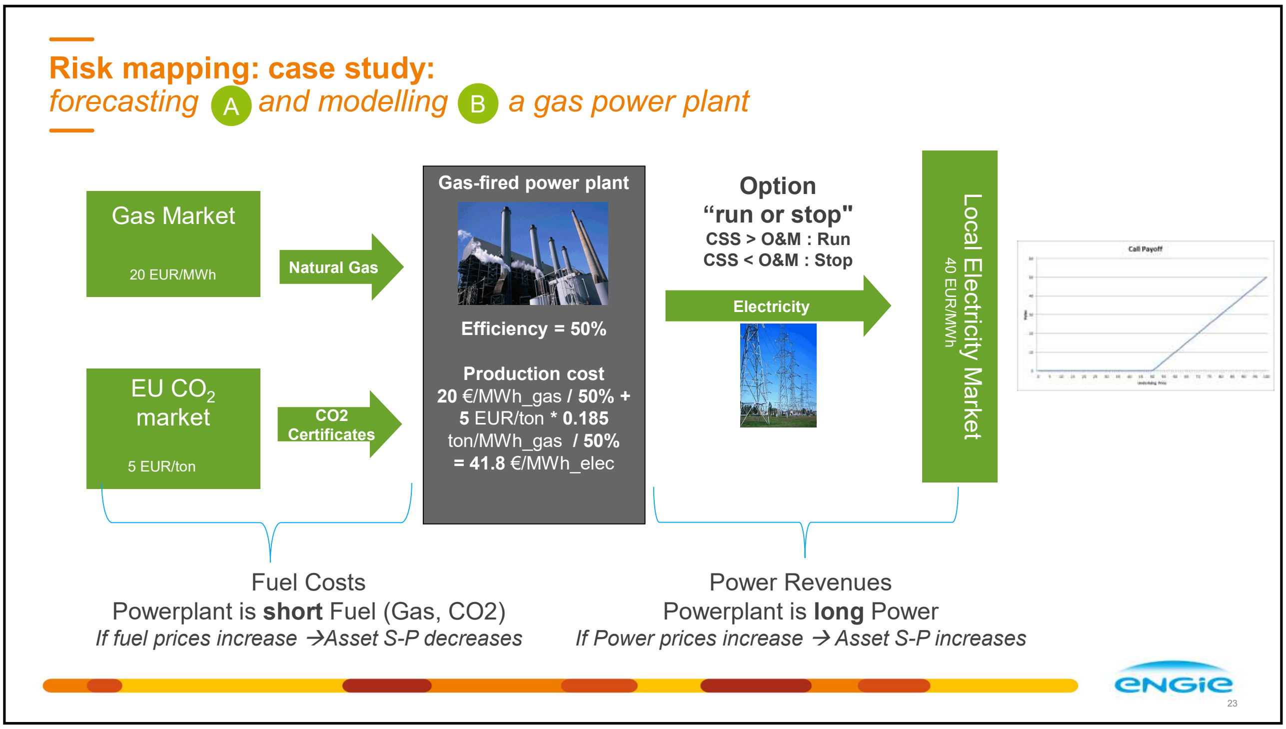
Risk mapping: case study:
forecasting A and modelling B a gas power plant
Gas Market
20 EUR/MWh
Natural Gas
EU CO2 market
5 EUR/ton
CO2 Certificates
Gas-fired power plant
Efficiency = 50%
Production cost
20 €/MWh_gas / 50% +
5 EUR/ton * 0.185
ton/MWh_gas / 50%
= 41.8 €/MWh_elec
Option
"run or stop"
CSS > O&M : Run
CSS < O&M : Stop
Electricity
Local Electricity Market
40 EUR/MWh
Call Payoff
Fuel Costs
Powerplant is short Fuel (Gas, CO2)
If fuel prices increase → Asset S-P decreases
Power Revenues
Powerplant is long Power
If Power prices increase → Asset S-P increases
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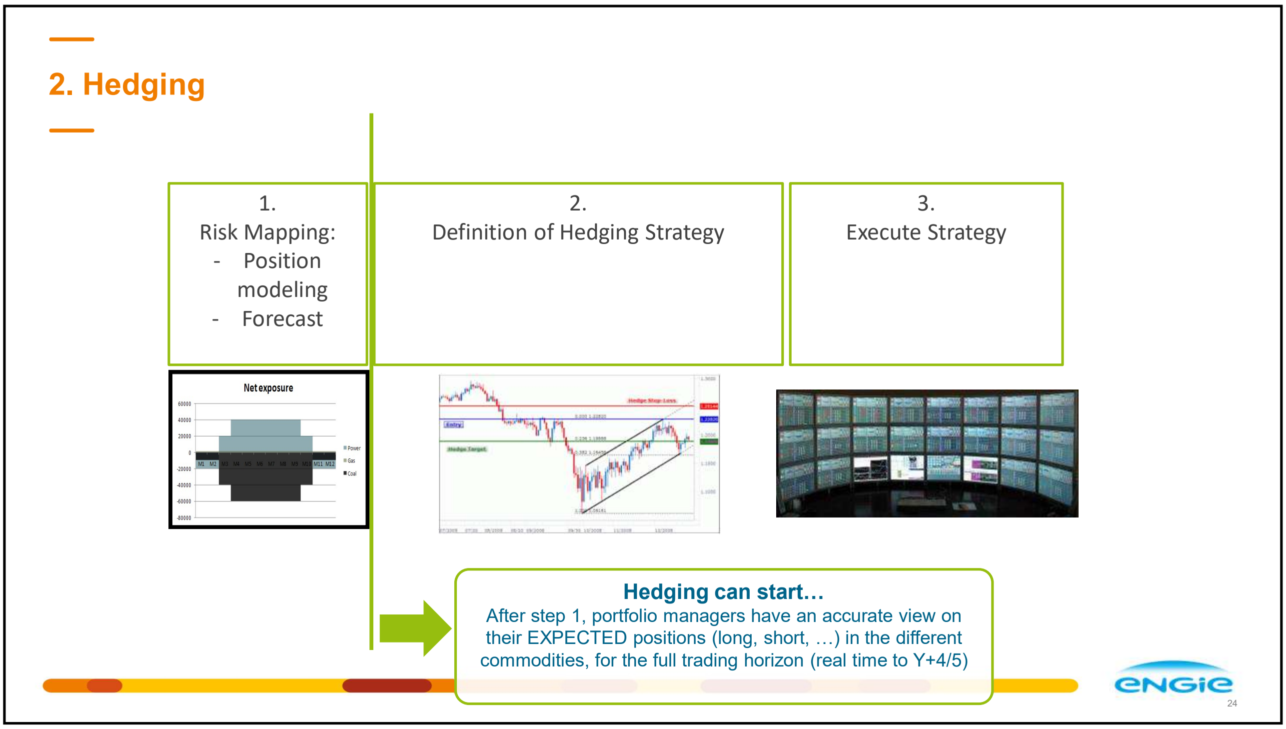
2. Hedging
1.
Risk Mapping:
- Position modeling
- Forecast
2.
Definition of Hedging Strategy
3.
Execute Strategy
Net exposure
Hedging can start…
After step 1, portfolio managers have an accurate view on their EXPECTED positions (long, short, …) in the different commodities, for the full trading horizon (real time to Y+4/5)
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Hedging: case study:
hedging a gas power plant

Power plant with 50% efficiency:
Input of 2 units of gas to produce 1 unit of power (we ignore CO2 for simplicity)

A. Strategy *"Hedge and Sleep"*

T1: forward gas 48 €/MWh ; power 100 €/MWh
- ⇨ Forecast: Plant margin: 4 €/MWh => plant will run
- ⇨ Hedging: Sell power, buy gas, margin of 4 €/MWh

T2: forward gas 50 €/MWh ; power 95 €/MWh
- ⇨ Forecast: Plant margin: -5 €/MWh, but already hedged at 4 €/MWh

T3: forward gas 49 €/MWh ; power 96 €/MWh
- ⇨ Forecast: Plant margin: 2 €/MWh, but already hedged at 6 €/MWh

P&L: 4 €/MWh

B. Strategy "Option Value"

T1: forward gas 48 €/MWh ; power 100 €/MWh
- ⇨ Forecast: Plant margin: 4 €/MWh => plant will run
- ⇨ Hedging: Sell power, buy gas, margin of 4 €/MWh

T2: forward gas 50 €/MWh ; power 95 €/MWh
- ⇨ Forecast: Plant margin: -5 €/MWh
- ⇨ Sell gas, buy power, additional margin 5€/MWh

T3: forward gas 49 €/MWh ; power 96 €/MWh
- ⇨ Forecast: Plant margin: 2 €/MWh
- ⇨ Sell power, buy gas, additional margin 2€/MWh

P&L: 11 €/MWh

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Why hedging ?
Good reasons to hedge

Avoid adverse mismatches with competitors

Meet shareholders expectations

Secure affordable prices for customers

Comply with your communication to the market

Secure your P&L

Why hedging ?
Good reasons to NOT hedge

Avoid too expensive or inefficient hedging

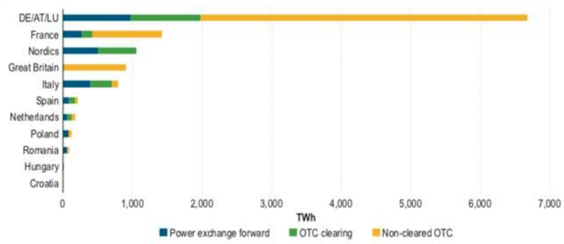
Avoid hedging uncertain positions

Due to expectations about price evolution

What do we need for good hedging ?

- Liquidity
- Cross-border instruments
- Thin granularity : only baseload products in most countries

Figure 20: Forward market trading volumes per type in the biggest European forward markets – 2017 (TWh)



Source: European Power Trading 2017 report, © Prospex Research Ltd and NRAs (2018).
Note: The respective source for each market is the same as the one described in Figure 19. For the Czech Republic and Slovenia, disaggregated information on the forward market volumes provided in Figure 19 was not available.

CONCLUSION: forward markets are crucial for the efficiency of electricity systems. They are key to ensure a competitive price for the final customers. Despite the increasing interest in short term markets generated by the energy transition, forward markets remain fundamental. NRAs and policy makers should hence also ensure their efficiency.