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Gas & Electricity

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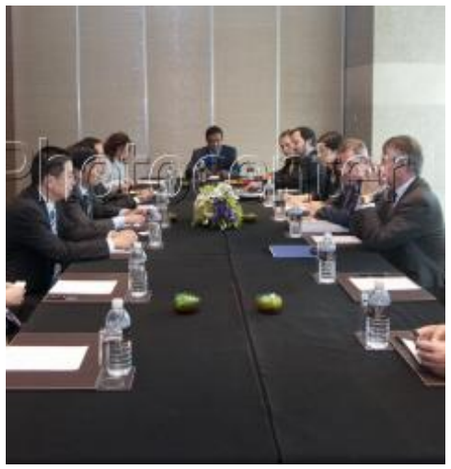
Outline

- **Introduction** — Engie Organization, Portfolio overview, Generalities
- **Gas** — Markets, Optimization, Operational deep dive
- **Power** — Markets, Optimization, Operational deep dive
- **X-COM** — Interactions Gas – Power : some concrete examples
- **Conclusions** — Conclusions

Introduction

Energy Management & Trading core activities



Defining and managing BEE portfolio

Optimizing BEE physical and contractual assets

Trading on European Markets

Negotiating with External Counterparties

Supporting BEE Marketing & Sales teams

EMT organization

Portfolio & Risk Management

- Develop consolidated view and steering for overall EMT portfolio
- Propose risk management framework and support EMT management in decision making
- Ensure consistency and quality of modeling and build and maintain competitive advantage

Optimization & Prompt

- Optimize the physical power & gas portfolio in CWE
- Identify and transfer options/positions to Trading
- Develop optimization and trading strategies beyond week-ahead
- Coordinate physical delivery, balancing & dispatch

Trading

- Maximize the value of the portfolio by identifying and capturing option value
- Ensure single voice to the market
- Capture value based on market views if proven competitive advantage

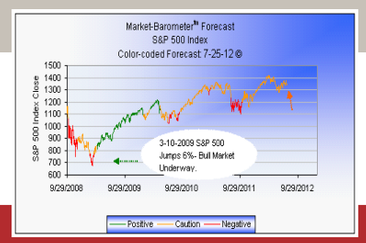
Origination & Sales Support

- Manage relationships with external counterparts, lead negotiations and conduct deal-making
- Ensure efficient Sales Support to M&S by serving as a single point of contact within EMT

EMT Set up in a nutshell

Origination / LT Gas / Capacity & Physical Assets / Structuring & Origin. Support

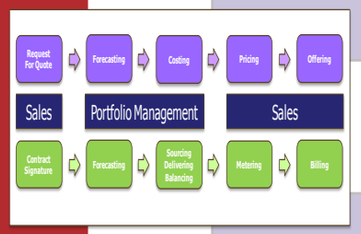
Trading



Gas Supply

O & P

Sales
gas



Generation

Sales
power

Sales Support

Local Contracting & Partnerships

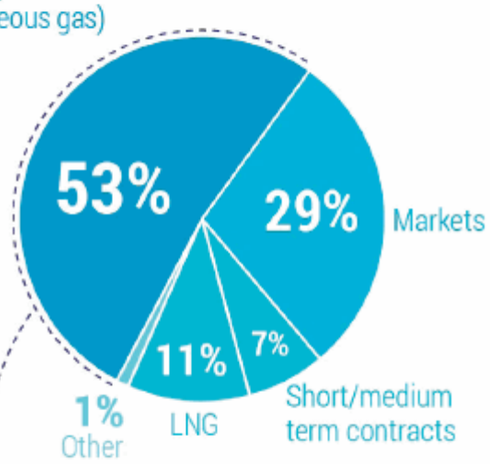
Some Key Figures

GAS

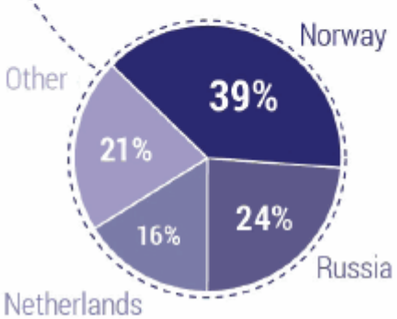
Breakdown of gas supplied by EMT:

800 TWh

Long-term contracts (gaseous gas)



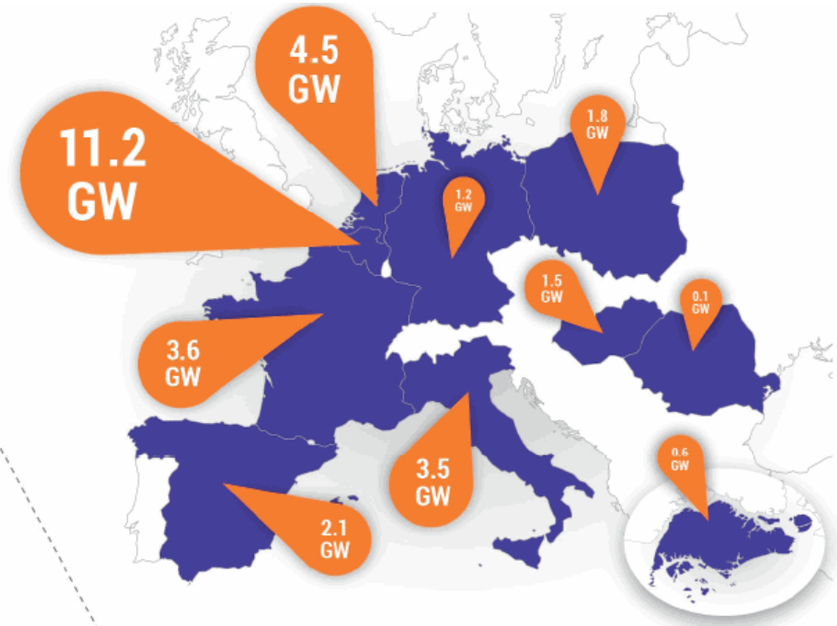
Focus on
Long-term contracts (gaseous gas)



POWER

European power capacity optimized by EMT:

30 GW broken down as follows



Volumes optimized:

100 TWh broken down as follows

NUCLEAR	GAS FIRED	COAL FIRED	OTHER	HYDRO
43 TWh	38 TWh	13 TWh	4 TWh (mainly biomass, pump storage, wind, solar...)	2 TWh

CLIENTS AND COUNTERPARTS SERVED

22M M&S B2B/B2C customers
served in power and gas within Europe

POWER: 64 TWh

GAS: 335 TWh

150 GIANTS customers

POWER: 42 TWh

GAS: 145 TWh

RISK MANAGEMENT SERVICES* 132 TWh

**incl. Market access, advisory, monitoring and hedging strategies services*

COMMODITIES TRADED BY EMT ON MARKET PLACES

Volumes traded eq. overall

10,000 TWh broken down as follows

- Gas: **4,500 TWh**
- Power: **1,500 TWh**
- Coal: **138 Mt** (1,000 TWh eq.)
- Oil: **218 Mt** (2,800 TWh eq.)
- CO_2 CO_2/emissions: **460 Mt** (230 TWh eq.)

Gas & Power : some generalities

- Electricity and Gas have their own characteristics…
  - Transport
  - Storage
  - Market organization
- … But
  - Markets are incomplete
  - More renewable energy
    - More need for flexibility
    - Enhanced role for gas-fired power generation
  - Pan European convergence on both gas & power
  - Common market regulation (REMIT, …)

- So… interactions between gas & power are / should be valuable

Optimization & Trading : some generalities

- Optimizers maximize the value of a portfolio taking into account all portfolio constraints and market conditions
  - Portfolio = power plants, gas storages, clients (B2C/B2B/Giants), regasification plants, LT contracts,…
  - Constraints = weather impact on consumption forecast, balancing obligations, power plants availabilities, gas transport availbilities, …

- Traders extract the maximum possible value from electricity and gas markets
  - Continuous trading
  - Auction trading

02

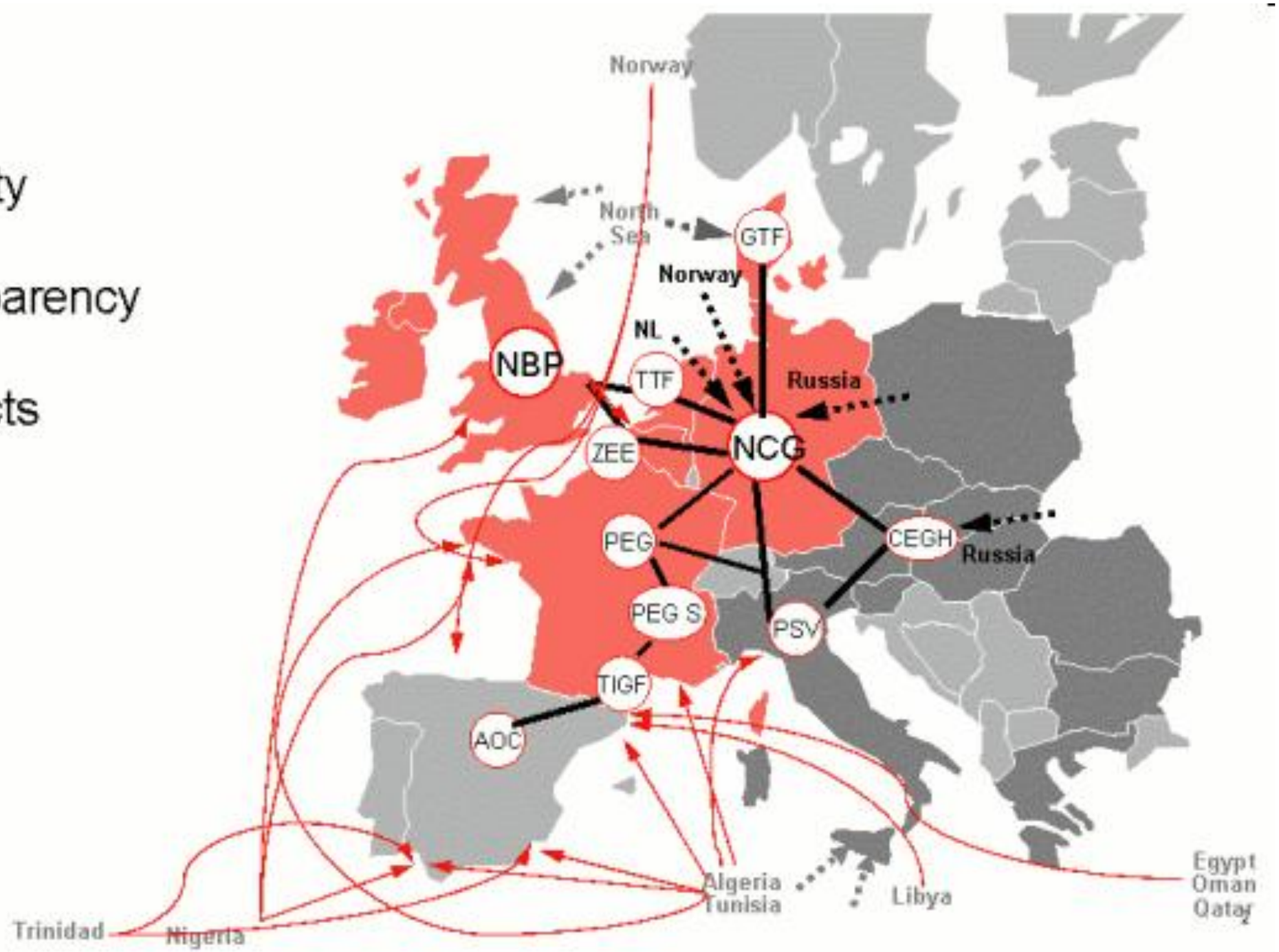
Gas

Gas Markets : introduction

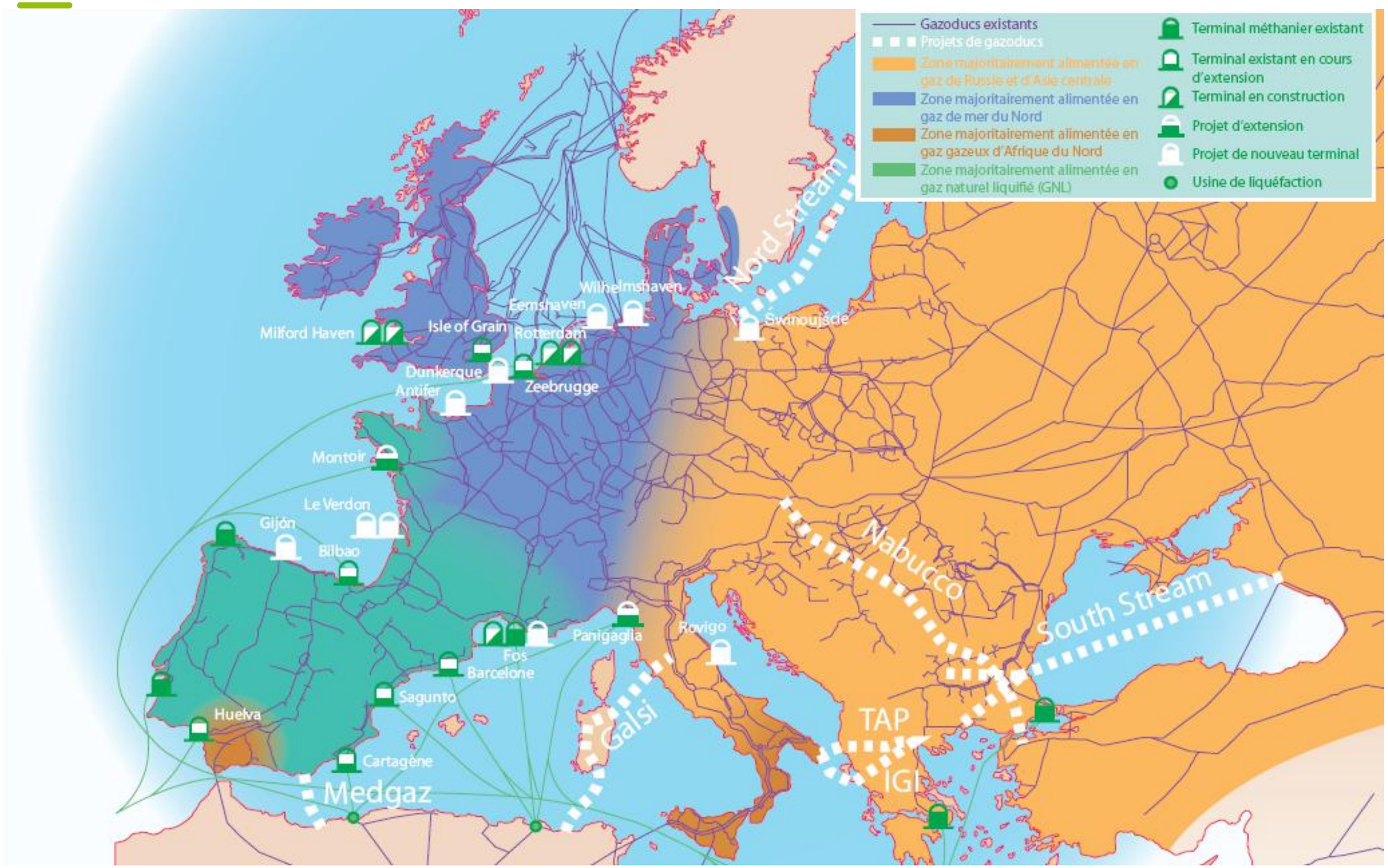
- Financial or physical products
- Different Maturities
  - Forward Y+1, Q+1, M+1
  - Spot
  - Intraday
  - Balancing markets
- Organized around Trading hubs
  - Hub = trading place or market, where energy volumes are exchanged.
  - Hubs create a common point for commercial trading contracts to settle with or without going to physical delivery
  - Hubs are intended to create price signals for geographical regions of the control area by aggregating a group of representative buses

Gas Markets : overview

- Liquidity
- Transparency
- Products



Gas Markets : overview



Gas Optimization: a conceptual overview

Upstream assets in portfolio

- Long Term gas supply contracts (LTC)
  - Pipe gas
  - LNG
- Structured transactions
  - -Swaps
  - -Buys
  - -Flexibility
- Transit capacities
- Storage capacities
- LNG Terminal capacities

Optimization constraints

Asset constraints

Downstream assets in portfolio

- Structured transactions (LT & ST)
  - -Swaps
  - -Sales
  - -Flexibility
- -Sales to customers
  - -Giants
  - -B2B
  - -B2C

*Implies **Security of supply obligations** to your protected customers*

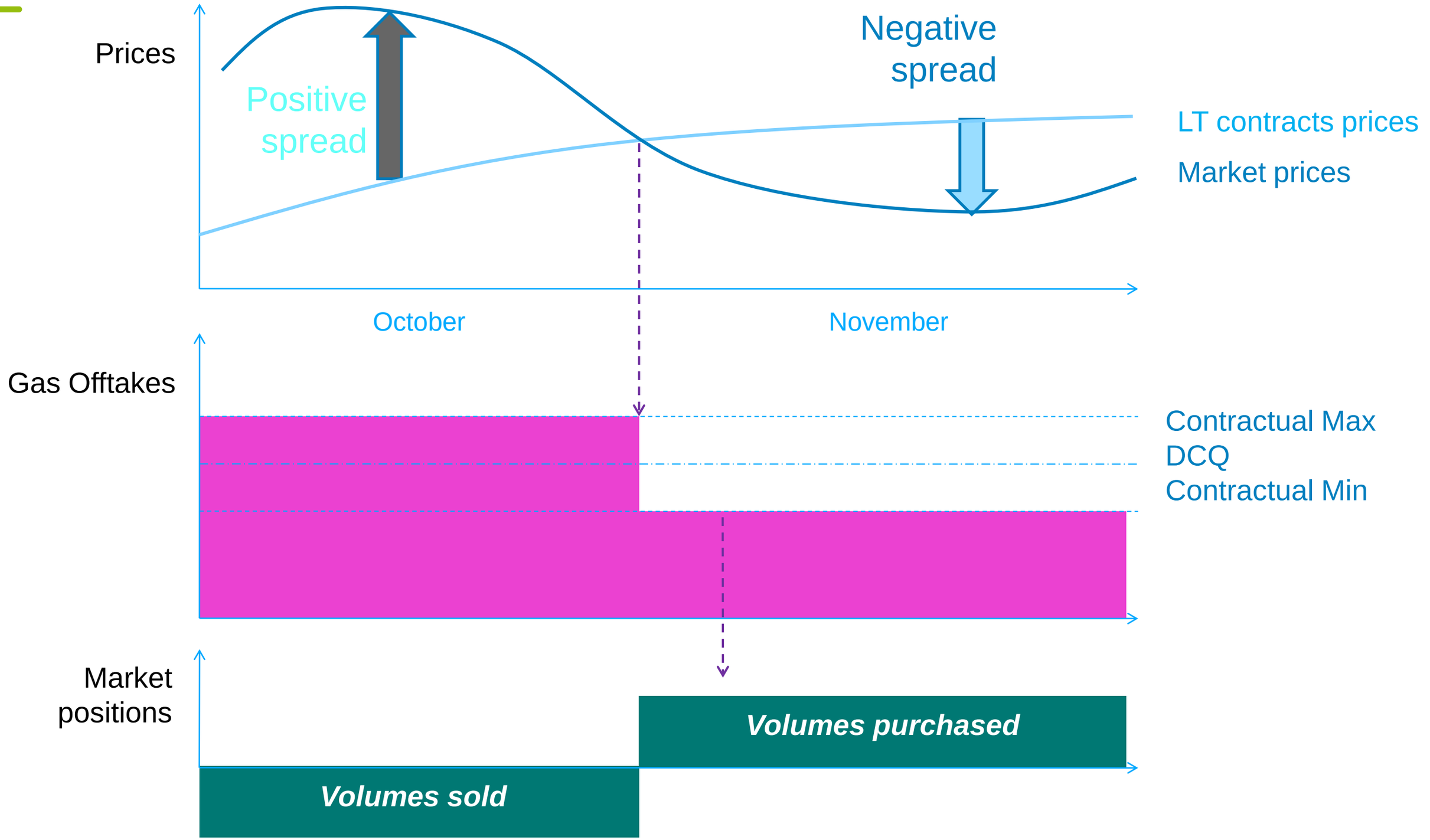
Optimization

Asset constraints

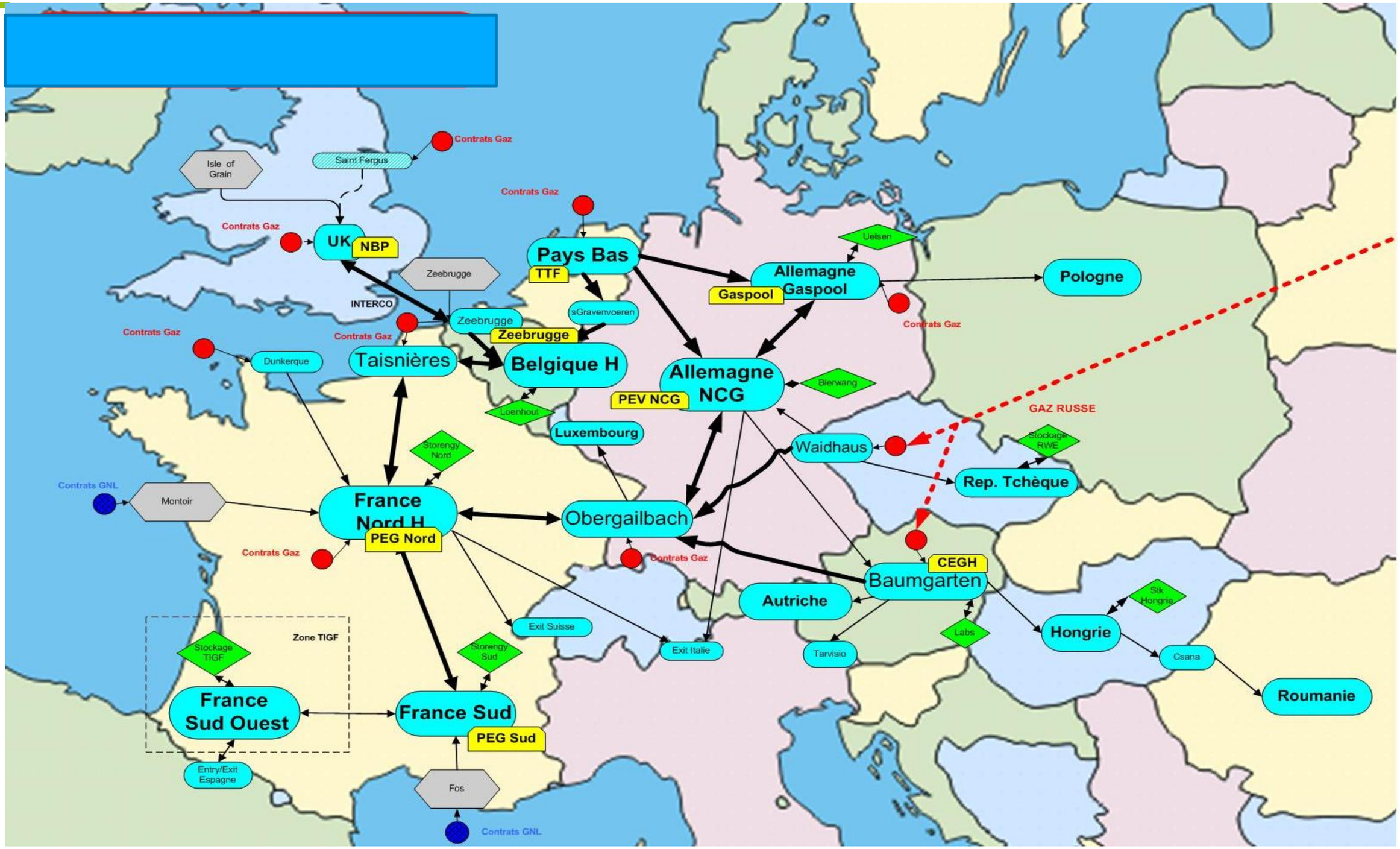
Reporting

Hedging

Gas Optimization : flexible assets against markets



Gas Optimization: portfolio overview



Gas Portfolio Overview

- Number of LT contracts, storages, grid capacities…

— 13 countries
— 360 TWh/year (final end-users, under average climate)
— 160 TWh/year (market interventions, direct or via origination)
— 80 TWh of transit and balanced swap

— 30 long term contracts
— 7 LNG long term contracts
— 4 LNG terminals

— 101 consumption areas
— 178 routing connections between the areas (with Italy and Spain)
— 20 storages with more than 90 TWh of WV (with Italy and Spain)

- Size of optimization problem modelling

— 380 000 variables
— 150 000 constraints

Gas Optimization : managing uncertainty – orders of magnitude

MATURITY	UNCERTAINTIES		LEVERS	
Monthly volumes ***January consumption (Normal weather) : ~ 75 TWh***	Weather risk	+/- 15 TWh	Monthly flexibilities of LT Contracts	+/- 5 →10 TWh
	LNG shortfall	3 TWh	Storages	+/- 15 TWh
	Gas shortfall	3 TWh	Market	Constrained by liquidity
Daily volumes ***Daily consumption in January (Medium weather) : ~1.5 TWh*** ***Peak demand : 3.35 TWh/d***	Weather risk	1500 GWh	Daily flexibilities of LT Contracts	+/- 300 GWh
	Daily uncertainties (D-1 → D)	200 GWh	Storages	+/- 1000 GWh
	One power plants outage	20 GWh	Interruptibles clients	20 GWh
	LNG downloads & terminal emissions	70 GWh	LNG emissions	+/- 250GWh
	Shortfalls and disruptions	100 GWh	Power plants with switch options	
	Note : Availability of physical assets under extreme conditions	*350 GWh*	Market	

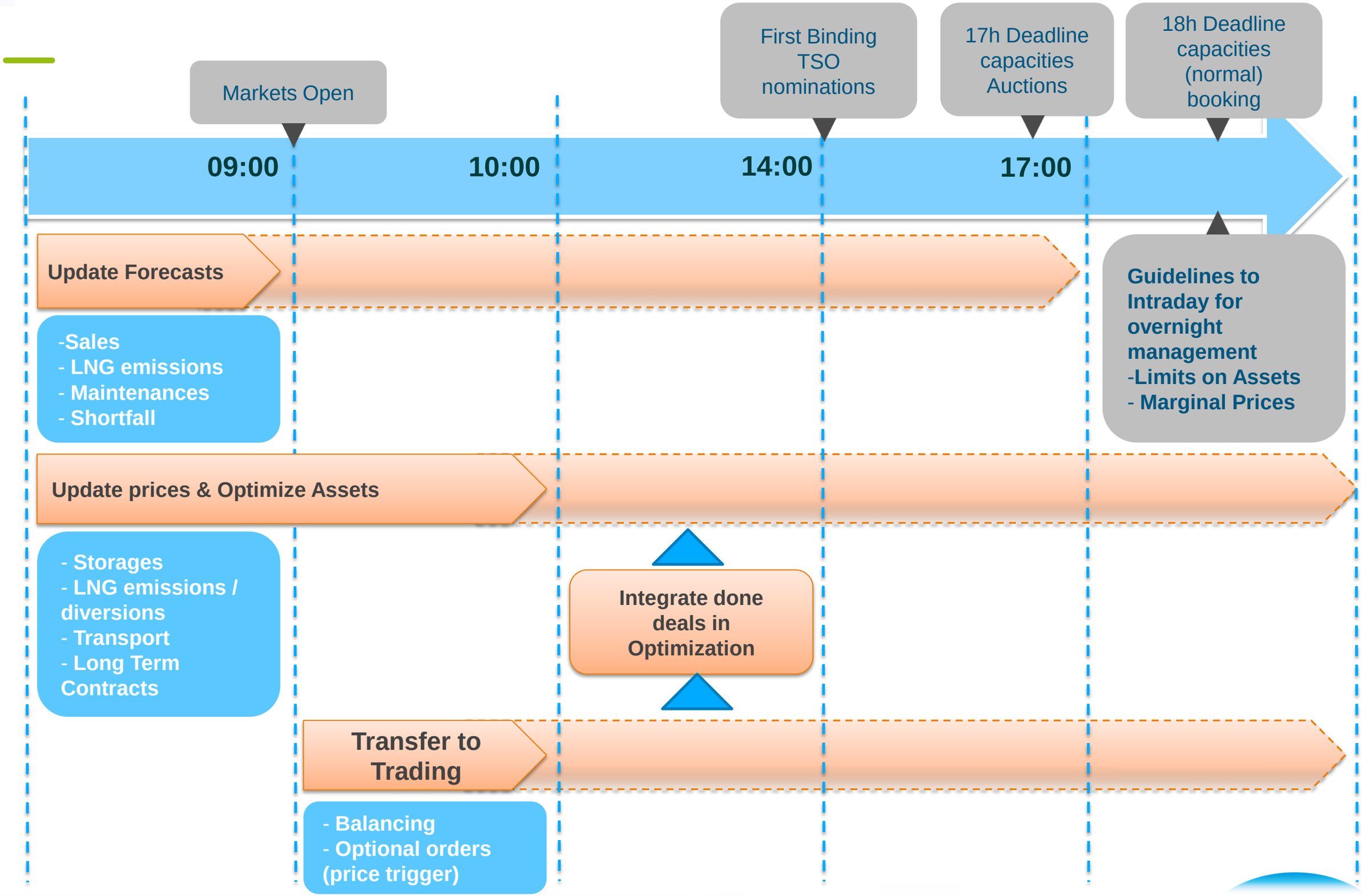
Uncertainties are managed with assets and markets

Gas Optimization & Trading : operational deep dive

- Portfolio is close to fully hedged on a mid term basis (before start of the month)
- Within month: management of the physical detailed characteristics of the portfolio
- Optimization based on assets costs and markets prices – 7/7 days
- Respect of risk framework, contractual and operational constraints

- Involved functions:
  - Optimization teams
  - Operational teams for nominations (TSO and counterparts)
  - Trading for market operations
  - Risk Control teams for respect of risk framework
  - Support teams for invoicing and reporting

Gas Optimization & Trading : operational deep dive



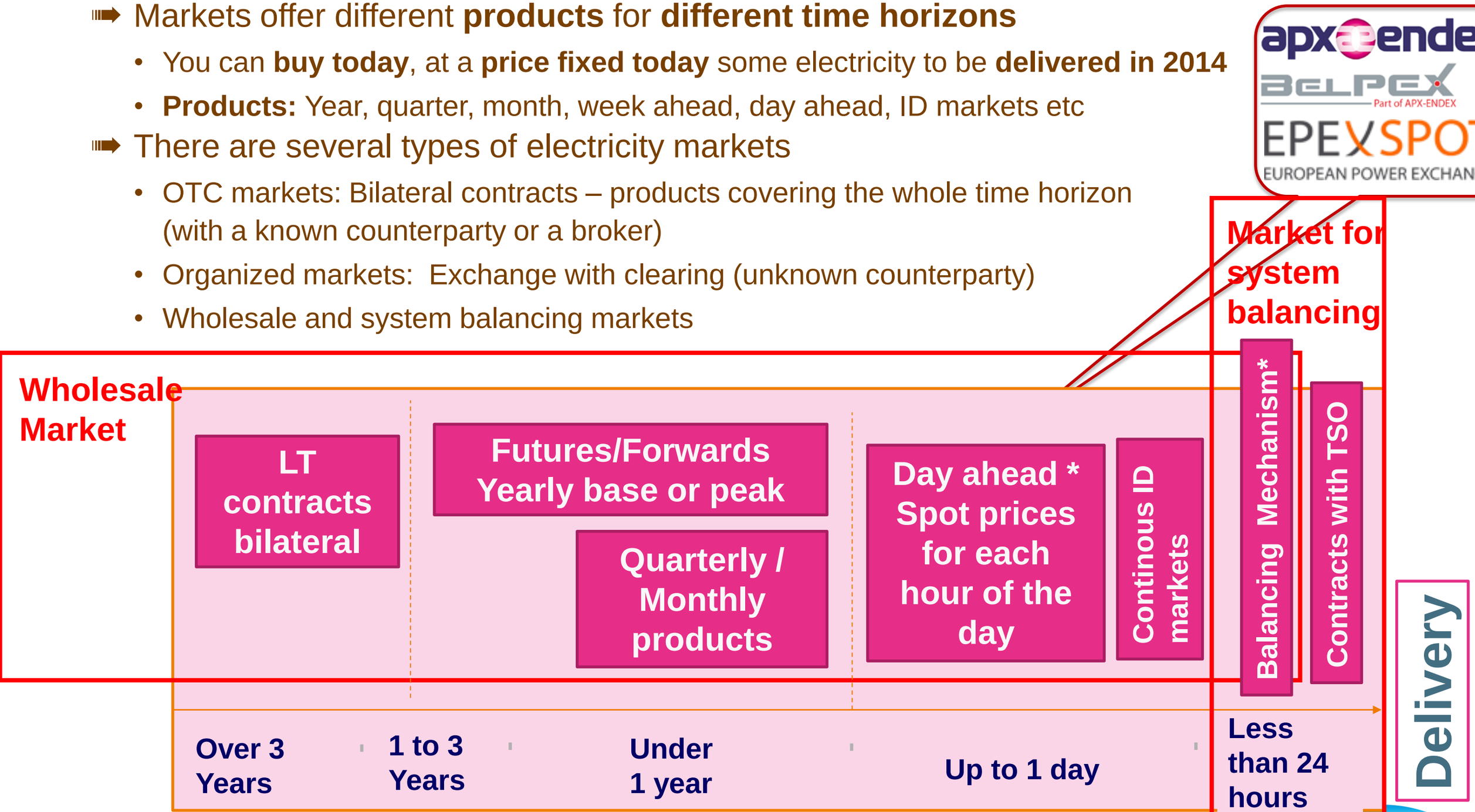
Power

Power Markets: introduction

- Different Markets
  - Commodity Markets
  - Ancillary Services markets
  - Capacity Markets
- Financial or physical products
- Different Maturities
  - Forward Y+1, Q+1, M+1
  - Spot
  - Intraday
  - Balancing markets
- Organized around Trading hubs

Power Markets : an overview

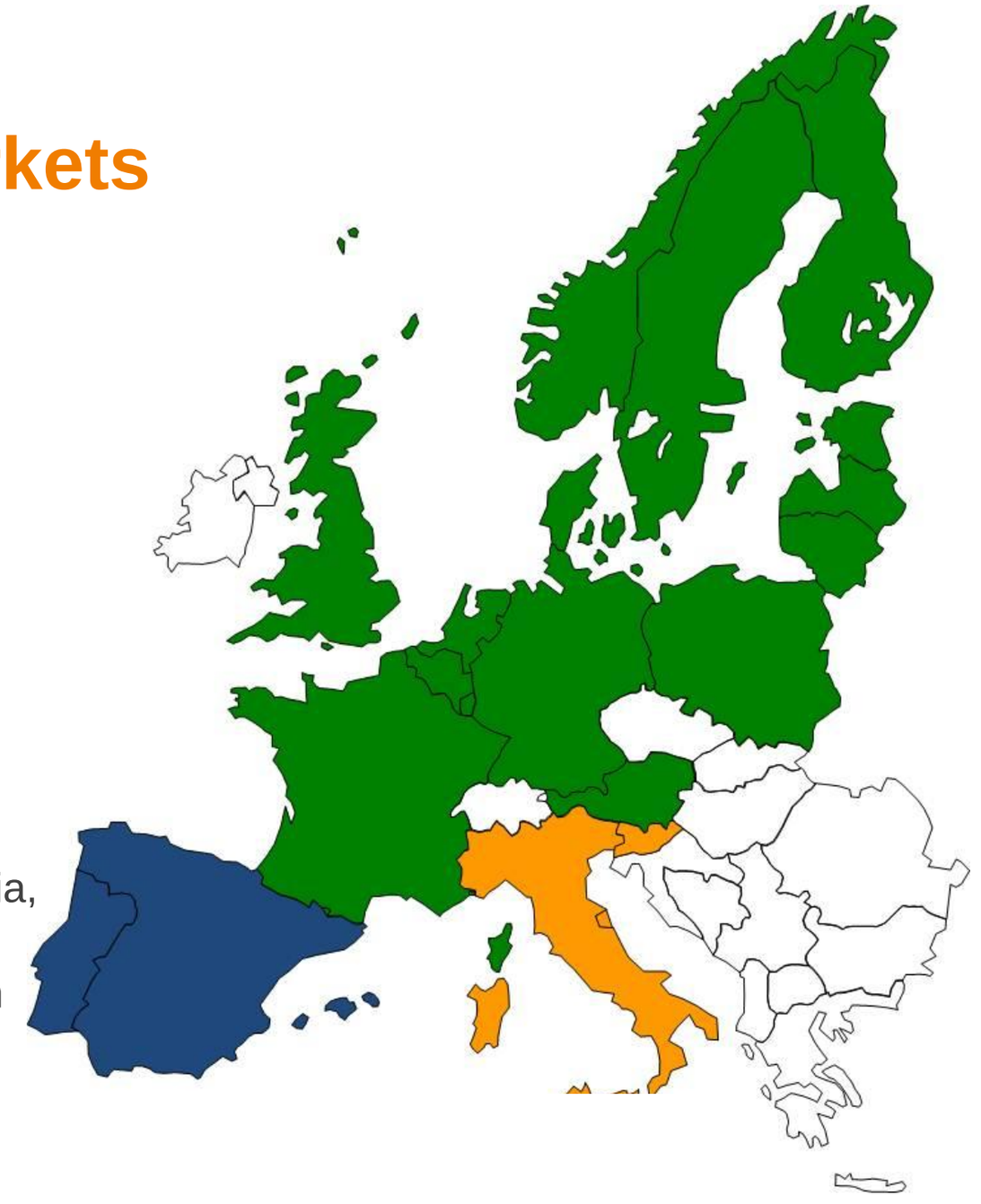
- Markets offer different **products** for **different time horizons**
  - You can **buy today**, at a **price fixed today** some electricity to be **delivered in 2014**
  - **Products:** Year, quarter, month, week ahead, day ahead, ID markets etc
- There are several types of electricity markets
  - OTC markets: Bilateral contracts – products covering the whole time horizon (with a known counterparty or a broker)
  - Organized markets: Exchange with clearing (unknown counterparty)
  - Wholesale and system balancing markets

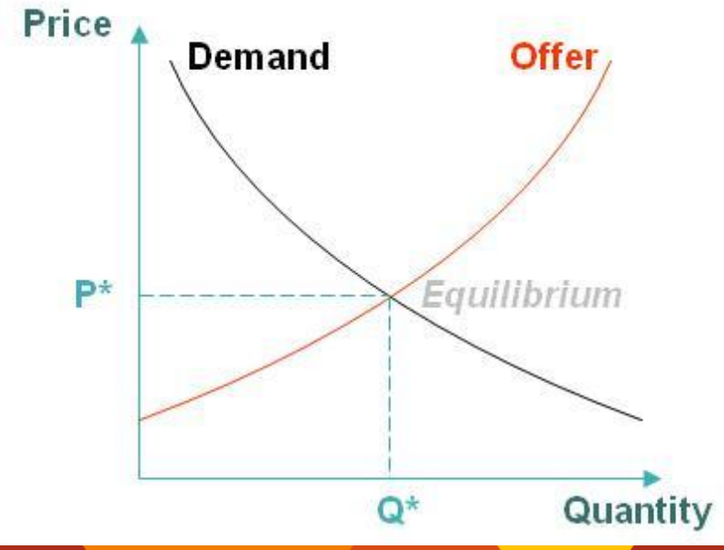


* OTC products as well

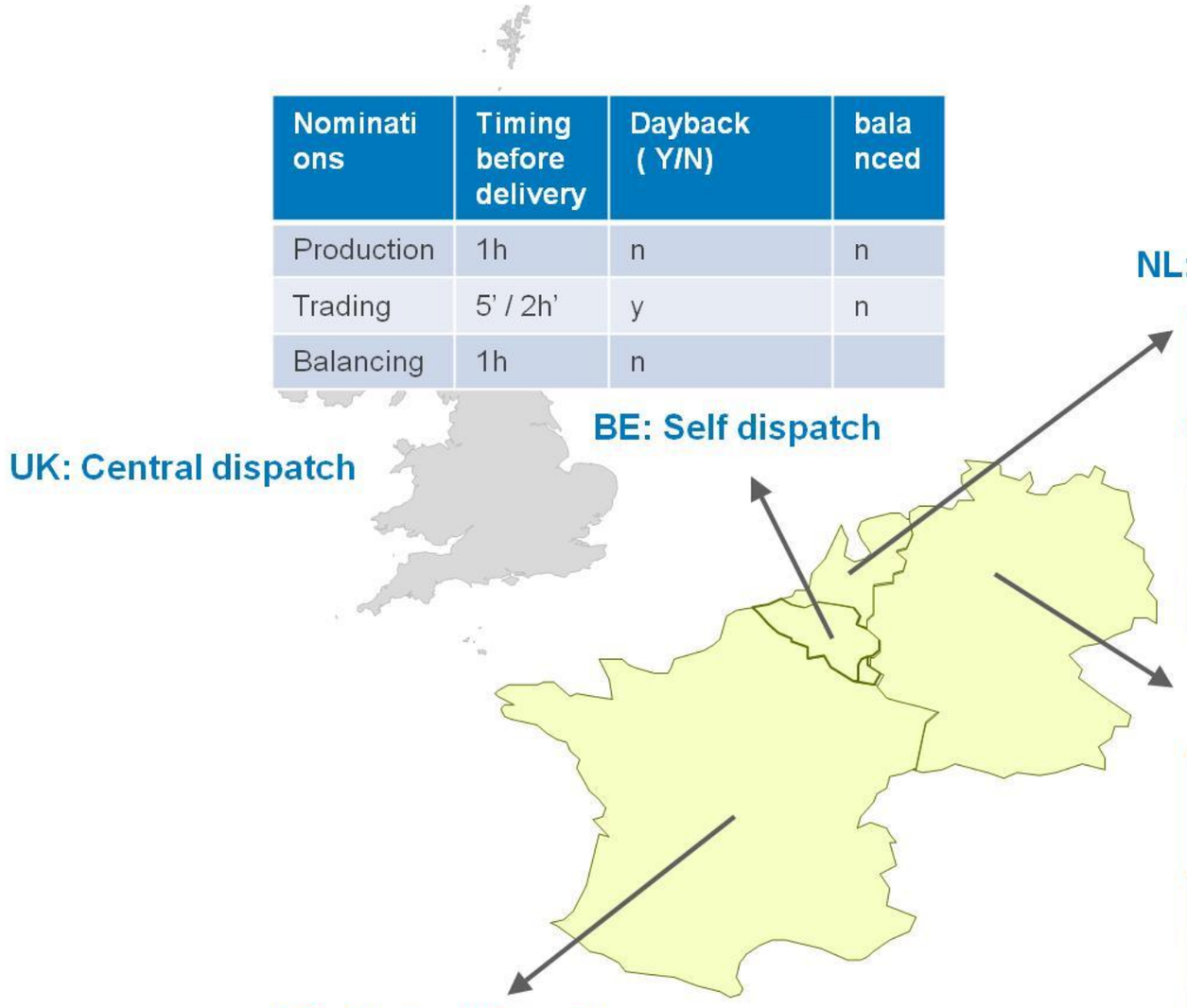
Power Markets: zoom on spot markets

- Towards a pan European commodity market
- Spot = day-ahead market
- Auction based
- Hourly granularity
- DA market coupling: 15 countries
  - market coupling between Austria, Belgium, Denmark, Estonia, Finland, France, Germany, Great Britain, Latvia, Lithuania, Luxemburg, The Netherlands, Norway, Poland, and Sweden
- Different products





Power Markets: zoom on intraday & balancing



Nominations	Timing before delivery	Dayback (Y/N)	balanced
Production	1h	n	n
Trading	5' / 2h'	y	n
Balancing	1h	n	

UK: Central dispatch

BE: Self dispatch

NL: Self dispatch

Nominations	Timing before delivery	Dayback (Y/N)	balanced
Production	1h	n	n
Trading	5' / 1h&2h	y	y
Balancing	15'	n	

DE: Self dispatch

Nominations	Timing before delivery	Dayback (Y/N)	balanced
Production	30'	n	Y
Trading	45' /1h	y	Y
Balancing	15'	n	

FR: Central dispatch

Nominations	Timing before delivery	Dayback (Y/N)	balanced
Production	1h	n	n
Trading	45'	y	n
Balancing	1h	n	

Power Optimization: a conceptual overview

Power Markets

Upstream assets
- Thermal power plants
- Nuclear power plants
- RES power plants

Optimization

Results

Downstream assets
- B2B sales portfolio
- B2C sales portfolio

Power Optimization : flexible assets against markets

Local Gas Market

27 EUR/MWh

Natural Gas

Gas-fired power plant

Efficiency 50%

Conclusion: 1 MWh gas = 0.2 ton CO_2

CO_2 Certificates

Electricity

56 EUR/MWh

Option
"Make or Buy"
CSS > X: Run
CSS < X: Stop

Cost PRICE OF ELECTRICITY

Clean Spark Spread

X= variable non-fuel cost (O&M)
Typical X for gas = 2 EUR/MWh

Local Electricity Market

50 EUR/MWh

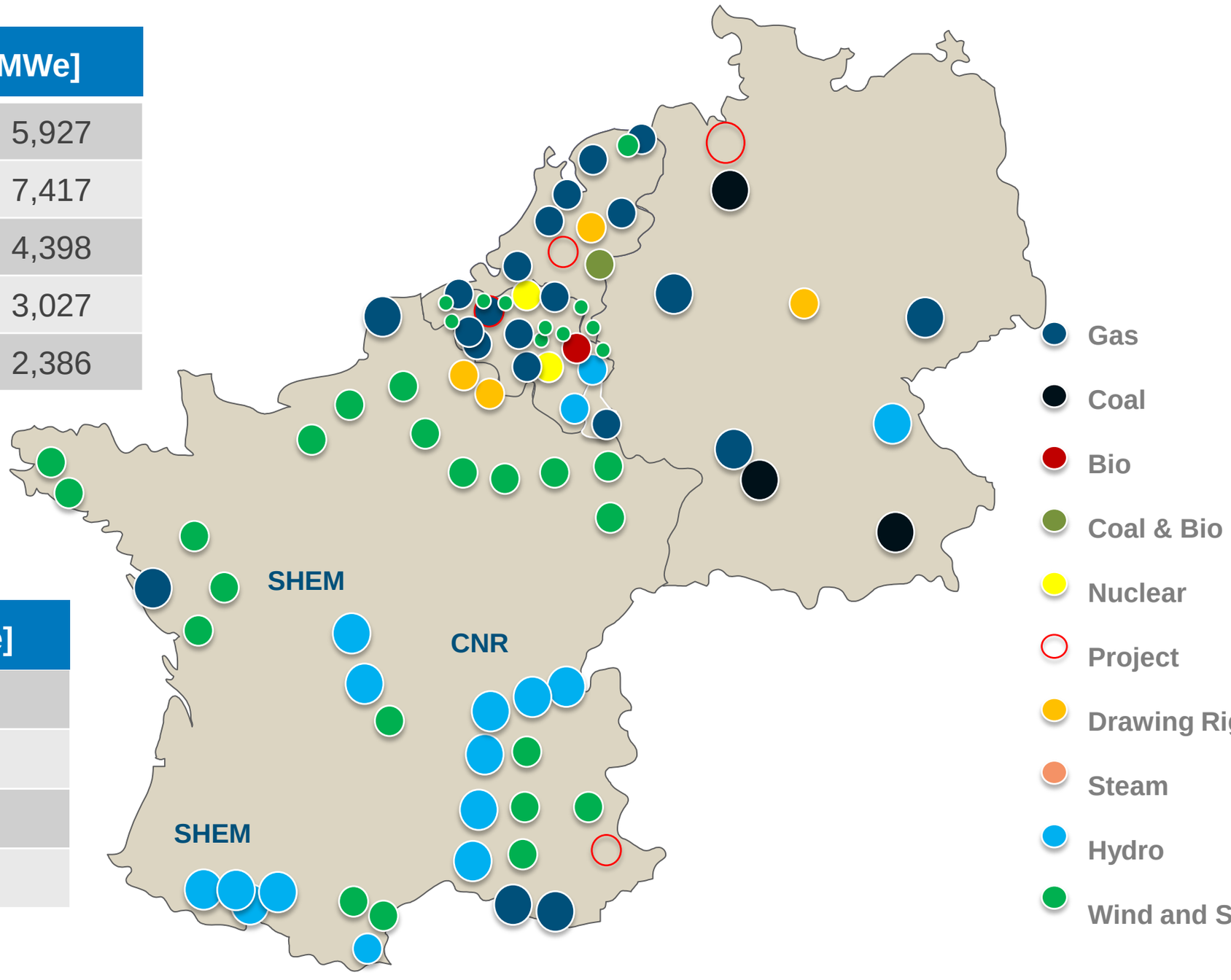
Global CO_2 market

5 EUR/ton

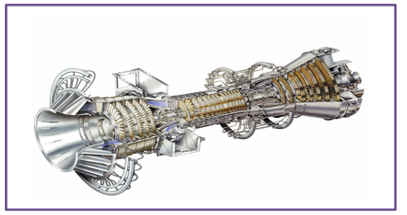
Power Portfolio Overview in CWE

Technology-based [MWe]	
Nuclear BE (100%)	5,927
CCGT	7,417
Coal & Biomass	4,398
Hydro & Wind	3,027
Other	2,386

Country-based [MWe]	
BELUX	13,050
NL	4,699
FR	2,983
DE	2,423



Power - Technology Overview (1)

Criteria	Nuclear	Coal	CCGT	CHP	GT / Diesel / TJ
					
Goal	Baseload inflexible but cheap generator	Baseload mid merit generator	Flexible generator, peak hours mainly	Inflexible, partnerships to supply heat	Very flexible, peaker
Load Factor	LF > 85 %	LF > 75 %	20% < LF < 50%	LF > 75 %	LF < 10 %
Flexibility	Startup: 24 h Modulation: Low	Startup: hours Modulation: Yes	Startup: 45’ -1.5 h Modulation: Yes	Startup: 1 h Modulation: No	Startup: < 15’ Modulation: Yes
Efficiency	33 %	30-50 %	50-60 %	Up to 85 % (considering heat)	30 %
Investment cost	3000-5000 €/kW (new EPR: 8 b€)	1500 €/kW	750 €/kW	500 €/kW	500-1000 €/kW
Fuel Cost	Very Low	Low	High	High	Very High

Power - Technology Overview (2)

Criteria	Hydro RoR	Hydro PS	Biomass	Wind	Photovoltaic
					
Goal	Flexible if reservoir	Very flexible, storage	No CO2, often Must Run	No CO2, Must Run & intermittent	No CO2, Must Run during day
Load Factor			~ 80 %	25 – 40 %	15 – 20 %
Flexibility	Startup: sec Modulation: not always	Startup: sec Modulation: Yes	Startup: ~ hours Modulation: +/-	Startup: - Modulation: No	Startup: - Modulation: No
Efficiency		75 %	35 – 42 %		
Investment cost	1000-2000 €/kW	Specific	1000-2000 €/kW	1500-4000 €/kW	2000 €/kW
Fuel Cost			High		

In general : trend toward more flexibility

Power Optimization & Trading : Operational Deep dive

Fleet information

FWD Prices

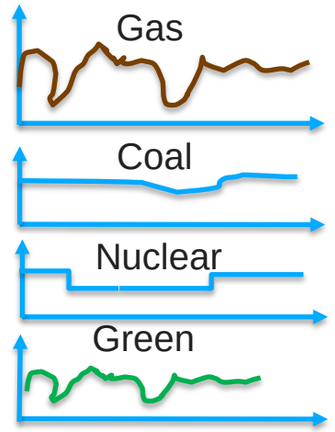
Constraints

Revision planning
Reserves
Special contracts
…

1 **Using fleet information, market prices and constraints as input...**

2 **OPTIMIZATION MODEL**

3 **...the production forecast and fuel consumption forecast is created...**



4 **...based upon which we take hedging (risk reducing) actions...**

5 **and we reiterate the optimization**

Power Optimization & Trading : Operational Deep dive

- **Portfolio is close to fully hedged on a mid term basis (before start of the month)**
- **Within month: management of the physical detailed characteristics of the portfolio**
- **Optimization based on assets costs and markets prices – 7/7 days (24/24)**
- **Respect of risk framework, contractual and operational constraints**

- **Involved functions:**
  - Optimization teams
  - Operational teams for nominations (TSO and counterparts)
  - Trading for market operations
  - Risk Control teams for respect of risk framework
  - Support teams for invoicing and reporting

Power Optimization & Trading : Operational Deep dive

- A few days before month M, the portfolio is close to fully hedged
- From that point on, management of the detailed physical characteristics of the assets

Month M-1		Month M				Month M+1 & Beyond			
Week W-1	**Week W**	**Week+1 (WA)**	Week W+2	Week W+3	Week W+5				

1 – Asset Coordination

Coordination with Powerplants and TSO by Prompt Optimization (Genco Coordination)

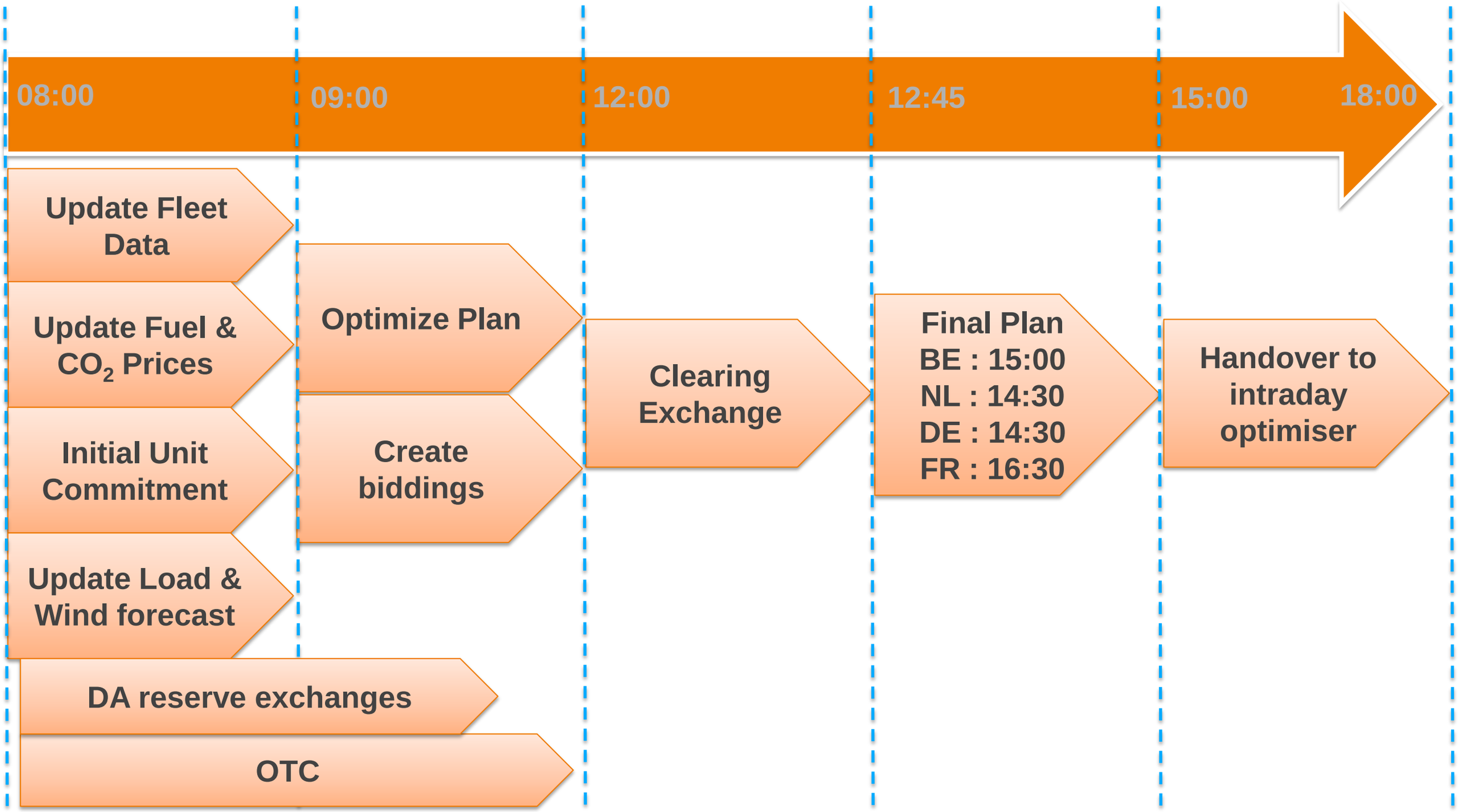
2 – Optimization & Trading

Portfolio economical optimization by Prompt Optmization
Position Management & margnal cost computation

Portfolio monetization by Prompt Trading

Market access

Power Optimization & Trading : Operational Deep dive



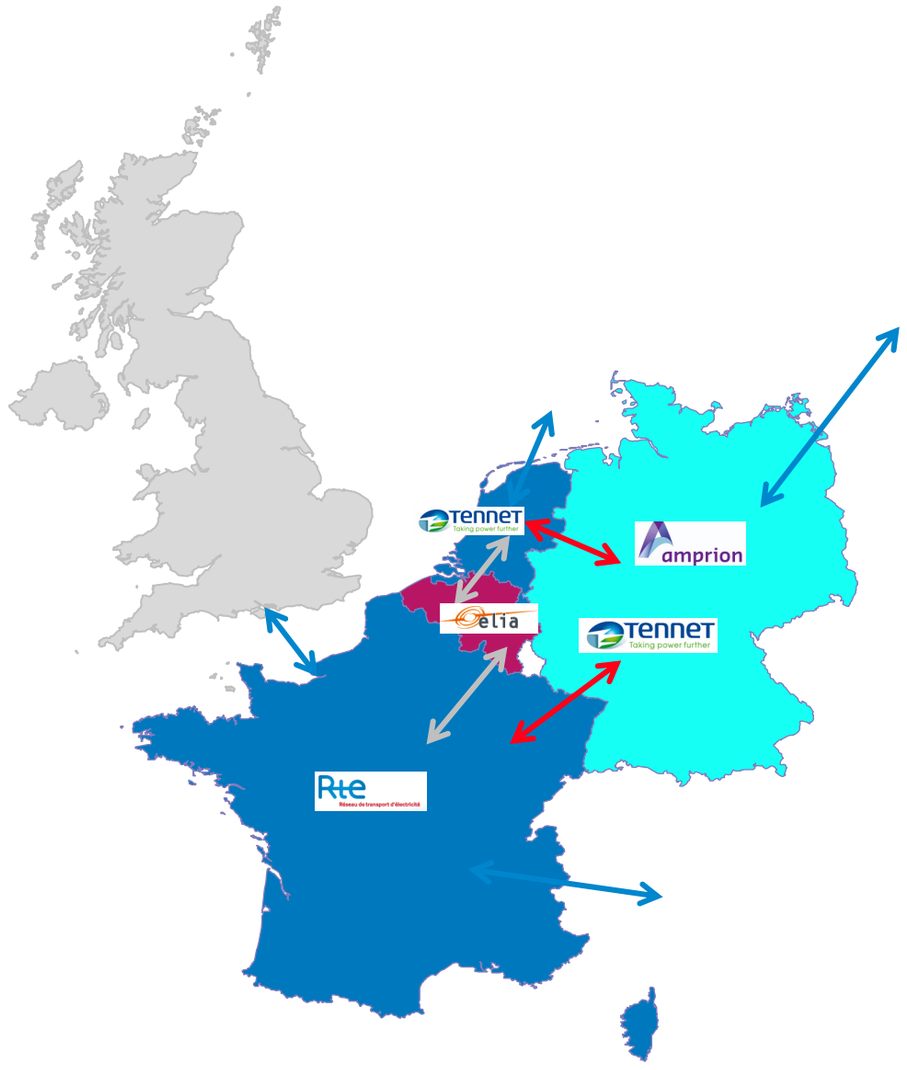
Power Optimization & Trading : Operational Deep dive

TIMELINE Intraday Optimization

- DA Delivery of Day-Ahead Plan at 14H

  1. 4 Final Day-Ahead Plan after DA Market Clearing (final DA Prices) around 14H

- IOT > 14H : Start additional day in continuous local market in addition to EOD CWE market.
- IOT 15:00 German: DA QH auction market, start continous QH next day.
- IOT > 16H : 1 HTC Optimization Plan for CWE till end of Day plus transferred D+1
- > 21H : Cross Boarder Capacity for D+1 Info to re-Optimize the whole Portfolio and Trade plan
- > 00H : Following ID Prices and Portfolio evolution to Optimize in real time against 2 hourly Cross Boarder Market gates



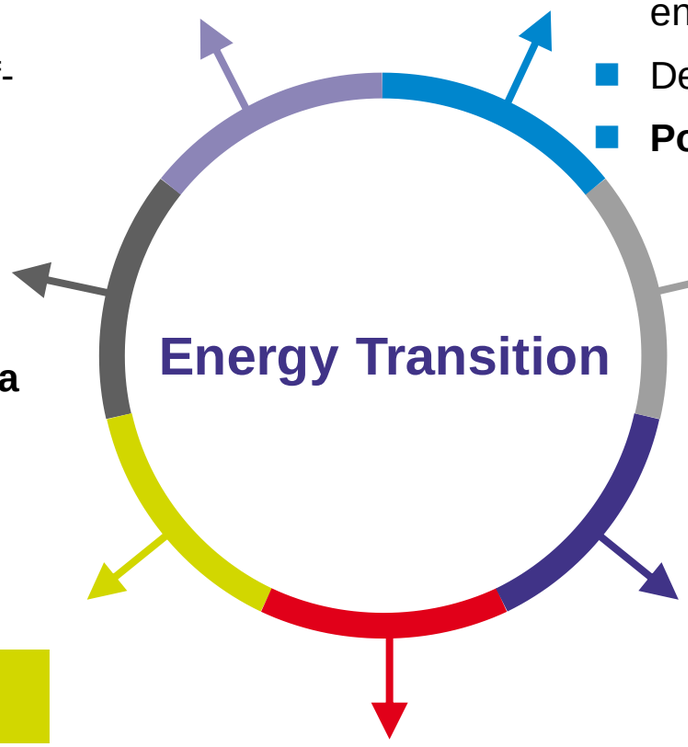
Our world is changing....

Renewable Energy

- Intermittent Wind / PV Energy management
- Hydro management: reservoir, run-of-river,...

Decentralized Energy

- Management / Optimization of decentralized energy + associated physical flows
- Decentralized = behind the meter
- **Power, Gas, and Heat production**



Micro Grid

- Energy management **at the level of a community / micro grid** involving different sources and useages of energy

Demand Response

- Valorization of final customers' consumption flexibilities
- Optimization of **storage**
- Mainly Power, but also Gas

Digital sales link

- Market Access Platform (Keytrade bank / Boursorama of the energy markets)
- Consumption forecast ?

Energy solutions for Giants

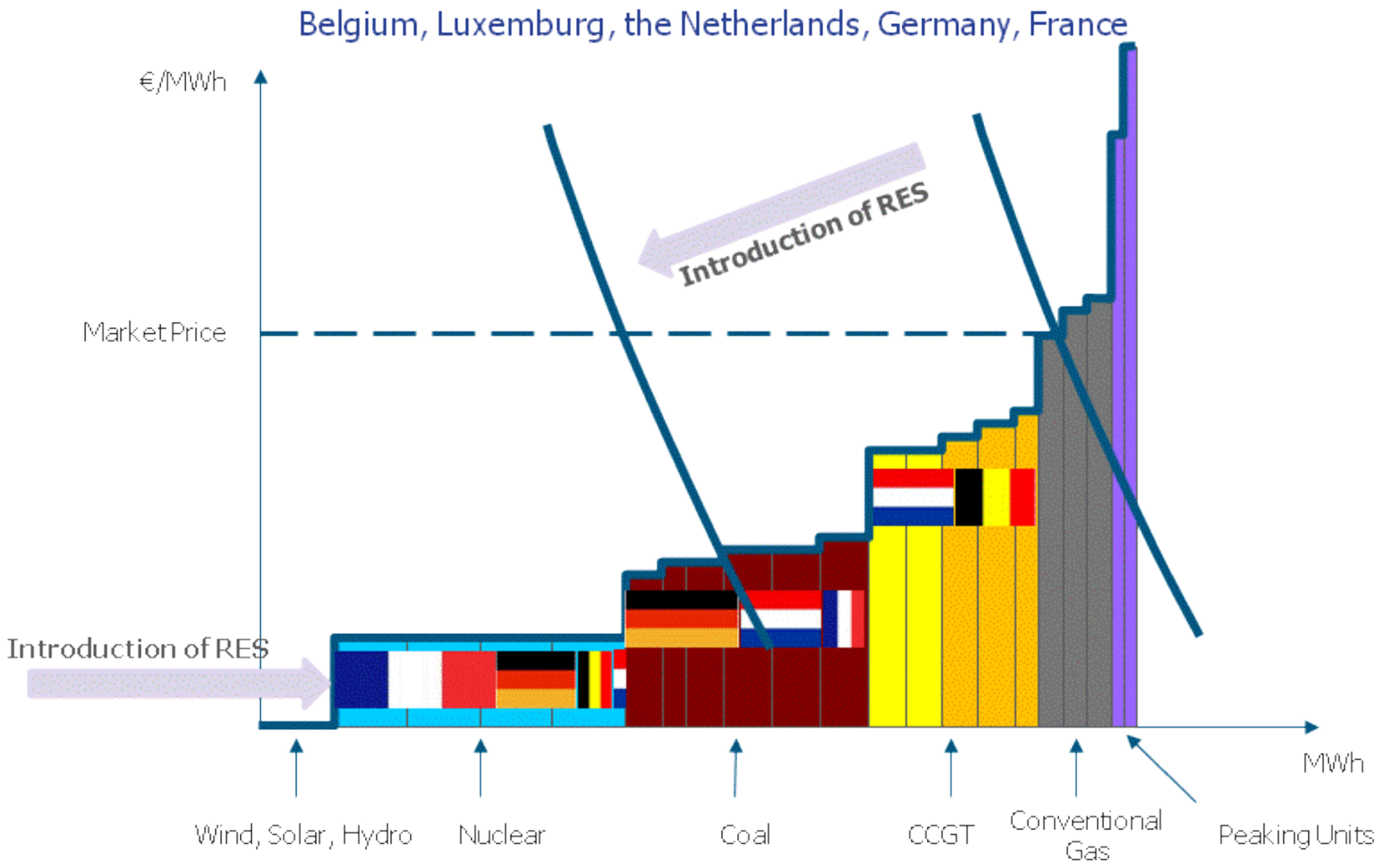
- Investment analysis service
- Bundled offers (commodity and maintenance..)

Green (New) Commodities

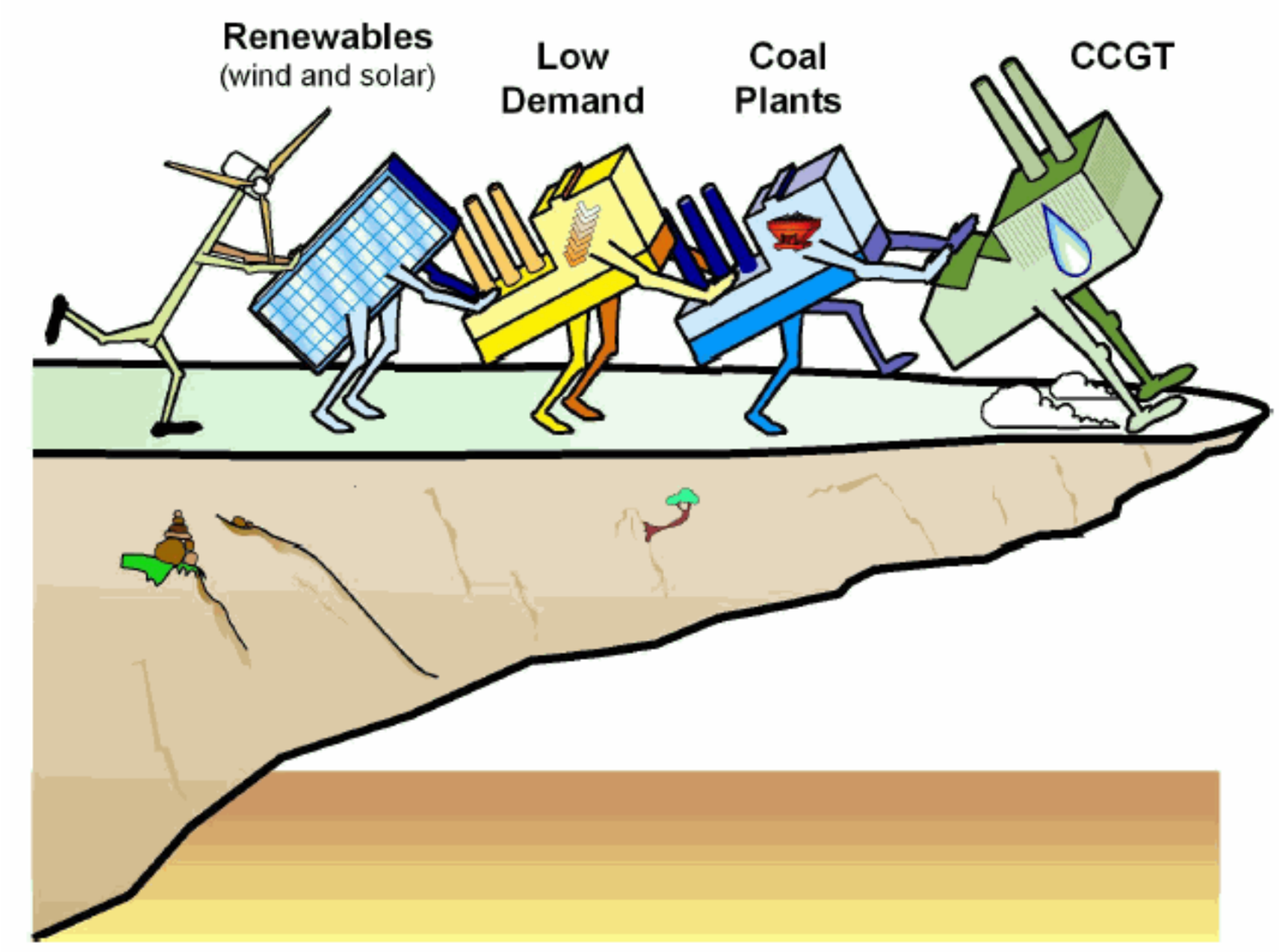
- Sales, wholesale and exchange trading
- e.g. GoO, LEC, biomass (including exchange), green gas, …

Merit Order and Price Setting

- Generators bid power plants at marginal cost, from the cheapest to the most expensive one (merit order)
- Intersection between supply and demand determines the assets that will be offered and the power price for each hour of the next day

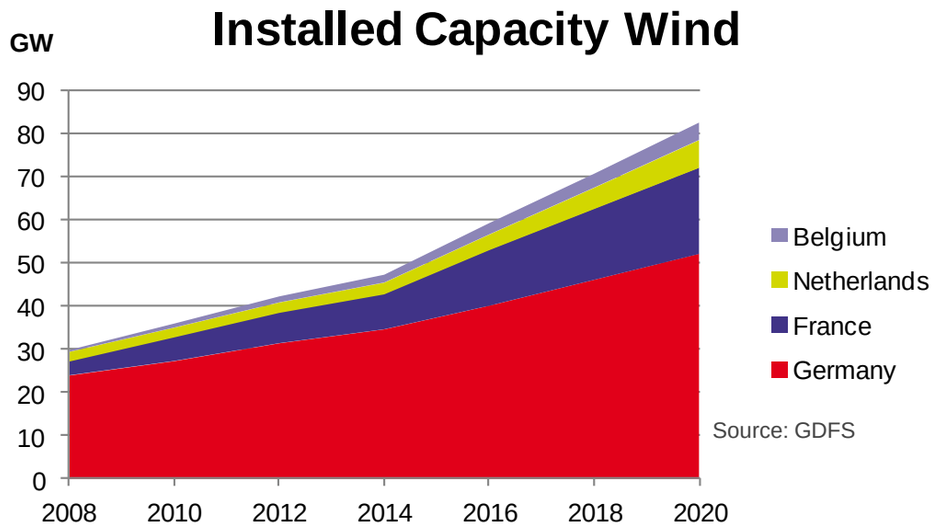


RES intermittency impact



The Growing Trend is Set to Continue…

- Expected evolution **wind capacity** in CWE:

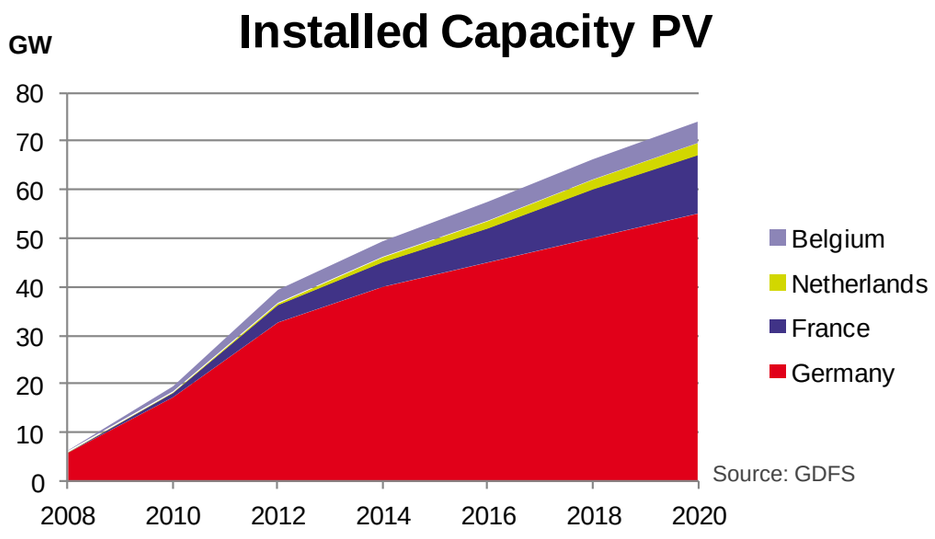


Source: GDFS

Massive increase expected:

	Increase by 2020	GW	% avg demand
Belgium	222%	4	39%
Netherlands	237%	6	45%
France	303%	20	37%
Germany	151%	52	79%

- Expected evolution **PV capacity** in CWE



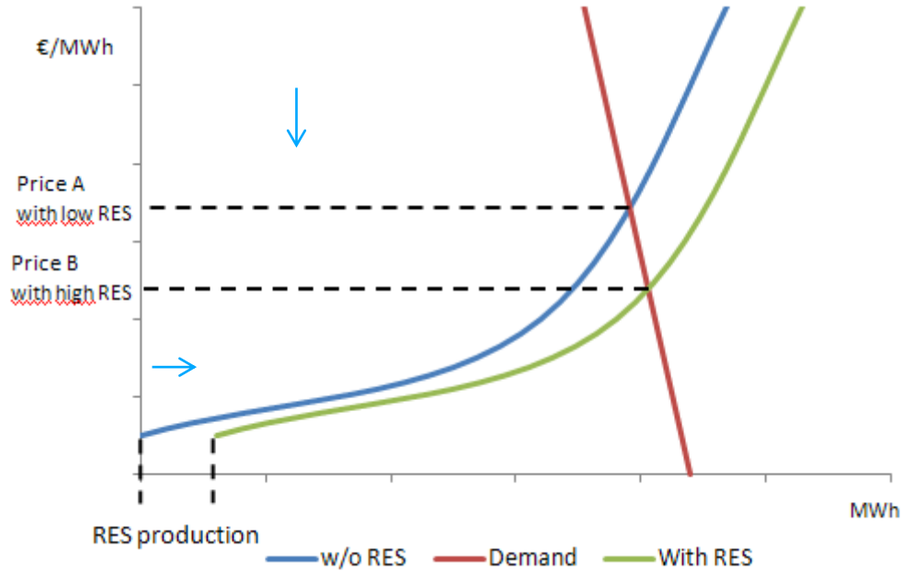
Source: GDFS

More steady increase expected:

	Increase by 2020	GW	% avg demand
Belgium	138%	4	31%
Netherlands	250%	3	7%
France	118%	12	9%
Germany	120%	55	60%

Impact on Wholesale Prices is Bigger than Expected (1/2)

- Merit order effect:

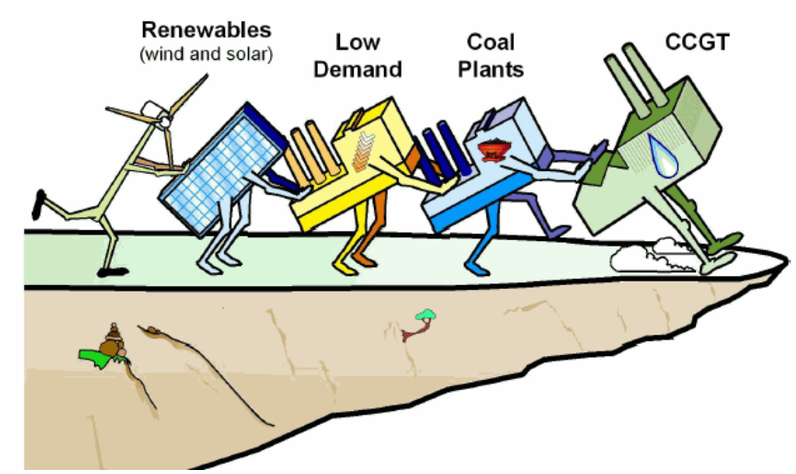


high wind & solar → low wholesale price

BUT

price for end-customer increases due to remuneration RES via subsidy

- RES pushes conventional power plants out of the merit order



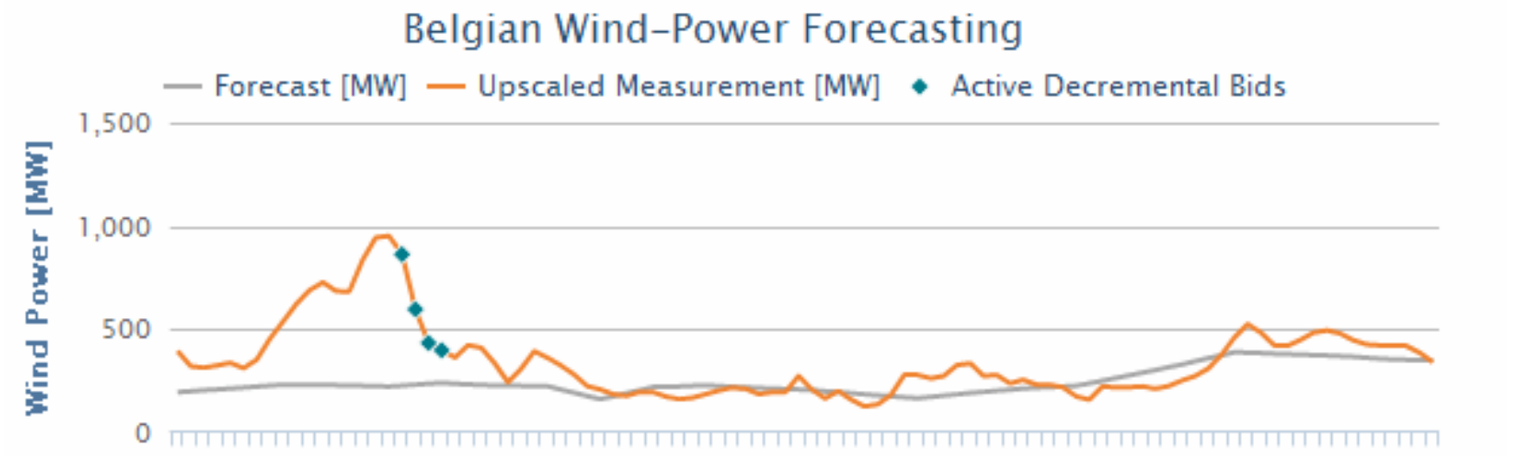
Classical units only remunerated through wholesale markets

Investment decision also impacted, resulting in :

- Mothballing, decommissioning
- Or modification to more flexibility

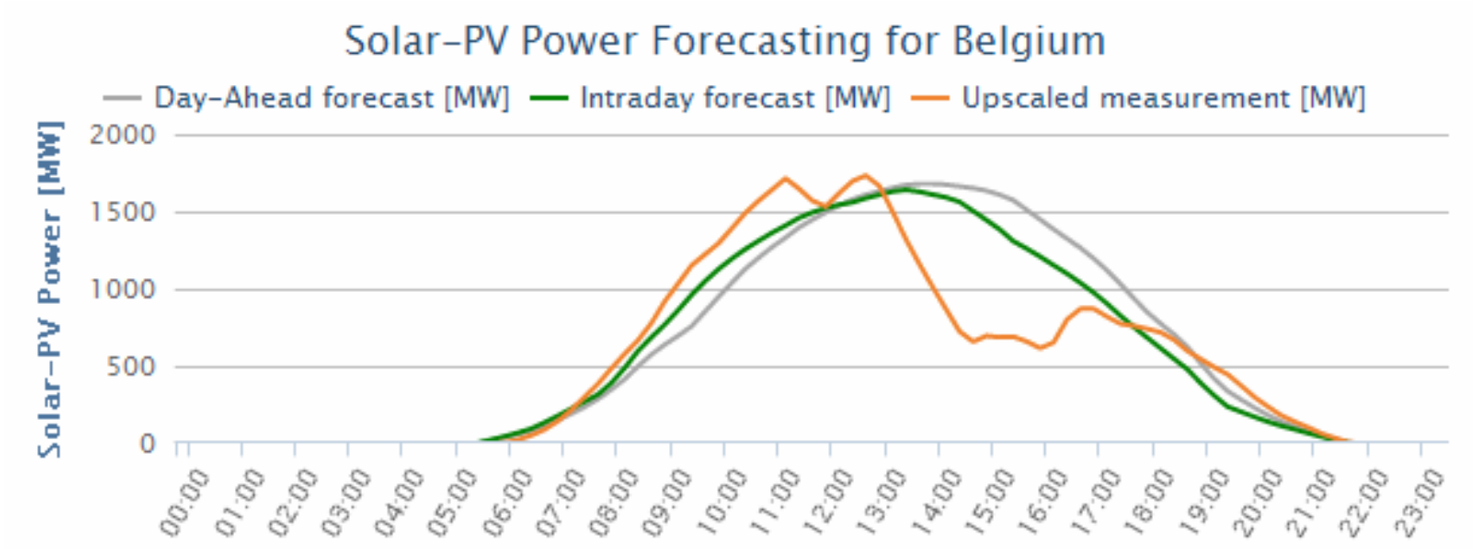
Impact on Imbalance Prices Off The Charts (1/2)

Example Belgium 10/06/2014:



Stormy weather conditions:

Unpredicted peak in wind generation: + 700 MW

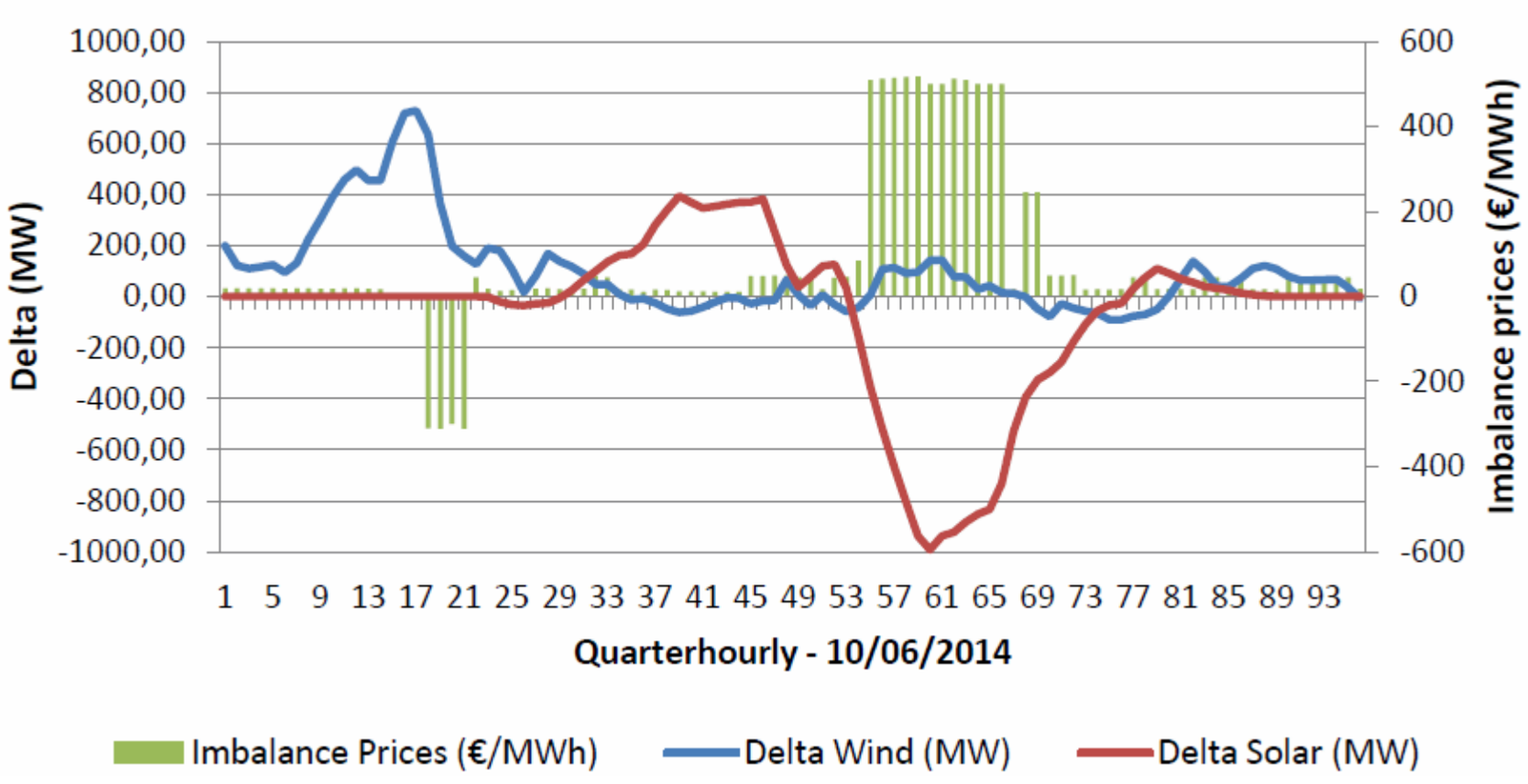


Drop in PV production not forecasted: -1000 MW

Impact on Imbalance Prices Off The Charts (2/2)

Need for flex to cope with RES intermittency: Demand Side Management will be key

Example Belgium 10/06/2014:



Belgian grid can almost not cope with these variations, imbalance price spike (see green bars):

- 300 €/MWh during the wind event & **500 €/MWh** during PV event

Cross-commodity : some concrete examples

Gas & Power interactions : methods & concepts

- Market analysis techniques
  - Statistical analysis
  - Fundamental Supply / Demand analysis
- Optimization techniques and models
  - Costs minimization or profit maximization under constraints
  - Concepts are similar
  - Processes are similar
- Trading techniques
  - OTC trading, Exchange tradings, brokets
- Operationally
  - Although gas and power are different animals, linking the gas & power portfolios is important from an optimization perspective

Gas & Power interactions : Some concrete examples

Example #1: Prolonged cold snap in BE-FR…

- Context
  - Gas portfolio
    - Gas Storages at (historically) low levels
    - Gas contracts off-takes at their maximum
    - Importation capacities saturated towards FR-BE
  - Power portfolio
    - CCGT running
  - Markets
    - Gas prices surged
- X-commodity optimization
  - CCGTs stopped, buy electricity in BE-FR
  - Use the gas for increased gas consumption

Gas & Power interactions : Some concrete examples

Example #2: Coping with nuclear outage in BE…

- Context
  - Power portfolio
    - Nuclear outage
  - Gas portfolio
    - Gas Storages level medium range, withdrawal capacities not at their max.

- X-commodity optimization
  - Start 3 CCGTs in BE
  - Withdraw more from Loenhout storage
  - Buy some next season gas.
  - Withdraw more from FR storage, reverse gas flows from the interconnection FR-BE towards FR

Gas & Power interactions : Some concrete examples

Example #3: Coping with very windy days...

- Context
  - Power portfolio
    - Stormy weather in the Norh Sea
    - Wind speed > 30 m/s (-> cut-off)
  - Gas portfolio
    - Still some spare capacity on our German Storages

- X-commodity optimization
  - Start 1 CCGT in the NL
  - Use XB power capacity NL - > BE to ship power to BE
  - Buy Gas on NCG (or withdraw from German storages)
  - use XB gas capacity DE->NL to ship gas in the NL

Gas & Power interactions : Some concrete examples

Example #4: Seizing market opportunities in volatile environment...

- Context
  - Power portfolio
    - CCGT running on the continent
  - Gas Markets
    - Prices surge in the UK following the announcement of an outage at the Rough facility

- X-commodity optimization
  - Stop CCGTs in Benelux
  - Buy power in BE, NL (if not enough liquidity, buy in FR)
  - Ship the gas in reverse flow towards the UK (via IC or BBL)
  - Sell gas on NBP

Conclusions

Conclusions

- Electricity and Gas have their own characteristics…
  - Transport
  - Storage
  - Market organization

- … But
  - Markets are incomplete
  - More renewable energy
    - More need for flexibility
    - Enhanced role for gas-fired power generation
  - Pan European convergence on both gas & power
  - Common market regulation (REMIT, …)

Conclusions

- Already today, linking gas & power portfolios is valuable…
  - To deal with portfolio events on either the gas or the power portfolios
    - Prolonged cold snap
    - Nuclear outage
    - Wind cut-off
  - To seize market opportunities as they arise
    - Taking advantage of price volatility
  - To cope with balancing obligations (gas & power)

- However, more could be done…

Conclusions

- More coherence needed from a market design perspective in both gas & electricity sectors…
  - Harmonization in electricity markets: intra-day markets, balancing markets, ancillary services markets
  - Harmonization in gas markets: intra-day markets, balancing obligations, …
  - Regional sharing of operational reserves

- More coordination needed between gas and electicity systems...
  - Harmonized gas & power markets
  - Coordinated gas & power reserve requirements
  - Coordinated markets organization

- … should naturally lead to a better gas & electricity system for the benefit of customers
  - More efficient: reduction of CAPEX, reduction of OPEX
  - Improved reliability & integraty