

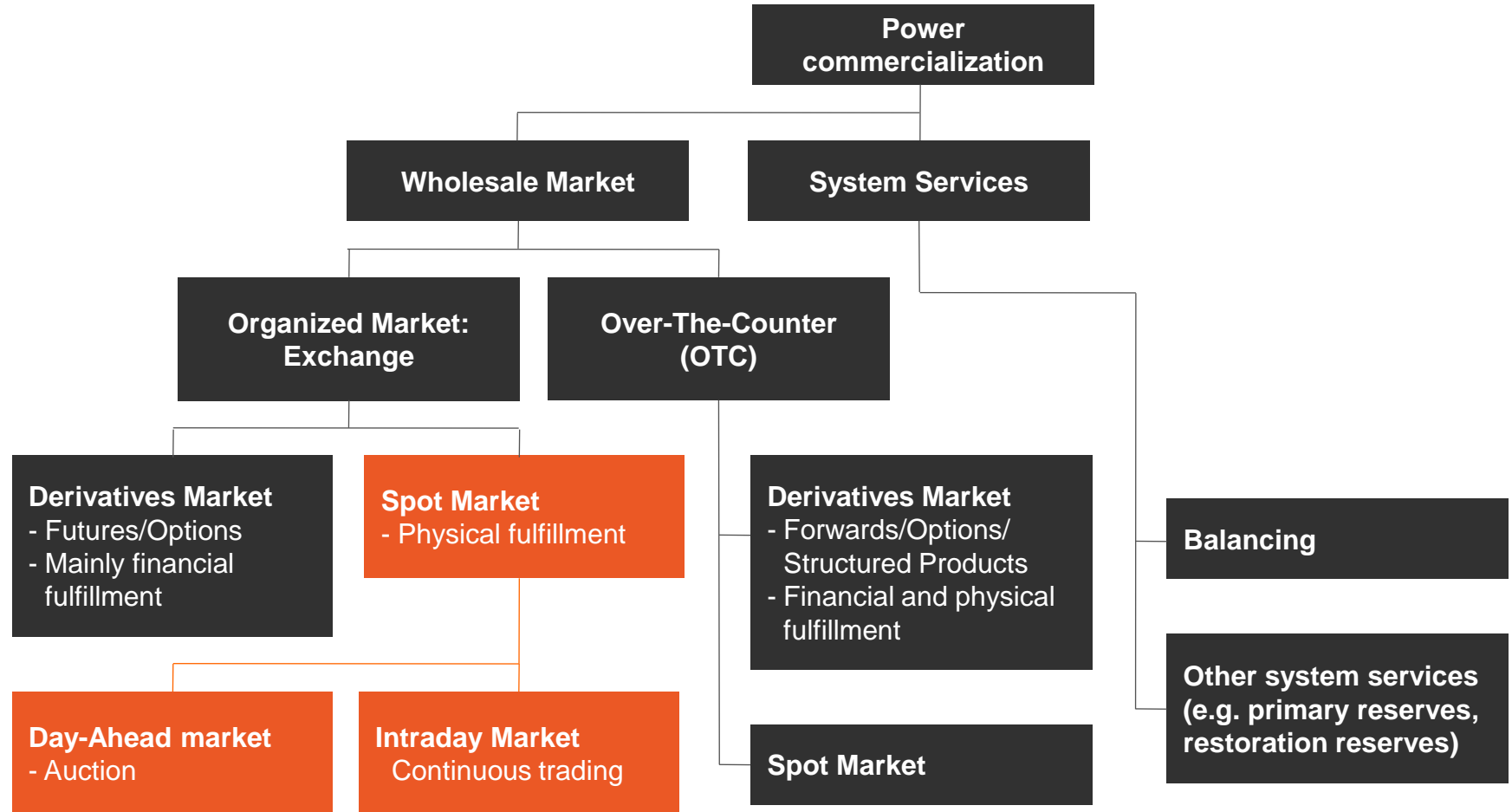
# Design of Smart Electricity Markets

Suitable products in a future energy market and requirements to activate flexibility potentials

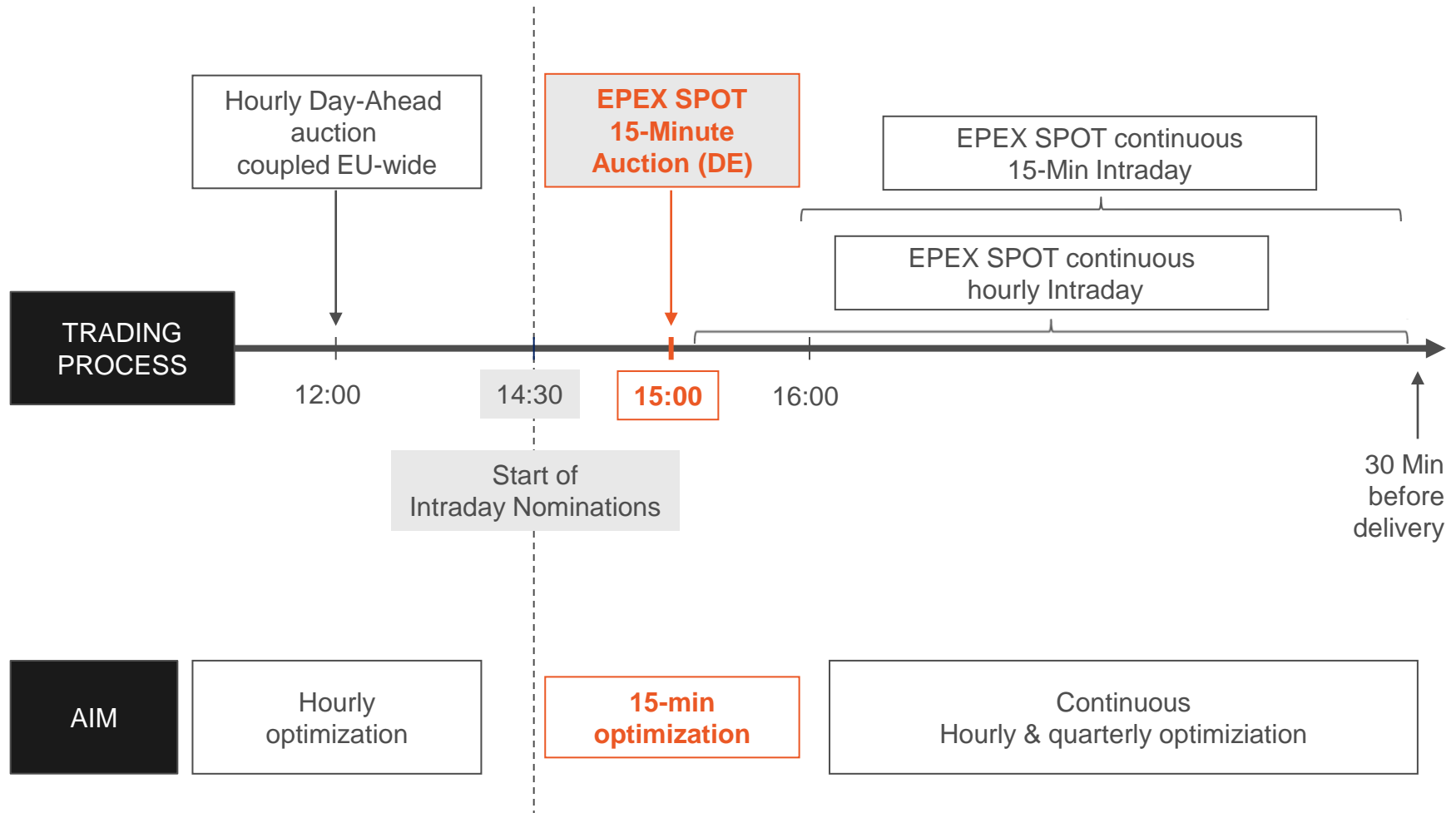
EPEX SPOT, Dr. Philippe Vassilopoulos

27/09/2016

# Ways of trading power on European Wholesale markets

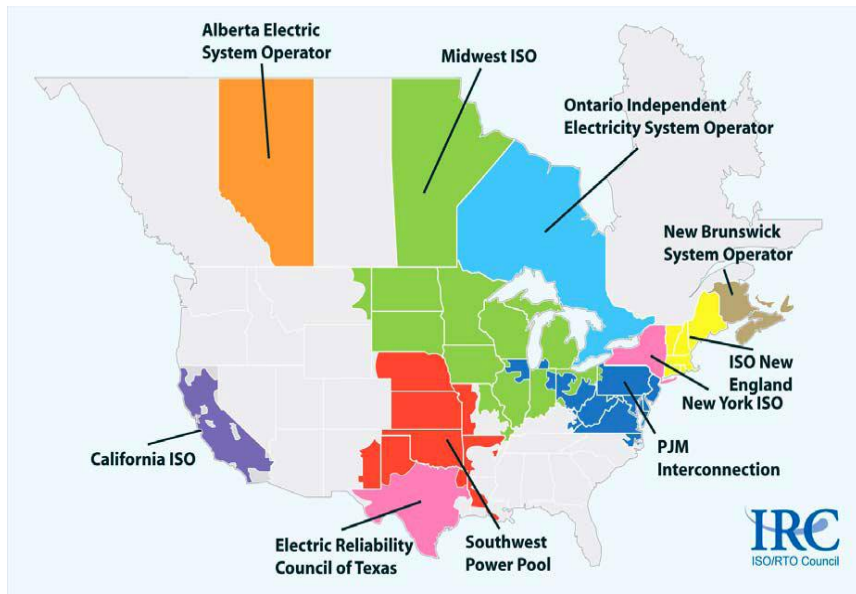


# The wholesale energy trading process

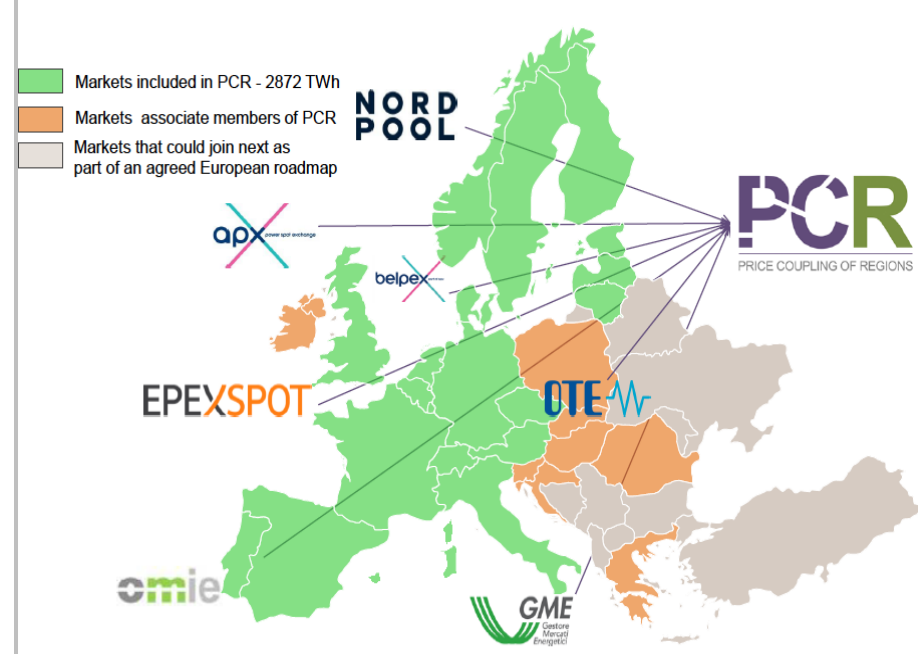


# In the Day-ahead, US search for a seamless integration has almost been completed in the EU

Footprint of the North American ISOs and RTOs



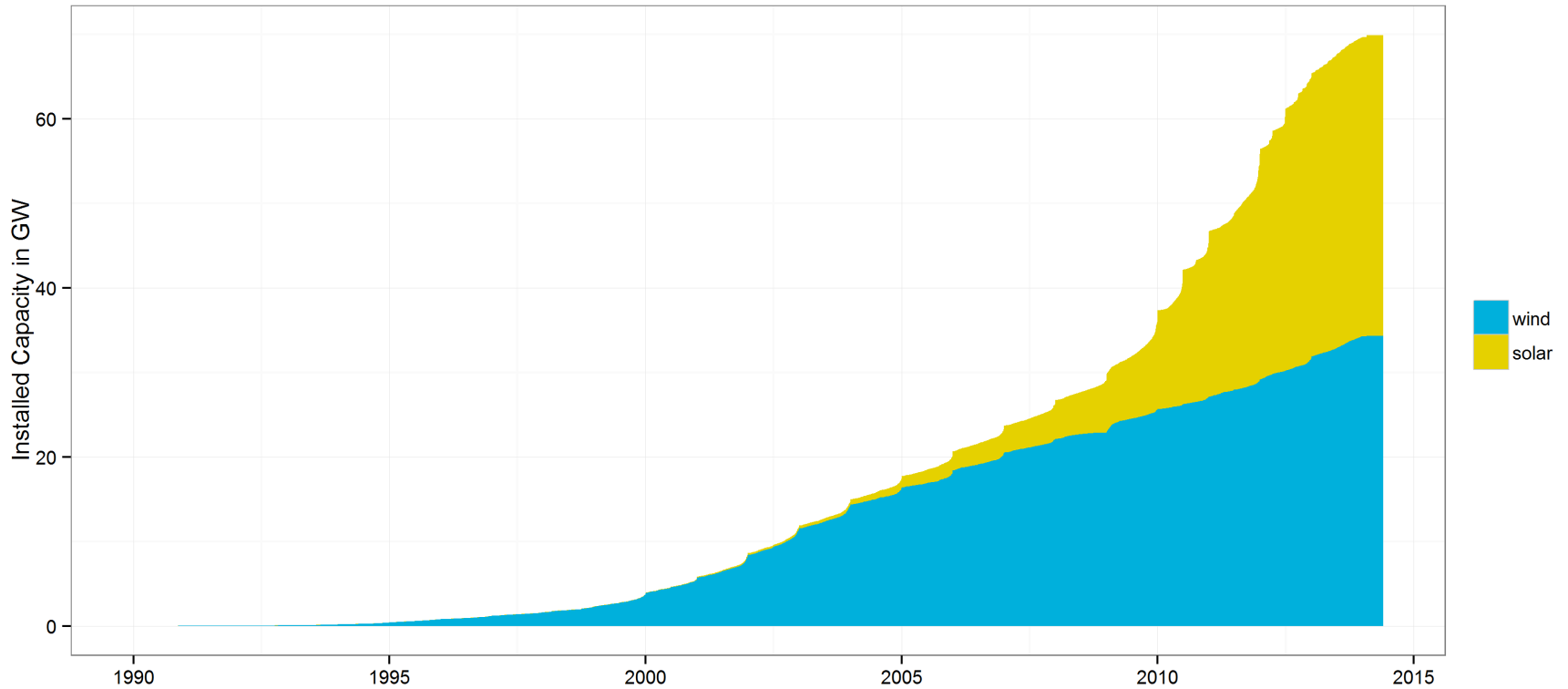
The EU Price Coupling of Regions



Source: PCR

# RES development has boosted need to balance on the Intraday market

## Solar and Wind Installed Capacity in Germany

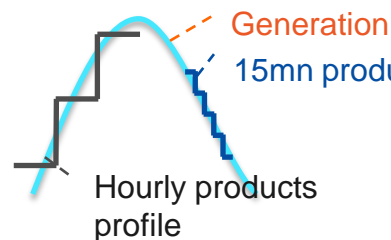


Source: Statkraft

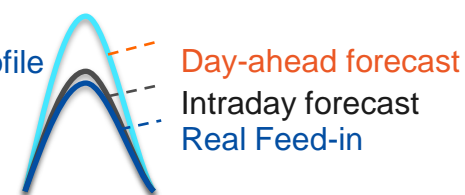
# Balancing needs exacerbated by forecast errors

- **Generation ramps** handled with quarters
- **Forecast deviations** :  
Wind/solar forecasts can vary significantly from Day-ahead forecast to last Intraday Forecast

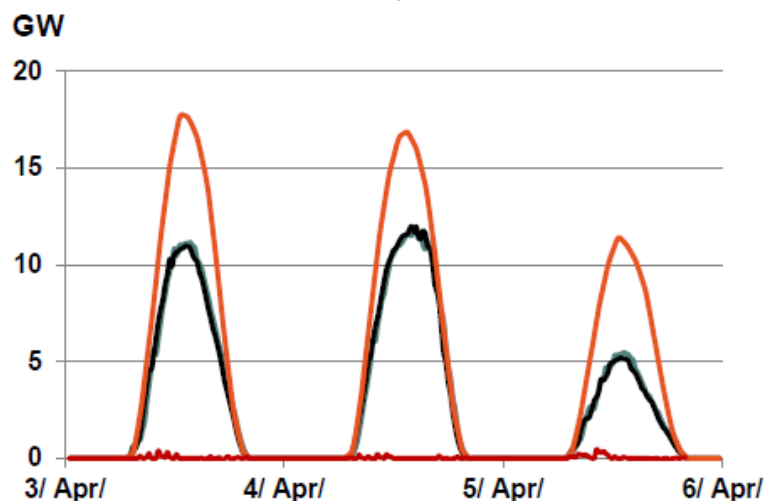
## Generation Ramps



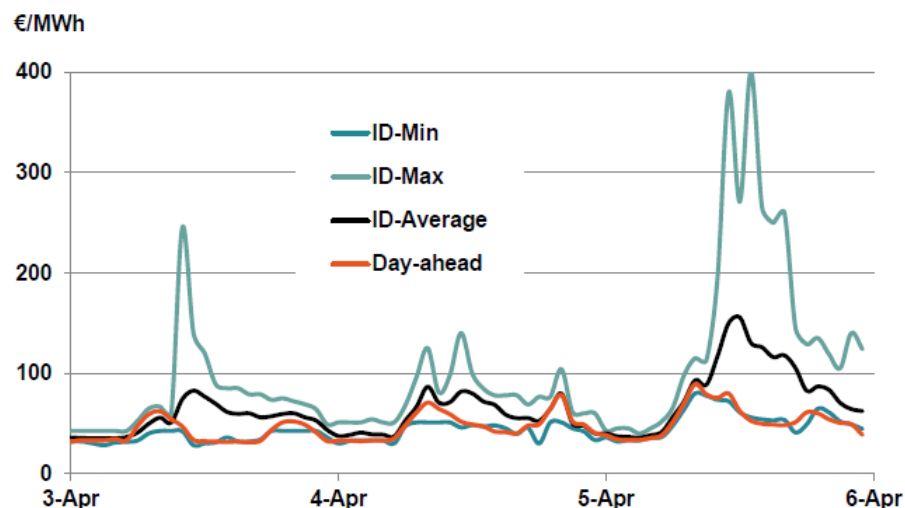
## Forecast Deviations



## Day-ahead PV forecast inaccuracy and Intraday price impact

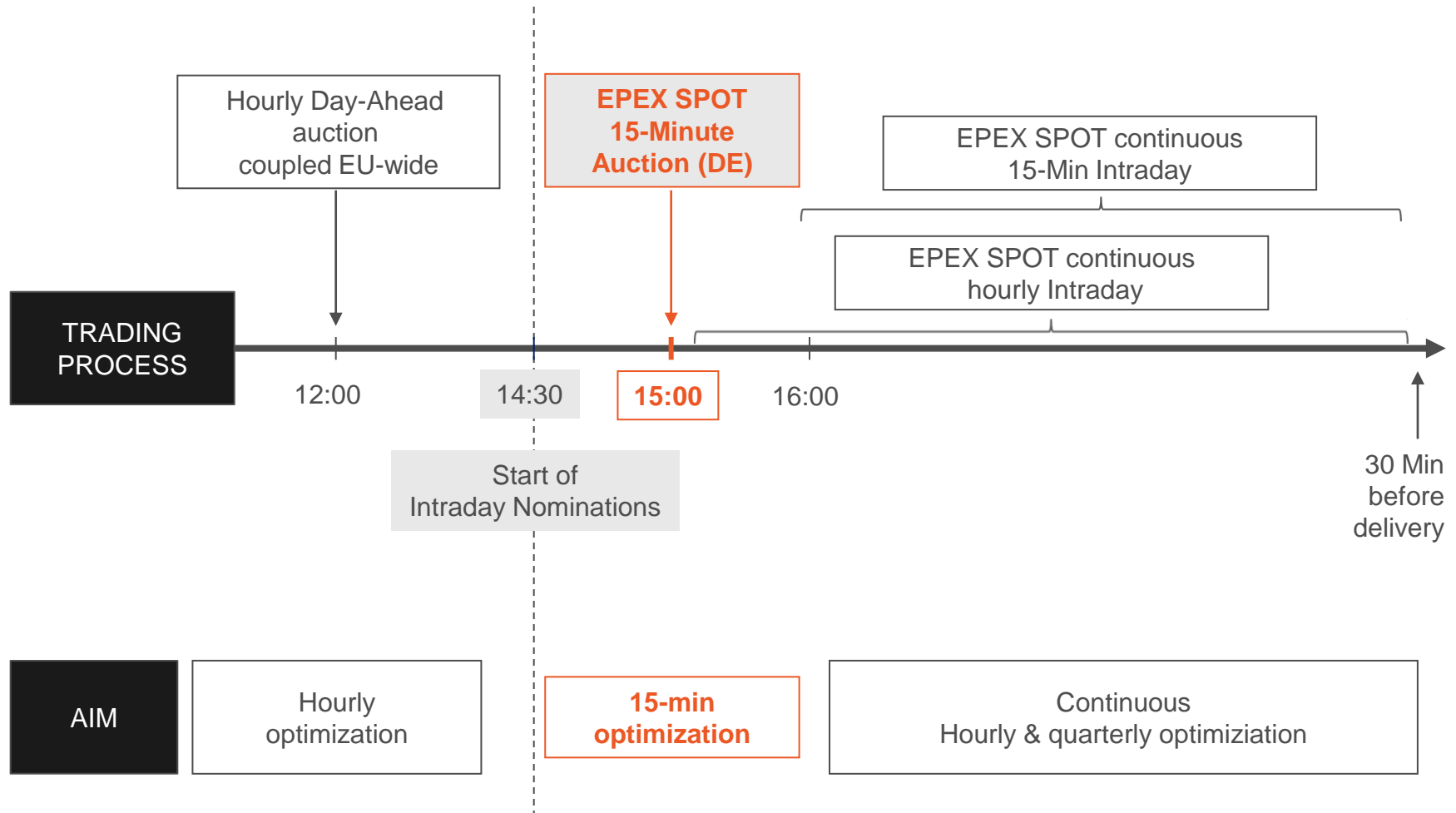


- Day-ahead PV forecast
- Last intraday PV forecast
- PV extrapolation

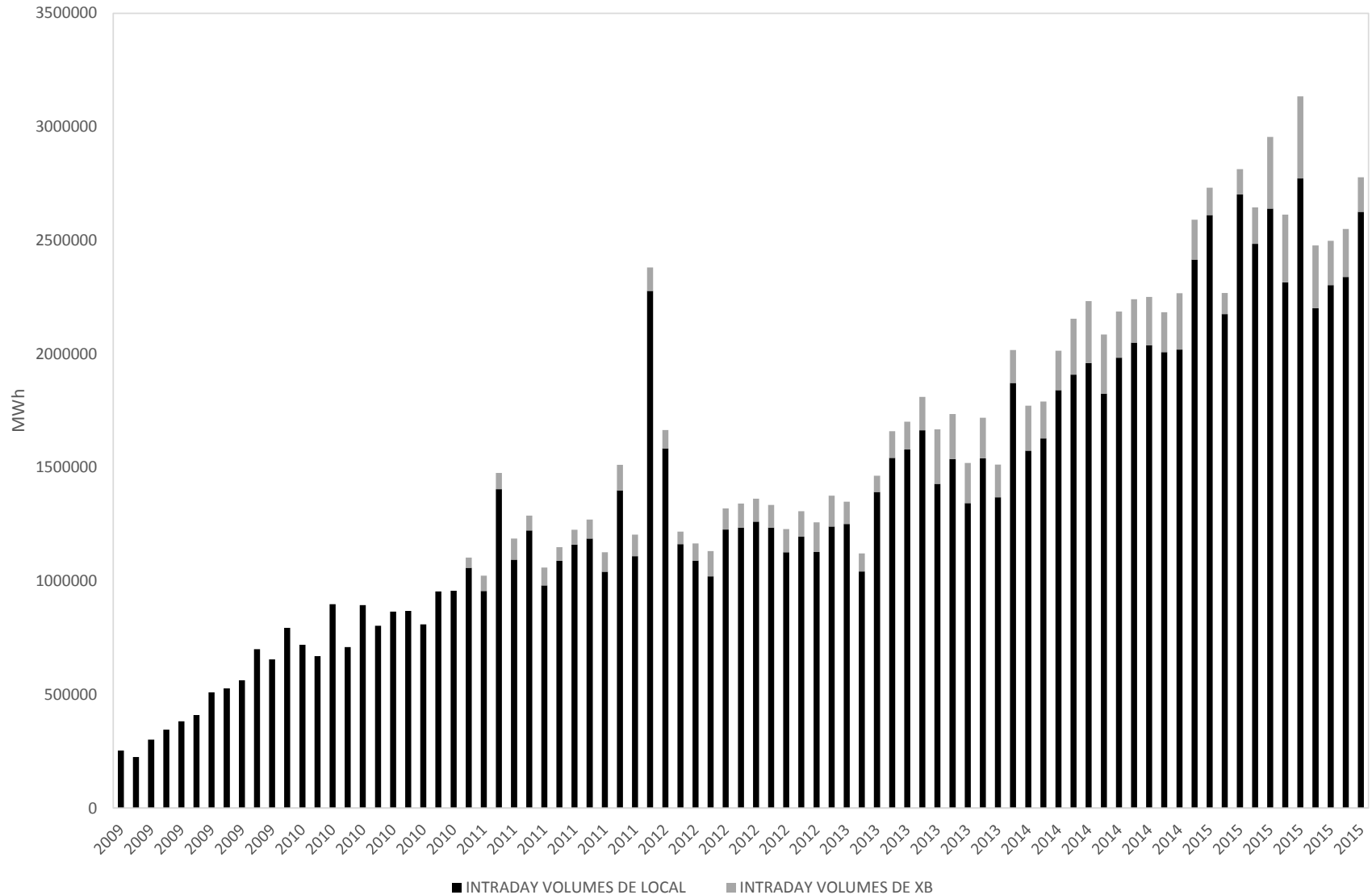


Source: 50 Hertz, EPEX SPOT

# The wholesale energy trading process

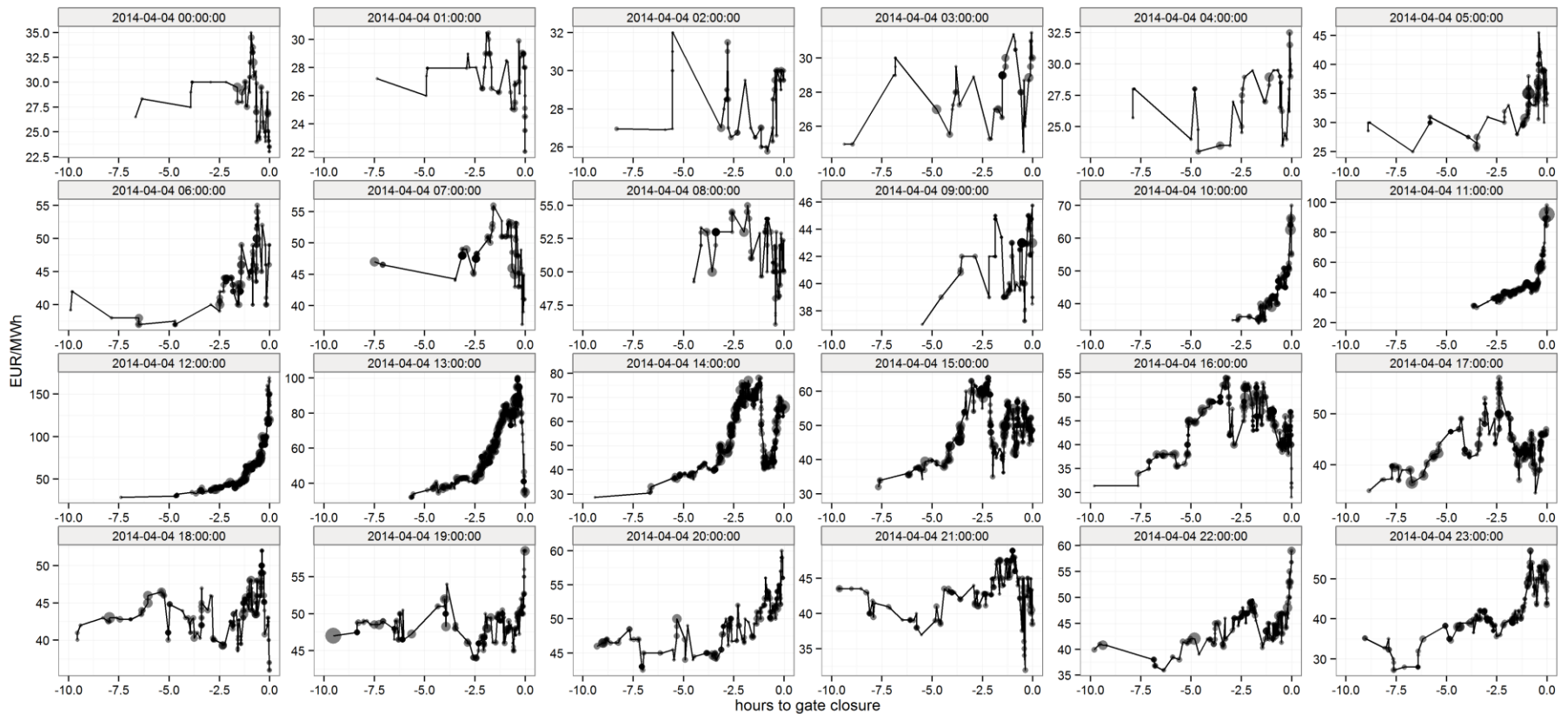


# The German IDM liquidity has been boosted by iRES penetration





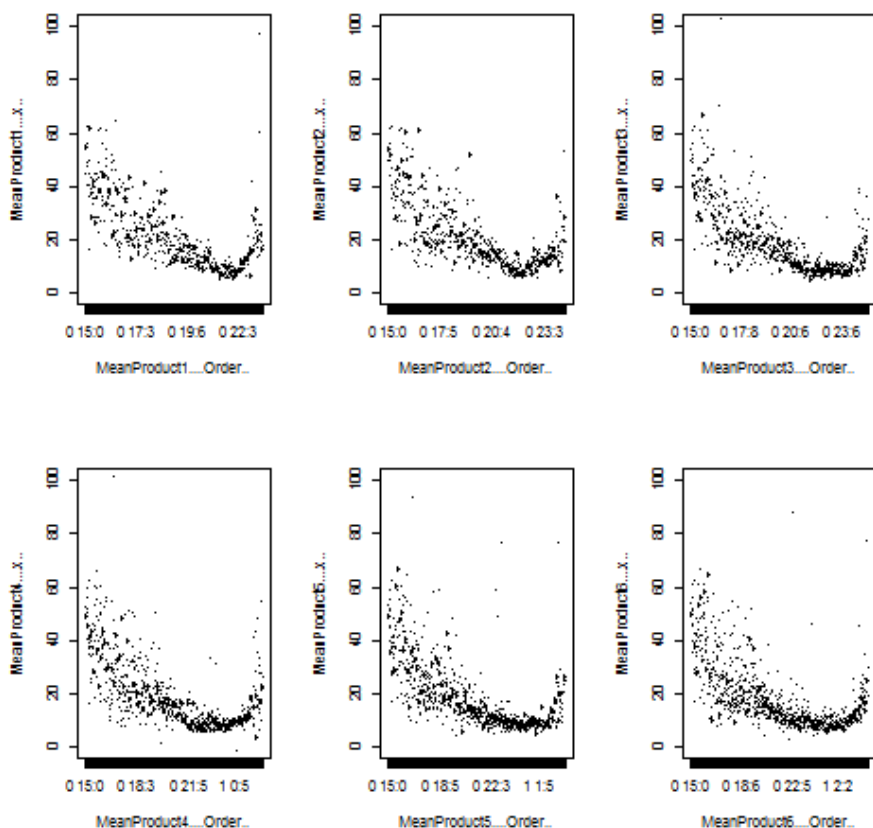
# Some Intraday Price Developments...



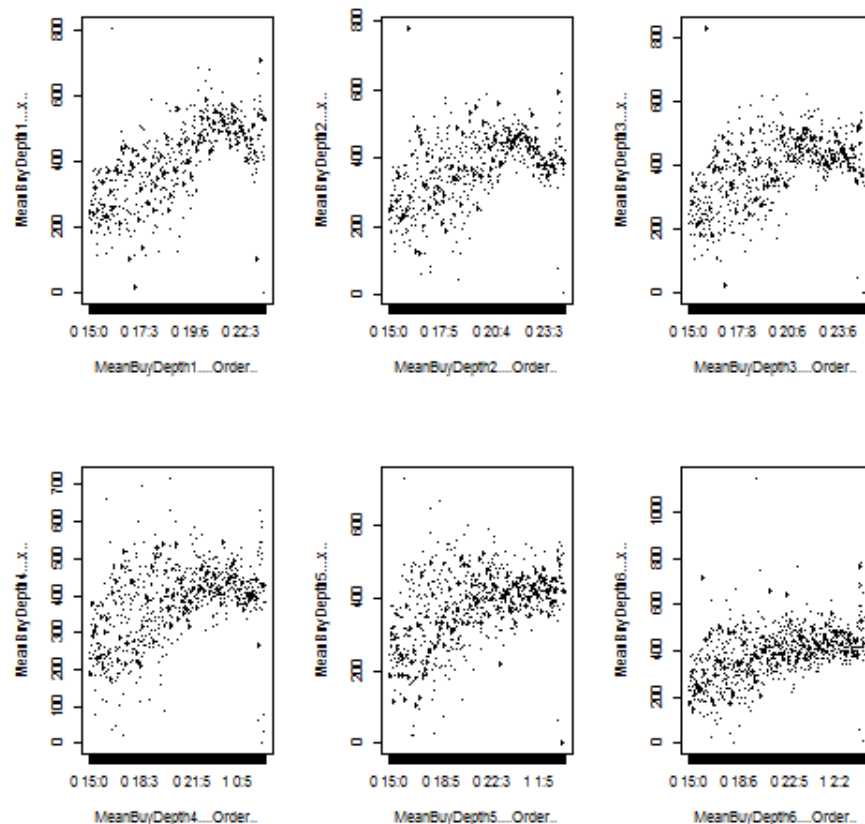
Source: EPEX SPOT

# Bid/Ask spreads and market depth for several individual continuous hourly products

**Bid/Ask spread during the session for individual products**

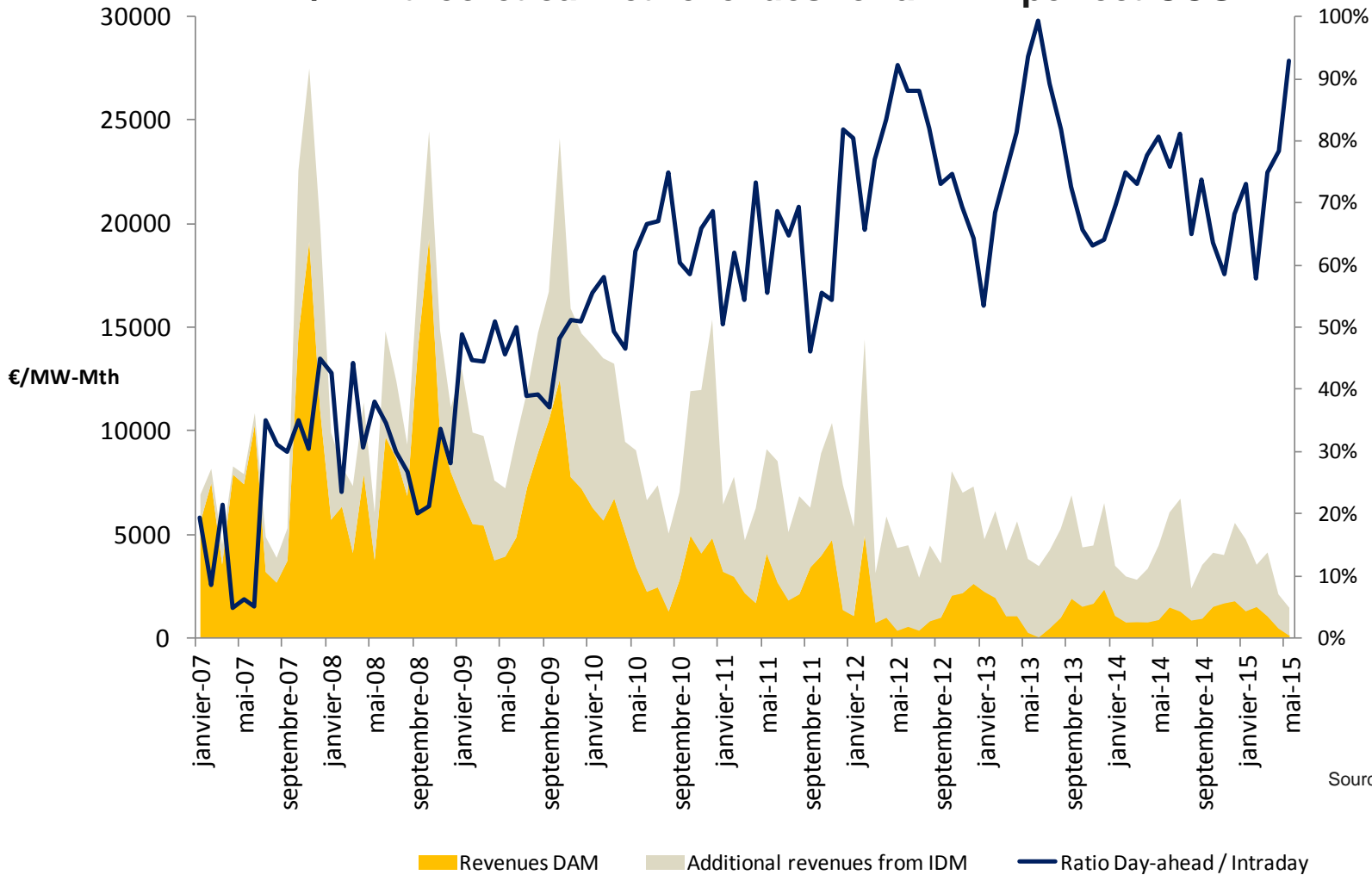


**Market depth during the session for individual products**



# The share of revenues from hourly Intraday compared to day-ahead

**DAM/IDM theoretical net revenues for a 1MW perfect CCGT**



# What is flexibility? Is there a value for flexibility on the Intraday?

System  
level

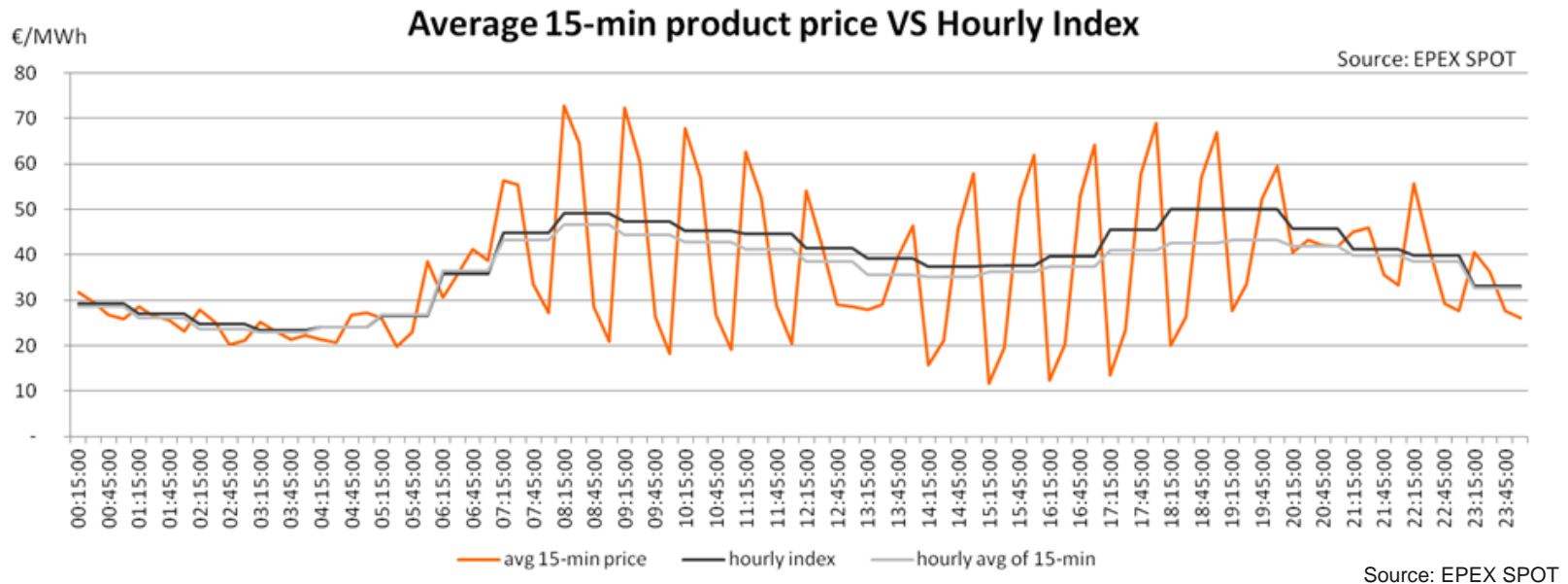


« Ability of the system to accomodate increasing levels of uncertainty while maintaining satisfactory levels of performance »

Ressource  
level

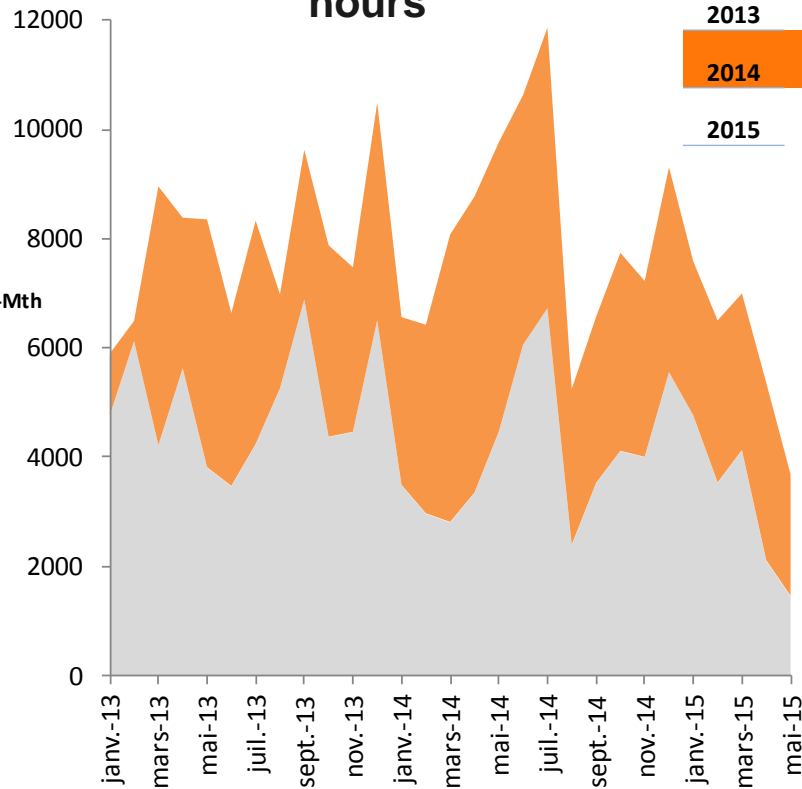


« Ability of a ressource to start-up quickly and adjust load output to changing market conditions »



# A flexible plant can increase revenues significantly on the quarterly market

## IDM theoretical net revenues for a 1MW CCGT with quarters/ hours



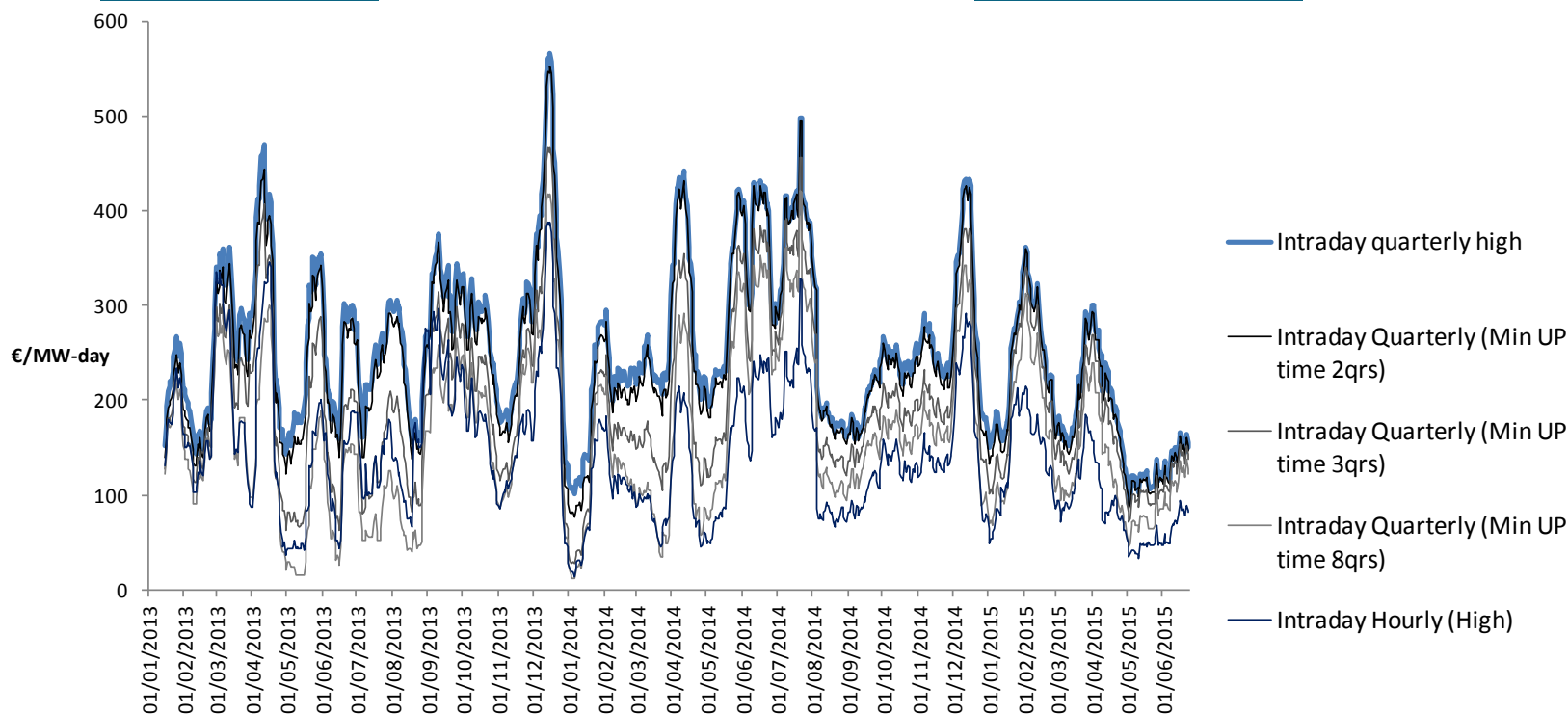
€/MW-yr	Continuous Hr (High)	Continuous Qr (High)	Continuous Qr (WAP)	Continuous Qr (Low)
<b>2013</b>	59 729,39	95 501,44	33 407,95	6 191,27
<b>2014</b>	49 436,61	98 187,12	30 737,11	5 203,61
<b>2015</b>	17 833,67	33 682,18	8 162,30	1 212,21

- On/Off decisions of the plant at the quarterly level
- Flexible plants benefit from higher price volatility at quarterly level
- Revenues almost double with quarters
- Perfect flexibility at quarterly level very challenging...

Source: EPEX SPOT, EEX

# An unflexible plant would not see benefits in trading quarterly contracts

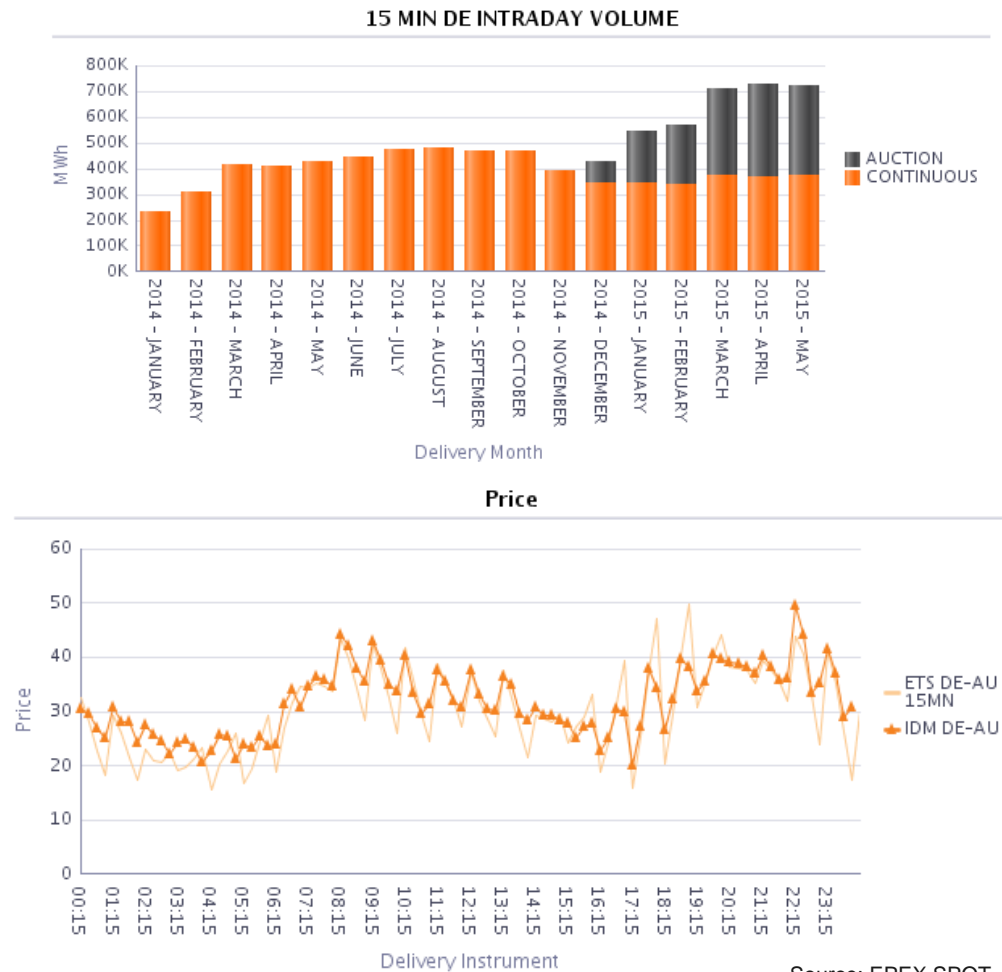
€/MW-Yr	Intraday quarterly (High)	Intraday quarterly (Min up time 2hrs)	Intraday quarterly (Min up time 3hrs)	Intraday quarterly (Min up time 8hrs)	Intraday hourly (High)
2013	95 501	89 553	70 757	54 242	59 729
2014	98 187,	94 328	77 506,	64 046	49 436
2015	33 682,	32 517	29 318,	24 295	17 833



Source: EPEX SPOT, EEX

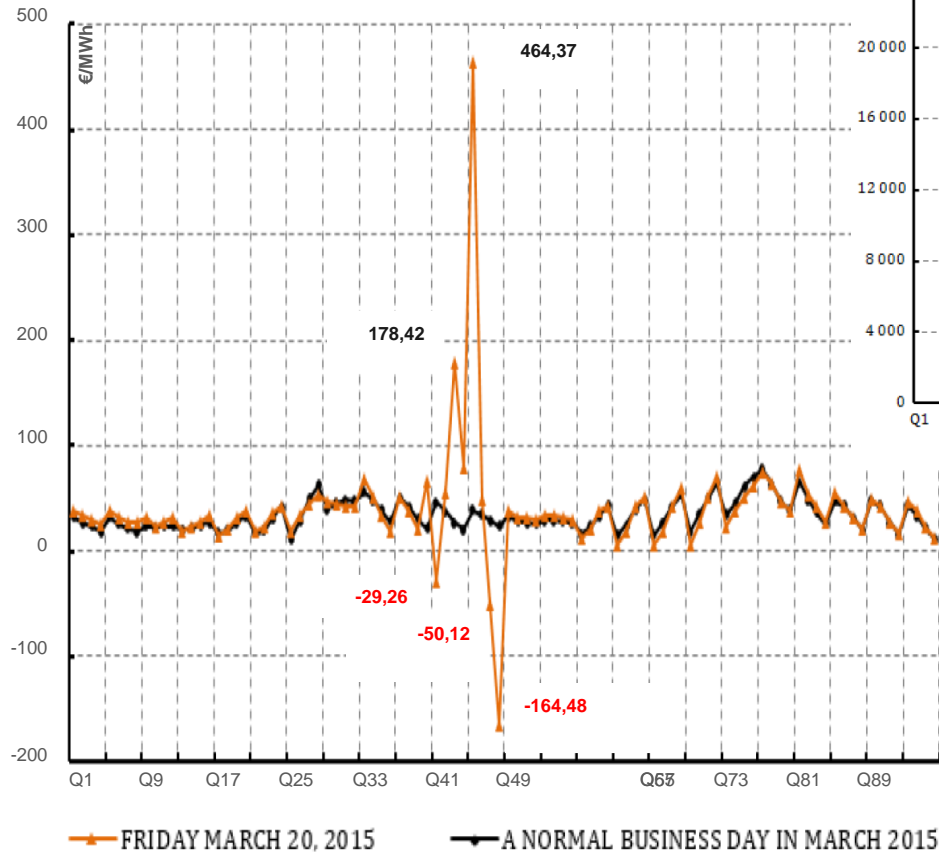
# Intraday auctions as a complement to continuous trading for a flexible target model

- **A short-term price signal** to reward flexibility
- **A question of liquidity:** Concentrating liquidity during times of varying market conditions can help ALL market players!
- **The power exchange can facilitate trading/Valuing of flexibility:** Decreased lead-time, 15mn products, local DE Auction
- **Some pros/cons of Intraday auctions Vs Continuous**
  - Liquidity (15mn auction  $\approx$  10-15GWh/day)
  - Uniform pricing Vs Pay As Bid
  - Continuous Vs Discrete
  - Transmission capacity pricing
  - Problem complexity (15/30/60mn+Block products, Smart blocks, multi-part bids)
  - Level-playing field : no arms race
  - Reliability
- **Regulations have an important role to play**
  - **Flexible regulatory framework**
  - **Target model** needs to be flexible enough to accommodate the evolution in market conditions

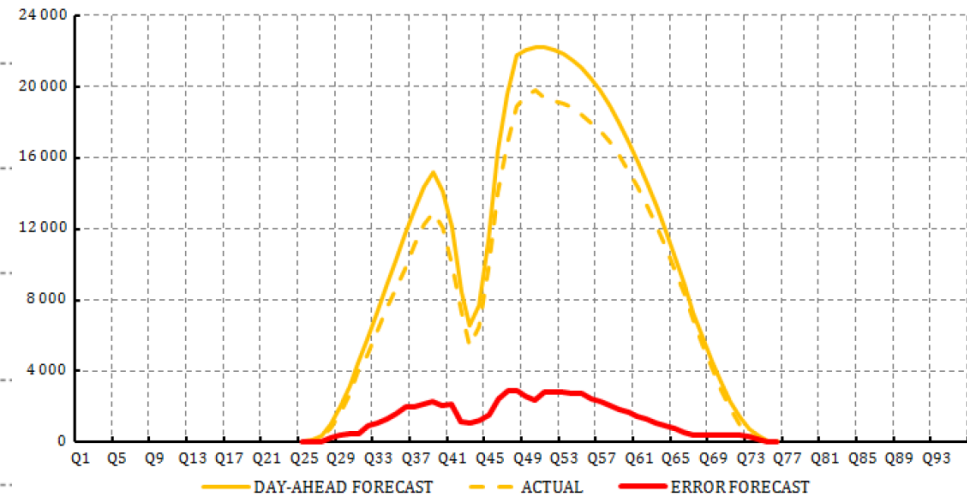


# European power exchange as a component of security of supply during the solar eclipse

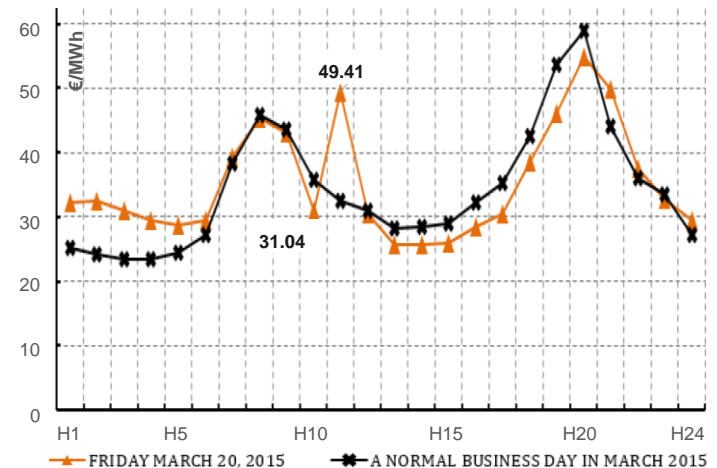
## INTRADAY PRICES



## SOLAR FORECAST



## DAY-AHEAD PRICES



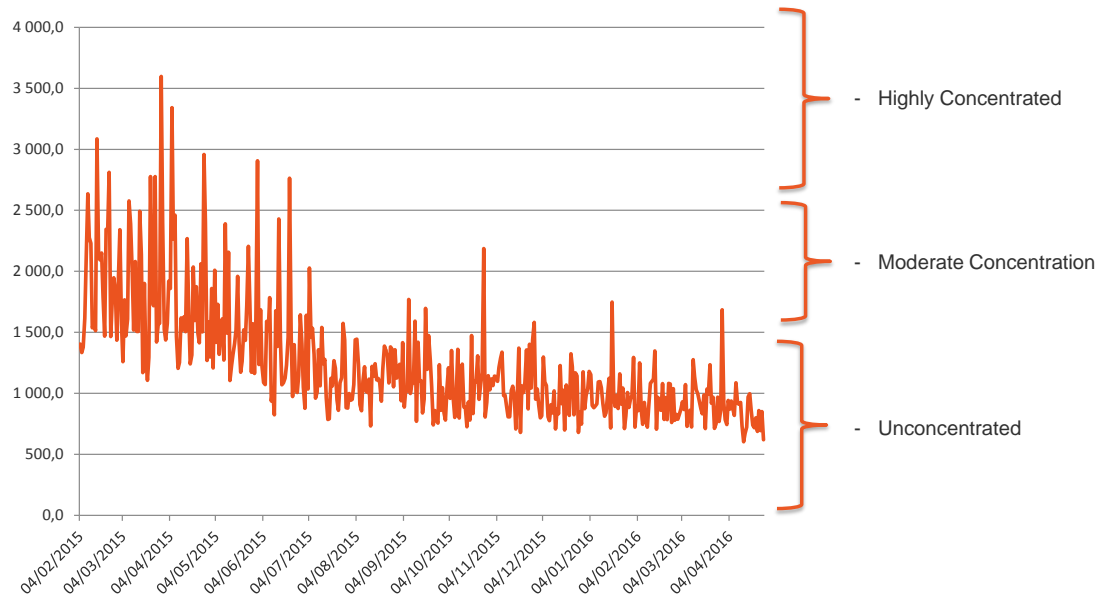
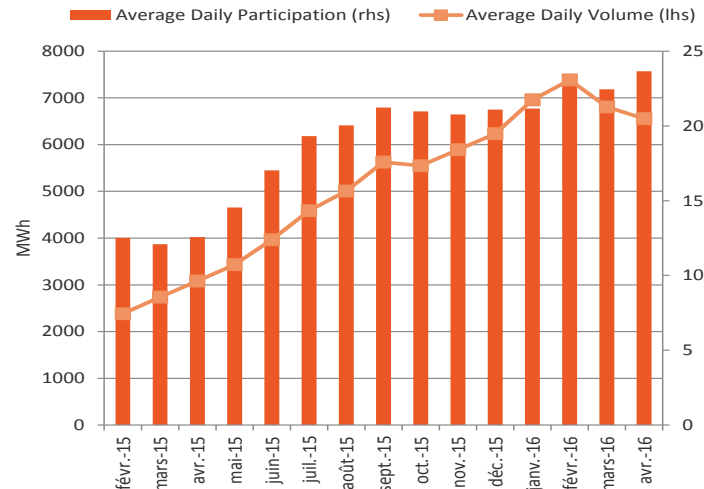
Source: EPEX SPOT, TSOs



# 30mn Auction Results in GB very encouraging since launch

- Some of the highlights of the HHDAM auction held everyday at 3:30pm UK time:
  - Inc. liquidity & participation
  - Low market concentration (HHI index)
  - Relatively high market Depth
- Blocks would allow participants to put greater volumes of to the auction

	Accepted Quantity	Submitted Quantity	Ratio
mean	424	3,013	14%
min	-	21	0%
25%	158	2,166	6%
50%	323	2,919	11%
75%	580	3,753	19%
max	3,356	9,356	99%



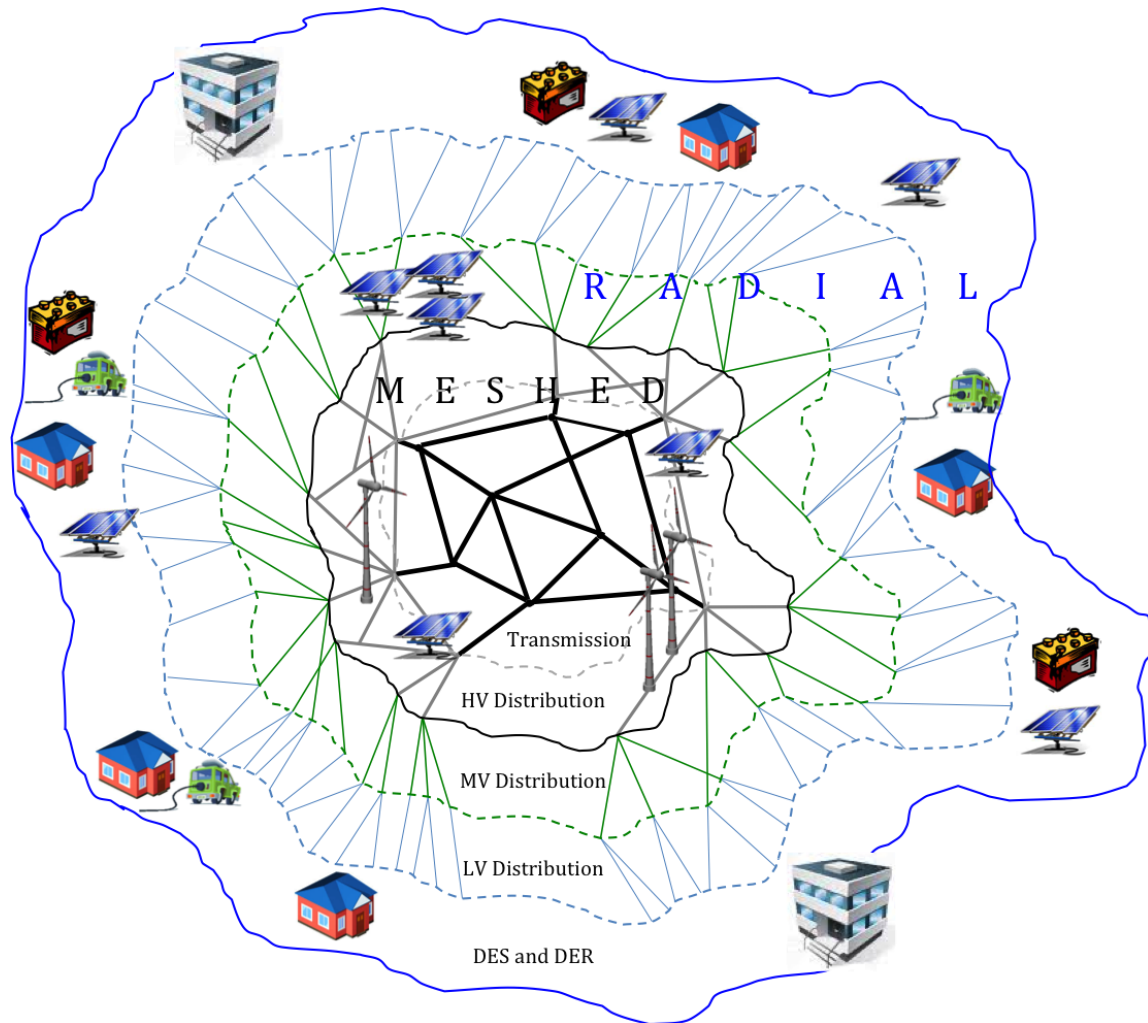
# Market design going forward



EPEX~~X~~SPOT

# Presence of DERs forcing us to abandon the customary “electricity trickling down” mind set...

- “Trickling down” mind set replaced by equal footing between DERs and centralised resources in providing services
- From LMPs to dLMPs. Blurs delineation between bulk power and distribution (wholesale and retail) as service provision, market participation, and pricing are applied more symmetrically across all system users
- Efficient coordination is needed from the local to the continental level



# ENERA: A market design to integrate large shares of RES and reduce grid congestions

## The Tender

- The tender “Schaufenster Intelligente Energie” - Showcase Smart Energy - was issued by the **BMWi** (Two categories: Wind and Solar)
- The aim is to show that **reliable power supply** is possible using **100% renewable energies**

## The Project

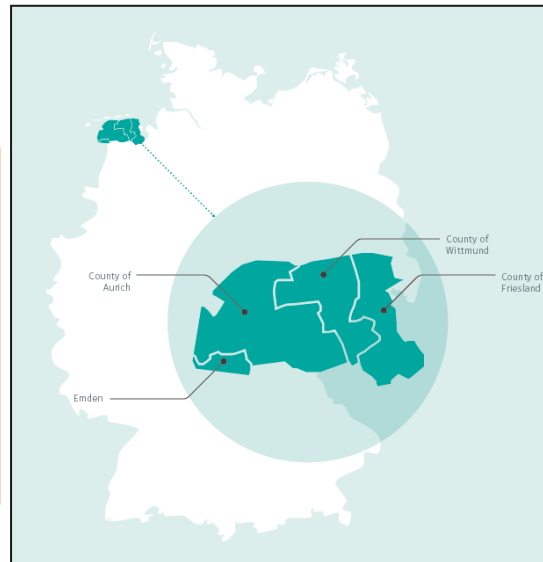
- The project “enera” is taking part in the tender in the category “**Wind**”
- There are **two main aspects** in the project
- To meet these, **three categories** are evolved and connected
- The categories have been divided into **14 work packages** where different partners are participating
- EPEX is involved in two work packages about regionalized markets (workstreams 6&7)

1. Leave out-dated structures & attitudes behind
2. Provide a secure & stable power supply

1. Network
2. Market
3. Data

## The Region

- Counties of Aurich, Friesland & Wittmund
- 390.000 inhabitants
- 200.000 households
- 1,75 GW installed renewable energy generation capacity
- 1,50 GW generated wind power
- 170% renewable energy

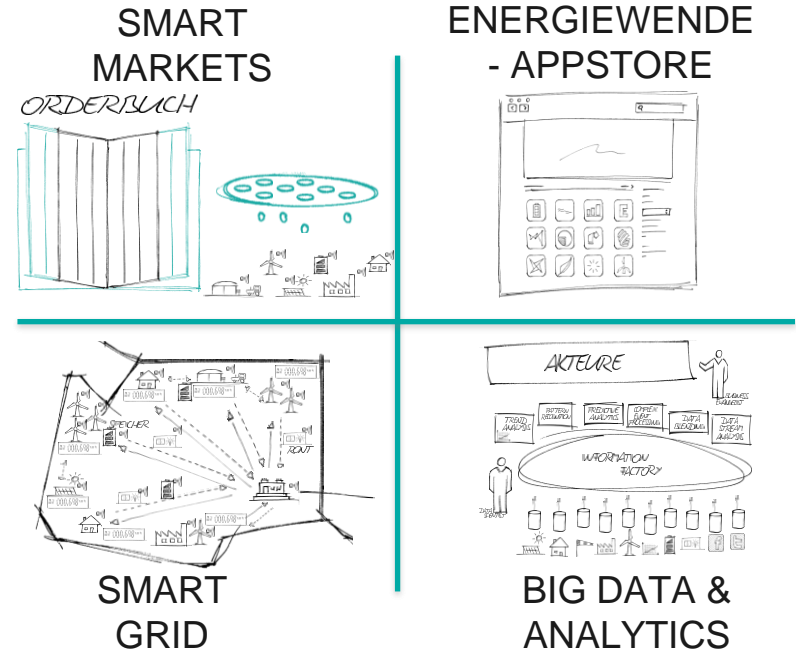


## The Partners



# Decentralized/Local markets: What is the rationale?

- Is reliable power supply possible using 100% renewables?  
This is the question the SINTEG projects want to answer.
- Network congestions could increase
- Consumers with solar panels on their roofs see a potential to trade their excess/buy missing energy locally and limit their T&D network usage.
- Local markets are seen as a solution to many problems currently occurring because of the growing share of renewable energies and distributed generation.
- Development of secondary markets and fragmentation of liquidity should be avoided
- Connection to existing ID platform, seems intuitively the best option but network constraints need to be tackled.



*i.e. Peer-to-peer with blockchain settlement*

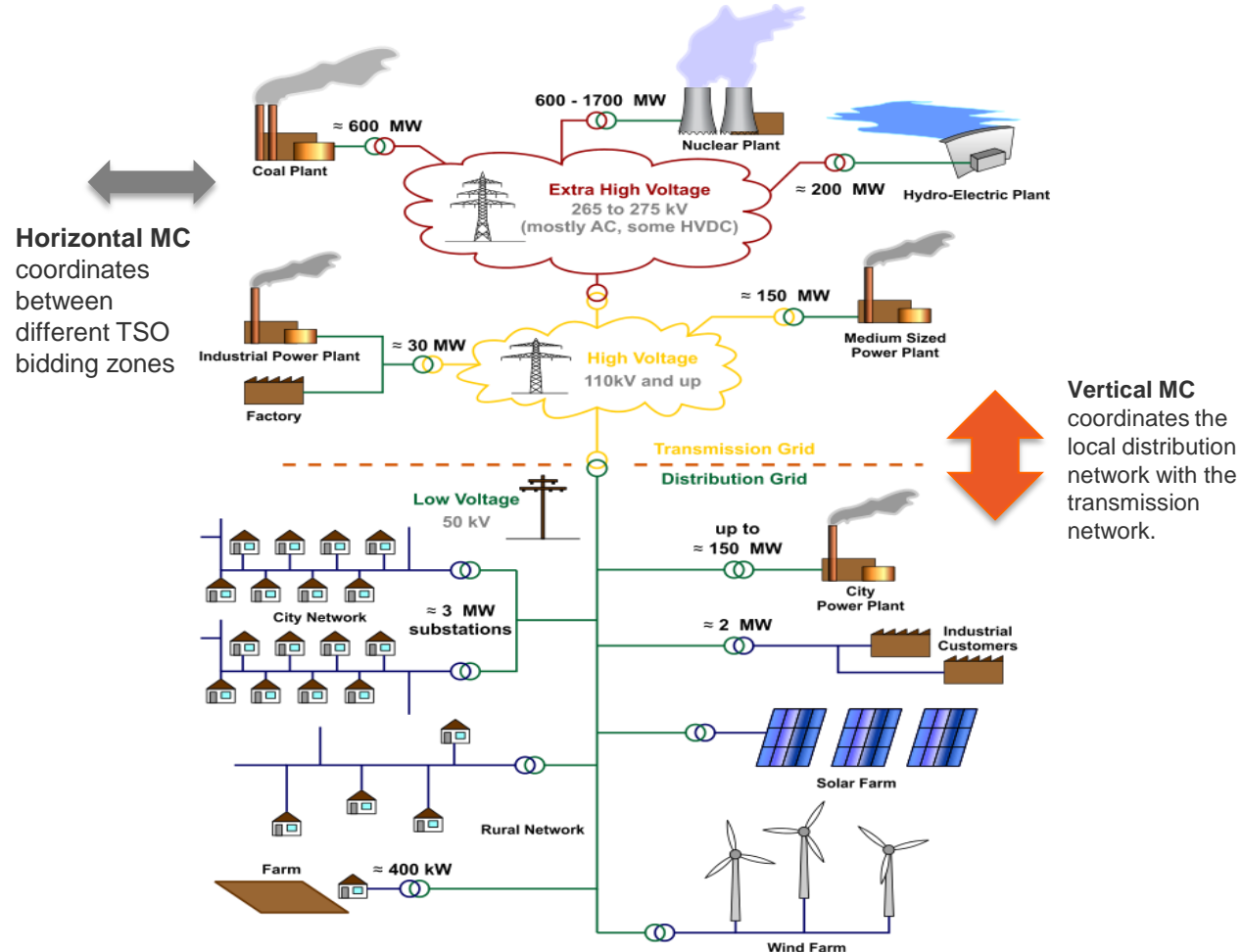


*i.e. Vertical Market Splitting at distribution node level*

# Vertical Market coupling: A concept yet to be defined and proven

## Horizontal and Vertical Market Coupling

- **Vertical market coupling** is the implicit market coordination of the local distribution network with the transmission network.
- The market can help DSOs to balance the supply/demand on their distribution network and coordinate with the transmission network
- A concept that still needs to be clearly defined and assessed together with TSO/DSOs and market participants
- i.e. Complex interactions and numerous stakeholders involved.

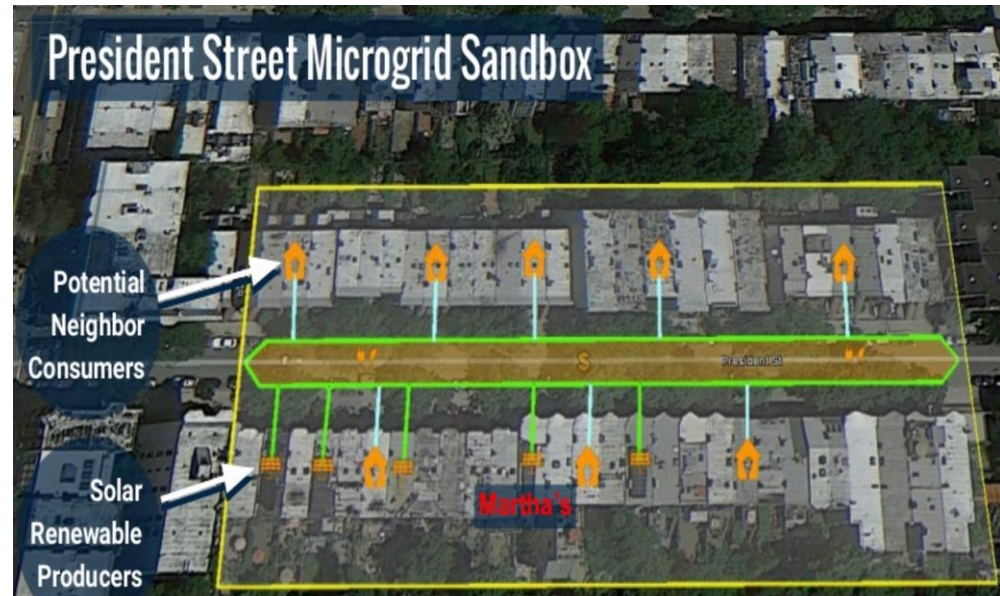




# Peer to peer blockchain settled local market at the « grid-edge »

- The most “revolutionary” decentralized design for Microgrids.
- “Transactive energy”
- Using emerging software and technologies associated with the Internet of Things, to instill intelligence into existing infrastructure such as a power grid by adding smart devices that communicate with one another
- Ex: smart fridge transactions with opposite building’s distributed solar panel
- Blockchain at first sight allows getting rid of all centralized settlement bodies.
- Peer to peer energy trading requires significant changes in the society. It should remain at pilot stage for several years to come

Transactive Grid Project in Brooklyn





EUROPEAN  
POWER  
EXCHANGE

EPEXSPOT