

Refining Short-Term Electricity Markets to Enhance Flexibility

Stocktaking as well as Options for Reform
in the Pentalateral Energy Forum Region

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based on a presentation from Christian Redl

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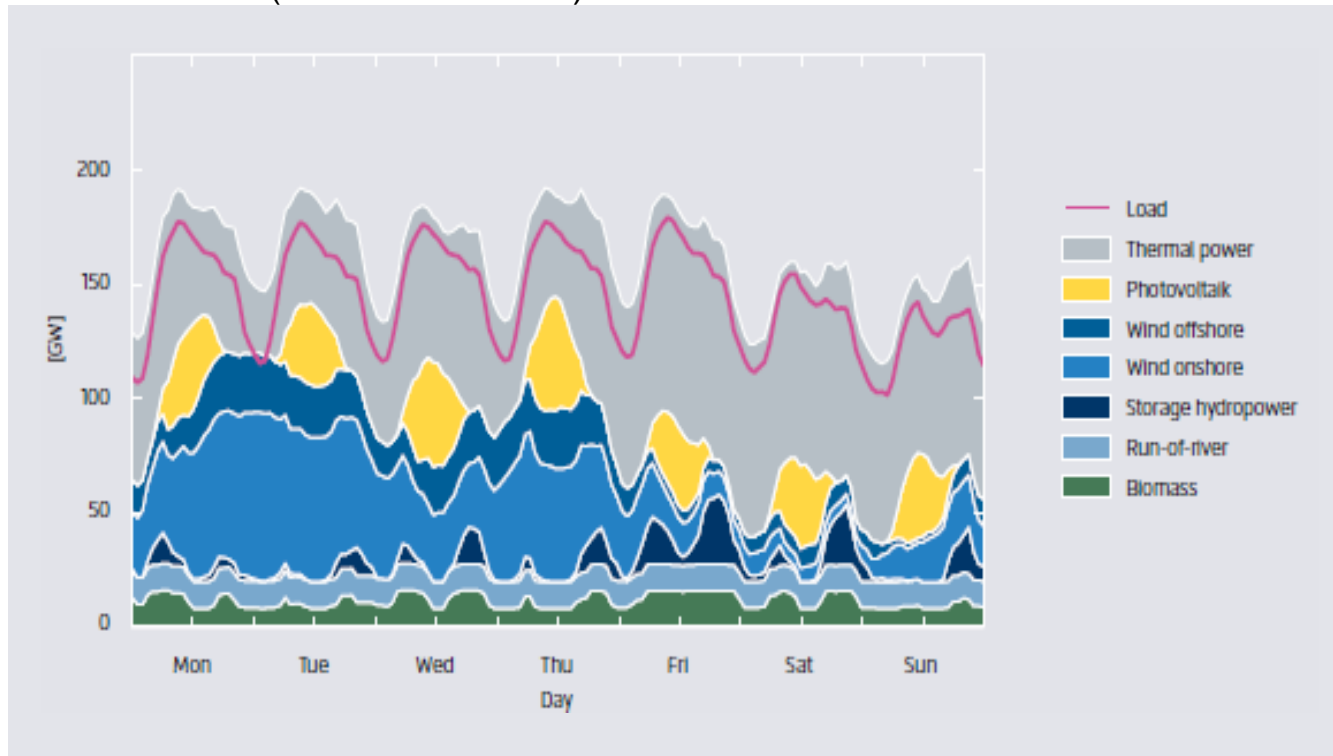


Starting point

- EU power systems increasingly shaped by wind power and solar photovoltaics (PV)
- Power systems will need to be capable of integrating vRES
 - Increased need for flexibility in the power system
- Refinements to design of short-term power markets (day-ahead, intraday, balancing; plus imbalance settlement) important no-regret option
 - Demand for and provision of flexibility materialises in short-term markets
 - Through market design refinements, flexibility needs can be partially mitigated and efficient flexibility provision can be achieved
- Agora Energiewende commissioned *CE Delft* and *Microeconomix* to conduct quantitative and qualitative analysis
 - Identify key market design elements that efficiently enable flexibility provision + potential options for improvement in **PLEF**
 - Focus: Improved pricing for efficiently supplying flexibility

The role of short-term markets in flexibility provision

Electricity generation* and consumption* in the PLEF region in a week in late summer 2030 (calendar week 32)



- Supply of flexibility by dispatchable generation, demand response and storage managed through the short-term electricity markets
- Balancing markets are associated with provision of flexibility, since they remunerate it explicitly
- However all short-term market segments contribute to flexibility provision and remuneration
- To enable flexibility efficiently, prices in short-term markets should reflect real-time value of electricity
- Critically, market design influences formation of these prices

Fraunhofer IWES (2015)

* Modelling based on 2011 weather and load data

Basic principles for efficient market prices

- **Marginal pricing principle:** Prices at marginal cost / value for the society ensure that market players produce if their internal marginal cost is lower or equal to price and consume if internal marginal benefit is higher or equal to price. *If prices follow marginal pricing, prices increase when market is tighter and vice versa*
- **Opportunity cost pricing principle:** Resources can be used to produce several goods (e.g. either sell energy on DAM or provide balancing services to BM). Efficient pricing needs to *include opportunity cost, i.e. foregone benefit of not producing alternative goods* (simplified: resource used for the BM cannot sell energy on DAM)
- **No-arbitrage principle:** Substitute products should be equal thus systematic arbitrage opportunities should not arise in efficient markets → *law of one price*. Temporal dimension: electricity with same delivery date but traded at DA, ID or balancing stages are substitutes to some extent; Spatial dimension: Electricity produced at different locations is another example of substitute products. Arbitrage enables that least-cost alternatives available in differing markets are utilised

Source: CE Delft and Microeconomix

Key market design parameters show broad range of implementation specifications:

Market access and Demand Side Participation

Demand side market access in the BMs (top) and regulatory arrangements facilitating independent aggregation (bottom)

	Load				Aggregated load			
	R1	R2	R3	Special (DSR) products	R1	R2	R3	Special (DSR) products
Austria	yes	yes	yes	n.a.	yes	yes	yes	n.a.
Belgium	partial (R1 Load share max. 33%)	no	partial 10% (R3 DP) + 40% (R3 ICH)	n.a.	partial (R1 Load share max. 33%)	no	partial 10% (R3 DP) + 40% (R3 ICH)	n.a.
France	yes	yes	yes	n.a.	yes	yes	yes	n.a.
Germany	yes	yes	yes	yes	yes	yes	yes	yes
The Netherlands	no	yes	yes	n.a.	no	no	no	n.a.
Switzerland	yes	yes	yes	n.a.	yes	yes	yes	n.a.

	DAM	IDM	R1	R2	R3	Special (DSR) products
Austria	no	no	no	no	no	n.a.
Belgium ⁴⁰	no	no	no	no	no	n.a.
France	yes	yes	yes	yes	yes	n.a.
Germany	no	no	no	no	no	no
The Netherlands	no	no	no	no	no	n.a.
Switzerland	no	no	yes	yes	yes	n.a.

- PLEF short-term markets typically allow demand side participation, usually relating to industrial consumption, as well as aggregated demand side market participation
- Independent aggregation (separating roles of BRP and BSP), which can further enable DSR, is marginally institutionalised in PLEF region

Key market design parameters show broad range of implementation specifications:

Market access and Product Duration

Product duration requirements imposed in the balancing markets in the PLEF countries in 2015

	Temporal product resolution energy bids			Contracting period for operational reserves capacity bids			
	R1	R2	R3	R1	R2	R3	Spec. (DSR) prods.
Austria	15mins	12hrs (WD), 48 hrs (WND)	4 hrs	1 week	1 week	1 week	D.a.
Belgium	15mins	15mins	15mins, 4hrs (IL)	1 month	1 month	1 year (1 month for 10% fraction)	D.a.
France	30mins	30mins	30mins	D.a. ⁴⁶	D.a. ⁴⁷	1 week or 1 year ⁴⁸	D.a.
Germany	15mins	12hrs (WD), 48 hrs (WND)	4 hrs	1 week	1 week	1 day	1 month
The Netherlands	15mins	15mins	15mins	1 week	1 quarter, 1 year	1 quarter, 1 year	D.a.
Switzerland	15mins	15mins	4 hrs	1 week	1 week	1 day	D.a.

- Product duration (how long a product has to be delivered) can have relatively restrictive consequences for market participation, especially in balancing markets
- The longer a product has to be contracted (capacity) or delivered (energy), the more this restricts the potential number of providers
- While product duration in DAM and IDM typically ranges between 15 minutes and one hour, product duration for reserve power to be offered in BMs much longer
- Operational reserves contracted from weekly products to yearly products in most PLEF countries. Daily products are a rare exception.
- Longer contracting requirements restrictive for RES and DSR (or small-scale storage) cannot be committed over longer time periods

CE Delft and Microeconomix based on TSO information

Key market design parameters show broad range of implementation specifications:

Market completeness and Delivery Periods

Alignment of delivery periods in short-term electricity markets in the PLEF countries in 2015

	Temporal product resolution energy bids				
	DAM	IDM	R1	R2	R3
Austria	60mins, 15mins	60mins, 15mins	15mins	12hrs (WD), 48 hrs (WND)	4 hrs
Belgium	60mins	60mins	15mins	15mins	15mins, 4hrs (IL)
France	60mins	60mins	30mins	30mins	30mins
Germany	60mins	60mins, 15mins	15mins	12hrs (WD), 48 hrs (WND)	4 hrs
The Netherlands	60mins	60mins	15mins	15mins	15mins
Switzerland	60mins	60mins, 15mins	15mins	15mins	4 hrs

- Delivery periods not aligned well across PLEF short term markets
- Increasing temporal granularity when moving to real-time, i.e. shortening the settlement period of the products traded when moving from day-ahead to balancing markets
- When imbalance settlement periods (ISPs) involves 15 minute while such products not traded in DAM and IDM these markets allow only for partial hedging of imbalance exposures
- Such differentials also appear across borders: ISPs set to 15 minutes in most PLEF countries, while French ISP is set to 30 minutes
- Any of these differentials imply that frictionless trading cannot be achieved leading to inefficiencies

CE Delft and Microeconomix based on PX and TSO information

Key market design parameters show broad range of implementation specifications:

Market pricing

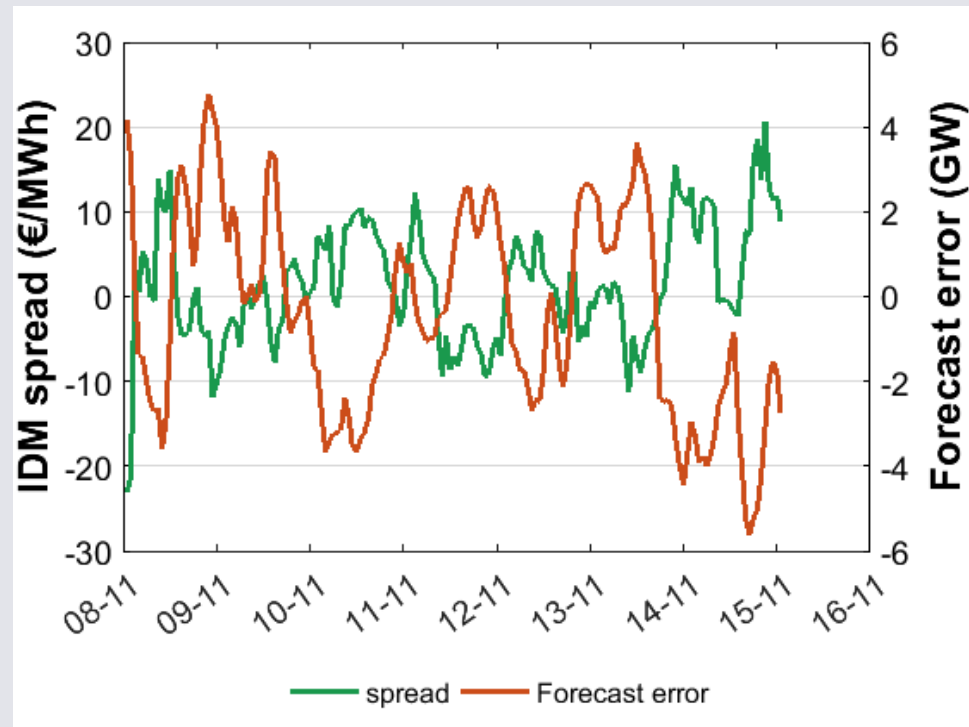
	Settlement price for balancing energy	
	R2	R3
Austria	Pay-as-bid	Pay-as-bid
Belgium	Pay-as-bid	Pay-as-bid
France	Pay-as-bid	Pay-as-bid
Germany	Pay-as-bid	Pay-as-bid
The Netherlands	Pay-as-cleared	Pay-as-cleared
Switzerland	Pay-as-bid	Pay-as-bid

- Pricing mechanisms in BM typically remunerate providers of balancing services on pay-as-bid basis
- Thought to induce inefficiencies as it is likely to diverge from marginal pricing
- Pay-as-bid remuneration incentivises inframarginal bidders to bid up to expected marginal price in order to capture inframarginal rents
- Resulting bidding induces inefficiencies in dispatch of supply and demand-side technologies.

CE Delft and Microeconomix based on TSO information

Efficiencies and inefficiencies are visible in current market prices: Intraday markets

IDM spread (defined as intraday minus day-ahead price) vs. day-ahead wind forecast error (actual wind generation minus forecast) in DE in November 2015

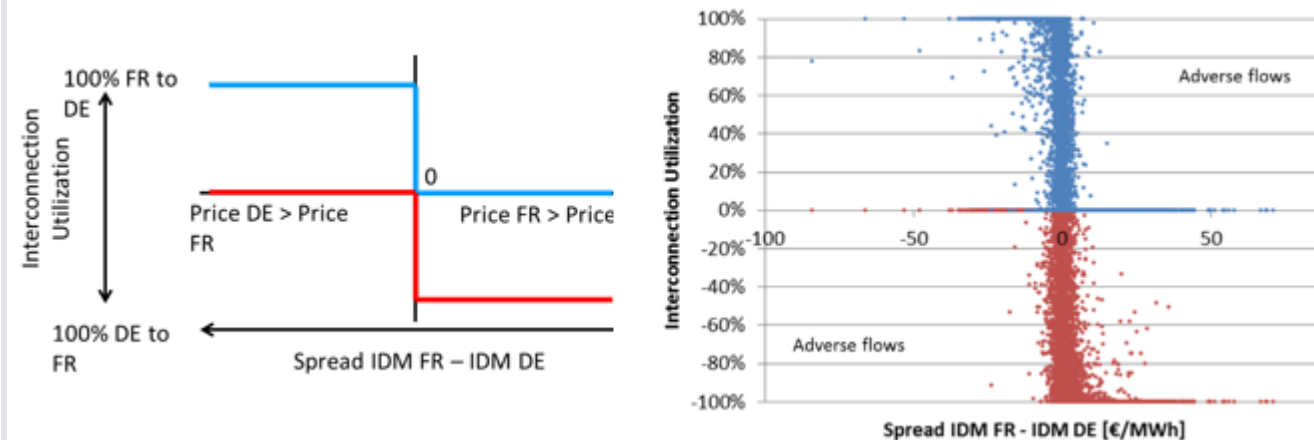


CE Delft and Microeconomix based on PX and TSO data

- IDM shows correlations with flexibility demand (e.g. to correct adjustments in day-ahead vRES forecasts)
- Correspondingly remunerates flexibility
- Results for Germany: Intraday spread (IDM minus DAM price) shows strong correlation with day-ahead wind forecast error, reflecting corrective trades on the intraday market
- Yet, liquidity issues of some PLEF intraday markets induce inefficiencies in price discovery
- Efforts seeking to increase liquidity in such instances represent a good market design reform
- Intraday market coupling can improve liquidity
→ high priority

Efficiencies and inefficiencies are visible in current market prices: Intraday markets

German-French IDM spreads (defined as French minus German intraday price) vs. cross border flows in 2014

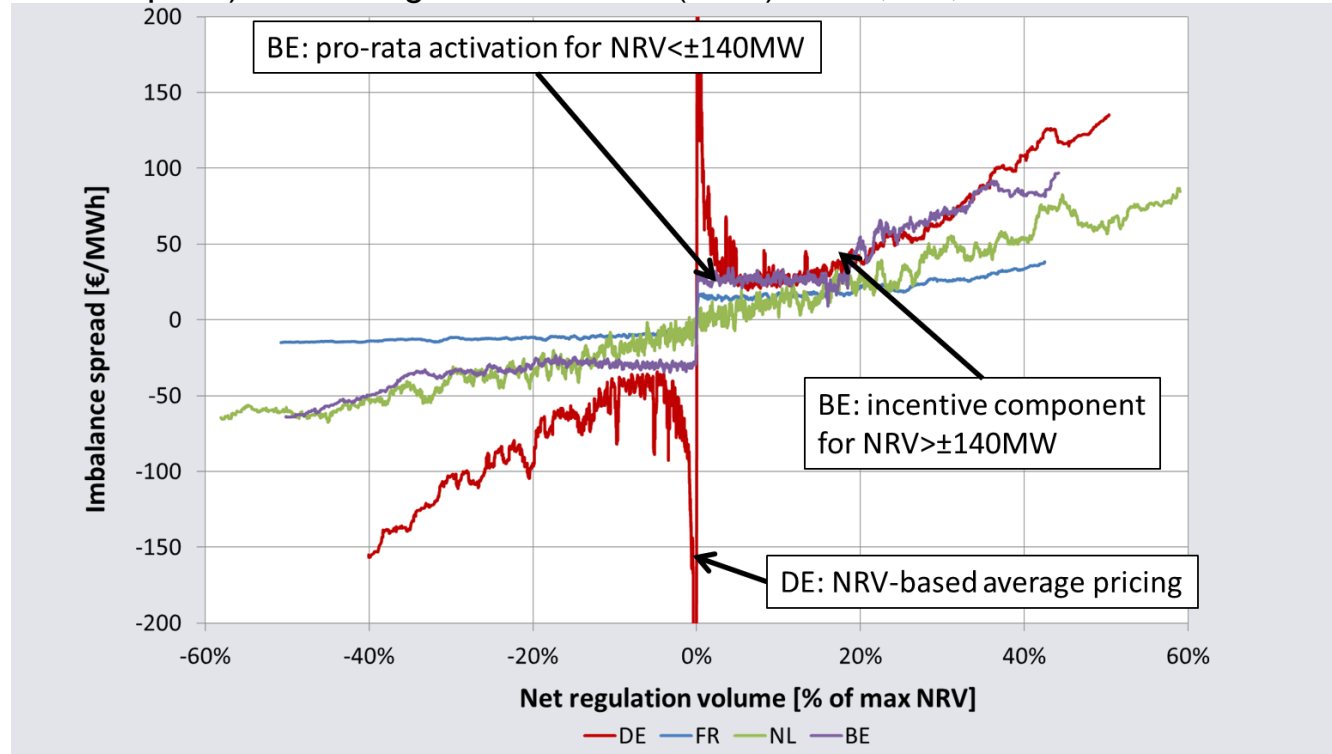


CE Delft and Microeconomix based on PX and TSO data

- Optimising cross-border ID trade important to improve liquidity and improve efficient flexibility provision and minimise system costs
- Current arrangements prohibit full consistency between cross-border power flows and cross-border intraday price differences
- Often interconnection not fully used although non-zero CB intraday price spread prevails
- Interconnector capacity occasionally reserved by market actors to deliver flows from high price to low price country → Flexibility often not provided at least cost
- Reasons: Parallel use of explicit and implicit allocation; Difficulties to design efficient implicit market coupling for continuous trading; Available CB transmission capacity offered free of charge in ID timeframe

Efficiencies and inefficiencies are visible in current market prices: Balancing markets

Balancing market spread (settlement; defined as imbalance price minus day-ahead price) vs. net regulation volume (NRV) in DE, FR, NL and BE in 2015



CE Delft and Microeconomix based on TSO data

- BMs remunerate flexibility in assessed countries, to a differing extent. The steeper spread as function of deployed balancing power and the closer IMB price reflects real-time value of power, the higher incentive to provide flexibility or minimise imbalance
- IMB spreads affected by IMB settlement pricing mechanisms (ranging from net regulation volume to gross regulation volume based and average pricing vs. marginal pricing) and activation mechanisms for balancing energy bids (parallel activation of all bids (“pro-rata activation”) vs. merit order activation) applied.
- Marginal pricing and merit order activation best practices while typically PLEF BM diverge considerably in this area

Key insight 1

- **Short-term markets in Central Western Europe are characterised by a rather inefficient patchwork of flexibility enabling and disabling design elements**
- Some key design elements of intraday and balancing markets as well as imbalance settlement rules distort wholesale power price signals, increasing the cost of providing flexibility
- This highlights the need to adjust key market design elements and requires continuous political momentum to coordinate efforts regionally

Key insight 2: Market access and demand response

- **Current market designs are biased against demand side response and renewables**
- Restrictive requirements for market participation, mainly relating to demand response and renewables, constrain the flexibility potential
- In the balancing markets, small minimum bid sizes and short contracting periods would be required
- A regulatory framework enabling independent aggregation should be implemented to fully tap the flexibility potential

Key insight 3: Balancing markets

- **Balancing market rules show large differences across the region, leading to inefficient pricing in pre-ceding day-ahead and intraday markets**
- A joint balancing market design in the PLEF region with short product duration, late gate closure and marginal pricing would enable efficient cross-border competition for flexibility services
- Getting the pricing right in balancing mechanisms is important as it supports efficient pricing in proceeding day-ahead and intraday markets – where most of the flexibility is traded

Key insight 4: Intraday markets

- **Cross-border intraday trading needs reform to improve efficiency and enhance liquidity**
- Intraday markets are critical for integrating wind and solar, as they allow for trades responding to updated generation forecasts
- Today, explicit cross-border capacity allocation as well as misalignments in gate closure times across the region and differing product durations result in inefficient intraday energy and interconnector capacity allocation
- Thus, harmonised rules and improved implicit cross-border allocation methods are needed

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