SCCER CREST
Swiss Competence Centers for Energy Research
Competence Center for Research in Energy, Society and Transition

Universität Basel
Wirtschaftswissenschaftliche Fakultät

WWZ

FoNEW
Forschungsstelle für Nachhaltige Energie- und Wasserversorgung

Wholesale Electricity Markets

‘The’ Electricity Market…

Ein neues «Markt-Design» soll Probleme des Strommarktes beseitigen

Neue Zürcher Zeitung

Absurder Strommarkt – Geld erhält, wer Strom bezieht

Tages-Anzeiger

ENERGIEWENDE

Streit um hohe Strompreise

Handelsblatt

Öffnung des Strommarktes

Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

Eidgenössisches Departement für Umwelt, Verkehr, Energie und Kommunikation UVEK

EPEX DAY AHEAD AUCTION

More +

	Price (€/MWh) Base	Price (€/MWh) Peak	Volume (MWh) Day	Volume (MWh) Month	Delivery Day
DE/AT	↘ 31.50	↘ 31.54	↘ 640,225	9,690,379	14/10/2017
FR	↘ 43.75	↘ 45.87	↘ 198,302	3,332,462	14/10/2017
NL	↘ 38.03	↘ 40.68	↗ 92,277	1,266,029	14/10/2017
BE	↘ 40.07	↘ 43.66	↘ 44,257	631,325	14/10/2017
CH	↘ 47.68	↘ 47.33	↘ 59,364	926,811	14/10/2017
ELIX	↗ 40.21	↗ 45.00	–	–	13/10/2017

EPEX INTRADAY CONTINUOUS

Delivery Day : 12/10/2017

More +

	Index (€/MWh) Base	Index (€/MWh) Peak	Daily Volume (MWh) Exchange	Daily Volume (MWh) OTC	Monthly Volume (MWh) Exchange	Monthly Volume (MWh) OTC
DE/AT	25.38	25.81	↗ 156,882	↗ 314	1,618,560	1,980
FR	49.88	60.42	↘ 11,796	↘ 0	164,986	1,828
NL	35.73	39.78	↘ 3,948	0	54,544	0
BE	51.94	60.51	↗ 2,968	0	43,257	0
CH	57.80	63.28	↘ 2,795	0	64,228	0

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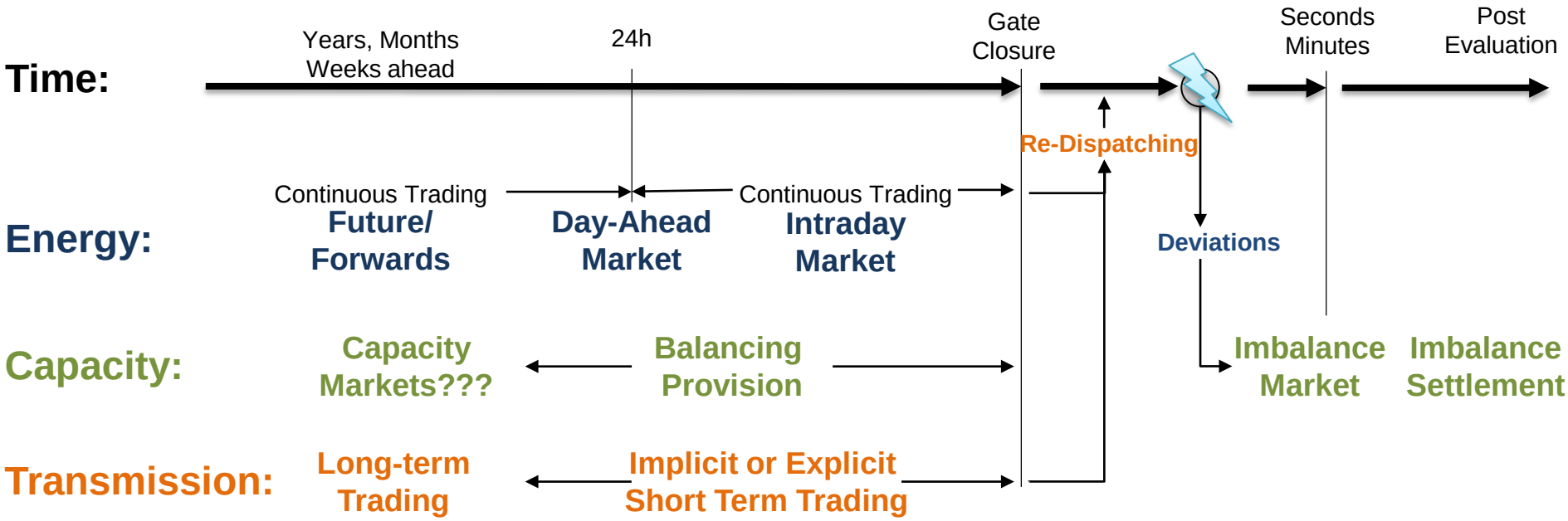
…is a set of multiple markets

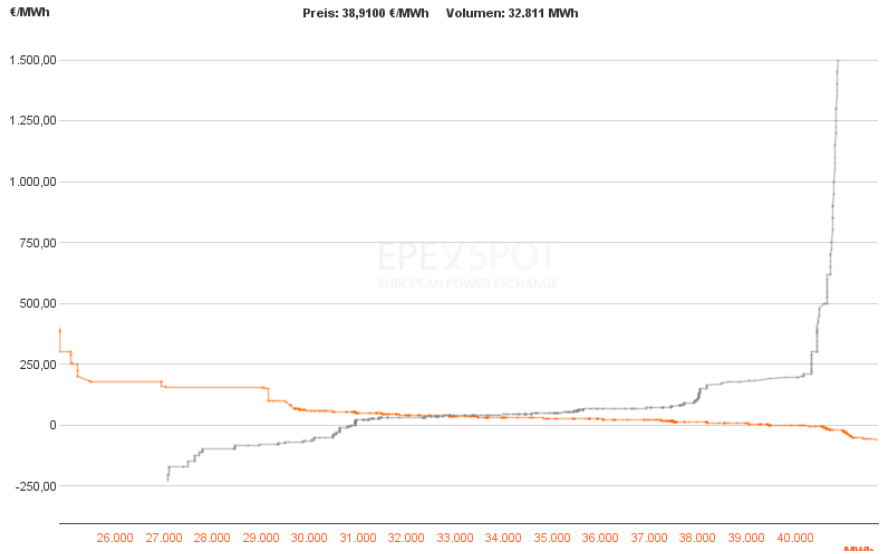


Energy Markets

Main Job: Ensure cost efficient usage of existing plant capacities thereby setting investment incentives (for those relying on market revenues)

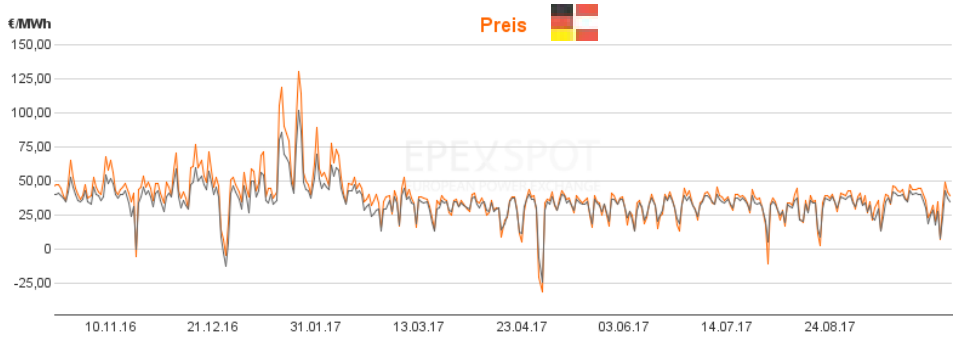
Design: DA and ID usually auction based (time constraint)

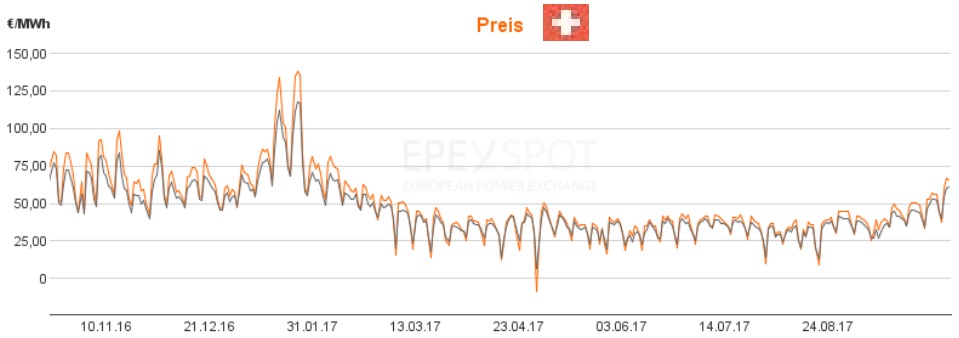
either as **exchange** (simple bids, many EU markets) or **pool** (complex bids, many US markets)



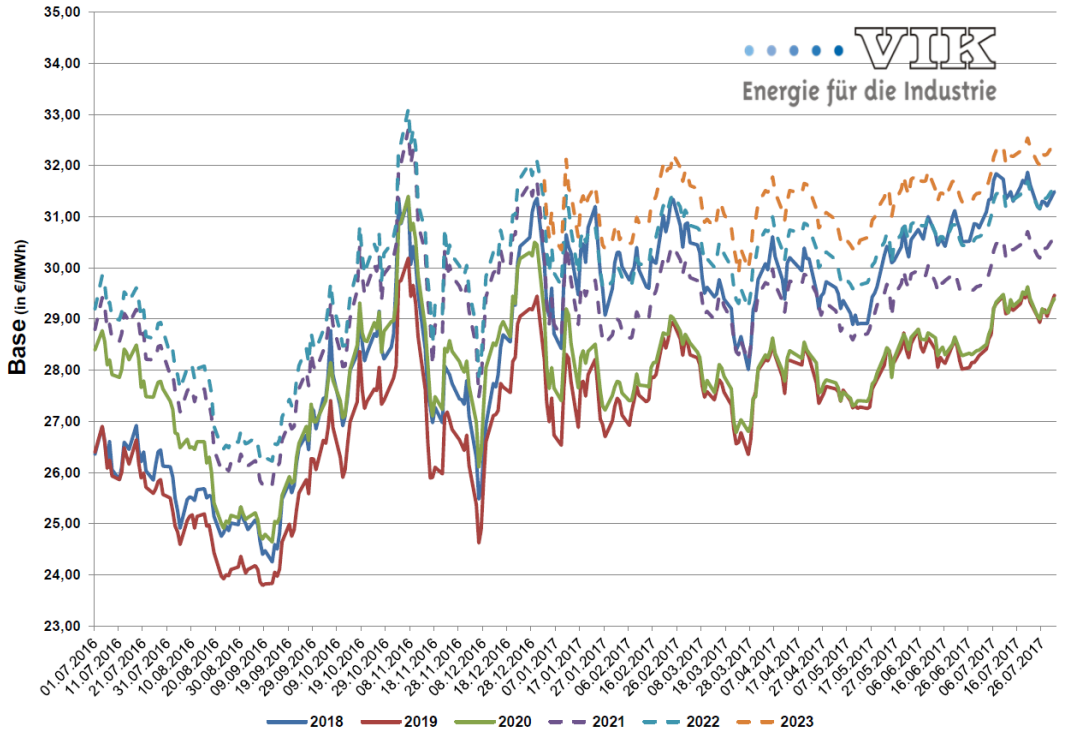
Source: EPEXSPOT

A look back and forward





Future/Forward prices represent the markets **expectations** about the future spot market price



Source: EPEXSPOT, VIK

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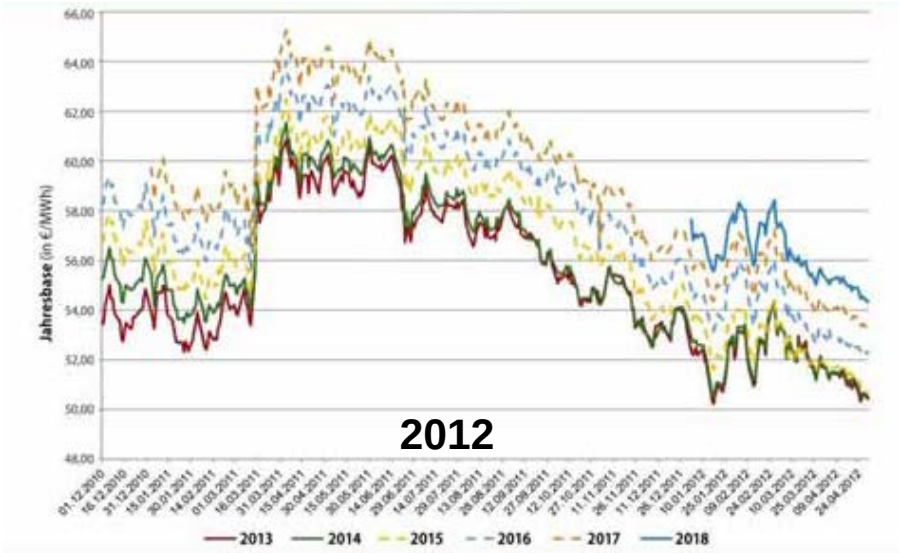
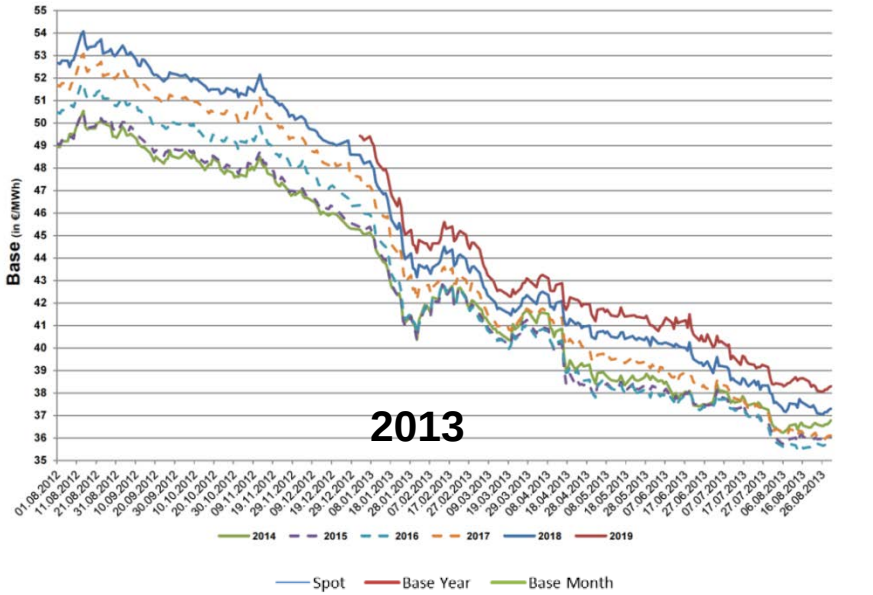
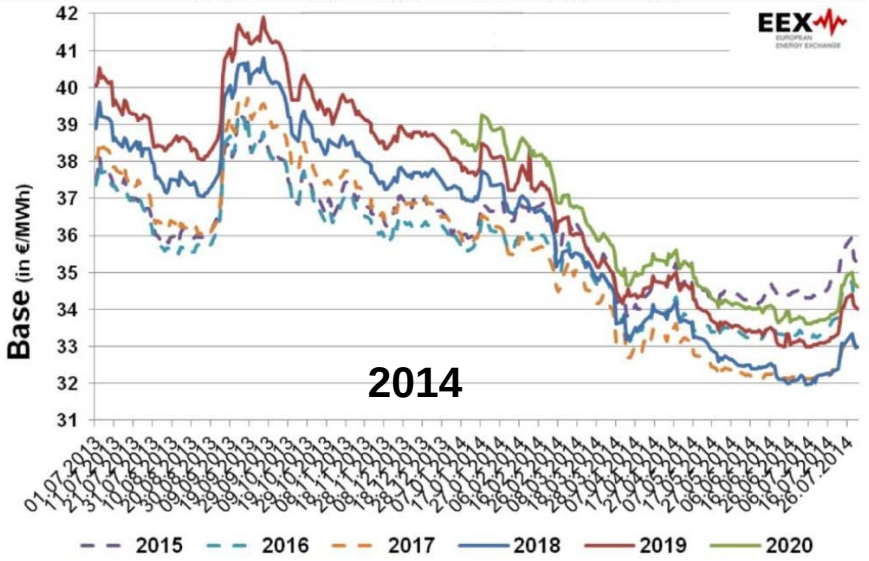
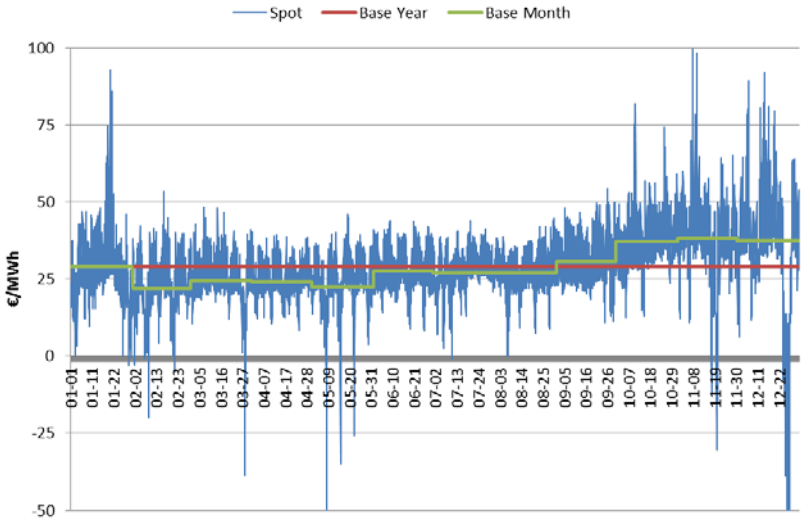
…and expectations change over time!









Source: VIK, EEX

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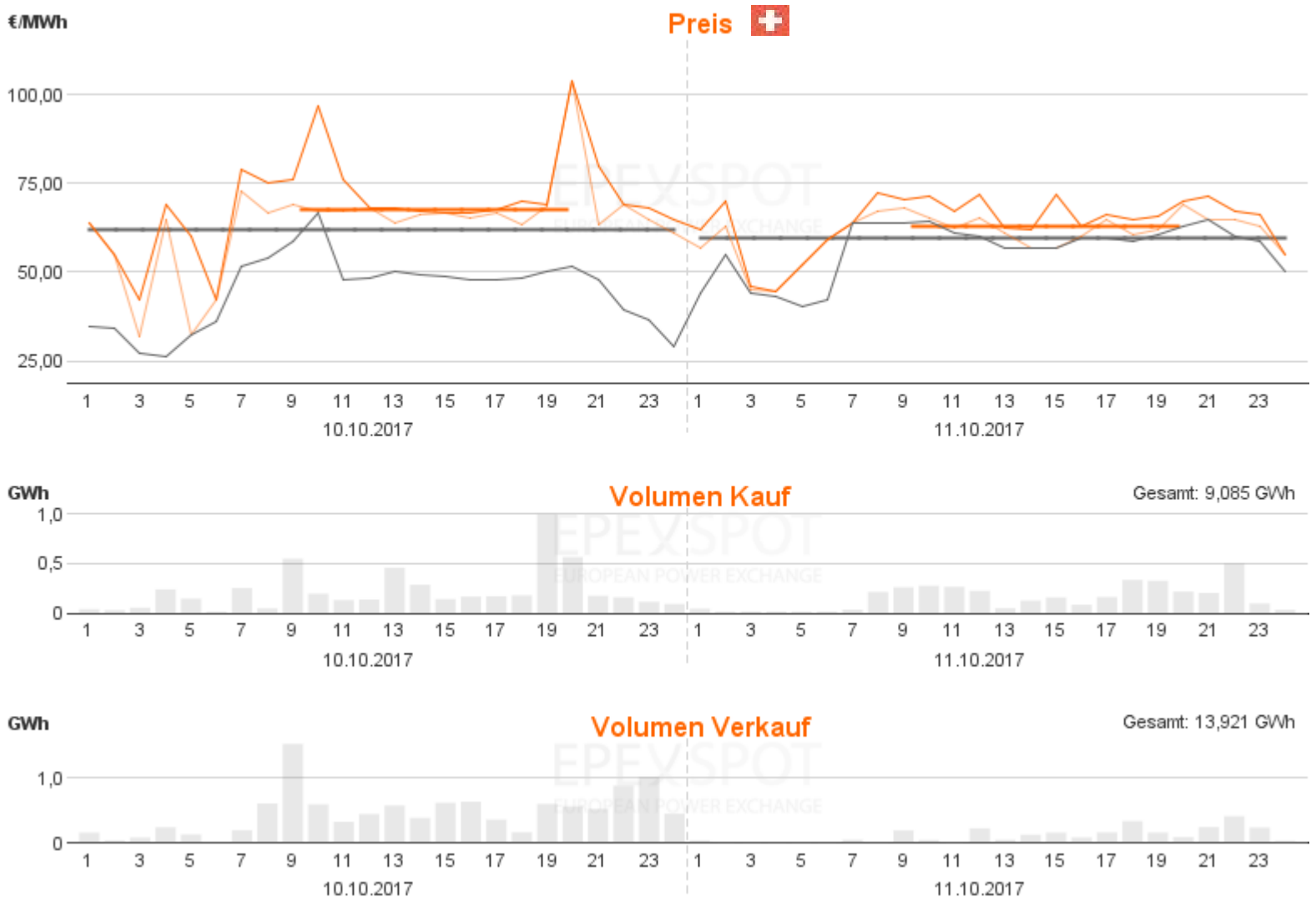
Intra-Day



Source: EPEXSPOT

Balancing Markets

Main Job: Ensure availability of available capacity for short term system stability (responsibility of System Operator)

Design: way too many…

Often split in an **provision price** (for the 'stand-by' service) and an **energy price** (for the actual call-up)

Pay-as-bid and uniform pricing rules

Timing varies greatly (often **weekly** and **daily**)

Symmetric and **positive/negative** bidding structures

→ Energy and balancing are coupled via **'opportunity costs'** (going on one market limits your activity on the other)

Pick Your Market Design

	Power market characteristics		*Balancing power market characteristics*			*Auction characteristics*	
	vRES share (2014)[1]	**Latest possible trading option[2]**	**FCR (automatic)**	**FRR (automatic)**	**RR**	**Pricing rule**	**Scoring rule**
Austria	7.3%	30min	PB; s; w; m.-o.; 1x168h; 1MW	PB&EB; ±; w; m.-o.; Mo-Fr 8am-8pm, rest; 5MW	PB&EB; ±; w; m.-o.; 42x4h; 5MW	PaB	lowest PBs
Belgium	9.2%	5min	TP; ±; m; *n/a.*; base, peak, offpeak; 1MW	PB&EB; ±; m; m.-o.; base, peak, offpeak; 5MW	PB&EB; ±; y; *n/a.*; base, peak, offpeak; 5MW	PaB	SP
Czech Republic	4.4%	*Day-ahead*	PB; s; d; *n/a*; 24x1h; *n/a*	PB; ±; d; p; 24x1h; *n/a*	PB; s; d; m.-o.; 24x1h; *n/a*	UP	lowest PBs
Denmark (DK1/DK2)	44.7%	60min	PB; ±; d; *n/a*; 6x4h; 0,3MW	PB; s; m; p.; 24x1h; 0,3MW	PB&EB; ±; d; *n/a*; 24x1h; 10MW	UP (DK1), PaB&UP (DK2)	*n/a*
Estonia	8.7%	60min	*provided by russian TSO*	TP; *n/a*; *n/a*; m.-o.; 24x1h; 5MW	TP; ±; *n/a*; *n/a*; 24x1h; 5MW	PaB	*n/a*
Finland	1.4%	60min	*n/a*; s; *n/a*; *n/a*; 24x1h; 1MW	EB; ±; *n/a*; p; 24x1h; 10MW	*non-existent*	UP	*n/a*
France	5.6%	30min	*compulsory, regulated prices*	*compulsory, regulated prices*	TP; ±; y; m.-o.; *n/a*; 10MW	PaB	*n/a*
Germany	18.2%	30min	PB; s; w; m.-o.; 1x168h; 1MW	PB&EB; ±; w; m.-o.; Mo-Fr 8am-8pm, rest; 5MW	PB&EB; ±; d; m.-o.; 6x4h; 5MW	PaB	lowest PBs
Hungary	1.9%	120min	PB; ±; *n/a*; *n/a*; 24x1h; *n/a*	PB&EB; ±; *n/a*; m.-o.; 24x1h; *n/a*	PB&EB; ±; *n/a*; m.-o.; 24x1h; *n/a*	PaB	*n/a*
Iceland	0.0%	*Day-ahead*	TP; s; w; m.-o.; 24x1h; 1MW	TP; s; w; m.-o.; 24x1h; 1MW	TP; ±; w; m.-o.; 24x1h; 1MW	UP	lowest TPs
Italy	13.1%	250min	*compulsory, regulated prices*	EB; s; d; p; 24x1h; 1MW	EB; s; d; m.-o.; 24x1h; 1MW	PaB	*n/a*
Latvia	2.1%	60min	*provided by russian TSO*	*manual*: *n/a*; ±; *n/a*; m.-o.; 24x1h; *n/a*	*non-existent*	*n/a*	*n/a*
Lithuania	13.7%	60min	*provided by russian TSO*	*manual*: TP; *n/a*; d; m.-o.; 24x1h; 5MW	TP; *n/a*; d; m.-o.; 24x1h; 5MW	UP	lowest TPs
the Netherlands	6.4%	5min	PB; s; w; m.-o.; 1x168h; 1MW	PB&EB; ±; d/y; m.-o.; *n/a*; 4MW	PB&EB; ±; d/y; m.-o.; *n/a*; 20MW	PaB & UP	lowest PBs *(FCR), n/a*
Norway	2.0%	60min	PB; s/±; d/w; *n/a*; 24x1h; 1MW	PB&EB; ±; w; p; *n/a*; 1MW	*non-existent*	UP	*n/a*
Poland	6.0%	180min	EB; ±; *n/a*; *n/a*; 24x1h; *n/a*	EB; ±; *n/a*; *n/a*; 24x1h; *n/a*	EB; ±; *n/a*; m.-o.; 24x1h; *n/a*	UP	SP
Portugal	27.9%	195min	*compulsory, no compensation*	PB; ±; d; p; 24x1h; *n/a*	PB&EB; ±; d; m.-o.; 24x1h; *n/a*	UP	lowest PBs
Romania	18.4%	90min	*compulsory, no compensation*	TP; ±; d; m.-o.; 24x1h; *n/a*	TP; ±; d; m.-o.; 24x1h; *n/a*	UP	lowest TPs
Slovenia	2.1%	60min	*compulsory, no compensation*	PB&EB; *n/a*; y; p; 24x1h; *n/a*	PB&EB; *n/a*; y; m.-o.; 24x1h; *n/a*	PaB	*n/a*
Spain	28.3%	195min	*compulsory, no compensation*	PB; ±; d; p; 24x1h; *n/a*	PB&EB; ±; d; m.-o.; 24x1h; *n/a*	UP	lowest PBs
Sweden	9.2%	60min	PB&EB; s; d/w; *n/a*; 24x1h; *n/a*	PB&EB; ±; w; p; *n/a*; *n/a*	*non-existent*	PaB	*n/a*
Switzerland	1.6%[3]	60min	PB; s; w; m.-o.; 1x168h; 1MW	PB; s; w; p.; *n/a*; 5MW	PB; ±; w; n/a; 6x4h; 1MW	PaB	lowest PBs (FCR), SP (FRR, RR)
Serbia	0,0%	*Day-ahead*	*non-existent*	TP; ±; d; p; 24x1h; *n/a*	TP; ±; d; *n/a*; 24x1h; *n/a*	UP	lowest TPs
United Kingdom	11.9%	75min	PB&EB; ±; m; *n/a*; Mo-Fr, Sa, Su; 10MW	PB&EB; ±; m; *n/a*; Mo-Fr, Sa, Su ; 10MW	PB&EB; s; m; *n/a*; Mo-Fr, Sa, Su; 50MW	PaB	*n/a*

Balancing Provision

Imbalance Pricing

Country	Pricing based on	Mechanism	Symmetric/ asymmetric	Settlement time unit
Austria	Total costs	One-price	-	15 min.
Belgium	Marginal prices	Two-price	Symmetric	15 min.
Denmark	Marginal prices	Two-price (production) One-price (consumption)	Symmetric	15 min.
France	Marginal prices	Two-price	Symmetric	30 min.
Germany	Total costs	One-price	-	15 min.
Italy	Marginal prices	One-price (small BRP) Two-price (big BRP)	Symmetric	60 min.
Spain	Marginal prices	Two-price	Symmetric	60 min.
Switzerland	Marginal prices	Two-price	Asymmetric	15 min.
The Netherlands	Marginal prices	Two-price	Symmetric	15 min.

Papageorgiou, et al. (2016)

Ocker, et al. 2016

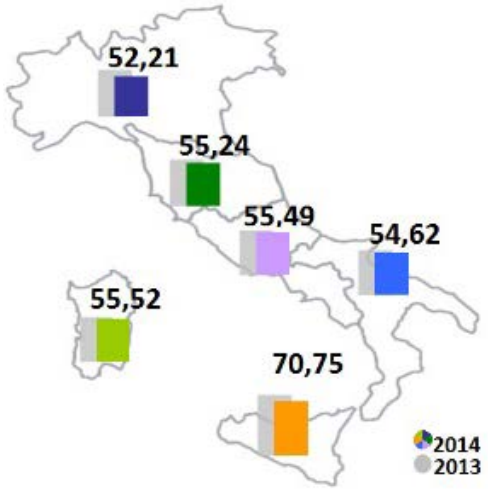
Abbreviations: ***manual***=manual activation; **PB**=power bid and/or **EB**=energy bid or **TP**=total price; **s**=symmetric product (no distinction between positive and negative balancing energy) or **±**=distinction between positive and negative balancing power; procurement: **d**=daily, **w**=weekly, **m**=monthly or **y**=yearly; **m.-o.**=merit-order activation of balancing energy or **p**=pro-ratio/parallel activation of balancing energy; **24x1h**=24 one-hour time slices per day; **5MW**=minimum power offer is 5MW; **PaB**=Pay-as-Bid pricing or **UP**=Uniform pricing (for EB and/or PB); **SP**=Stochastic Programming or **lowest PBs/TPs**=lowest capacity bids/total prices are considered until balancing demand is met; ***n/a***=parameter not available (e.g. not published)

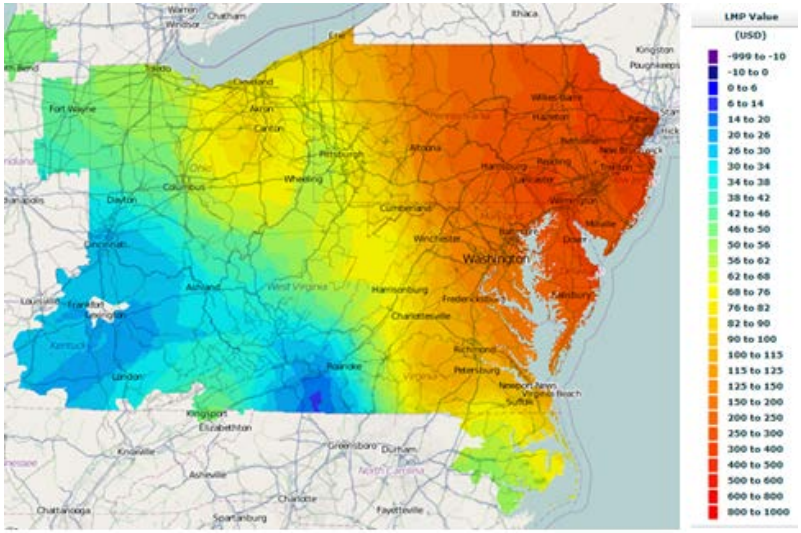
Going Cross Border

Main Job: Ensure efficient usage of transmission capacity between regions

Design: Normally linked to energy markets (**market coupling**)

Uniform, zonal or nodal pricing option for accounting of network constraints





Source: Clear Energy Wire, Breaking Energy, PJM

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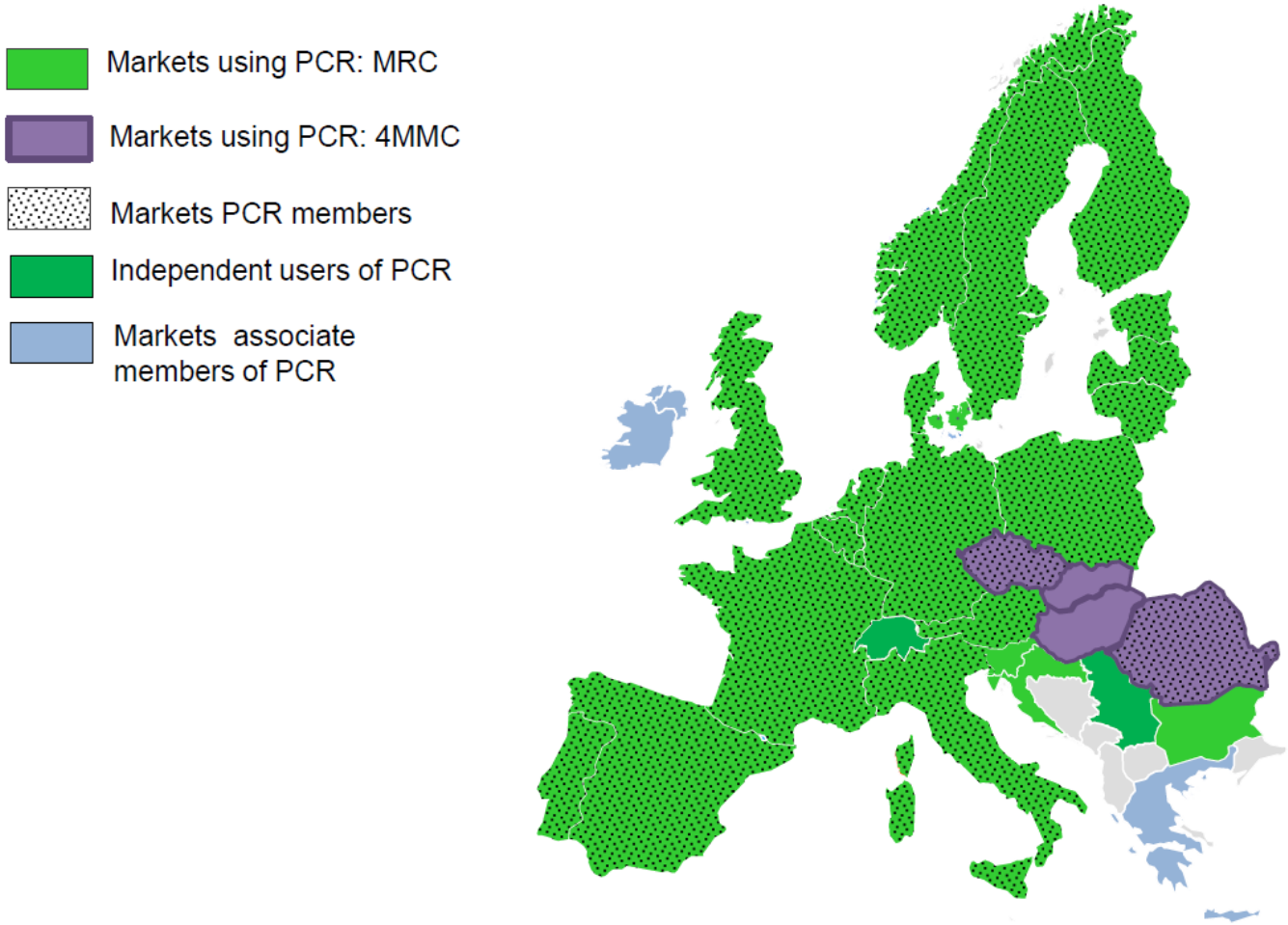
Europe is finally integrating



After initial local cooperation (i.e. Benelux trilateral market coupling) **cross-border trading rules** are harmonized across Europe

→ **Price Coupling of Regions**

Source: EEX PCR