

**CSEE REGION WHOLESALE POWER
MARKET:
HIGH-PRICE ENVIRONMENT ANALYSIS**

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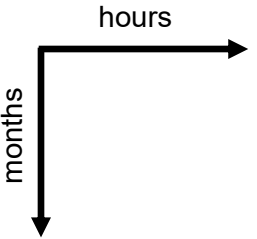
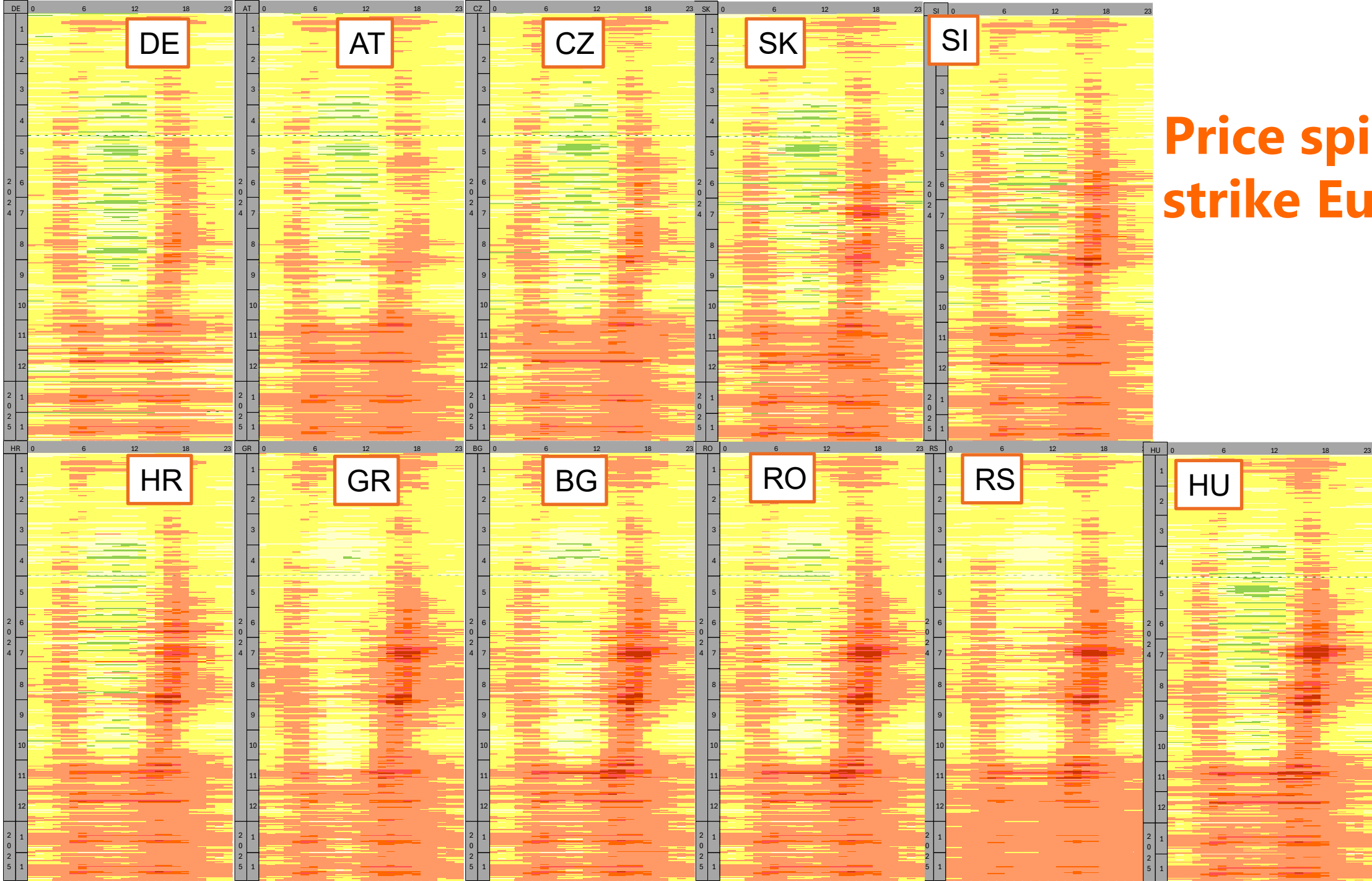
October 2025

Outline

- The Fragmentation of Wholesale Prices in Europe (2024.01.01. – 2025.07.31.)
- What factors can cause the formation of price regions?
 - Demand-side factors
 - Supply-side factors
 - System bottlenecks: price differences arising from network constraints
- Identification of the key network elements in the region
- Relationship between the remaining available margin (RAM) and price differences
- Determining the combined effect of the factors: regression analysis
- Role of critical parameters in the case of TOP5 CNEC
 - Flow without any commercial exchange (F_{0all})
 - Flows from assumed commercial exchanges outside the Core region (F_{uaf})
- Modeling the high-price environment -> scenarios analyses
- Summary and policy conclusions

THE FRAGMENTATION OF WHOLESALE ELECTRICITY PRICES IN EUROPE

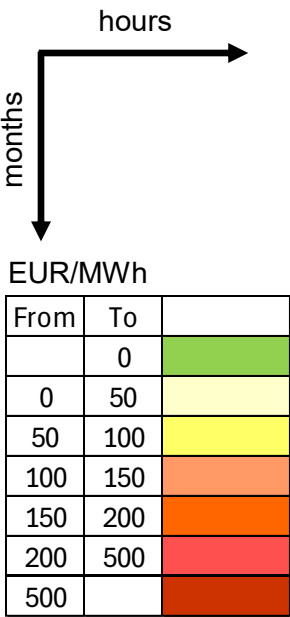
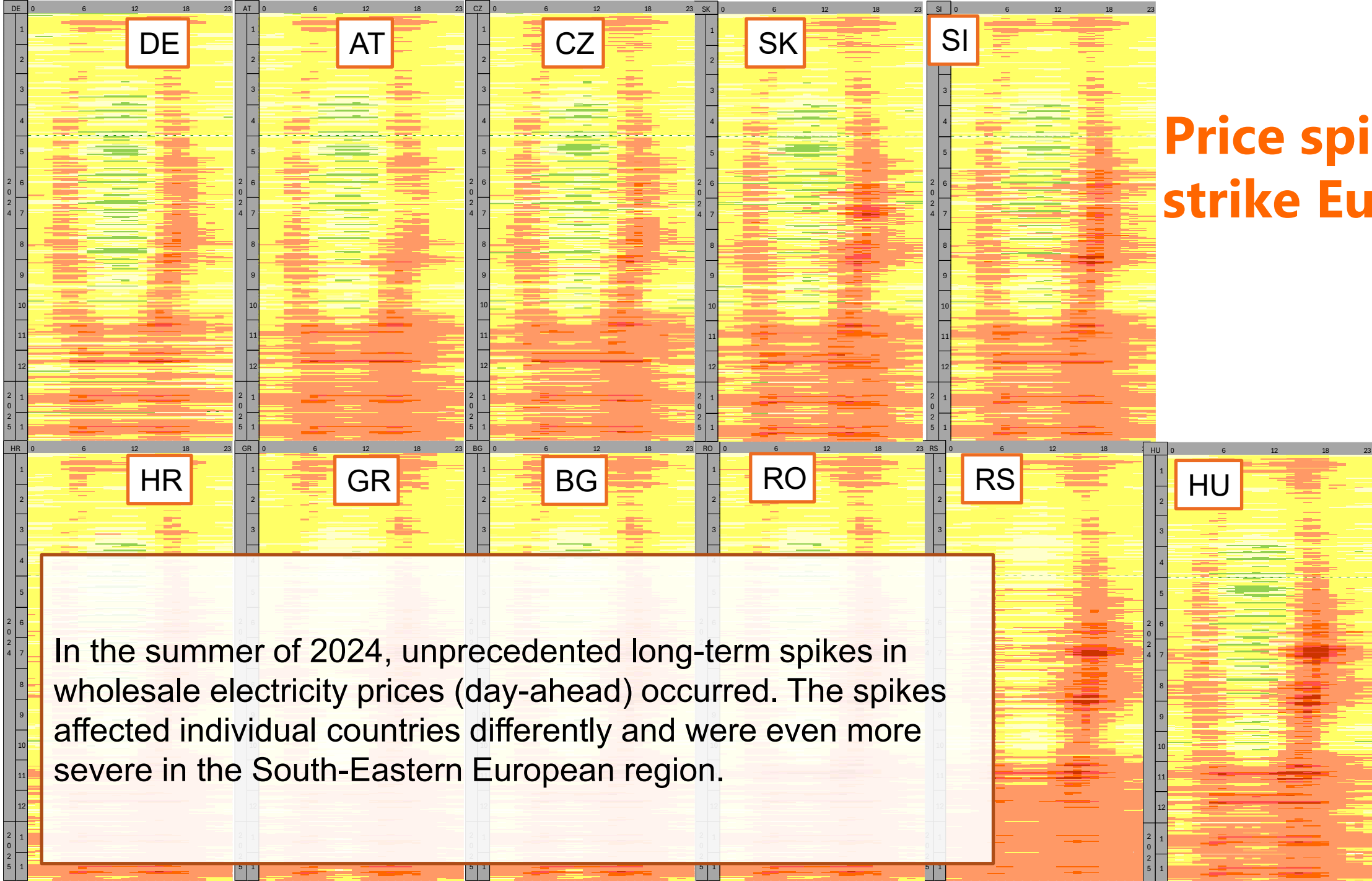
Price spikes strike Europe



EUR/MWh

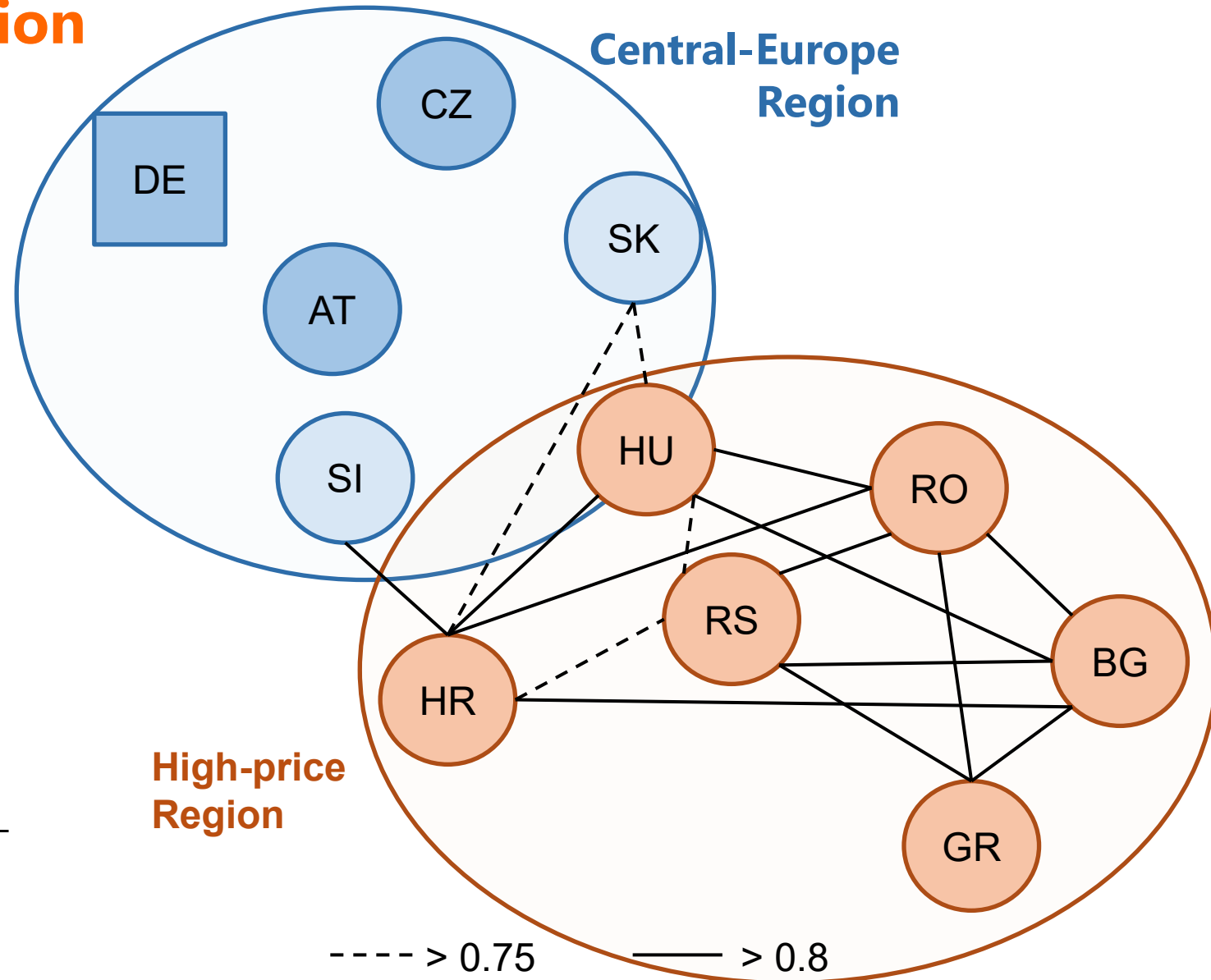
From	To	
	0	
0	50	
50	100	
100	150	
150	200	
200	500	
500		

Price spikes strike Europe



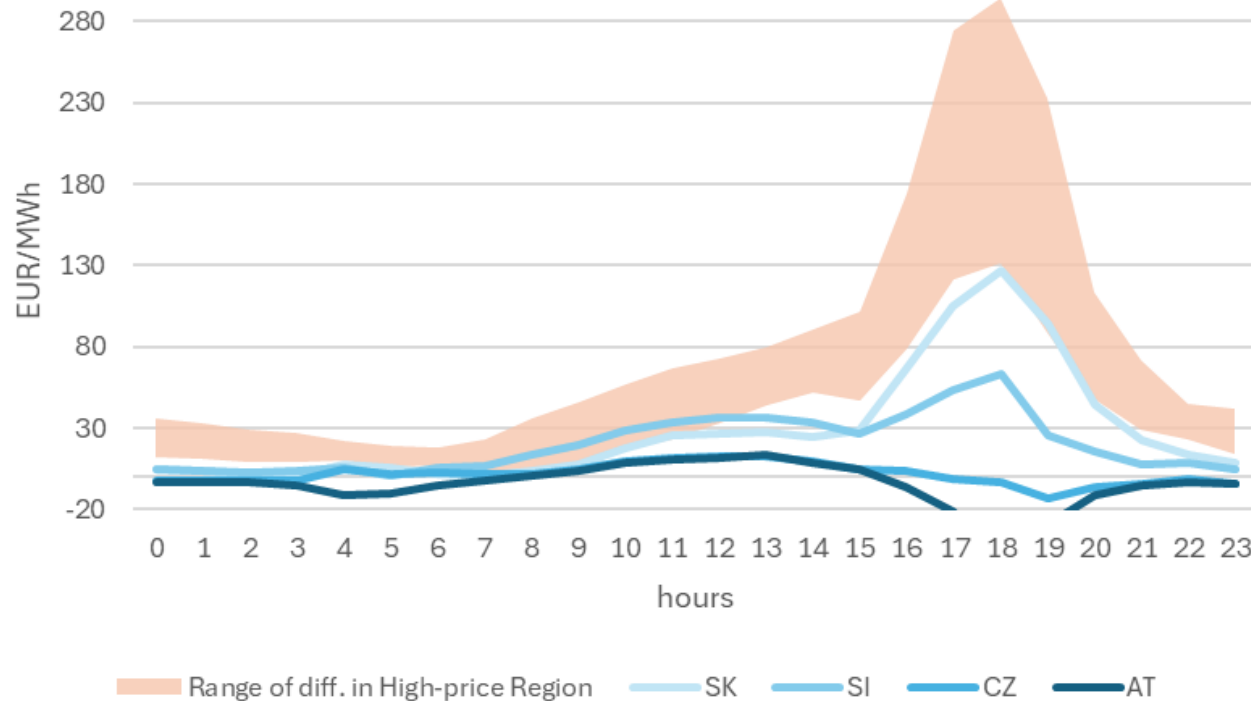
Correlation of price differences compared to the German DAM identifies the High-price Region

- To define the region, it is useful to examine price developments compared to the German day-ahead market price (DAM)
- Threshold: 0.8 (or 0.75 as a softer limit)
 - Across European countries, the correlation of their price differences with Germany reaches 0.8 in only 5% of cases.
- Based on this, our price region is defined as follows:
 - High-price Region: HR-HU-RS-RO-BG-GR
 - "In between": SK and SI

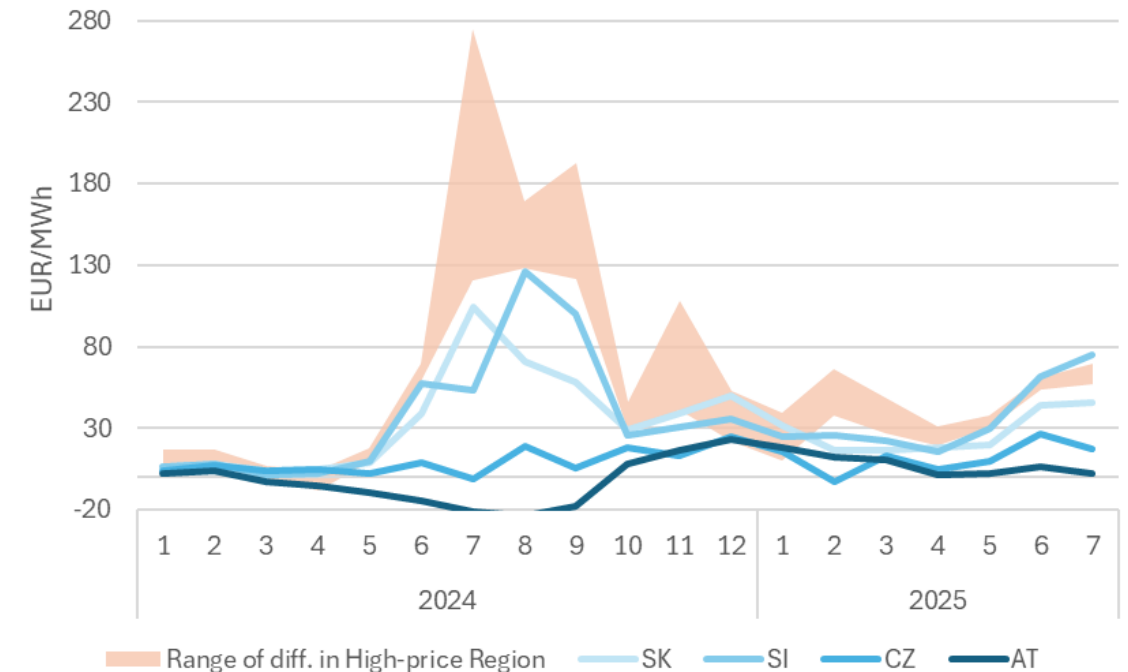


Price Divergence Peaks in Late-Afternoon Summer Hours

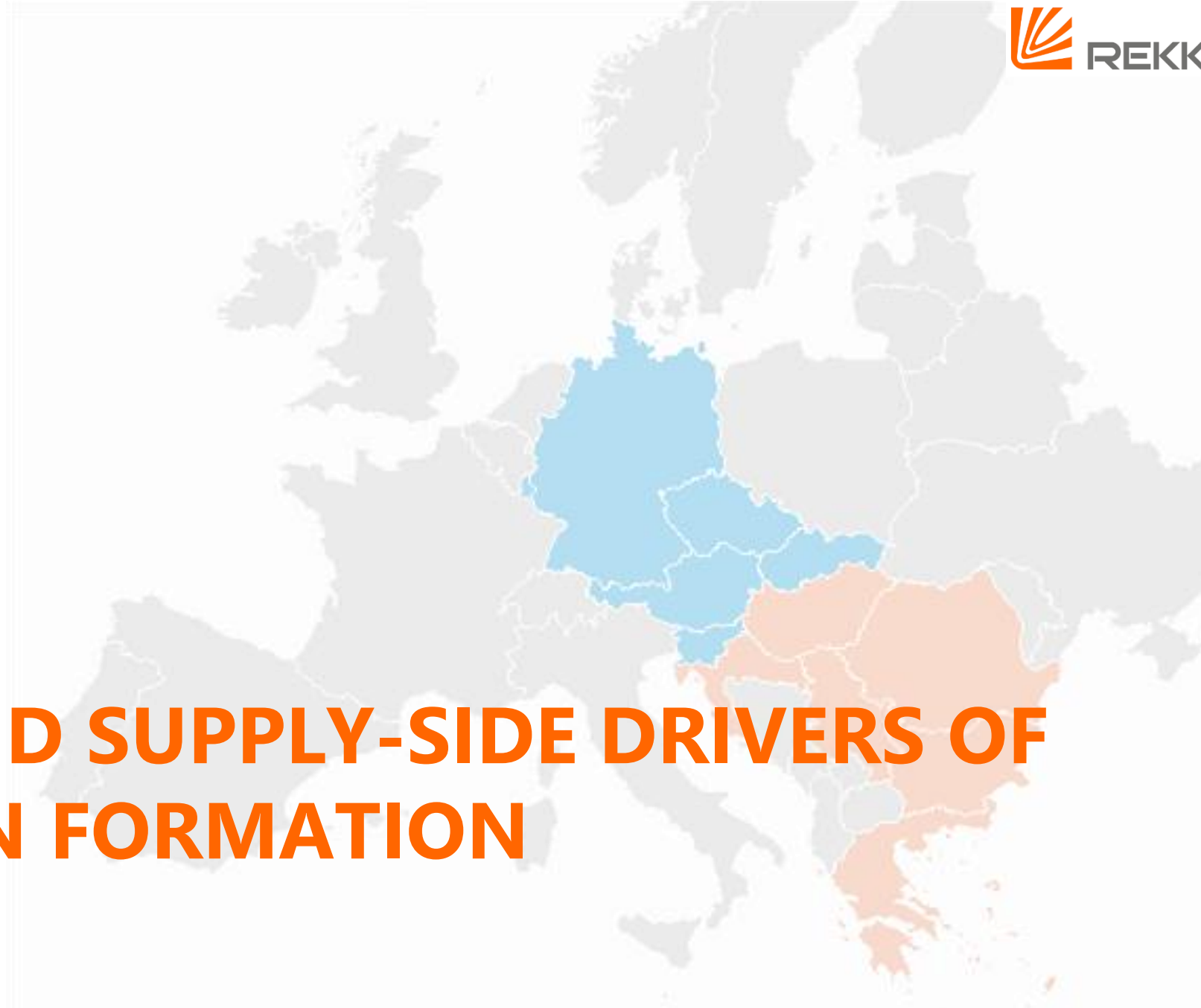
Diff. compared to DE: 2024/7



Diff. compared to DE: 17:00 - 18:00



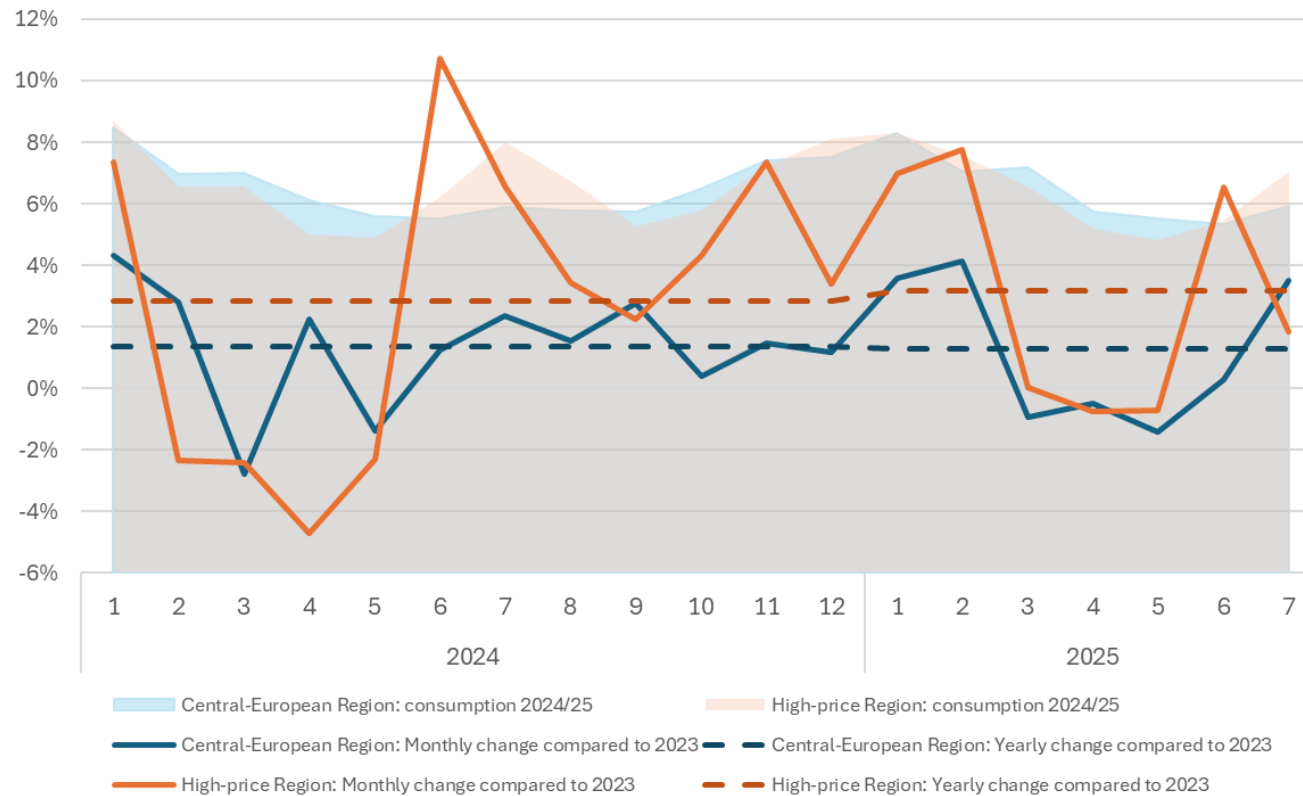
- The largest break is observed in July 2024, this phenomenon could not be observed in the summer of 2025
- The price difference is volatile within a day, the price spread in late-afternoon hours varies markedly over the analysed period
- Based on this, the focus of the study is: **Why do prices in the High-price Region differ so significantly from those in Central Europe?**

A map of Europe with several regions highlighted in different colors. A large blue area covers Central Europe, including Germany, Poland, Czech Republic, Slovakia, Austria, and Hungary. An orange area covers Southern Europe, including Spain, Italy, Greece, and parts of France, the Balkans, and Turkey. Other regions are shown in light gray.

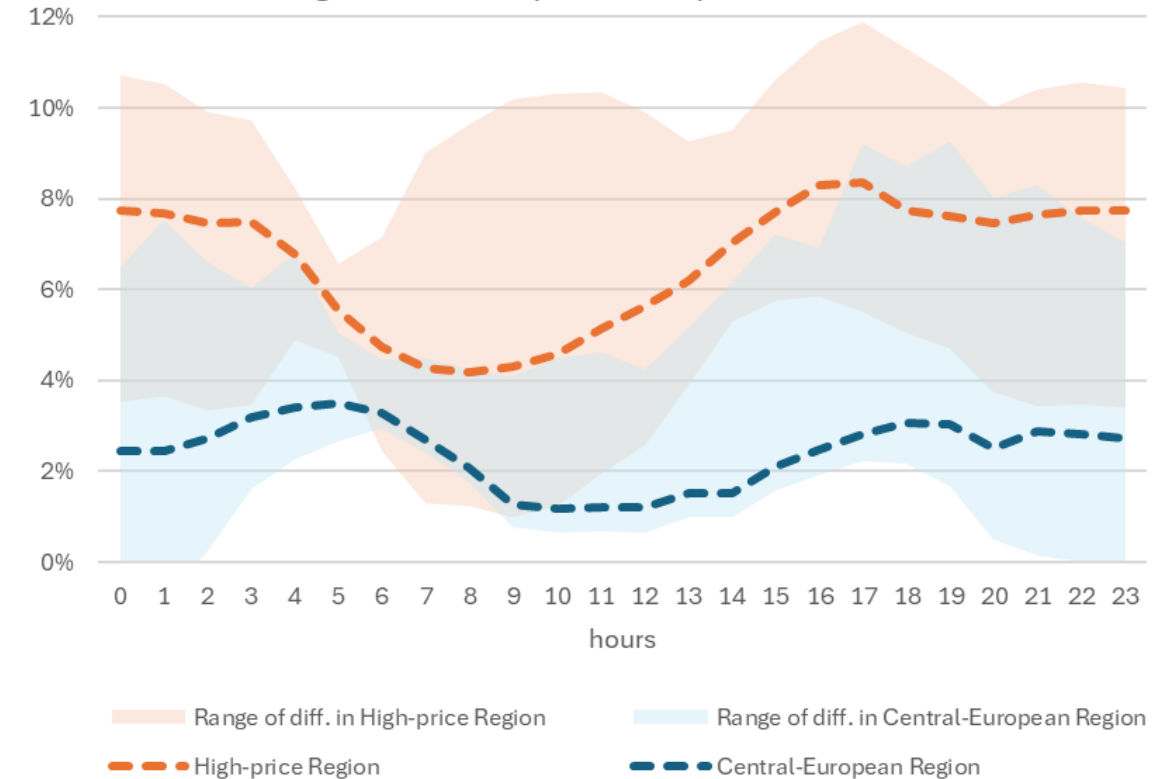
DEMAND- AND SUPPLY-SIDE DRIVERS OF PRICE-REGION FORMATION

Highest consumption growth appears during critical periods in the High-price Region

Change of consumption (2024/2025)



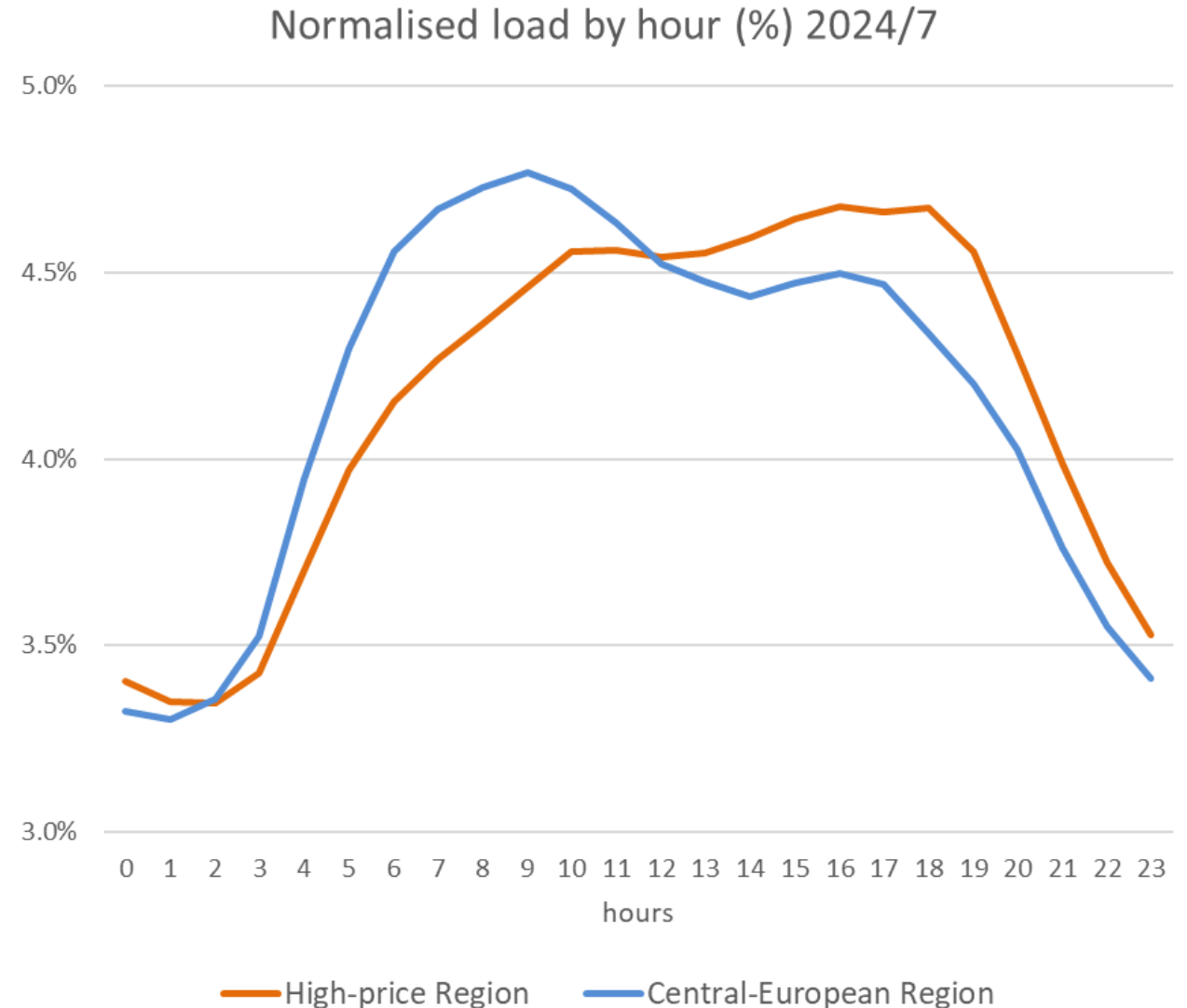
Change of consumption compared to Y-1: 2024/7



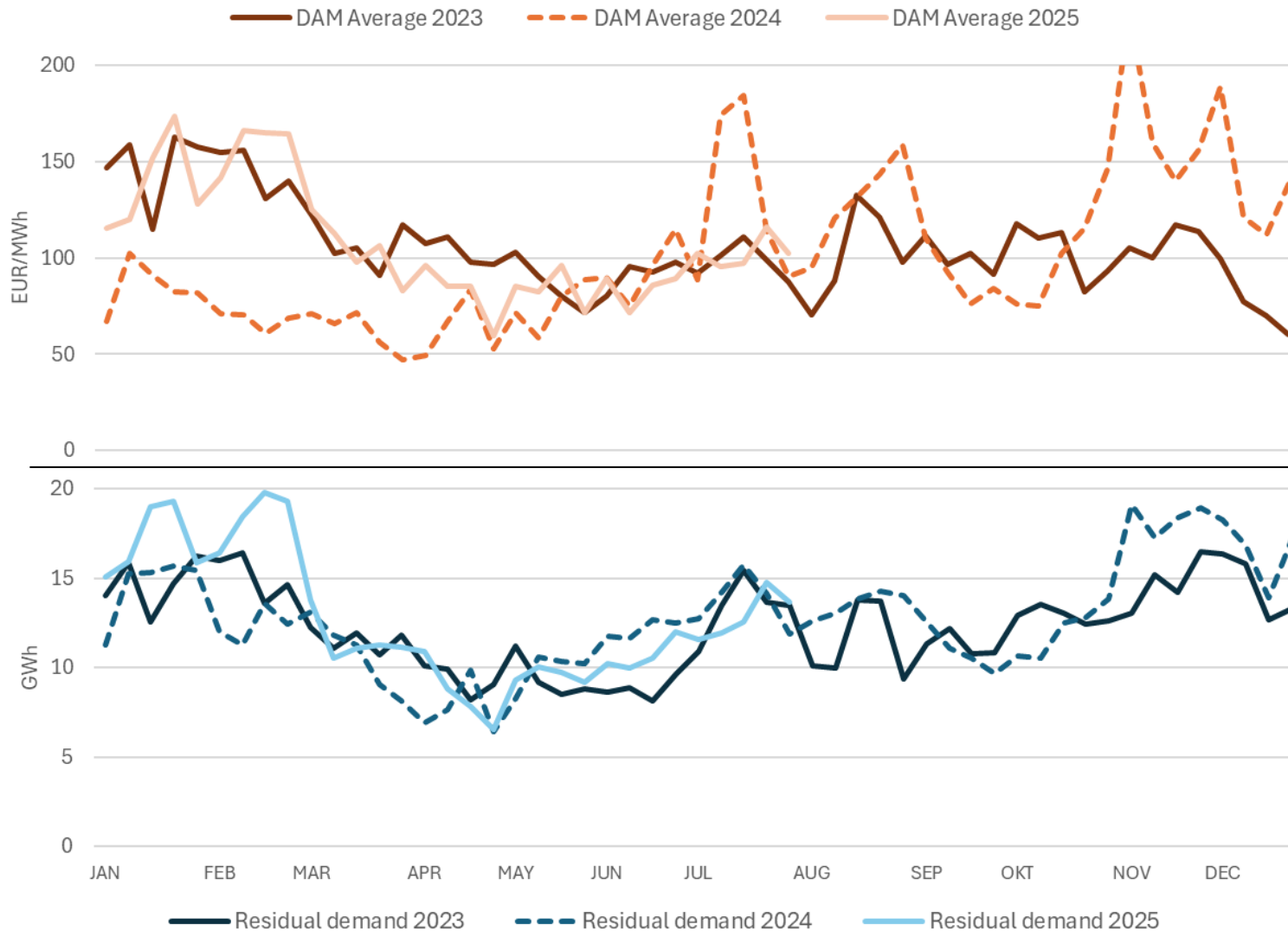
- Annual demand growth in the High-price Region (~3%) is substantially higher than in the Central-European Region (~1%).
- The gap widens most during periods with pronounced price divergence.
- In 2024 July, the consumption increase was always higher in the High-price Region and the difference was particularly significant in the late-afternoon hours.

Daily consumption profile also differs in the two regions

- In July 2024 the intraday consumption curve has completely “slipped” between the two regions
- **The high system load observed in the afternoon-evening hours in the High-price Region may partly cause the prices to diverge**



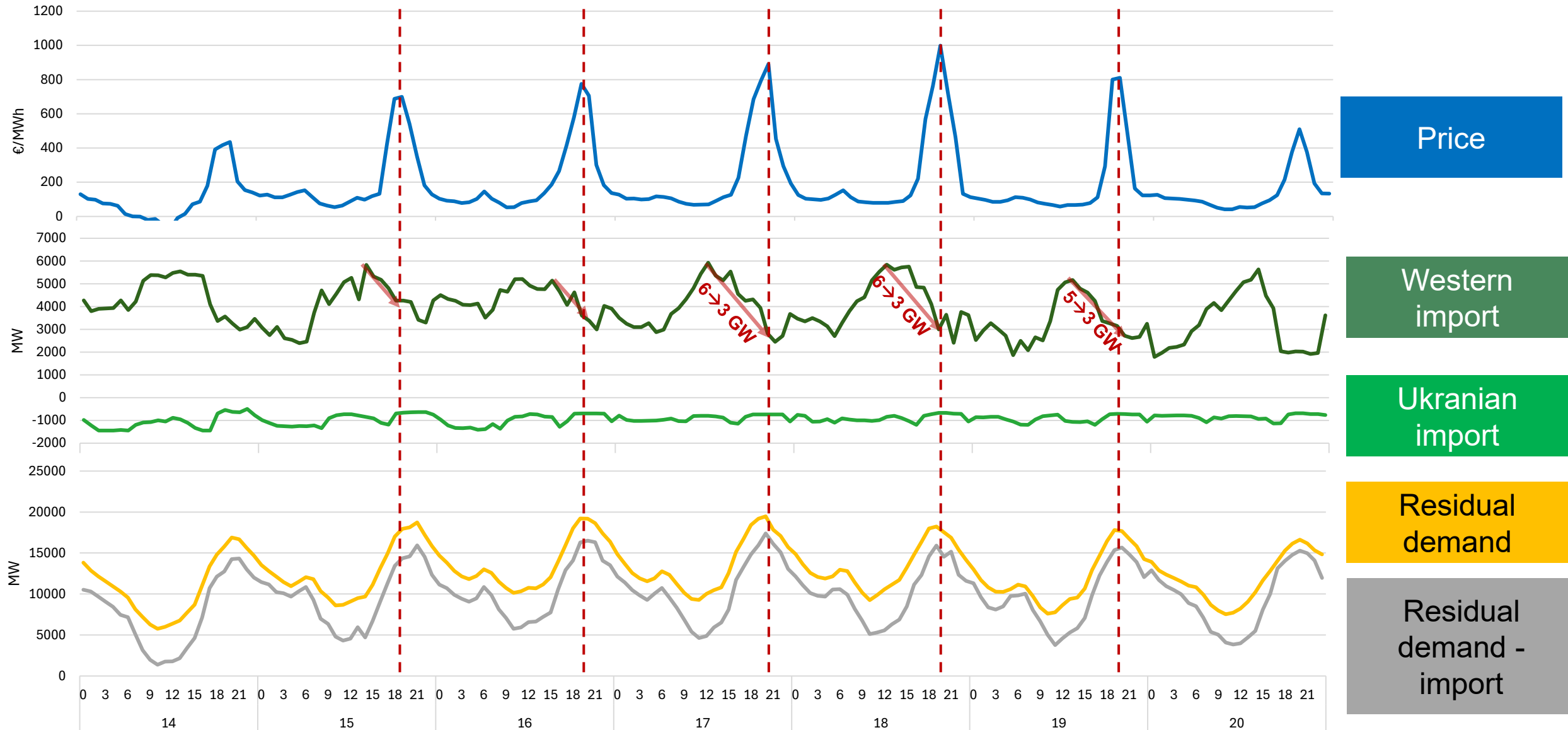
Production: the increase in residual demand shows the missing generation in the High-price Region



- Relatively small difference in residual demand:
 - Higher regional consumption (+1000 MW)
 - Lower nuclear power generation (~100-200 MW)
 - Lower hydropower generation (~1000 MW)
- There is no significant difference in production that would explain the extreme high prices/price difference by itself in July 2024

*Residual demand: Regional demand – RES generation – Nuclear generation

Western-import cuts down during price peaks



Hourly regional electricity mix, July 14-20, 2024.

DETERMINING THE MOST IMPORTANT NETWORK ELEMENTS FOR THE REGION

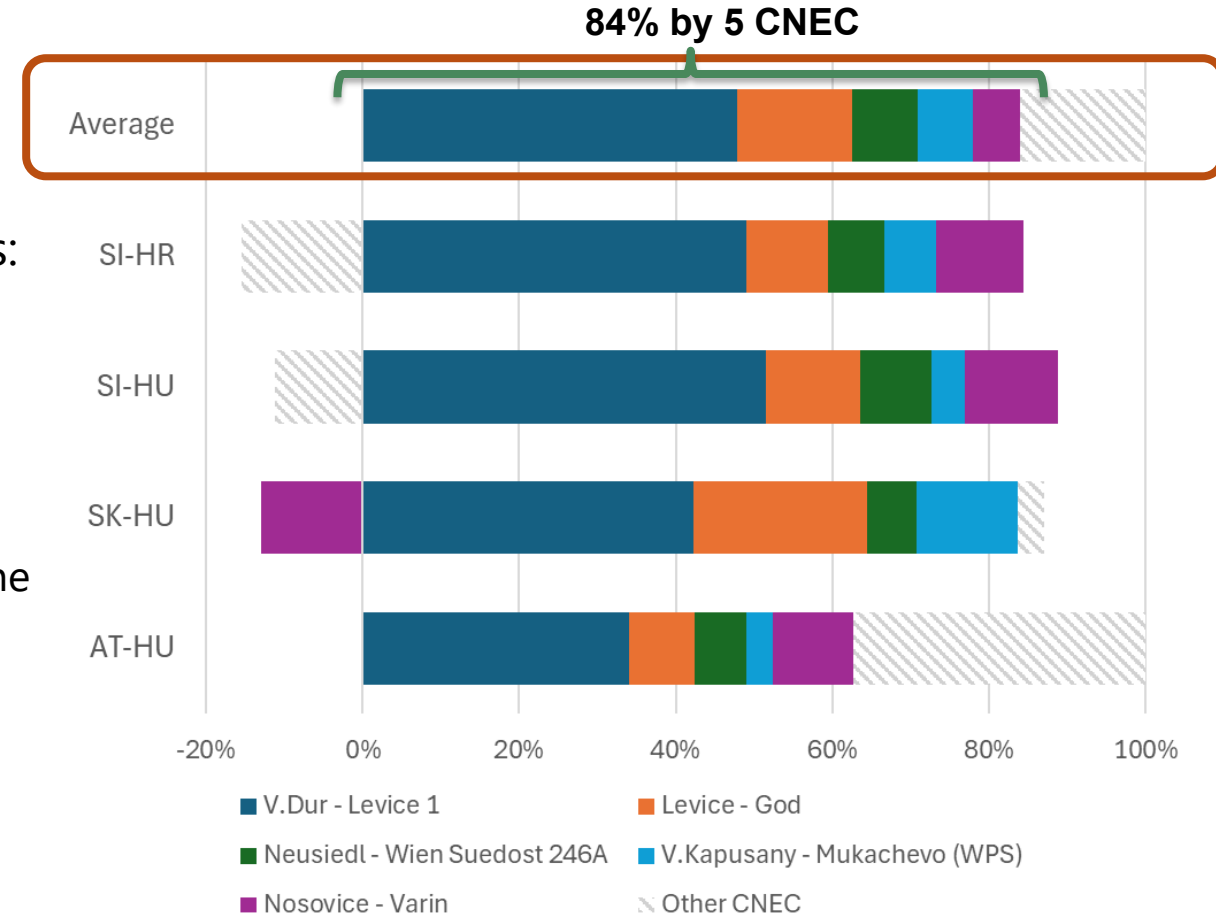
Critical network elements play a significant role in determining price differences

- In the day-ahead market (across the Core European Region), **flow-based market coupling** is used to allocate cross-zonal capacity by maximizing social welfare while ensuring simultaneous feasibility based on network constraints, rather than fixed coordinated NTC limits.
- **CNECs** (Critical Network Elements with Contingencies) are the specific grid elements and their associated contingencies (e.g., an outage) that define the constraints in the flow-based calculation.
- The contrast between the High-price Region and the Central-European Region is well captured by the average price spread across their shared borders.
- Accordingly, we analyse the average impact of critical network elements on the price spread for the AT–HU, SK–HU, SI–HR, and SI–HU borders.



Five grid bottlenecks account for 84% of price differences

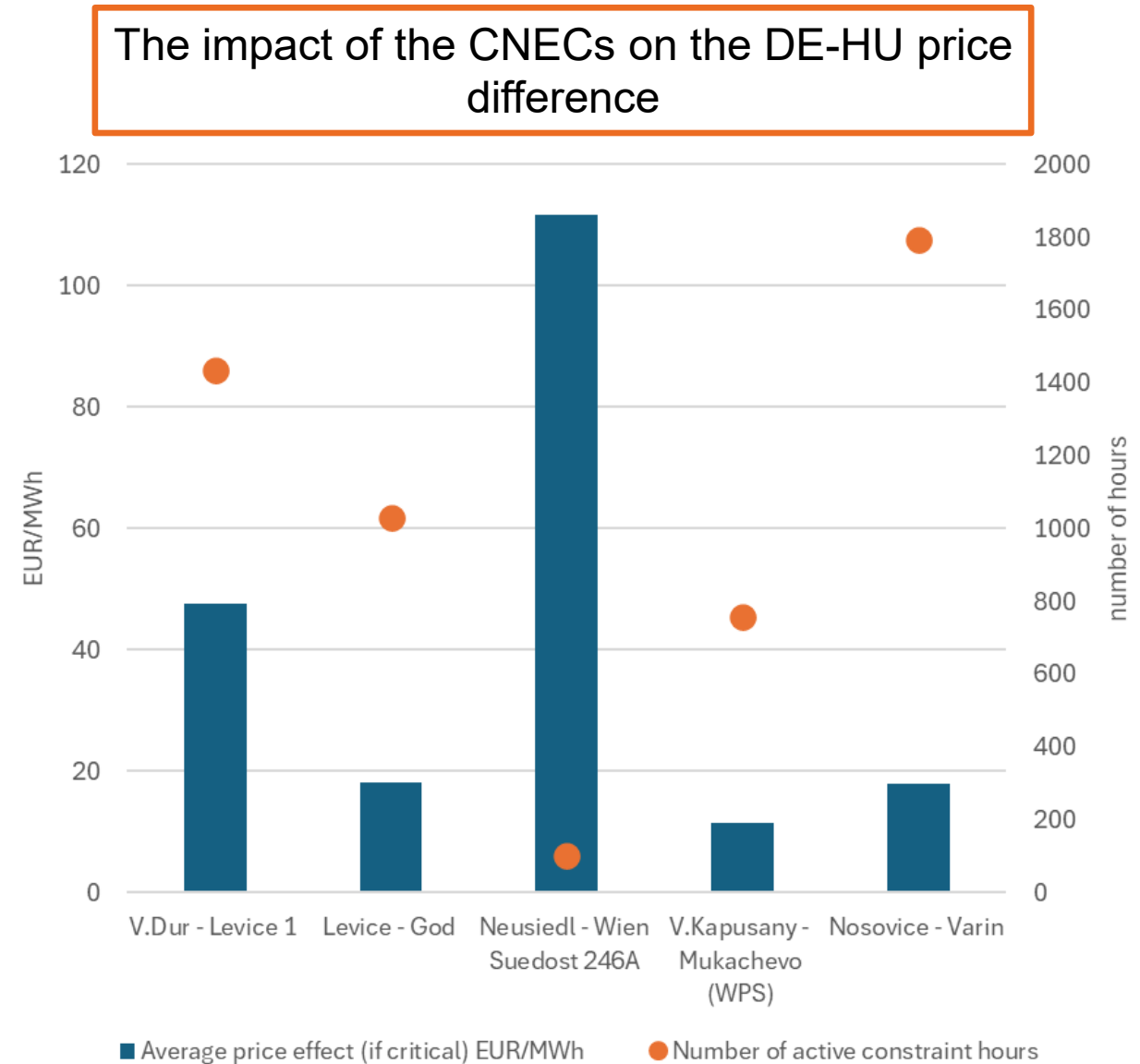
- TOP5 network elements account for 84 percent of the price difference between the two regions.
- Almost 60% of the total congestion between the two regions is caused by the bottlenecks of two internal lines: one Slovak and one Austrian network element.
- Congestion on certain pipelines may even have a downward effect on the price difference between two countries:
 - e.g. the congestion of the Czech-Slovak pipeline reduces the Slovak-Hungarian price difference (because it prevents Slovak prices from falling to the level of western markets),
 - but at the same time increases the overall price difference between the two regions, because cheaper electricity from the west is less accessible to the region.



CNEC Name	Description	Maximum admissible power flow (MW)
V.Dur - Levice 1	Internal line in SK	1455-1839
Levice - God	Cross-border line: SK-HU	1386
Neusiedl - Wien Suedost 246A	Internal line in AT	312
V.Kapusany - Mukachevo (WPS)	Cross-border line: SK-UA	1088-1372
Nosovice - Varin	Cross-border line: SK-CZ	1550

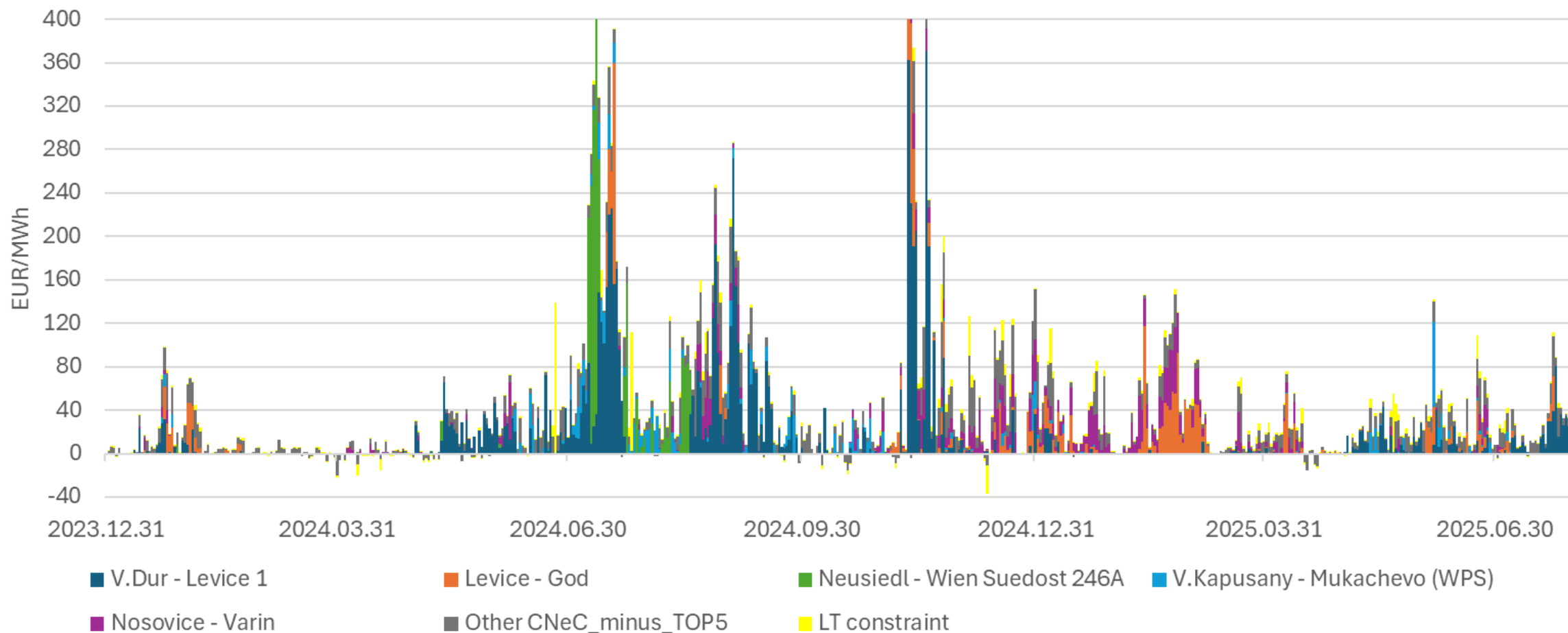
A single CNEC can cause a price increase of 110 EUR/MWh

- The TOP5 CNEC's average impact and the number of times they represent a constraint vary significantly.
- V.Dur–Levice 1: the most impactful overall; when critical (>1,400 hours), it is associated with an average DE–HU spread of €48/MWh.
- Neusiedl–Wien: relatively rarely critical (~100 hours), but in those cases the associated average spread is €110/MWh.
- Nosovice–Varin: the opposite profile – critical in ~13% of hours, yet the average associated spread is about 18 €/MWh.



Recurring price differences, drifting critical network elements

Average daily price difference caused by a given network element: DE-HU



- The impact of network elements varies significantly throughout the year

Most critical transmission lines change over time

V.Đur - Levice 1 : price effect/ DE-HU

Year	2024														2025						
	Month	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	
hours	0	0	0	0	0	32	11	30	27	0	0	0	0	0	0	0	0	1	5	12	
	1	0	0	0	0	39	10	29	17	0	0	0	0	0	0	0	0	1	4	5	
	2	0	0	0	0	40	4	25	7	0	0	0	0	0	0	1	0	1	3	4	
	3	0	0	0	0	27	1	23	10	8	0	0	0	0	0	1	0	2	2	4	
	4	0	1	0	0	22	1	17	41	18	0	0	0	0	0	2	0	2	1	2	
	5	0	0	0	0	13	0	36	0	23	0	34	0	0	0	0	0	0	0	0	
	6	0	0	0	0	0	0	13	0	3	0	96	0	2	0	0	0	0	0	0	
	7	17	0	0	0	0	0	2	0	0	0	206	3	0	0	0	0	0	0	0	
	8	0	0	0	0	0	0	0	0	0	0	138	1	0	0	0	0	0	0	0	
	9	0	0	0	0	0	0	19	0	0	0	121	1	0	0	0	0	0	0	0	
	10	0	0	0	0	0	0	12	0	0	0	187	1	0	0	0	0	0	0	0	
	11	0	0	0	0	0	0	0	0	0	0	128	1	0	0	0	0	0	0	0	
	12	0	0	0	0	0	0	24	0	0	0	72	0	0	0	0	0	0	0	0	
	13	0	0	0	0	0	0	34	0	0	0	105	0	0	0	0	0	6	0	0	
	14	1	0	0	0	0	18	10	56	15	29	0	206	2	15	0	0	0	5	2	0
	15	15	13	0	0	10	16	57	36	47	3	208	11	37	2	2	1	8	45	8	0
	16	19	14	0	1	9	15	148	84	97	38	197	21	17	6	7	10	19	24	35	0
	17	15	15	0	2	20	39	289	101	172	36	134	12	0	0	1	0	23	26	34	0
	18	22	22	0	1	32	52	310	164	115	20	141	5	0	0	4	0	31	40	48	0
	19	13	11	1	1	30	53	248	31	36	3	40	1	0	0	8	2	12	20	31	0
	20	14	0	0	0	6	20	128	15	12	0	21	0	0	0	1	0	13	10	17	0
	21	0	0	0	0	10	14	58	13	11	0	4	0	0	0	0	0	12	8	9	0
	22	0	3	0	0	28	13	38	9	5	0	0	0	0	0	0	0	6	2	6	0
	23	0	0	0	0	29	9	38	0	0	0	0	0	0	0	0	0	6	3	6	0

Neusiedl - Wien Suedost 246A : price effect/ DE-HU

Year	2024														2025						
Month	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7		
hours	0	0	0	0	0	0	0	17	0	0	0	0	0	0	0	0	0	0	0		
	1	0	0	0	0	0	0	21	0	0	0	0	0	0	0	0	0	0	0		
	2	0	0	0	0	0	0	15	0	0	0	0	0	0	0	0	0	0	0		
	3	0	0	0	0	0	0	36	0	0	0	0	0	0	0	0	0	0	0		
	4	0	0	0	0	0	29	0	0	0	0	0	0	0	0	0	0	0	0		
	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
	11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
	13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
	14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
	15	0	0	0	0	0	0	0	33	0	0	0	0	0	0	0	0	0	0		
	16	9	0	0	0	2	0	310	78	0	0	0	0	0	0	0	0	0	0		
	17	0	0	0	1	0	12	345	106	0	0	0	0	0	0	0	0	0	0		
	18	0	0	0	1	1	1	312	103	0	0	0	0	0	0	0	0	0	0		
	19	0	0	0	0	32	0	249	51	0	0	0	0	0	0	0	0	0	0		
	20	0	0	0	0	0	0	93	37	0	0	0	0	0	0	0	0	0	0		
	21	0	0	0	0	0	0	203	28	0	0	0	0	0	0	0	0	0	0		
	22	0	0	0	0	0	0	48	16	0	0	0	0	0	0	0	0	0	0		
	23	0	0	0	0	0	0	32	13	0	0	0	0	0	0	0	0	0	0		

Levice - God : price effect/ DE-HU

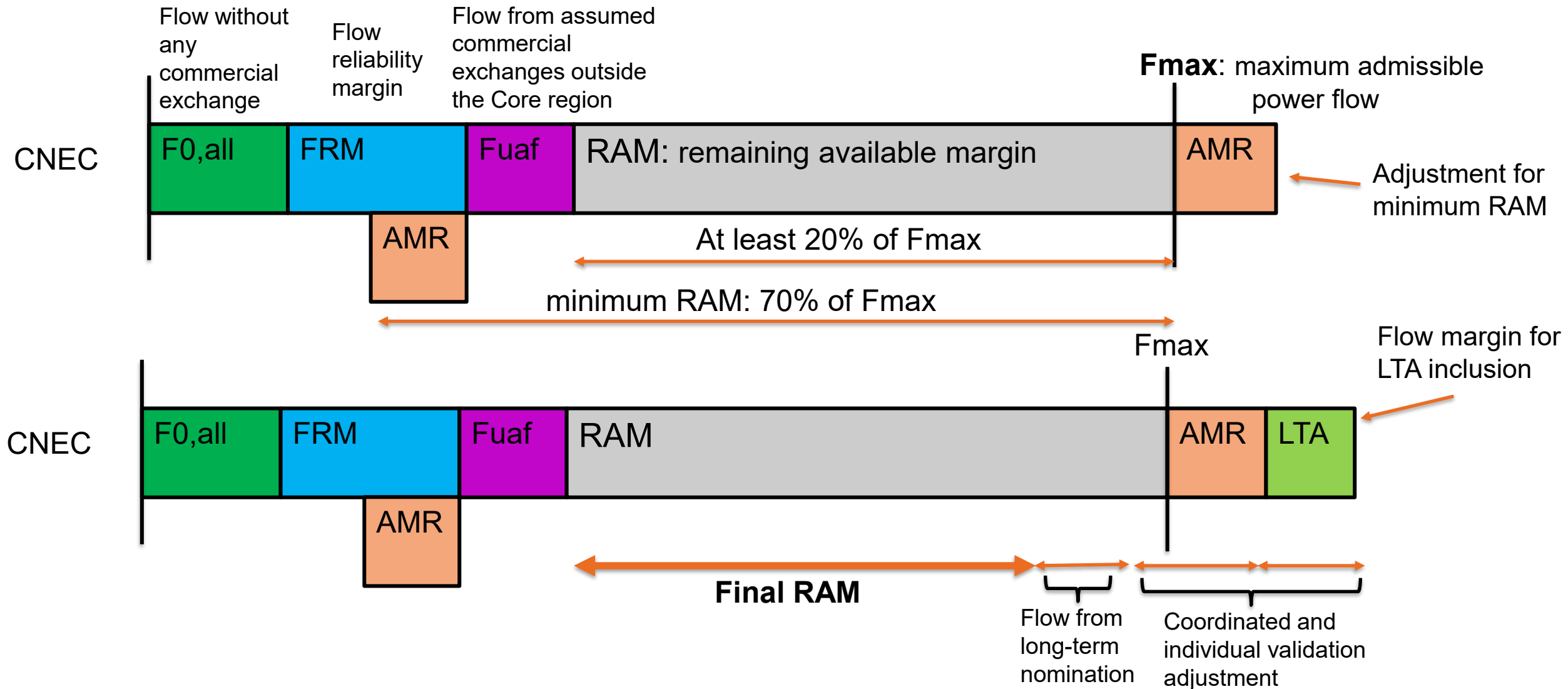
Year	2024														2025						
	Month	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	
hours	0	1	16	0	0	0	0	8	0	0	0	0	0	2	10	6	1	0	28	0	
	1	1	1	1	0	0	0	25	0	0	0	0	0	1	0	3	1	0	18	0	
	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	1	0	35	0	
	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	6	1	0	10	
	4	1	1	0	0	0	1	0	0	0	0	0	9	0	6	12	1	0	0	0	
	5	8	10	0	0	0	0	0	0	0	0	3	6	8	30	18	0	0	0	0	
	6	36	7	0	0	0	0	0	0	0	0	4	12	8	37	35	0	0	0	0	
	7	24	0	0	0	0	0	11	0	0	0	55	4	5	3	21	0	0	0	0	
	8	16	0	0	0	0	0	0	0	0	0	39	2	2	0	0	0	0	0	0	
	9	2	0	0	0	0	0	0	0	0	0	33	1	5	0	0	0	0	0	0	
	10	0	0	0	0	0	0	0	0	0	0	53	0	5	0	0	0	0	0	0	
	11	0	0	0	0	0	0	0	0	0	0	1	0	3	0	0	0	0	0	0	
	12	0	0	0	0	0	0	11	0	0	0	75	1	5	0	0	0	0	0	0	
	13	0	0	0	0	0	0	43	0	0	0	45	8	1	0	4	0	0	0	0	
	14	6	0	0	0	0	0	45	0	0	0	95	4	2	3	5	0	0	0	0	
	15	22	5	0	0	0	0	48	0	0	0	27	20	15	26	14	2	0	11	5	
	16	15	10	0	0	0	0	125	0	0	0	27	16	24	70	44	27	0	17	11	
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	18	14	4	0	0	0	0	75	0	0	0	17	13	11	57	58	31	0	22	1	
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	23	30	18	0	0	0	0	25	0	0	0	0	4	4	8	3	1	0	35		

Nosovice - Varin : price effect/ DE-HU

Year	2024														2025					
Month	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	
hours	0	16	0	0	2	1	14	0	21	2	1	10	20	13	30	12	5	0	22	
	1	10	0	0	1	1	8	0	20	3	0	10	16	13	25	8	1	0	20	
	2	5	0	0	2	1	14	0	22	5	2	17	21	8	25	11	7	0	18	
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	4	26	0	0	1	0	1	0	12	0	12	21	22	15	30	31	5	0	1	
	5	7	0	0	0	0	0	0	2	1	5	22	23	21	32	16	5	0	0	
	6	8	0	0	-2	0	0	0	0	0	1	29	33	30	20	2	2	0	0	
	7	8	0	0	-2	-2	0	0	16	0	0	13	23	18	8	0	6	0	0	
	8	3	0	0	0	-1	0	4	12	0	0	6	11	8	16	0	6	0	0	
	9	4	0	0	0	0	0	0	6	0	0	4	7	4	9	3	1	0	0	
	10	9	0	0	-1	-2	0	0	18	0	0	3	7	8	23	0	4	0	0	
	11	6	0	0	0	-1	1	0	16	0	0	3	7	8	19	0	3	0	0	
	12	11	0	0	0	0	0	0	19	0	0	3	6	9	29	1	2	3	0	
	13	21	0	0	0	2	8	5	22	0	1	9	10	9	16	1	4	0	0	
	14	8	0	0	0	10	30	0	16	12	6	18	20	14	21	6	4	11	4	
	15	20	0	0	0	0	0	0	36	0	26	33	24	22	27	15	7	21	22	
	16	0	0	0	0	3	0	0	41	0	11	32	26	17	33	12	8	16	16	
	17	3	0	0	0	0	0	0	15	0	13	25	31	19	31	21	19	0	11	
	18	2	0	0	0	0	0	0	0	0	23	18	35	25	32	14	18	0	0	
	19	12	0	0	5	4	0	0	12	30	15	41	31	23	32	21	11	0	1	
	20	3	0	0	4	1	0	0	21	39	8	25	32	23	34	29	15	0	19	
	21	3	0	0	6	1	0	0	36	21	11	18	28	20	33	20	15	1	26	
	22	0	0	0	9	7	11	0	39	22	15	16	24	18	30	23	11	0	13	
23	1	0	0	3	7	16	0	24	7	7	12	26	10	33	18	16	0	26		

RELATIONSHIP BETWEEN RAM AND PRICE DIFFERENCES

Remaining available margin (RAM) caps the traded volumes on day-ahead flow-based market coupling



Fullfilling the 70% rule can bring substantial change

- **Minimum RAM requirement (the “70% rule”)**
 - In flow-based market coupling, TSOs must make **at least 70% of each critical network element’s capacity** available from January 2026 for **cross-zonal trade** in the day-ahead (and intraday) timeframes.
 - Temporary derogations/action plans can apply where full compliance isn’t yet feasible.
- Currently, the minimum required allocated capacity (MinRAM factor) on the two critical internal lines (V.Dur Levice1 and Neusiedl-Wien) is significantly lower than 70%.
- When V.Dur-Levice1 is an active constraints, the ex-post calculated RAM factor does not always meet even this lower threshold.
- Because these lines drive sizable price differentials between the High-price Region and the Central-European Region, ensuring compliance with the 70% minimum RAM requirement is critical to foster price convergence and maximize social welfare.

	V.Dur - Levice 1	Levice - God	Neusiedl - Wien Suedost 246A	V.Kapusany - Mukachevo (WPS)	Nosovice - Varin
MinRAM Factor	50%	70%	40%	70%	70%
Calculated RAM Factor: active constraint	49%	63%	60%	85%	81%
Calculated RAM Factor: no constraint	52%	69%	68%	88%	81%

Reduced RAM leads to larger price spreads



Cnec: Levice - God - Ram

Year Month	2024												2025							
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	
hours	0	908	910	933	944	904	878	826	822	884	912	929	883	898	901	931	909	911	853	875
	1	914	912	935	943	906	878	827	823	882	912	927	884	899	913	929	914	909	859	882
	2	910	913	932	942	903	879	829	820	875	914	899	879	898	908	937	907	905	874	877
	3	902	911	934	938	902	874	824	816	865	908	888	873	895	885	925	904	905	866	861
	4	897	897	929	929	874	878	814	818	847	903	877	855	869	847	904	881	909	891	894
	5	878	884	919	926	879	878	761	832	849	898	853	834	826	779	877	901	918	919	911
	6	863	877	906	930	889	889	763	838	873	899	850	820	815	775	861	909	927	925	918
	7	871	894	907	932	901	897	773	853	879	911	855	820	824	814	884	918	934	926	920
	8	880	911	910	933	918	901	794	856	880	913	855	835	840	850	923	925	938	927	919
	9	890	916	915	938	920	905	784	850	879	918	853	841	860	870	928	924	938	928	918
	10	894	914	916	946	923	904	784	848	881	919	853	836	862	903	929	922	935	930	918
	11	887	907	915	945	917	902	772	845	882	919	833	841	860	872	917	920	935	923	919
	12	886	904	913	942	909	896	767	839	878	914	838	833	855	863	912	917	933	922	911
	13	868	895	909	930	899	881	755	825	868	907	844	816	838	838	886	910	925	914	904
	14	851	885	904	913	877	865	776	810	859	907	840	810	803	779	856	897	911	884	884
	15	814	826	888	900	856	861	790	791	843	889	833	790	769	751	825	865	862	868	842
	16	826	820	903	894	849	866	814	792	834	875	827	787	777	745	809	781	859	766	783
	17	836	830	906	897	857	869	837	801	839	877	828	790	784	748	809	756	856	739	780
	18	841	869	906	900	853	870	825	790	837	885	830	794	798	760	819	745	836	710	791
	19	853	891	903	912	851	867	822	792	842	902	839	791	800	772	822	768	842	704	789
	20	868	892	915	928	896	877	818	788	834	904	853	820	835	798	839	821	851	709	795
	21	894	905	926	933	904	874	814	786	847	910	865	851	861	808	828	863	859	741	820
	22	895	915	925	940	904	874	817	779	877	907	883	863	851	806	864	890	899	763	850
	23	912	912	935	942	906	878	821	813	887	910	893	882	872	843	898	914	902	809	861

Cnec: Nosovice - Varin - Ram

Year	Month	2024												2025						
		1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7
hours	0	1053	1083	1069	923	897	859	899	939	864	914	1072	1120	1067	1096	1122	966	945	845	932
	1	1048	1082	1062	927	906	860	903	943	867	917	1063	1100	1075	1112	1128	973	957	837	933
	2	1048	1078	1066	924	904	864	901	936	861	924	1056	1107	1064	1099	1134	973	964	844	923
	3	1057	1069	1053	927	911	850	890	925	855	912	1070	1096	1058	1094	1129	954	945	839	913
	4	1029	1060	1041	931	886	833	858	914	846	895	1061	1083	1063	1082	1106	917	941	844	911
	5	1016	1063	1037	915	881	844	874	912	833	882	1014	1040	996	1011	1063	933	950	852	928
	6	993	1061	1040	952	889	846	884	912	863	879	995	1009	930	977	1085	974	952	924	957
	7	1012	1076	1074	969	903	855	901	931	903	903	1042	1005	952	1039	1149	977	965	938	969
	8	1045	1098	1087	969	896	862	904	929	914	916	1057	1030	1018	1114	1177	978	961	911	974
	9	1065	1115	1088	970	898	875	904	919	906	910	1076	1057	1076	1155	1179	979	942	897	959
	10	1080	1113	1089	958	900	882	908	916	900	906	1078	1064	1070	1162	1167	973	934	901	940
	11	1082	1105	1094	940	894	884	897	919	892	905	1073	1065	1067	1147	1161	972	943	911	939
	12	1069	1114	1084	927	887	880	899	920	893	908	1070	1045	1031	1152	1142	967	934	907	936
	13	1049	1108	1075	928	892	871	896	937	875	919	1054	1028	990	1124	1130	950	938	886	924
	14	1021	1089	1066	940	878	855	908	932	866	901	1022	993	948	1052	1111	937	933	860	923
	15	1000	1060	1054	937	877	872	907	928	862	907	982	989	944	1043	1060	912	927	831	893
	16	1009	1065	1034	926	881	858	919	939	872	887	977	979	897	948	1065	903	901	818	857
	17	1015	1057	1041	918	877	878	938	953	858	874	972	984	951	949	1050	896	936	819	876
	18	1018	1066	1031	910	857	889	940	942	866	873	974	989	956	984	1087	912	926	833	910
	19	1018	1065	1031	905	848	883	931	935	833	847	975	1002	965	985	1069	911	932	841	913
	20	1009	1052	1023	908	874	887	923	923	818	863	979	1029	989	1027	1066	905	942	847	920
	21	1019	1083	1035	908	881	907	906	918	836	904	1005	1054	1041	1051	1047	925	927	830	929
	22	1032	1083	1055	914	878	861	900	927	857	915	1050	1093	1020	1051	1071	963	928	822	912
	23	1037	1092	1069	922	897	858	901	927	866	915	1105	1113	1036	1058	1092	970	928	813	913

Cnec: V.Kapusany - Mukachevo (WPS) - Ram

Year	Month	2024												2025						
		1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	
hours	0	1175	1044	1162	1244	921	860	535	731	723	871	1145	1131	1148	1114	1195	1197	913	874	915
	1	1174	1037	1152	1248	919	853	541	721	721	871	1147	1130	1147	1147	1201	1202	913	869	913
	2	1167	1029	1152	1243	917	852	527	711	696	856	1126	1128	1141	1135	1194	1187	898	851	899
	3	1154	1021	1147	1236	920	836	520	691	661	810	1105	1105	1116	1109	1155	1146	874	843	876
	4	1142	1008	1146	1230	853	851	483	651	623	768	1055	1059	1085	1051	1118	1112	859	880	872
	5	1137	1027	1165	1247	899	848	479	694	660	770	1018	1009	1032	981	1084	1147	880	954	941
	6	1109	1012	1183	1312	946	678	521	747	736	808	1014	972	984	965	1118	1233	934	1021	1007
	7	1107	1045	1212	1354	983	698	575	808	816	927	1053	978	993	1018	1194	1272	965	1036	1038
	8	1156	1134	1259	1361	980	717	610	836	853	966	1099	1006	1041	1102	1238	1274	986	1042	1044
	9	1186	1171	1270	1363	977	727	632	844	866	991	1121	1035	1096	1151	1236	1263	993	1033	1038
	10	1195	1167	1271	1350	968	739	647	848	872	990	1131	1040	1103	1162	1232	1252	981	1032	1026
	11	1199	1151	1267	1327	944	745	631	831	850	966	1110	1036	1098	1157	1224	1238	970	1005	1012
	12	1175	1142	1254	1305	908	725	598	790	807	894	1077	1012	1058	1136	1188	1213	948	987	969
	13	1148	1105	1233	1240	873	676	543	726	750	799	1030	984	1012	1066	1144	1177	920	941	928
	14	1109	1060	1183	1167	817	636	514	632	648	693	995	952	975	995	1068	1112	827	863	868
	15	1045	956	1133	1120	779	649	530	604	586	660	943	923	957	906	983	1044	754	781	811
16	1043	936	1119	1114	733	677	580	635	580	636	939	911	927	909	981	990	636	706	733	
17	1055	951	1111	1133	755	706	605	659	592	663	957	927	995	911	994	979	632	698	766	
18	1069	988	1119	1150	775	700	619	660	571	701	973	941	1010	963	1003	999	725	740	788	
19	1092	1033	1133	1176	757	689	613	657	542	744	994	963	992	975	1013	1053	773	771	799	
20	1122	1051	1171	1283	936	704	600	681	595	803	1031	1006	1043	1038	1087	1121	820	833	855	
21	1158	1070	1194	1282	943	709	576	710	660	834	1090	1061	1075	1084	1142	1158	868	855	919	
22	1165	1058	1194	1253	911	666	532	721	701	841	1123	1094	1106	1112	1172	1170	897	857	899	
23	1160	1055	1167	1257	907	660	528	741	723	854	1166	1115	1140	1121	1196	1188	903	850	899	

Strong correlation between the price difference and the RAM of the critical network elements

- Price spreads correlate closely with the RAM on the key CNECs driving them.
 - July 2024: For all four elements –except Levice–Göd – capacity is scarcest at night and especially in the afternoon, coinciding with the extreme price differences.
 - September 2024: Scarcity is most evident on Nosovice–Varin and Dur–Levice, primarily in the afternoon.
 - Jan–Feb 2025: Low RAM is most pronounced on Levice–Göd during the hours with large price spreads.
 - Summer 2025: Afternoon prices rise again (well below 2024 peaks), driven by recurring RAM scarcity on the same lines.

RAM is significantly lower, price difference is significantly higher when a critical CNEC is active constraint

2024 July	DE-HU Price spread (€/MWh)	Dur-Levice 1 RAM (MW)	2024 July	DE-HU Price spread (€/MWh)	Neusiedl-Wien RAM (MW)
Active FB constraint-average	118	500	Active FB constraint average	265	158
Non active FB constraint-average	43	637	No constraint average	38	211

- Focusing on July 2024, it is clearly visible in the case of Dur-Levice and Neusiedl-Wien (afternoon hours) that for non-active constraint hours the average RAM is significantly higher, while the price difference is much lower
 - V. Dur-Levice:** When this CNEC is an active constraint, average RAM is more than 20% lower and the DE–HU price spread is ~170% higher than in non-binding hours.
 - Neusiedl–Wien:** When it is an active constraint, average RAM is ~25% lower, while the associated DE–HU spread is ~600% higher compared with non-binding hours.

Very high daily swings across RAMs of CNECs

Dur_Levice_RAM

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
2024.07.01	582	584	579	562	536	623	623	624	692	694	670	623	594	524	518	524	637	642	599	604	604	554	536	536
2024.07.02	552	535	532	525	535	554	539	571	605	620	622	600	601	581	570	574	580	616	604	609	607	558	548	542
2024.07.03	532	521	516	544	561	643	622	629	657	662	649	635	630	617	625	606	670	658	644	593	621	559	521	524
2024.07.04	531	522	530	532	538	567	557	553	604	587	612	577	597	630	559	548	576	572	601	576	574	561	505	531
2024.07.05	553	550	551	540	525	521	536	545	530	524	518	521	510	499	513	523	510	516	543	508	507	536	543	539
2024.07.06	529	535	533	532	533	544	537	569	612	644	625	622	614	572	546	530	529	578	582	541	529	546	562	563
2024.07.07	565	573	567	573	569	588	610	633	699	681	668	715	715	688	639	610	577	602	579	562	550	551	607	598
2024.07.08	654	631	629	640	664	641	633	665	696	738	758	741	724	668	638	620	577	557	518	521	523	550	543	549
2024.07.09	554	561	574	573	538	541	581	622	558	624	719	746	741	629	607	589	589	569	573	583	582	567	514	518
2024.07.10	424	484	532	481	515	515	514	529	557	575	596	558	573	513	510	526	570	582	575	582	541	436	531	468
2024.07.11	460	543	543	550	530	523	525	535	583	610	595	570	555	523	512	515	572	584	585	595	570	531	549	446
2024.07.12	550	494	559	437	506	371	530	558	560	561	580	569	557	546	537	536	527	514	473	572	486	512	528	455
2024.07.13	534	526	469	540	541	401	484	546	554	553	576	562	568	571	542	479	357	300	261	230	285	334	511	517
2024.07.14	448	447	489	491	524	529	550	566	596	593	591	643	629	562	531	518	514	514	527	496	499	529	510	455
2024.07.15	456	524	453	428	536	482	416	511	557	563	562	561	563	553	471	559	574	513	515	577	469	438	549	542
2024.07.16	538	550	547	420	541	360	400	504	556	561	563	554	534	535	498	457	451	570	421	397	413	502	519	427
2024.07.17	441	459	479	481	511	340	454	554	567	560	555	550	535	407	513	438	448	556	545	347	382	313	498	490
2024.07.18	447	499	499	448	473	395	440	531	540	558	560	554	534	520	527	566	571	559	451	556	390	545	515	361
2024.07.19	425	556	438	402	500	451	488	560	552	550	550	545	537	536	482	444	422	404	456	386	426	371	498	262
2024.07.20	308	290	281	298	495	374	471	561	572	552	554	549	538	507	395	417	389	376	374	376	376	343	556	398
2024.07.21	408	430	442	446	526	419	544	549	568	557	583	578	563	545	467	502	449	495	542	542	454	522	530	512
2024.07.22	537	547	521	512	514	721	750	791	797	835	852	835	816	791	739	717	656	649	631	629	633	630	621	639
2024.07.23	680	693	691	667	609										695	729	727	715	717	709	724	695	616	629
2024.07.24	662	663	680	675	662										734	649	658	643	639	611	608	628	632	662
2024.07.25	676	712	709	712	698										709	629	579	627	629	636	641	633	695	731
2024.07.26	727	742	753	723	747	687	695	725	729	733	731	705	692	678	673	628	646	668	643	660	656	657	613	641
2024.07.27	629	634	644	597	595	662	712	779	791	777	793	790	757	724	659	630	656	627	612	609	644	627	648	657
2024.07.28	658	650	666	685	707	747	763	803	832	840	844	858	847	811	780	741	696	688	684	691	704	697	750	732
2024.07.29	730	739	750	751	750	756	786	816	840	865	885	901	900	842	774	792	798	791	772	789	820	800	763	758
2024.07.30	802	804	797	780	723	734	794	835	851	856	848	858	860	803	765	712	674	655	650	634	683	700	764	787
2024.07.31	810	819	795	768	756	747	824	858	827	828	824	836	844	813	774	740	726	721	696	672	679	674	663	730

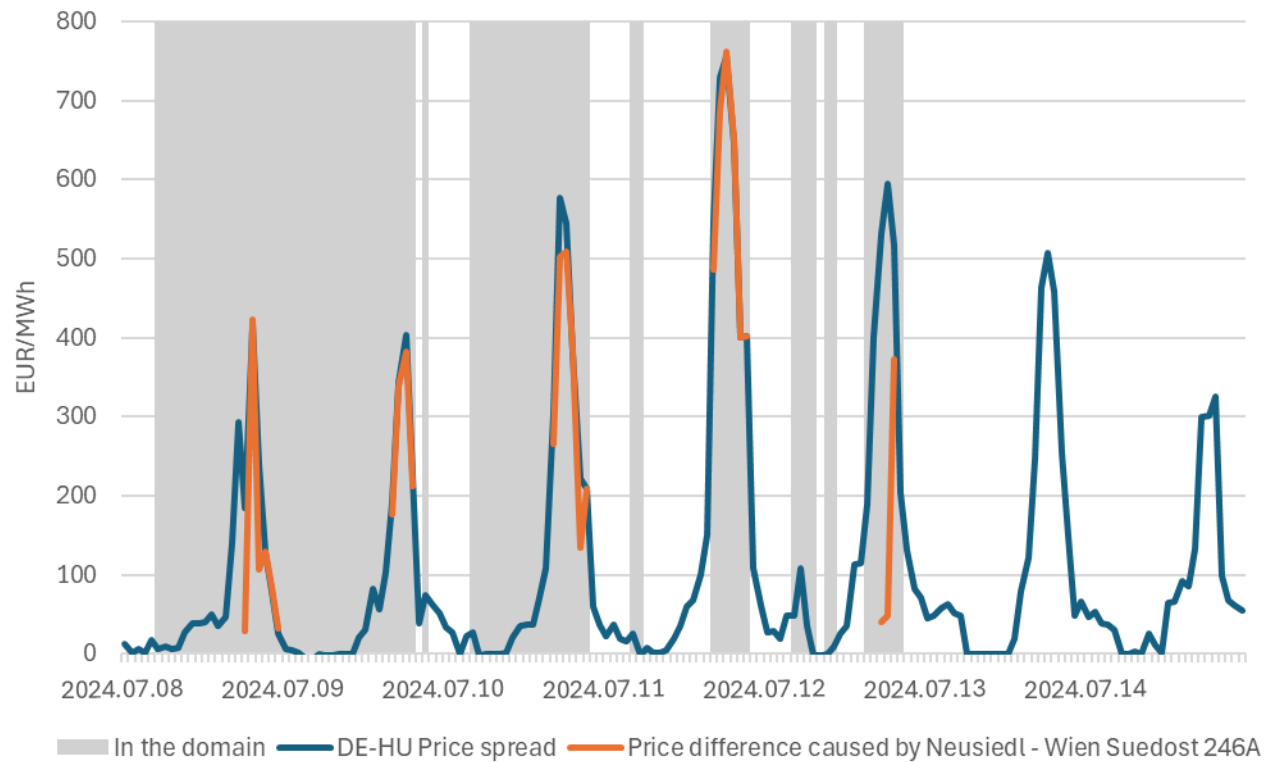
Neusiedl_Wien_RAM

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
2024.07.01						236			272	244	232	231	227	224	226									
2024.07.02																					184	187		
2024.07.03						239																		
2024.07.04													287	288										
2024.07.05						199	231	254	270	274	273	270	265	260	246	221	191	171						
2024.07.06																								
2024.07.07																								
2024.07.08						229	236	262	272	282	268	272	260	245	239	200	174	162	150	148	157	154	148	157
2024.07.09	162	165	168	171	173	198	195	218	212	234	237	243	235	211	194	178	158	152	155	155		150		
2024.07.10					143	170	194	200	218	229	237	239	234	211	200	186	155	151	150	144	140	127		
2024.07.11					168	180											155	151	148	144	149	139		
2024.07.12					132	145	168	185		209	227					176	165	151	142	144	157			
2024.07.13																								
2024.07.14																								
2024.07.15																								
2024.07.16																								
2024.07.17																								
2024.07.18																								
2024.07.19																								
2024.07.20																								
2024.07.21																								
2024.07.22																					165	193		
2024.07.23																	195	187	187	182				
2024.07.24																		192	192		194			
2024.07.25		204																						
2024.07.26																								
2024.07.27						185								258	243	228	198	175	168	170	175	176	185	
2024.07.28															216	192	184	173	186	176	177			
2024.07.29						176												170	181	186	190		188	
2024.07.30	193	185	183	198	182																183	179	200	
2024.07.31						200																		

Note: If the cell is empty, the network element is not part of the domain.

- RAM changes significantly within a short period of time:
 - It is often observed that the available capacity is higher during the midday hours, while it is 20-25% lower during the critical afternoon hours of the same day.
 - It is also common for capacity at a given hour to be twice as high as it is at the same hour a day later.

The 5% rule also can play an important role in price differences: the example of Neusiedl-Wien



- The “5% rule” (PTDF threshold)** in flow-based market coupling
 - a CNEC is included in the flow-based calculation only if, for that hour, at least one Core zone-to-zone exchange has a **max |PTDF| ≥ 5%**
- Hourly, on/off effect: because the rule is applied per time periods, a line can be binding in one hour and absent the next, purely due to small PTDF changes.
- Case study — Neusiedl–Wien:**
 - in hours when the line meets the 5% threshold and becomes critical, it is associated with an average DE–HU price spread is higher than €110/MWh;
 - in the very next hour, if it falls below 5% and is excluded, it no longer drives a spread.

2024. July	DE-HU Price spread (EUR/MWh)	Price difference caused by Neusiedl - Wien Suedost 246A (EUR/MWh)
Average if Neusiedl - Wien Suedost 246A is not in the domain	61	
Average if Neusiedl - Wien Suedost 246A is in the domain	97	
Average if Neusiedl - Wien Suedost 246A is active constraint	265	215

DETERMINING THE COMBINED EFFECT OF FACTORS: REGRESSION ANALYSIS

Model specifications and database variations

- **Dependent variable:** Consumption-weighted difference in DAM prices between DE and the High-price Region [EUR/MWh]
- **Explanatory variables**
 - Consumption data: regional load [MWh]
 - Generation data: PV, wind, hydro and nuclear production in the region, and variable RES-E in Germany [MWh]
 - RAM of critical elements in the FB domain, in the region [MW]
 - German DAM price [EUR/MWh]
- **Datasets:**
 - entire period (January 2024 – July 2025)
 - high price period (one year period between end of March, 2024 and beginning of April, 2025)
- **2 models for each period:** DE_DAM level included/not included
 - the results vary slightly depending on the model specification, but they can be considered robust to the main variables.

Robust regression results

- R^2 over 0.3 - the models explain over 30% of the variation in price differences.

Effects of explanatory variables (other factors held constant)

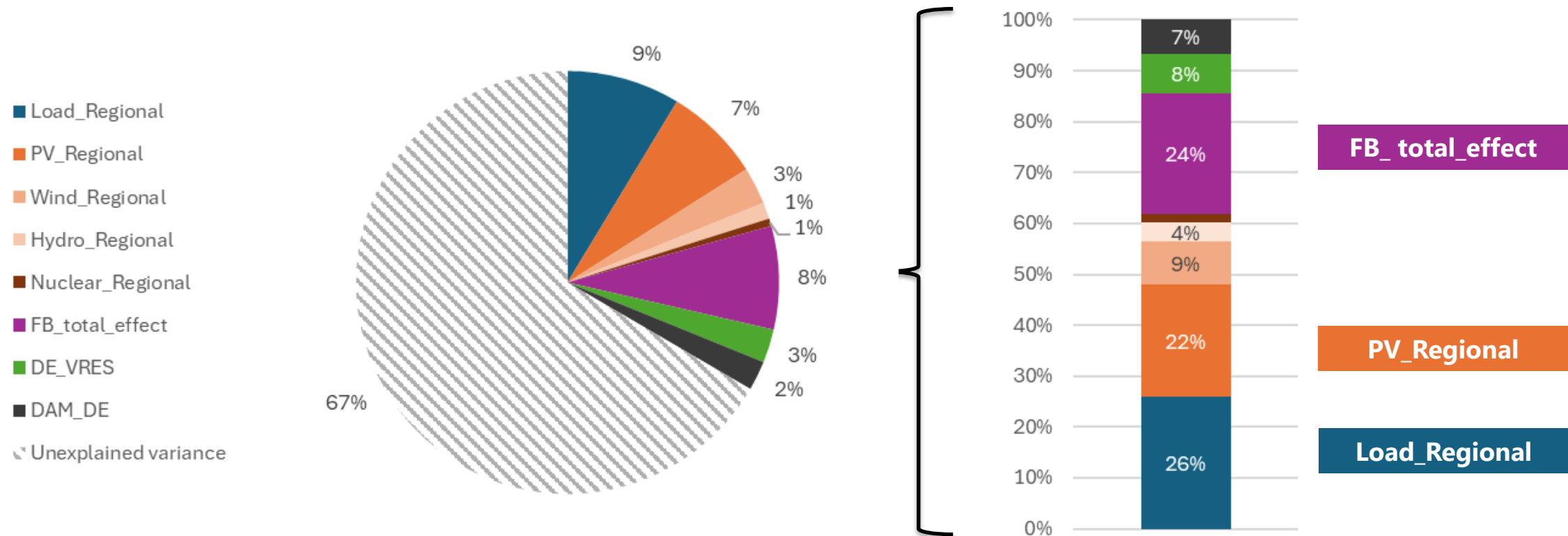
- A 1 GWh increase in regional load raises prices by 5.9 EUR/MWh.*
- A 1 GWh increase in PV, wind, nuclear, or hydro generation on a regional level lowers prices by 5.4, 7.7, 9.5, or 2.6 EUR/MWh, respectively.*
- A 1 EUR/MWh rise in German DAM price reduces price difference by 0.297 EUR/MWh.
- Increasing RAM by 100 MW for the included critical network elements cuts price differences by 1.1–3.5 EUR/MW.

*Under the 1st specification

Dependent variable	Price difference between DE and the region, [EUR/MWh]			
	1	2	3	4
Specification	Entire period		High price period	
<i>N</i>	12725	12725	7877	7877
<i>R Square</i>	0.334	0.302	0.380	0.330
<i>Adjusted R Square</i>	0.334	0.301	0.379	0.329
Coefficients				
(Constant)	33.5720***	30.8303***	-26.8921***	4.1637
Load_Regional	0.0059***	0.0041***	0.0073***	0.0045***
PV_Regional	-0.0054***	-0.0052***	-0.0067***	-0.0064***
Wind_Regional	-0.0077***	-0.0073***	-0.0087***	-0.0080***
Nuclear_Regional	-0.0095***	-0.0082***	-0.0084***	-0.0084***
Hydro_Regional	-0.0026***	-0.0027***	0.0010***	0.0000
DAM_DE	-0.2974***		-0.4160***	
DE_VRES	0.0003***	0.0012***	0.0004***	0.0016***
Levice_God_RAM	-0.0348***	-0.0312***	-0.0208***	-0.0307***
Dur_Levice_RAM	-0.0111***	-0.0209***	-0.0212***	-0.0352***
Nosovice_Varin_RAM	-0.0277***	-0.0212***	-0.0065	-0.0032

Availability of CNECs are as important as supply-demand patterns

Relative importance of explanatory variables: Regression 1 (Full dataset)



- We examined the relative importance of each variable: this shows how much of the price difference each variable explains
- The RAM variables related to network elements together account for a quarter of the explanatory power, meaning that based on the regressions they clearly influence price differences.

- Since the F0,all forecasts of the TSOs are not transparent, the RAM value is difficult to monitor and predict.

Dur_Levise_Fuaf																										
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
2024.07.01	134	130	136	154	180	134	154	170	168	171	179	183	190	216	198	192	116	119	128	112	139	162	183	183	175	179
2024.07.02	174	180	184	191	182	163	178	158	159	156	145	154	153	169	147	145	137	101	113	109	111	158	168	181	178	179
2024.07.03	191	195	200	194	167	140	166	166	156	155	159	166	165	179	186	186	130	121	122	130	124	158	197	193	193	193
2024.07.04	193	195	187	185	180	152	170	192	168	174	174	160	168	189	159	170	142	146	116	141	143	156	214	184	187	187
2024.07.05	165	168	167	178	194	198	183	173	189	194	199	196	206	218	205	194	208	203	174	209	210	183	175	178	178	178
2024.07.06	187	183	184	186	184	174	187	180	159	154	146	134	140	156	172	186	188	139	136	176	187	171	155	154	154	154
2024.07.07	152	144	149	143	148	147	153	161	129	128	128	126	141	165	166	168	166	160	155	167	166	173	176	176	176	176
2024.07.08	162	175	179	179	170	200	213	203	210	206	197	211	213	213	198	204	195	200	199	200	199	166	173	164	164	164
2024.07.09	163	155	141	143	179	177	176	142	201	182	167	156	150	188	182	202	164	155	144	135	135	151	204	197	197	197
2024.07.10	213	209	185	179	204	203	199	205	184	190	179	180	175	206	209	193	149	138	140	135	177	179	187	179	179	179
2024.07.11	177	174	174	167	188	196	192	181	170	171	162	165	173	194	207	203	146	132	132	121	146	187	170	167	167	167
2024.07.12	168	150	158	169	213	201	187	159	157	156	137	148	160	172	183	161	162	151	146	154	140	165	189	189	189	189
2024.07.13	183	183	182	175	175	181	185	171	164	164	141	155	150	146	175	202	233	245	249	250	208	176	206	200	200	200
2024.07.14	218	221	218	214	192	187	167	151	152	160	159	146	149	184	186	199	204	192	190	190	190	192	181	205	190	190
2024.07.15	194	192	192	197	180	161	176	142	161	156	157	158	157	166	179	159	146	149	142	141	155	181	169	175	175	175
2024.07.16	179	167	170	182	177	187	180	157	163	157	157	165	186	184	222	178	145	147	154	155	159	188	198	203	203	203
2024.07.17	193	192	191	198	205	191	170	165	153	159	159	169	184	193	172	157	142	161	172	169	178	199	217	226	226	226
2024.07.18	226	216	218	221	224	219	192	160	161	161	160	165	185	187	185	137	146	159	164	161	162	172	202	201	201	201
2024.07.19	169	160	175	180	218	180	176	160	169	170	170	176	184	183	217	155	150	148	156	147	145	167	221	242	242	242
2024.07.20	234	241	248	241	222	203	186	157	146	167	165	168	181	200	248	232	202	214	205	200	203	223	161	178	178	178
2024.07.21	223	215	199	191	189	205	173	152	149	159	134	139	154	172	189	206	212	199	175	175	185	195	183	201	201	201
2024.07.22	176	166	193	201	203	152	141	114	112	109	111	111	114	117	131	105	99	90	91	92	89	101	103	105	105	105
2024.07.23	102	92	93	105	123										142	112	91	93	90	86	85	100	103	120	116	116
2024.07.24	121	113	115	119	137										142	137	121	100	104	111	114	124	117	122	122	122
2024.07.25	118	104	109	117	135										154	147	154	109	107	103	113	123	128	115	115	115
2024.07.26	119	117	110	121	129	162	169	140	126	121	120	125	156	167	176	168	131	112	116	119	123	135	133	142	142	142
2024.07.27	131	131	129	126	128	156	131	134	131	135	127	121	138	143	183	188	115	114	111	119	114	139	121	128	128	128
2024.07.28	139	137	138	138	142	132	130	120	122	132	132	127	156	162	171	134	104	70	77	74	83	95	91	88	88	88
2024.07.29	89	88	81	81	99	86	85	77	63	67	56	48	69	98	114	99	88	69	69	73	72	90	103	97	97	97
2024.07.30	86	87	87	80	112	110	91	97	88	85	80	80	88	108	128	125	117	91	76	92	112	98	100	84	84	84
2024.07.31	83	76	87	95	103	122	90	103	108	110	112	114	118	128	128	110	72	44	62	107	91	90	74	60	60	60

	Region_DE_PS_weighted																							
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
2024.07.01	8	12	14	18	16	5	6	4	6	2	18	20	41	65	80	111	126	172	187	141	79	84	21	23
2024.07.02	21	18	15	19	21	2	5	5	3	6	8	15	20	28	24	24	24	37	63	15	11	21	24	24
2024.07.03	22	18	19	16	9	1	11	3	11	14	19	25	25	44	44	22	22	30	45	39	27	29	41	44
2024.07.04	55	63	67	66	54	61	63	74	74	76	82	80	102	151	187	170	104	72	60	30	24	30	64	59
2024.07.05	56	55	63	63	49	36	14	7	11	20	39	48	73	69	69	54	44	85	56	30	31	18	42	48
2024.07.06	45	51	50	58	63	56	48	29	16	22	43	52	58	62	107	94	102	118	142	114	89	77	85	80
2024.07.07	81	78	64	45	22	4	1	3	5	9	14	18	18	19	48	71	85	84	56	42	11	12	12	11
2024.07.08	9	3	4	4	9	3	8	8	9	24	35	36	40	5	39	49	112	185	117	183	95	63	34	13
2024.07.09	5	1	-3	-6	-9	-4	-14	-6	5	7	10	33	44	74	55	62	121	173	163	103	41	50	52	41
2024.07.10	36	25	3	21	16	1	5	3	4	8	23	37	41	45	55	72	138	280	254	143	84	99	45	24
2024.07.11	19	19	15	14	10	-5	5	4	8	14	30	47	58	59	74	132	326	411	390	347	217	218	69	54
2024.07.12	24	26	15	36	18	47	20	0	2	3	9	17	28	58	59	112	256	395	421	359	214	140	71	78
2024.07.13	60	59	60	62	54	51	14	16	18	25	34	39	57	82	98	136	256	395	421	359	214	140	71	78
2024.07.14	60	66	63	63	50	13	19	19	20	37	55	70	84	87	99	99	160	309	312	315	121	82	56	54
2024.07.15	55	39	36	41	20	6	25	15	24	37	58	72	88	75	62	63	314	447	428	384	200	114	50	45
2024.07.16	47	55	51	42	23	36	24	25	34	57	85	100	107	130	155	17	342	472	576	504	161	83	55	54
2024.07.17	35	38	31	24	25	12	9	18	24	38	49	63	80	97	103	163	382	533	548	573	291	182	95	43
2024.07.18	24	21	17	11	-2	24	11	11	26	38	52	57	63	54	66	12	394	545	556	431	270	46	29	25
2024.07.19	16	7	4	4	-4	-7	0	2	12	26	34	58	61	62	61	50	207	617	587	329	78	43	30	41
2024.07.20	22	17	12	7	7	5	6	7	35	42	66	69	75	92	96	70	115	271	166	250	100	59	89	101
2024.07.21	87	71	57	31	16	21	25	37	38	34	36	41	50	54	59	79	40	27	71	123	73	27	22	16
2024.07.22	21	20	23	24	32	27	15	25	27	33	43	67	83	97	90	111	211	289	268	155	111	36	26	26
2024.07.23	22	22	20	17	1	6	13	14	23	30	40	51	59	61	79	35	55	211	300	102	28	23	24	22
2024.07.24	25	19	18	20	9	-8	35	36	45	66	91	91	95	134	171	174	133	209	265	118	18	11	66	40
2024.07.25	28	22	20	14	29	45	35	34	41	64	77	96	105	97	89	74	199	303	324	180	87	60	19	8
2024.07.26	8	8	6	9	9	-6	-3	-1	4	0	4	6	9	13	11	22	34	74	144	36	26	22	6	4
2024.07.27	2	1	2	4	0	-4	-3	3	11	9	10	13	17	15	15	18	21	48	66	44	19	12	16	9
2024.07.28	14	18	15	12	18	0	-11	-5	0	3	19	42	65	65	67	95	60	45	53	41	29	17	-2	-4
2024.07.29	-4	-10	-12	-4	2	-10	3	5	33	42	24	35	57	62	63	34	39	70	13	18	10	-2	15	1
2024.07.30	-1	-1	-3	-6	-11	-11	-4	-3	0	9	22	26	31	30	30	22	10	27	22	6	11	-1	0	1
2024.07.31	2	-4	-5	-6	-7	-12	-1	6	7	6	28	35	42	51	45	21	44	82	128	82	33	8	11	18

F_{Uaf} : flows from assumed commercial exchanges outside the Core region

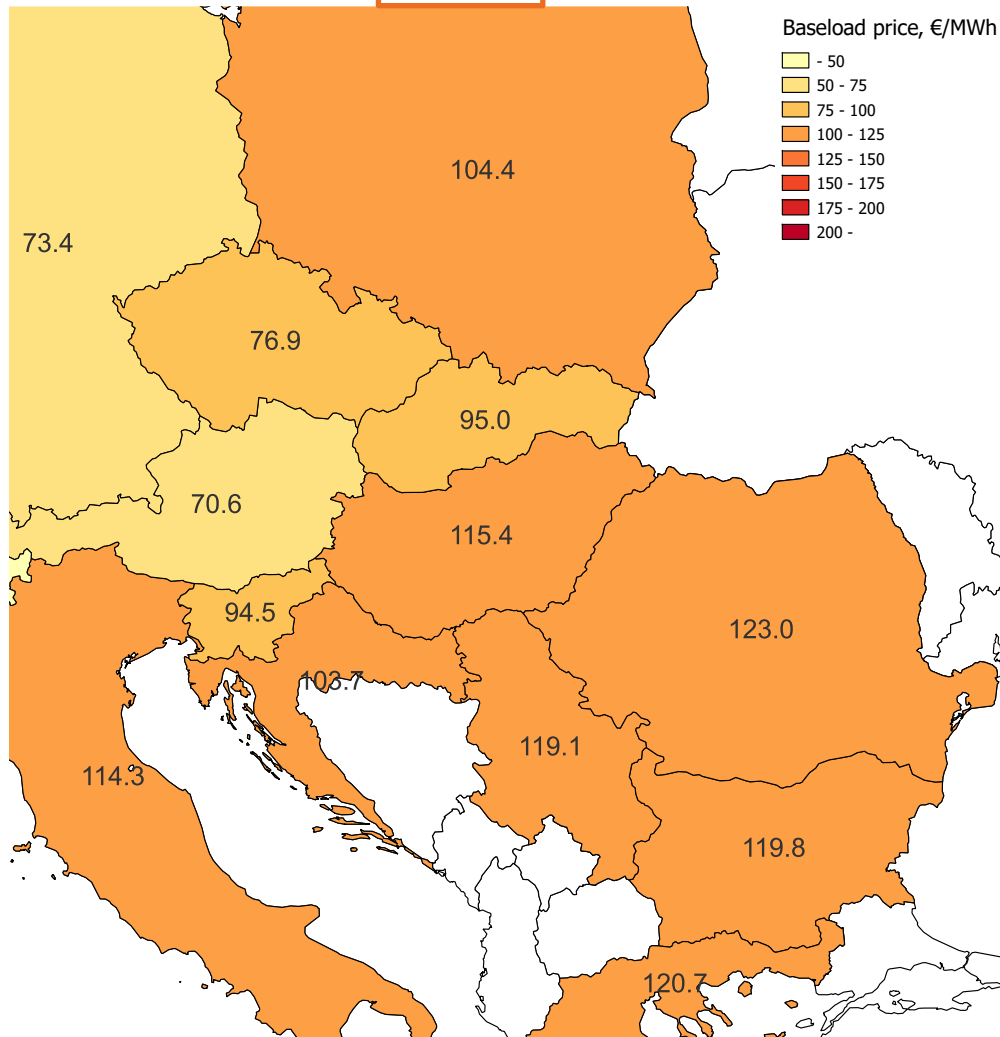
MODELING THE PRICE SPIKES IN CEE-SEE

Methodology

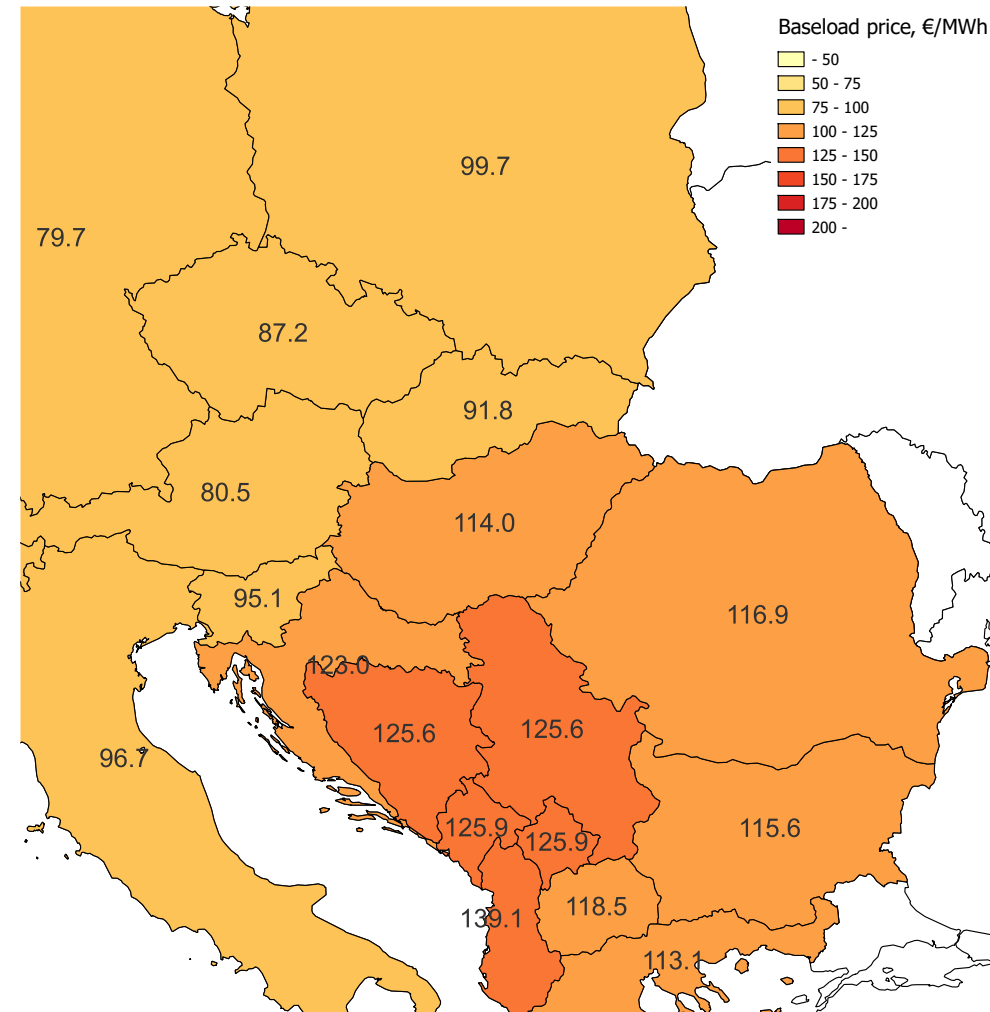
- Analysed period: 06.04.2024-08.28.2024. (2016 hours)
- Using the European Power Market Model (EPMM)
- Data collection:
 - Actual hourly demand for all countries based on ENTSO-E Transparency Platform data
 - Actual PV and wind for all countries based on ENTSO-E Transparency Platform data
 - Actual monthly nuclear and hydro generation for all countries based on ENTSO-E Transparency Platform data
 - Net Transfer Capacity = Actual hourly day-ahead scheduled commercial flow + initial offered capacity for intraday trading -> based on Transparency Platform

Reference results – average DAM prices in the analysed periods

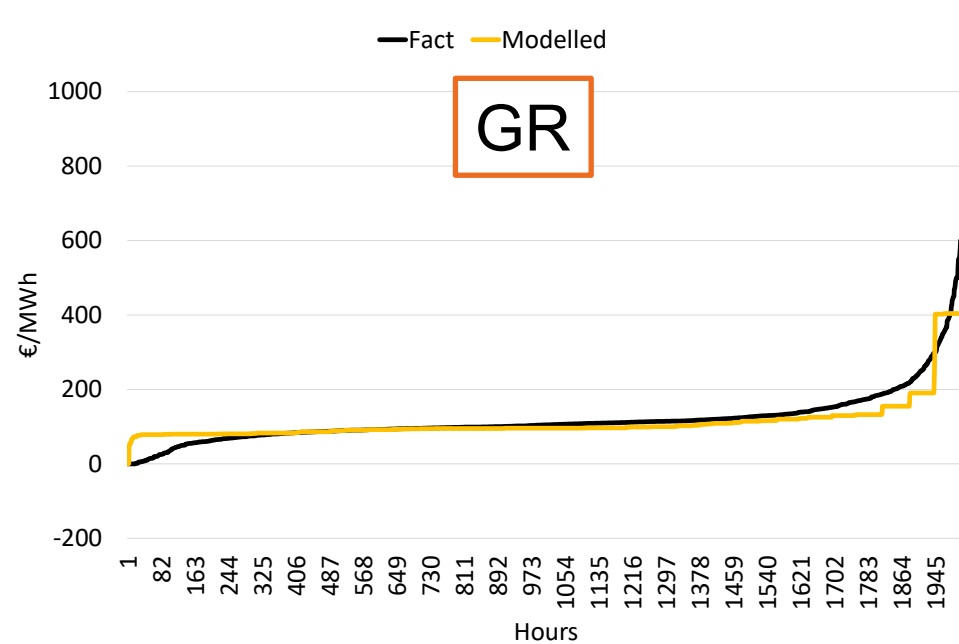
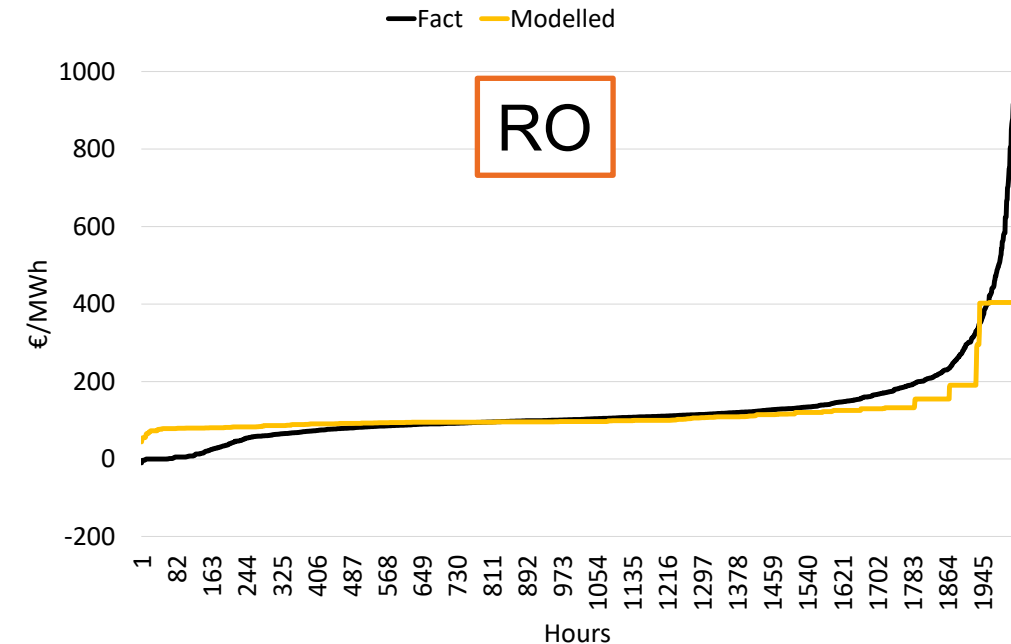
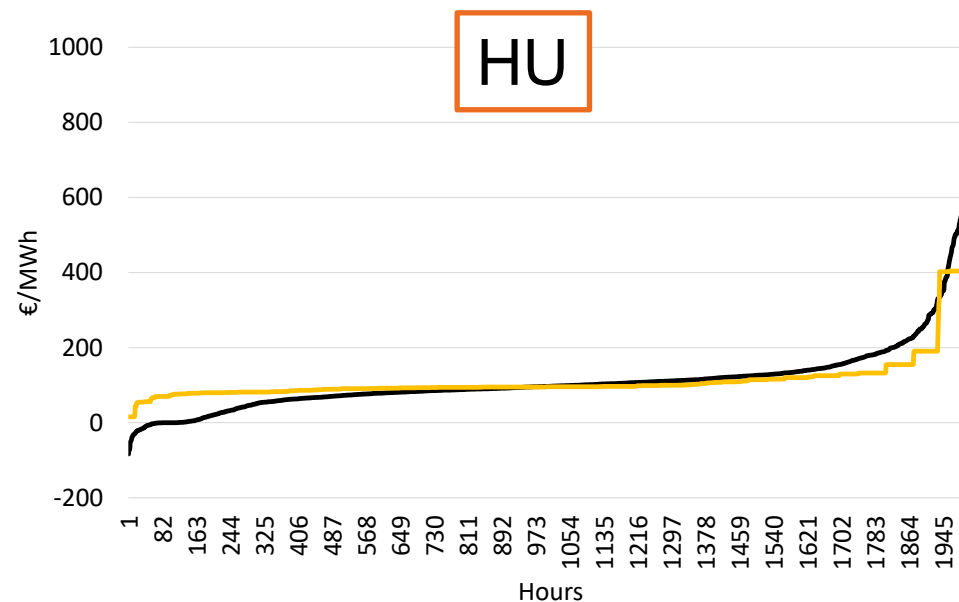
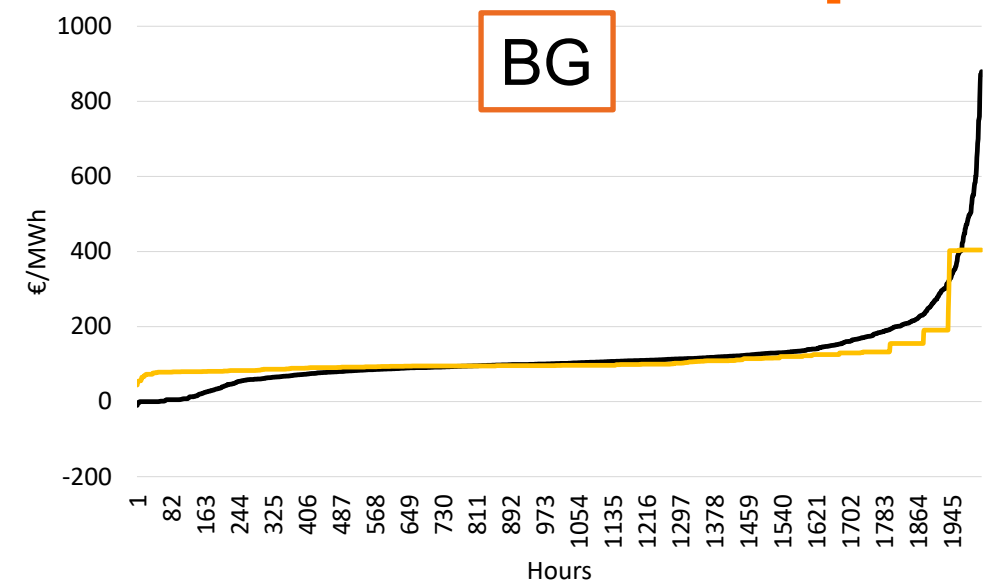
Fact



Modelled



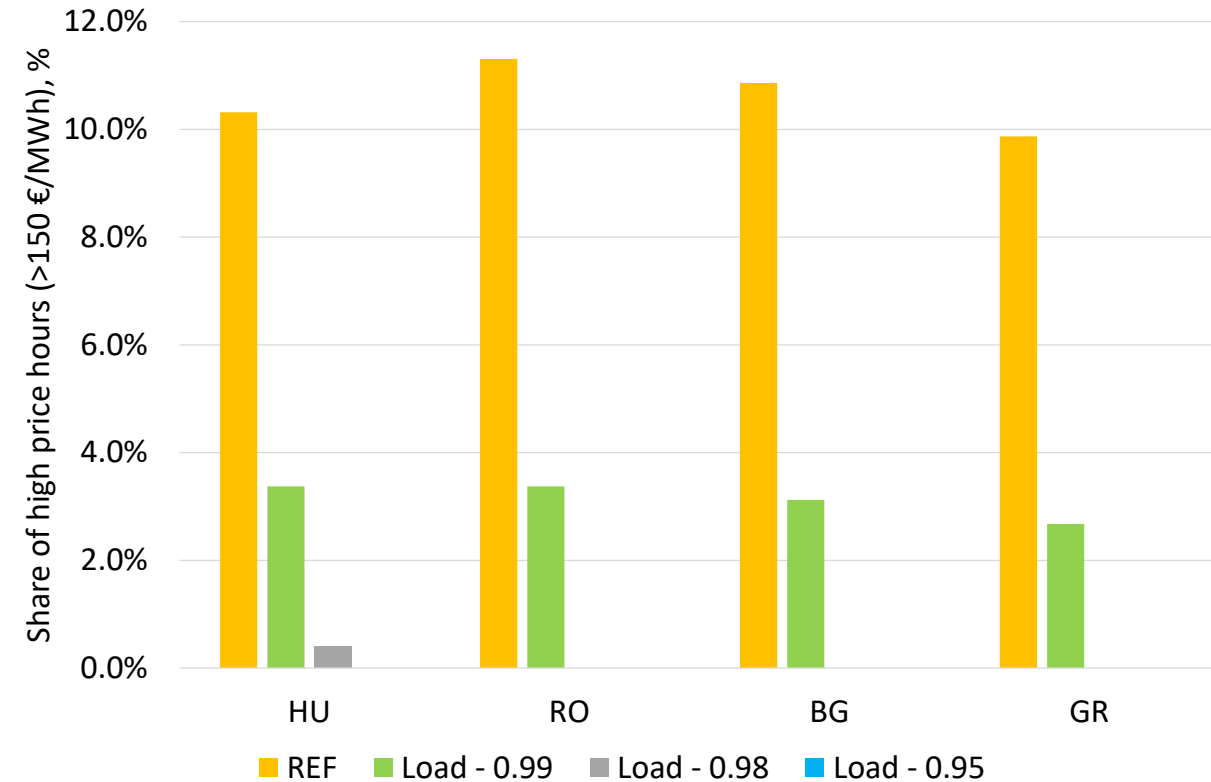
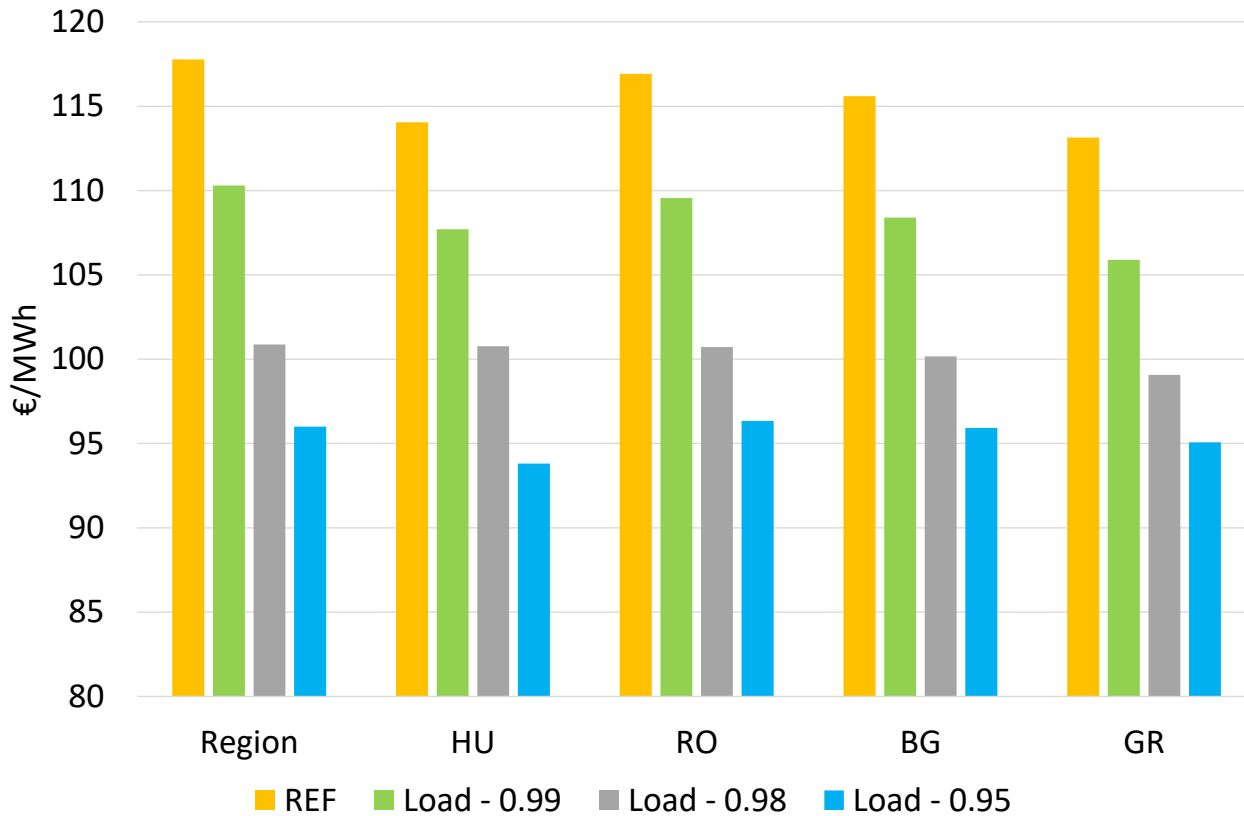
Reference results – price duration curve



Scenarios

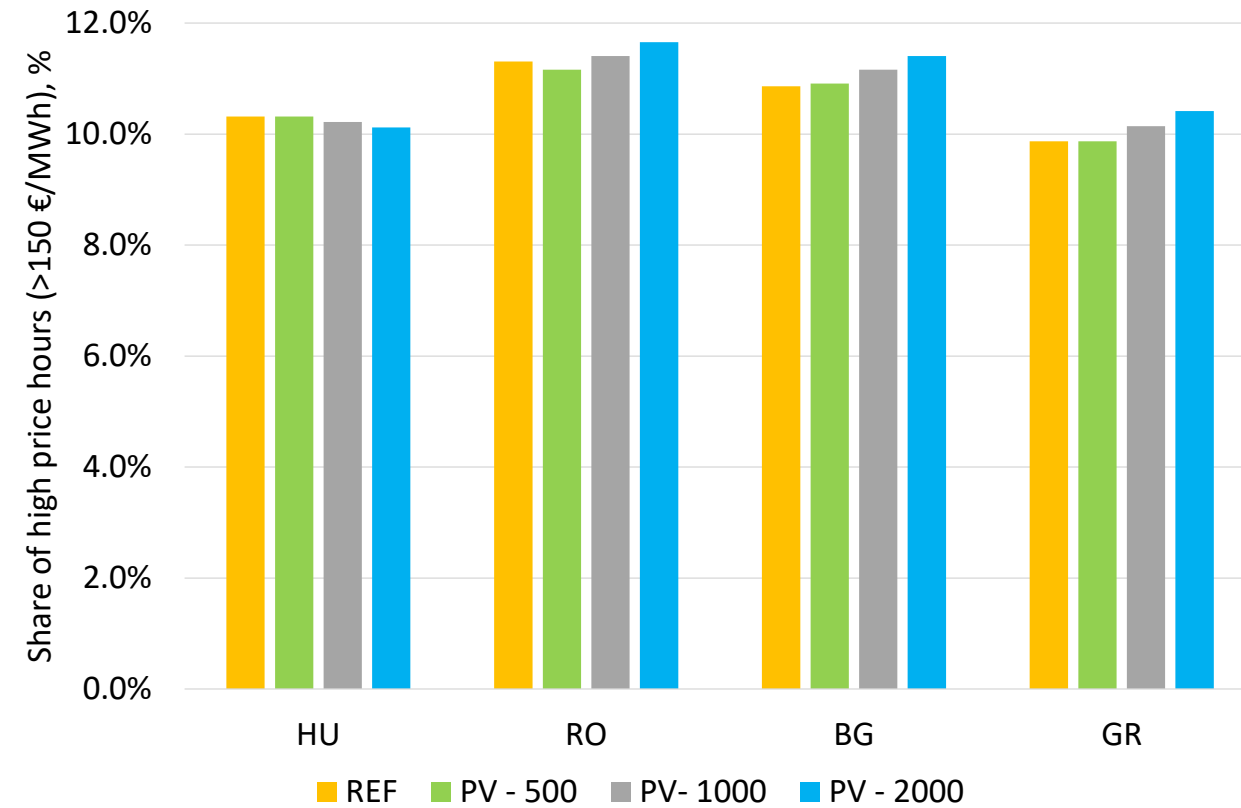
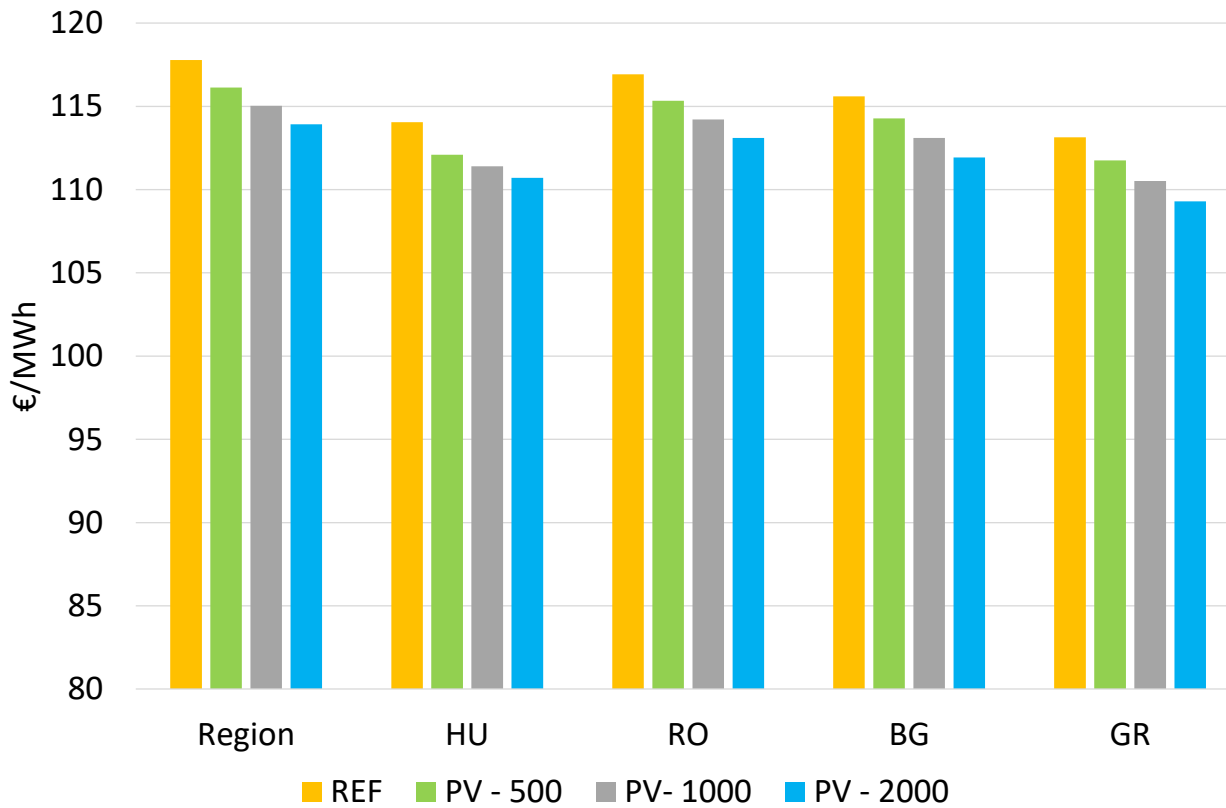
- Reference
- Trade: +500/1000/2000 MW additional capacity splitted 50 by the AT-HU and 50 % by both on CZ-SK and CZ-HU borders (both export and import)
- Consumption: Decrease the consumption in the High-Price Region by 1,2,5 % -> average Regional decerase in consumption is 300-600-1500 MW
- New PV capacity: +500/1000/2000 MW additional capacities splitted proportionally by the average installed capacities between the countries
- New wind capacity: +500/1000/2000 MW additional capacities splitted proportionallyby the average installed capacities between the countries
- New gas capacity: +500/1000/2000 MW additional capacities splitted proportionally by the average installed capacities between the countries
- New BESS capacity: +500/1000/2000 MW additional capacities splitted proportionally by the average installed capacities between the countries

Small decrease in consumption has a significant effect on average prices and also on price-spikes



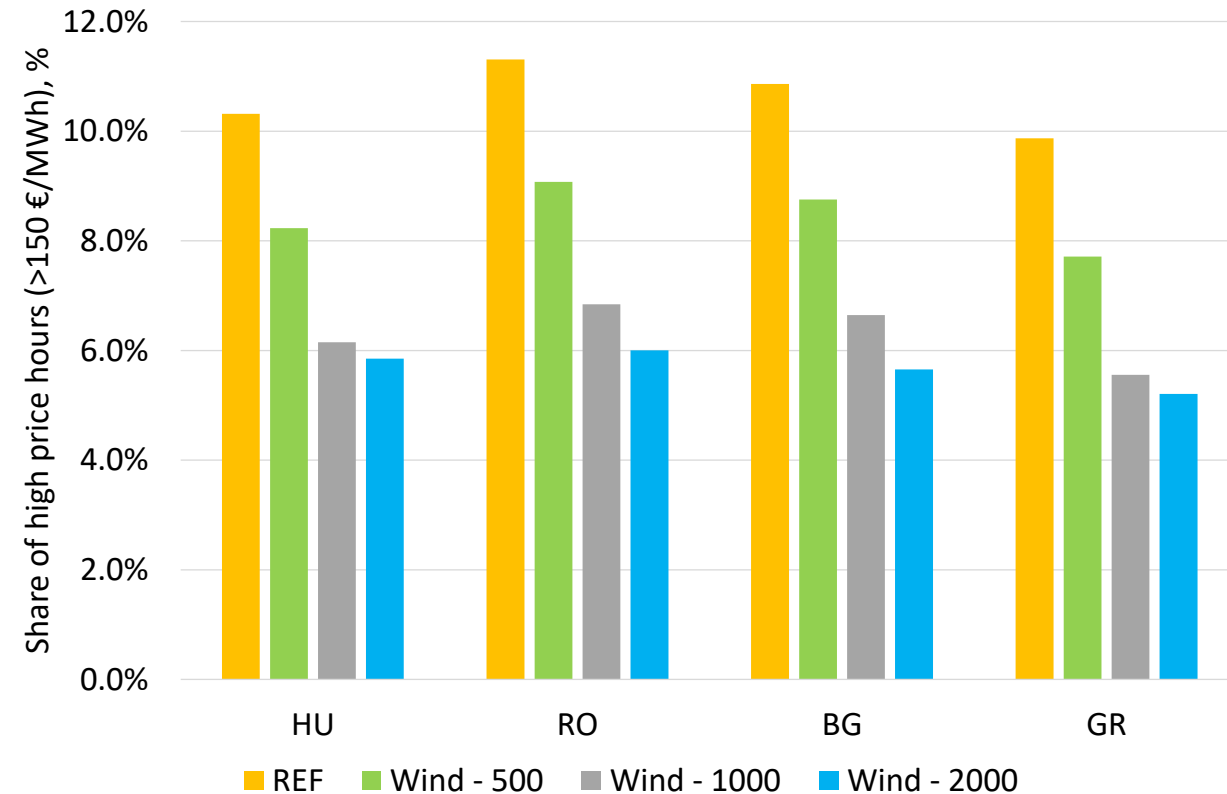
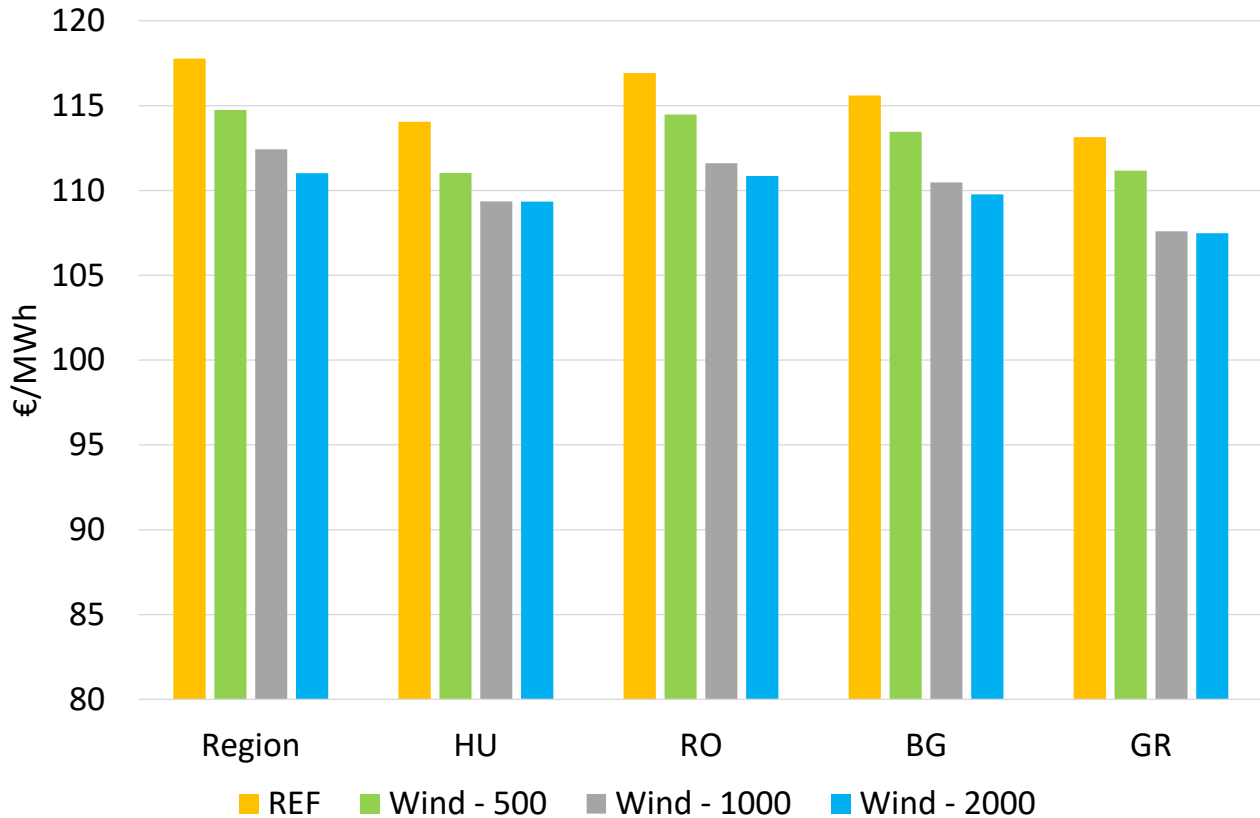
- 1 % of consumption decrease has a very significant effect both on the average price, and on the share of high price hours
- In case of 2 % consumption decrease in the Region almost diminishes the high-price hours (prices above 150 €/MWh)
- Similar effect has happened in all the four SEE countries

Additional PVs have limited effect on average prices, and could even increase the number of high-price hours



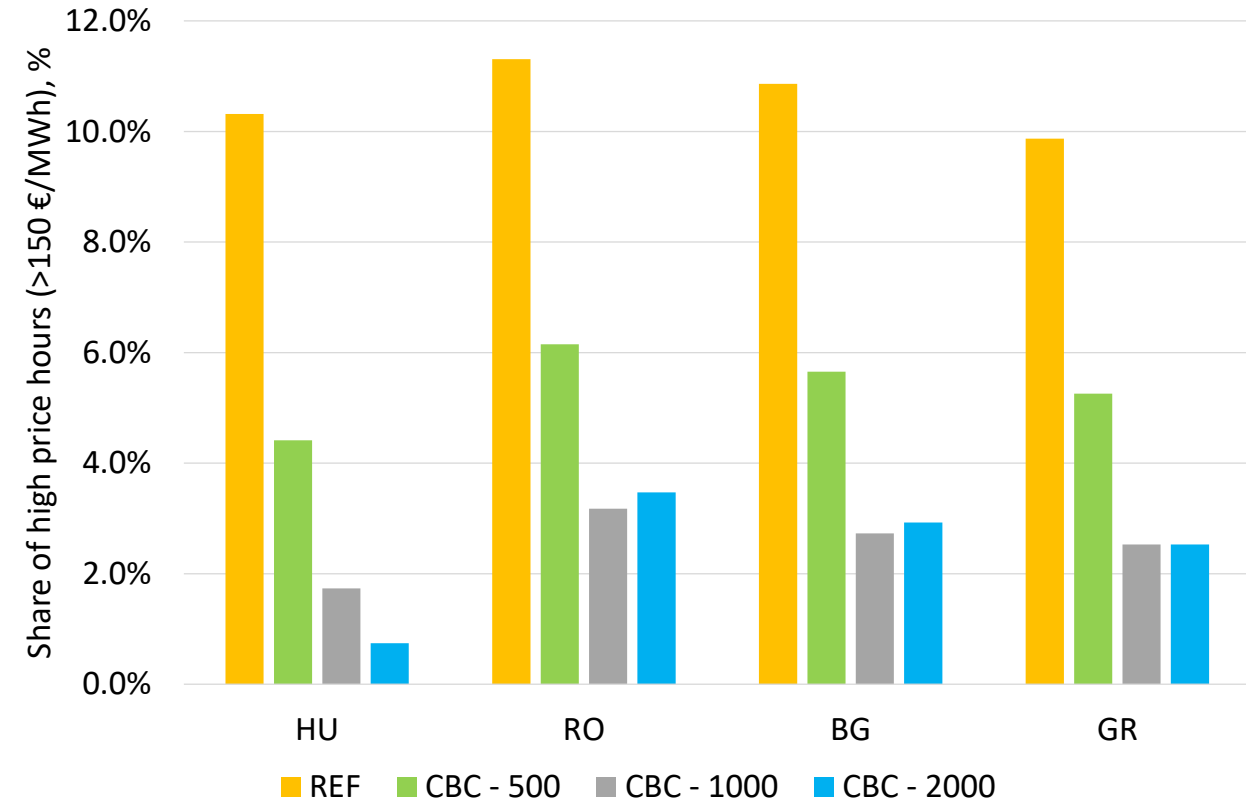
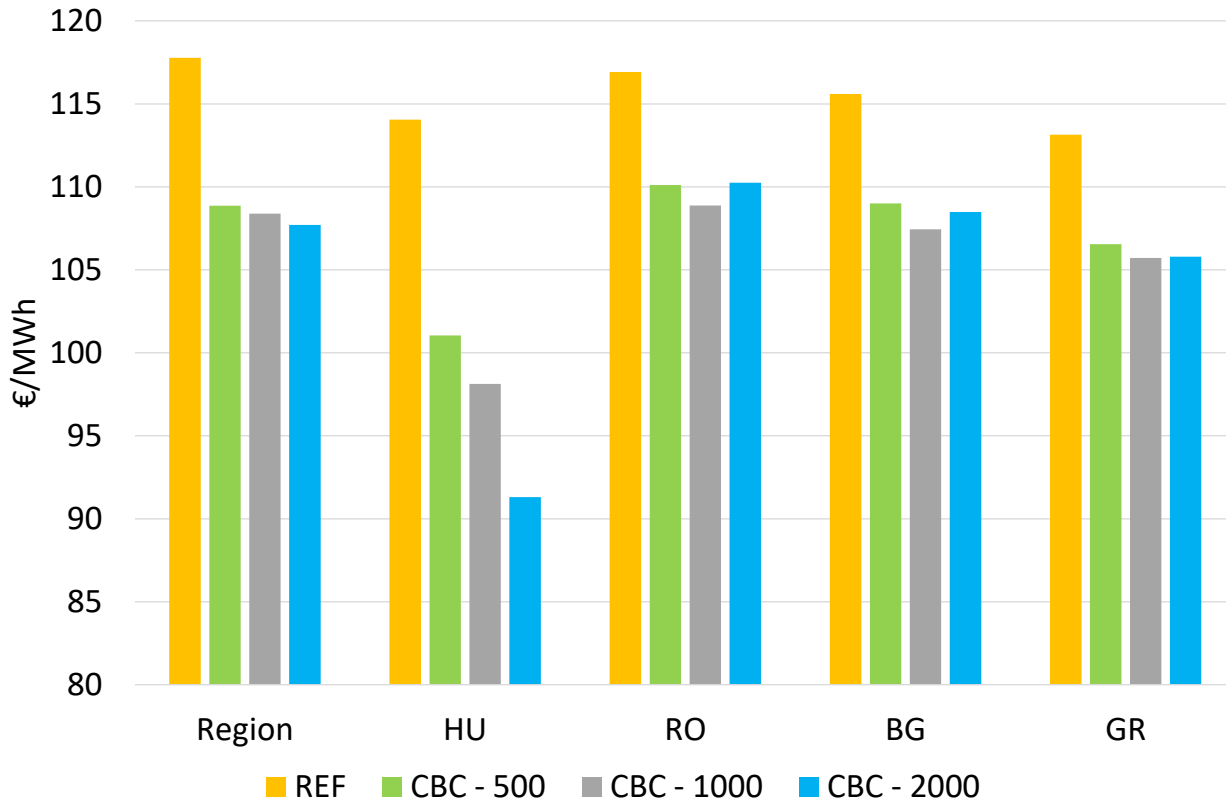
- PV have positive prices on average, however the number of price spikes hours increases ->
 - High-price hours occur mostly when the overall PV production is zero (evening hours)
 - Higher PV capacities increase the capacity reserve needs, which could increase the number of high-price hours in many countries

Wind can also decrease average prices in the Region



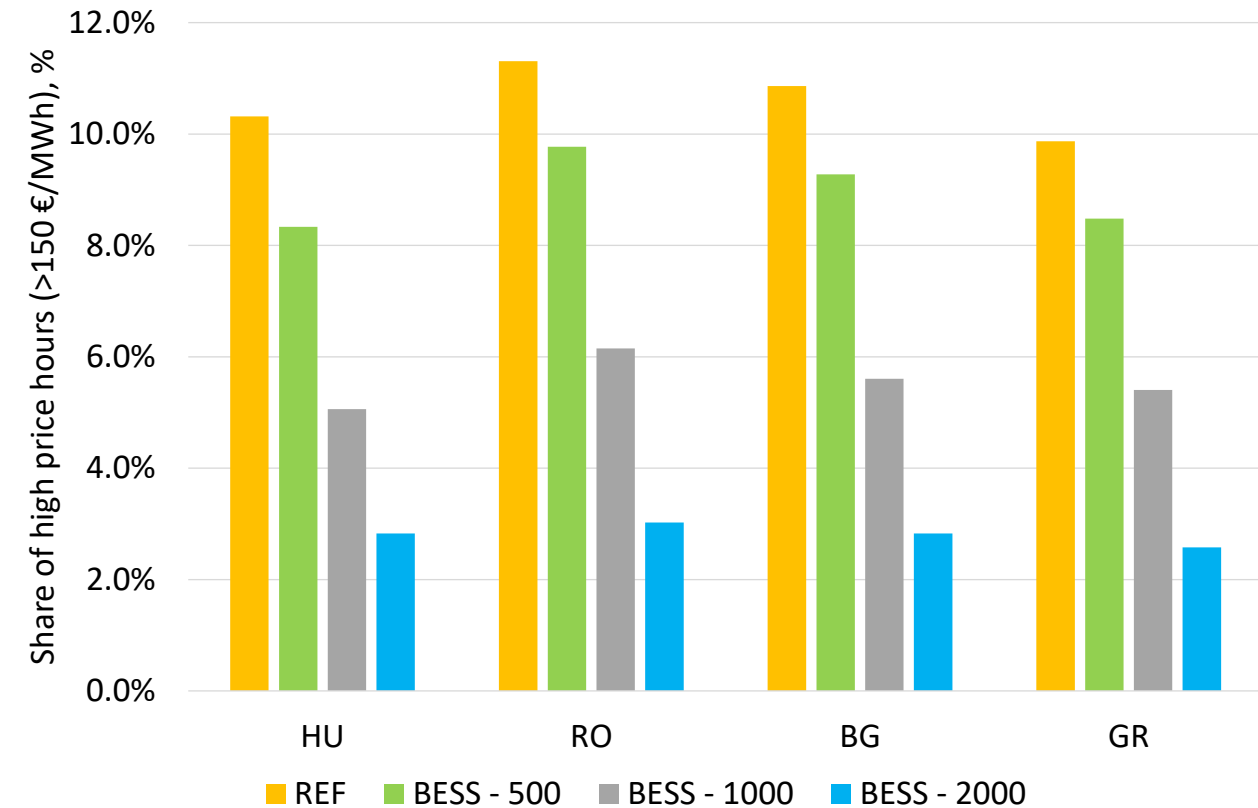
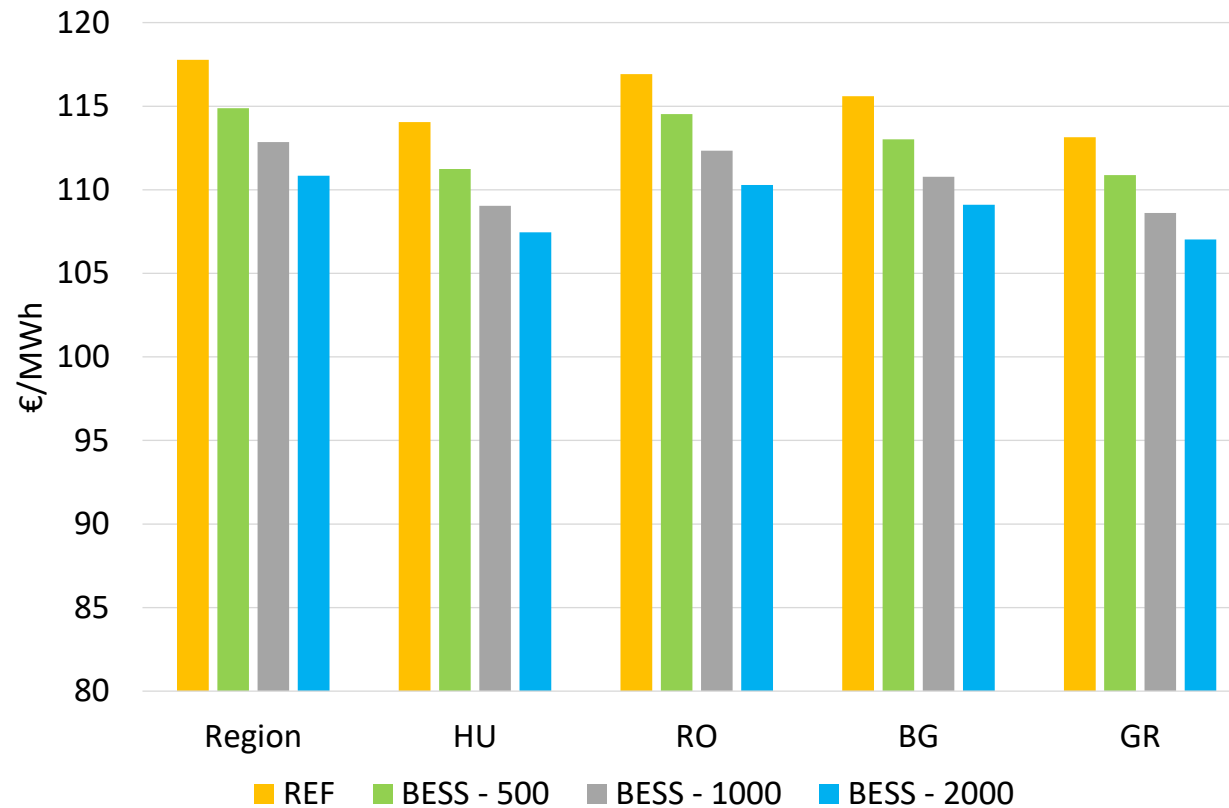
- Additional wind capacities have positive effect on prices on average, and the the number of price spikes hours also decreases
- Wind power plants can produce electricity even in the high-price hours (in contrast to PV)
- Although higher wind capacities increase the capacity reserve needs, but the „production” effect is stronger than the reserve need growth

Even small increase in CBC capacities has a huge effect on average prices in the Region



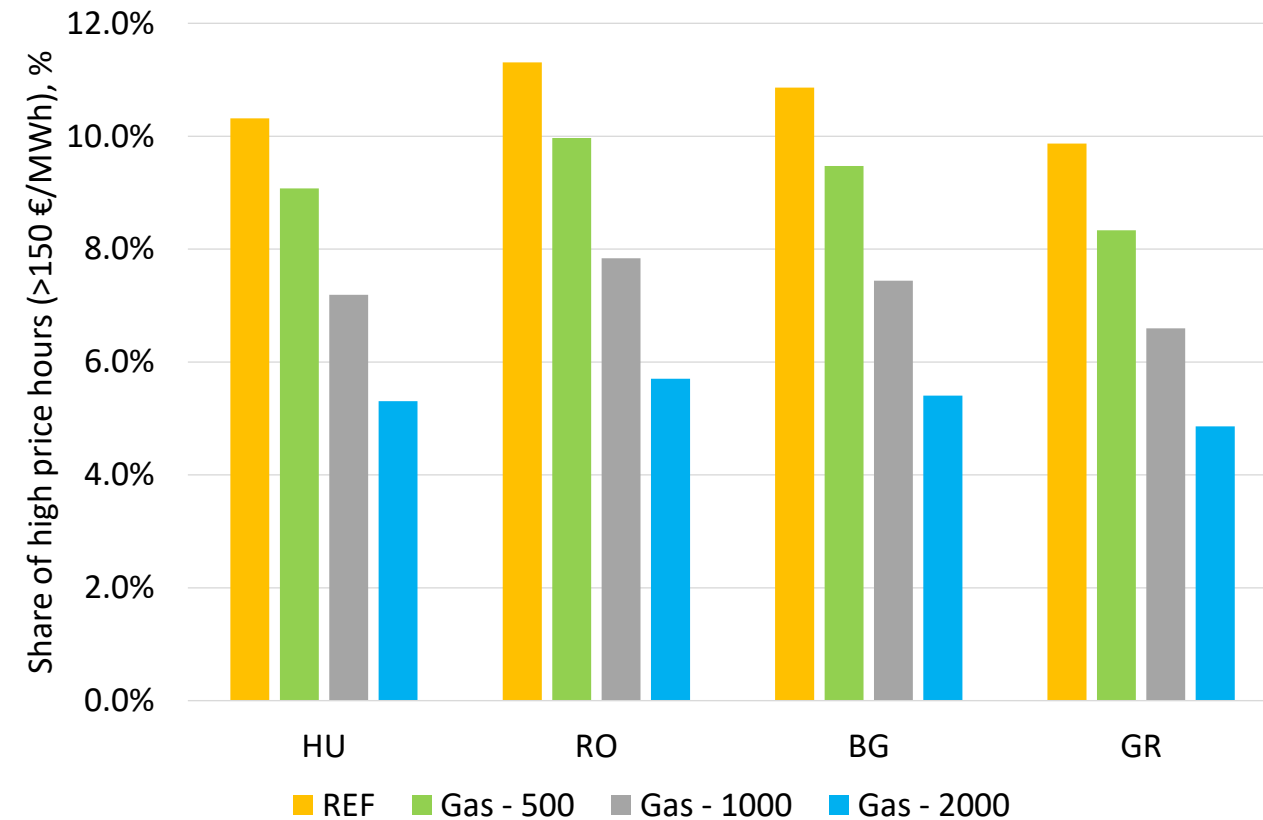
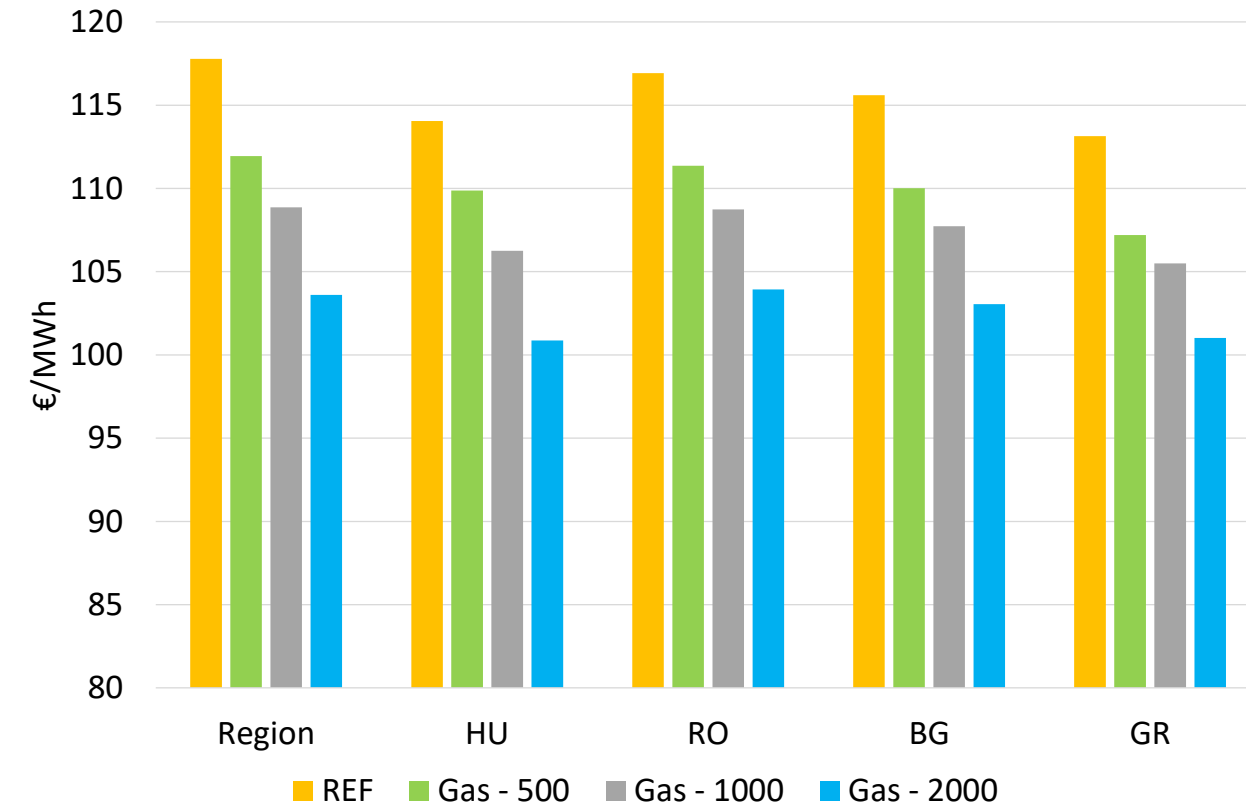
- Small increase in CBC capacities (in relation of AT-HU and CZ-SK-HU borders) have a very high effect on average prices in the Region, and it also helps to decrease the number of high-price hours
- The highest effect is in Hungary -> in the high CBC capacity expansion case Hungary and their neighboring countries are splitted into two price regions; Hungary becomes cheaper, and congestions build up in its southern borders

BESS capacities have a linear effect on DAM prices



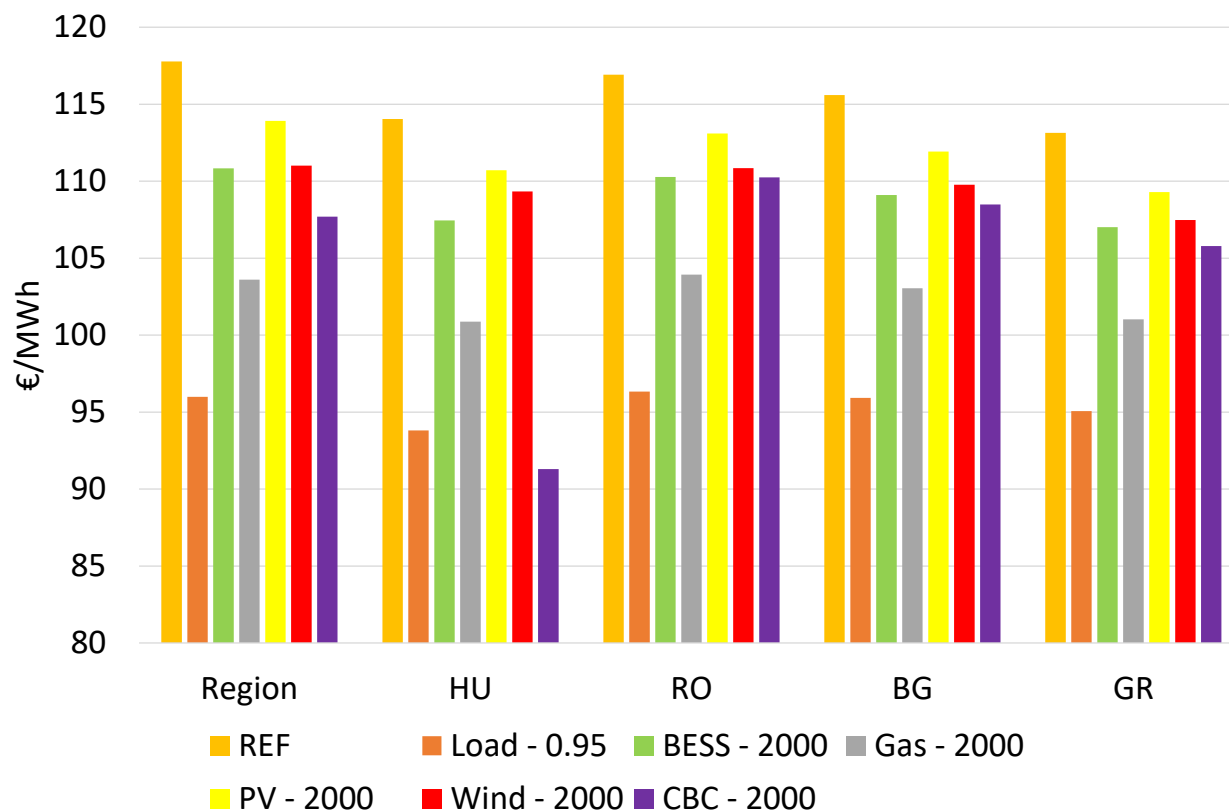
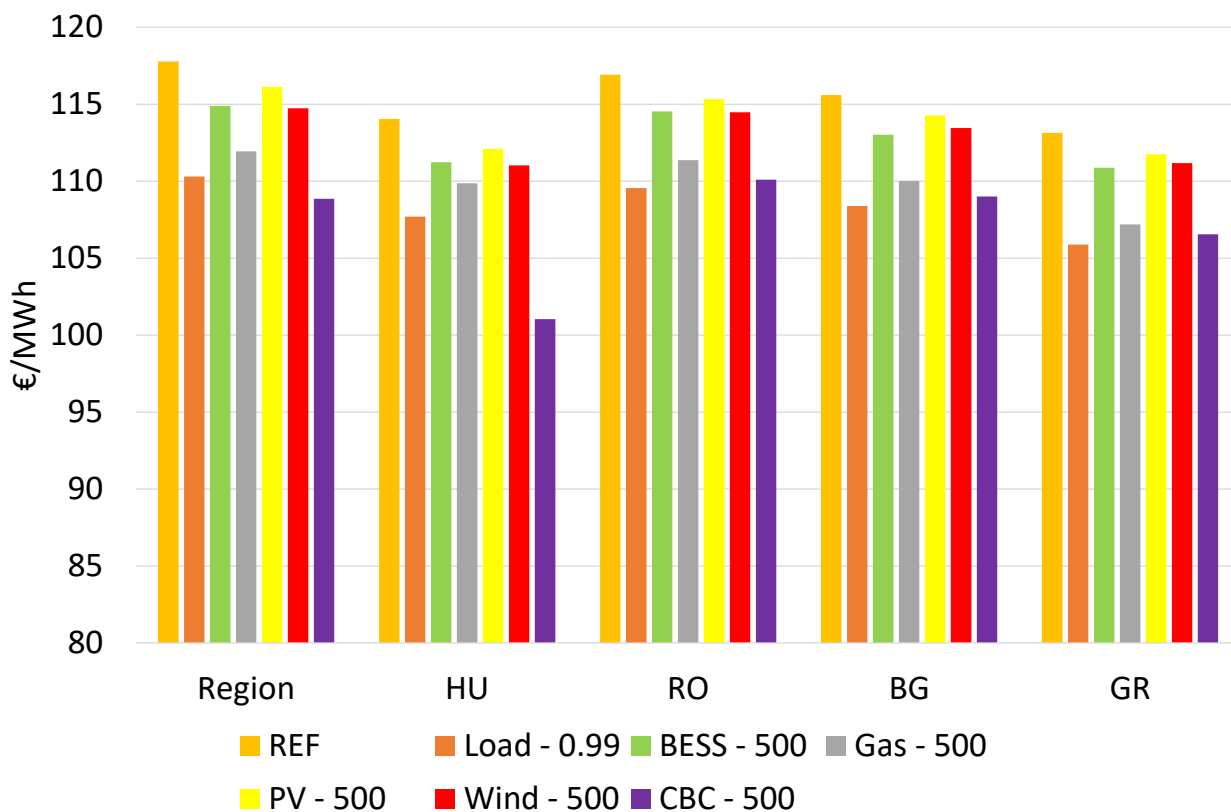
- High penetration of battery storage helps to decrease not only the number of spike price hours, but it also has a positive effect on the average prices
- Similar effect can be seen for all countries

Additional available gas capacities have huge effects on the price-spikes and on the average prices as well



- Additional available gas capacity has the second largest effect on the prices in average, however they can not eliminate the price spikes
- Similar effects observed on all countries

Summary



- Consumption decrease has the highest effect both on the average prices and price spikes
- Small increase in CBC capacities could decrease very significantly the Hungarian prices
- Additional PV has limited impact on prices
- Wind and BESS has almost the same effect on average prices

MAIN FINDINGS AND POLICY CONCLUSIONS

Main findings I.

- Based on the co-movement of price differences versus the German DAM, the High-price Region (HR–HU–RS–RO–BG–GR) can be clearly identified
- The price differences of High-price and Central European Region in 2024 - mainly in summer (especially July) - provides a good basis for examining the reasons behind this phenomenon
- Demand and supply factors also played a significant role:
 - higher demand and demand volatility,
 - lower nuclear and hydro generation in the region
- One of the most important factors behind regional price differences is the scarcity of network elements associated with flow-based allocation
- Five key lines are the most critical; together they account for 84% of the total price difference between the two regions
 - Of the 84%, 60% is attributable to two internal lines, whose reinforcement is problematic: costs are borne domestically, while benefits accrue abroad
 - The average impact and frequency of constraint differ markedly across critical elements: some lines constrain in few hours but cause extreme price differences, while others constrain often but with smaller effects

Main findings II.

- For Dur–Levice and Neusiedl–Wien: when they are not active constraints, average RAM is much higher, and the inter-regional price difference is significantly lower.
- Issues/questions around RAM:
 - RAM changes significantly within a short period; the reason is unclear and it cannot be reliably forecasted.
 - On two critical lines, the 70% rule is far from being met.
 - The 5% PTDF rule can create sharp discontinuities in which constraints shape the FB domain—and thus observed price spreads.
- Incorporating RAM values of the critical elements, together with the main demand and supply factors into a regression framework shows that CNEC's RAM has a significant impact on price differences even after controlling for other factors.
- For the critical network elements studied, long-term allocations are negligible; variability in RAM is mainly driven by changes in $F0_{all}$ and $Fuaf$.

Main findings III.

- The modeling shows the following results:
 - Consumption decrease has the highest effect both on the average prices and price spikes
 - Small increase in CBC capacities could decrease very significantly the Hungarian prices
 - Additional PV has limited impact on prices
 - Wind and BESS has almost the same effect on average prices

Policy conclusions I.

- Although flow-based market coupling can increase EU-wide efficiency, its benefits are unevenly distributed across regions. The High-price Region suffers from higher prices due to not only cross-border congestion, which previously did not affect prices.
- In many respects the flow-based system operates like a black box, making it harder for market participants to understand than the previous NTC-based cross-border regime.
- Transparency is needed when determining RAM in order to explain and predict sudden RAM swings.
- The 70% minimum RAM requirement should be strictly enforced where it matters most, with full compliance prioritized on the CNECs that drive the largest price spreads.
- A review of the 5% PTDF rule is needed, as the threshold can cause discontinuities in the flow-based domain. A justified below 5% inclusion pathway with publicly available reasoning should be permitted, and sensitivity analyses should be conducted on alternative thresholds.

Policy conclusions II.

- In order to address the issue of the internal-line investment incentive gap, cost-sharing or compensation mechanisms should be introduced for internal CNECs with cross-border benefits, so that the hosting country is not penalised for upgrades that primarily benefit neighbouring countries.
- PCI/PMI selection should target true welfare bottlenecks. Candidate projects ought to be ranked by persistent shadow prices, measured welfare losses, and spread-reduction potential.
- Storage (especially batteries) and demand-side response (DSR) should be incentivized to deliver peak-hour relief when flow-based constraints are most binding.
 - Demand should be shifted away from the 17:00–21:00 peak window by introducing time-of-use or dynamic tariffs.
 - Supply adequacy should be addressed by using fast, flexible capacity. Where the residual gap is modest, batteries and wind-plus-storage can cost-effectively cover peak hours.

THANK YOU FOR YOUR ATTENTION

BACK-UP SLIDES

Determining price differences using shadow prices

- The price difference between bidding zones A and B at a given hour can be determined as follows (without LTA domain):

$$PS_{A-B,j} = \sum_{i=1}^n (PTDF_{A,i} - PTDF_{B,i}) \cdot SP_{j,i}$$

where PS_{A-B} Price difference between price zone A and B in hour ,j'

$PTDF_{A,i}$ shows how a change in the net position of country A by 1 MW affects the CNEC.

$SP_{j,i}$ The shadow price of the i-th CNEC in hour ,j' (if we increase the capacity of the given CNEC by 1 MW, how much does it increase the total welfare

Example: Estimating the AT-HU price difference in the given hour

[1]	[2]	[3] = [1] - [2]	[4]	[5] = [3] * [4]
PTDF_AT	PTDF_HU	AT-HU	Shadow Price	
0,01153	- 0,04089	0,05242	5 656,34	296,505
- 0,09862	- 0,08568	- 0,01294	240,08	- 3,107
0,03256	0,04217	- 0,00961	1 979,70	- 19,025
0,00077	0,02192	- 0,02115	1 097,32	- 23,208
- 0,00811	- 0,00745	- 0,00066	499,54	- 0,330
Price Spread:				250,836

- If the LTA domain is also active, the calculation is similar, but its shadow price must also be added.