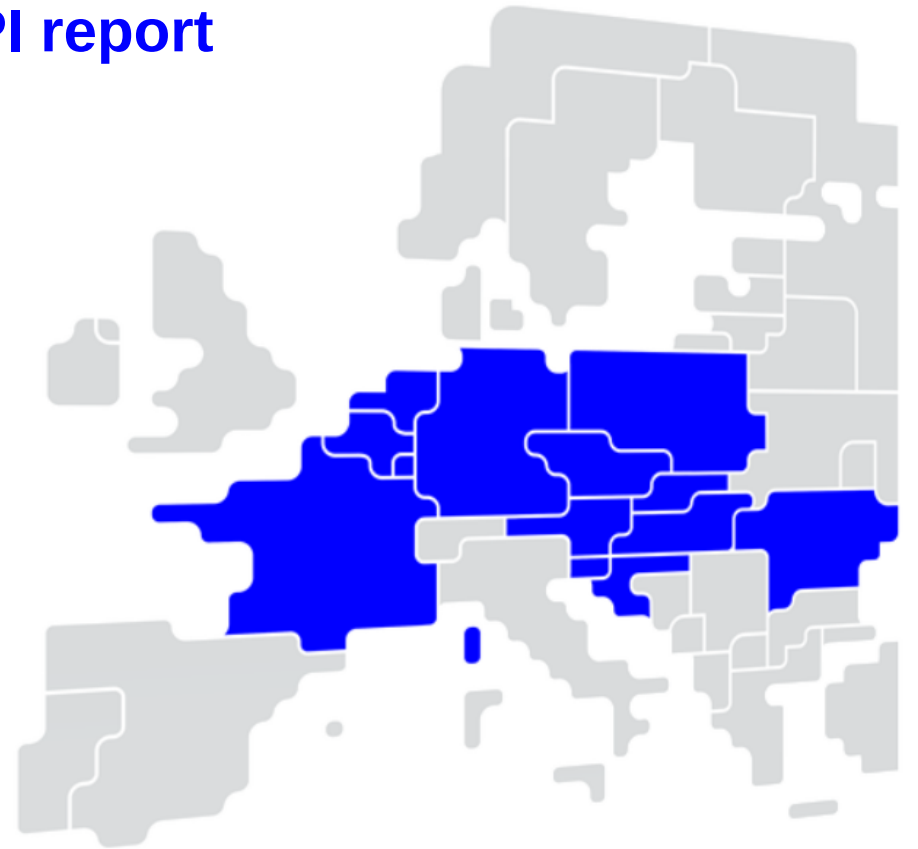


Core FB MC Operational KPI report

August 2023



Overview of Operational KPIs



Adjustment for minimum RAM Inclusion

- KPI 1: Average maximum AMR per CNE
- KPI 2: Average maximum AMR per TSO

TSOs' adjustment after validation

- KPI 3: Share of MTUs with intervention per TSO
- KPI 4: Average IVA applied for each CNE affected by TSO intervention

Power System Impact Analysis

- KPI 5: Min & max net positions per BZ hub
- KPI 6: Virtual margins at market balance for CORE TSOs
- KPI 7: Non-Core exchanges delta flow

Non-costly Remedial Action Optimization Analysis

- KPI 8: Relative Time Share of Applied RAs, by TSO, Type and Mode
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Market Impact Assessment

- KPI 11: Most often presolved CNEs (top 20)
- KPI 12: Most limiting CNEs (top 20)
- KPI 13: Allocation Constraints

KPI 1: Average maximum AMR per CNE (Top 10)

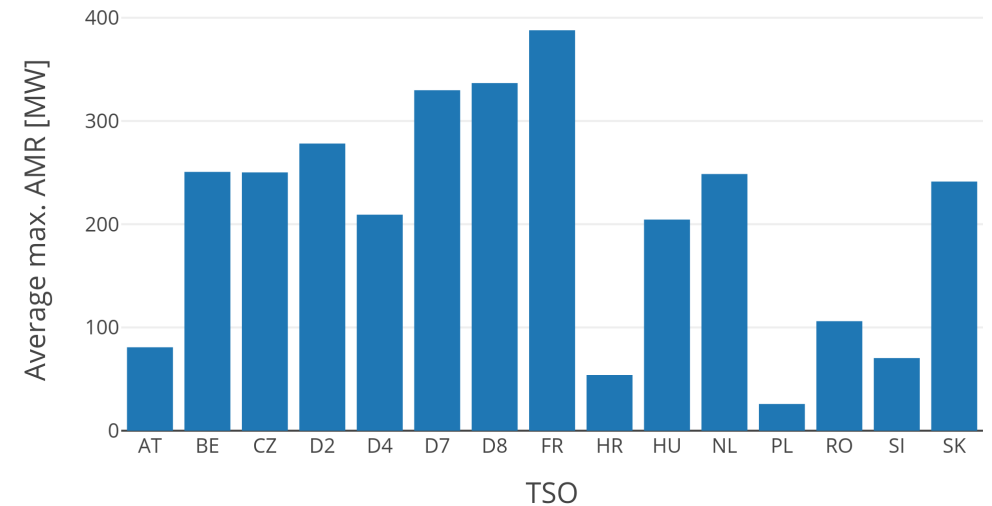
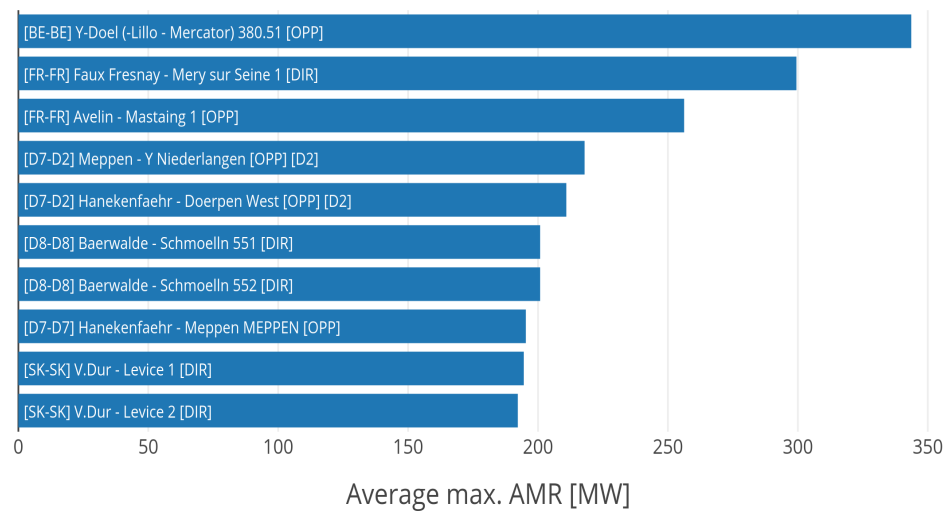
KPI 2: Average maximum AMR per TSO



| CNE | Average Maximum AMR (MW) | AMR as % of Fmax |
|---|--------------------------|------------------|
| [BE-BE] Y-Doel (-Lillo - Mercator) 380.51 [OPP] | 343.65 | 0.53% |
| [FR-FR] Faux Fresnay - Mery sur Seine 1 [DIR] | 299.45 | 18.27% |
| [FR-FR] Avelin - Mastaing 1 [OPP] | 256.23 | 14.38% |
| [D7-D2] Meppen - Y Niederlangen [OPP] [D2] | 217.92 | 10.55% |
| [D7-D2] Hanekenfaehr - Doerpen West [OPP] [D2] | 210.89 | 9.70% |
| [D8-D8] Baerwalde - Schmoelln 552 [DIR] | 200.80 | 8.05% |
| [D8-D8] Baerwalde - Schmoelln 551 [DIR] | 200.80 | 8.05% |
| [D7-D7] Hanekenfaehr - Meppen MEPPEN [OPP] | 195.30 | 6.86% |
| [SK-SK] V.Dur - Levice 1 [DIR] | 194.51 | 14.03% |
| [SK-SK] V.Dur - Levice 2 [DIR] | 192.21 | 13.87% |

| TSO | Average maximum AMR per TSO |
|-----|-----------------------------|
| AT | 80.82 |
| BE | 250.69 |
| CZ | 250.16 |
| D2 | 278.15 |
| D4 | 209.23 |
| D7 | 329.86 |
| D8 | 336.68 |
| FR | 387.90 |
| HR | 53.98 |
| HU | 204.51 |

| TSO | Average maximum AMR per TSO |
|-----|-----------------------------|
| NL | 248.69 |
| PL | 25.89 |
| RO | 106.07 |
| SI | 70.33 |
| SK | 241.35 |



KPI 3: Share of MTUs with intervention per TSO



Total BDs

31

Total MTUs

744

MTUs without IVA

172

Share of distinct MTUs without IVA

23.12%

MTUs with IVA

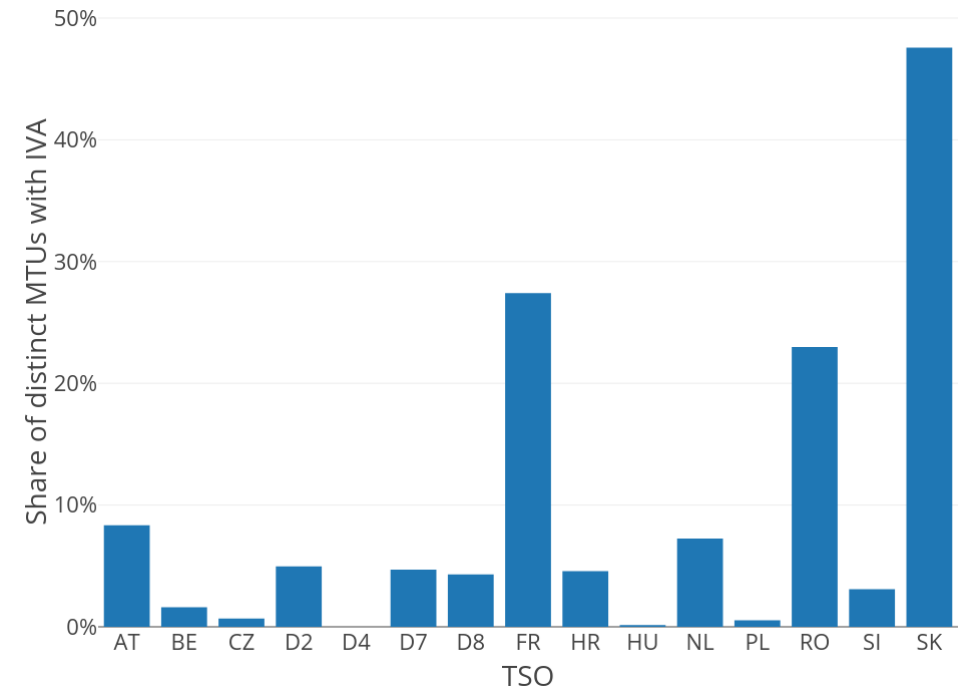
572

Share of distinct MTUs with IVA

76.9%

| TSO | Share of distinct MTUs with IVA | Distinct MTUs with IVA |
|-----|---------------------------------|------------------------|
| HR | 4.57% | 34 |
| CZ | 0.67% | 5 |
| SI | 3.09% | 23 |
| AT | 8.33% | 62 |
| D7 | 4.70% | 35 |
| D8 | 4.30% | 32 |
| D2 | 4.97% | 37 |
| PL | 0.54% | 4 |
| D4 | 0.00% | 0 |
| SK | 47.58% | 354 |

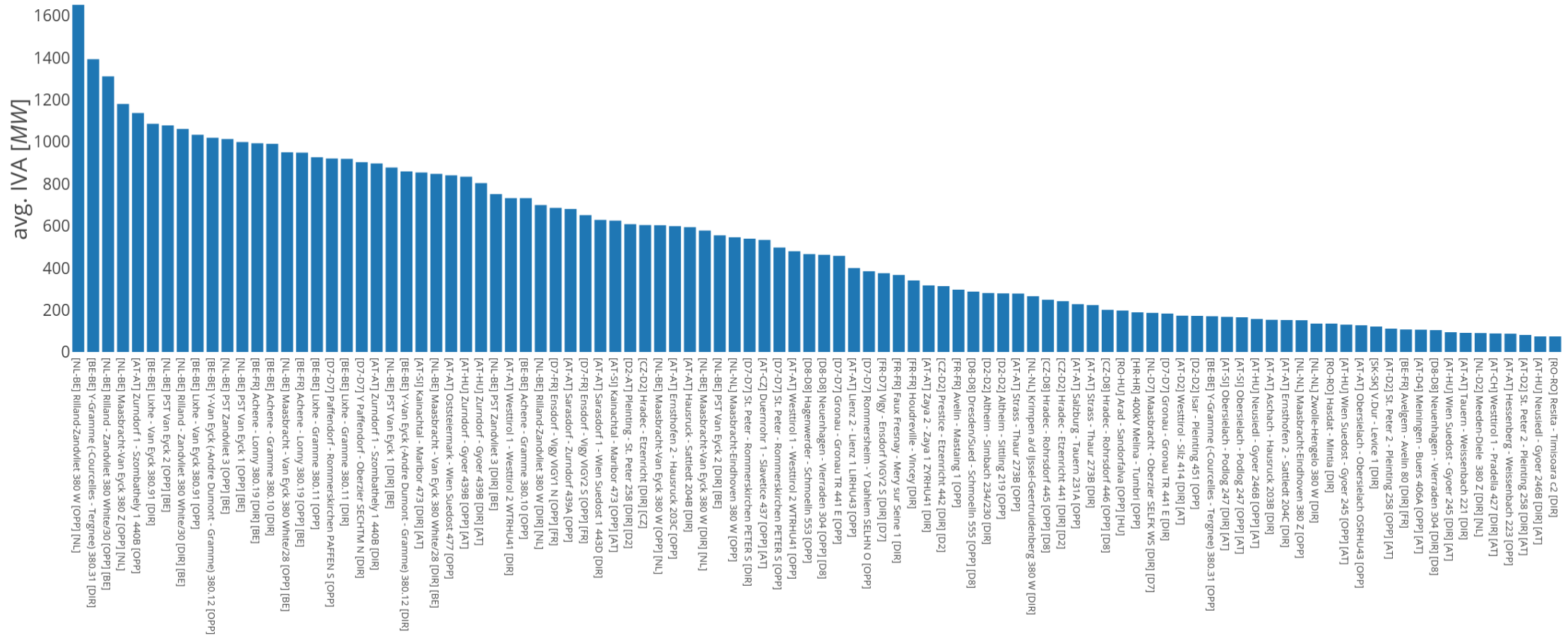
| TSO | Share of distinct MTUs with IVA | Distinct MTUs with IVA |
|-----|---------------------------------|------------------------|
| HU | 0.13% | 1 |
| BE | 1.61% | 12 |
| NL | 7.26% | 54 |
| FR | 27.42% | 204 |
| RO | 22.98% | 171 |



KPI 4a: Average IVA applied for each CNE affected by TSO intervention



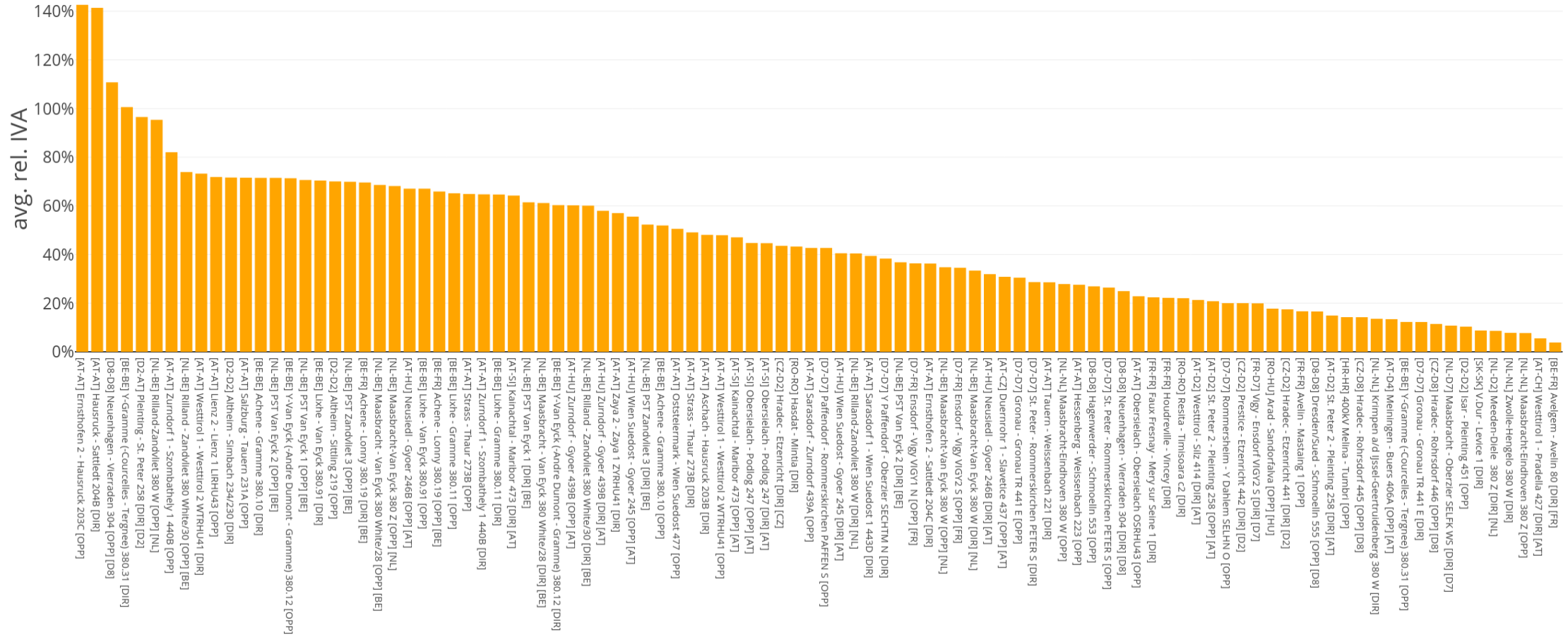
$$\text{avg. IVA}_{CNE} = \frac{1}{\#(CNEC, MTU)[IVA_{CNEC, MTU} > 0]} \sum_{MTU, CNEC} IVA_{CNEC, MTU} [IVA_{CNEC, MTU} > 0]$$



KPI 4b: Average relative IVA applied for each CNE affected by TSO intervention



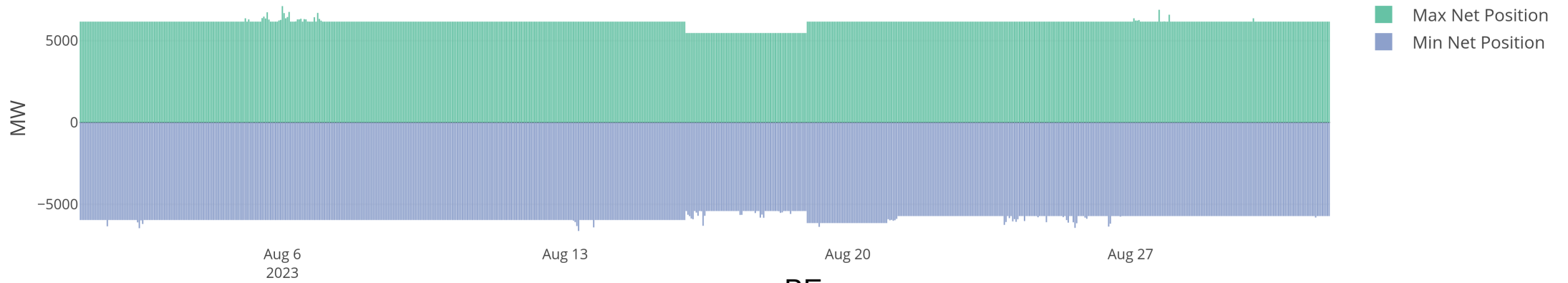
$$\text{avg. rel. IVA}_{CNE} = \frac{1}{\#(CNEC, MTU)[IVA_{CNEC, MTU} > 0]} \sum_{MTU, CNEC} \frac{IVA_{CNEC, MTU}[IVA_{CNEC, MTU} > 0]}{F_{max, CNEC, MTU}[IVA_{CNEC, MTU} > 0]}$$



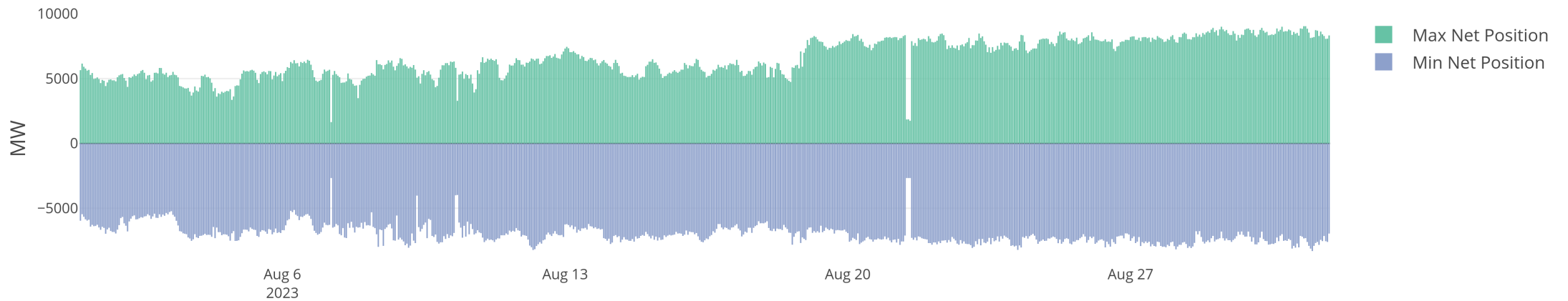
KPI 5: Min & max net positions per BZ hub



AT



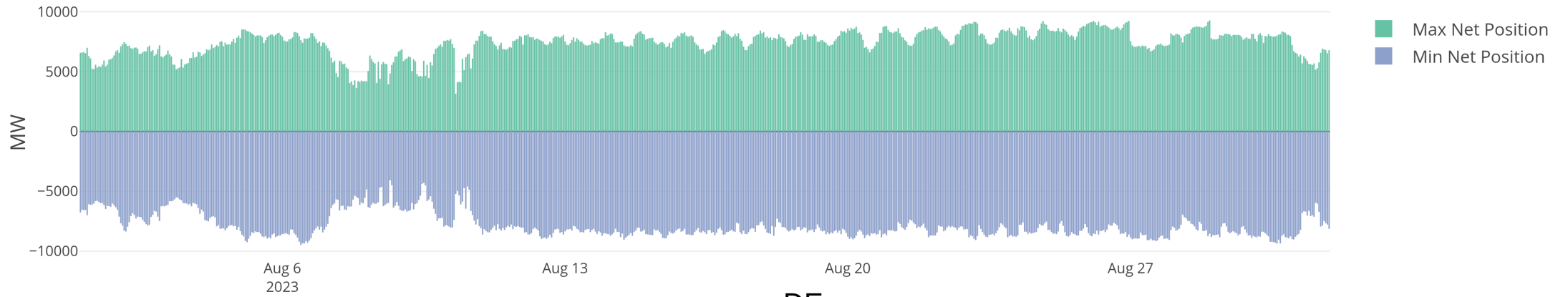
BE



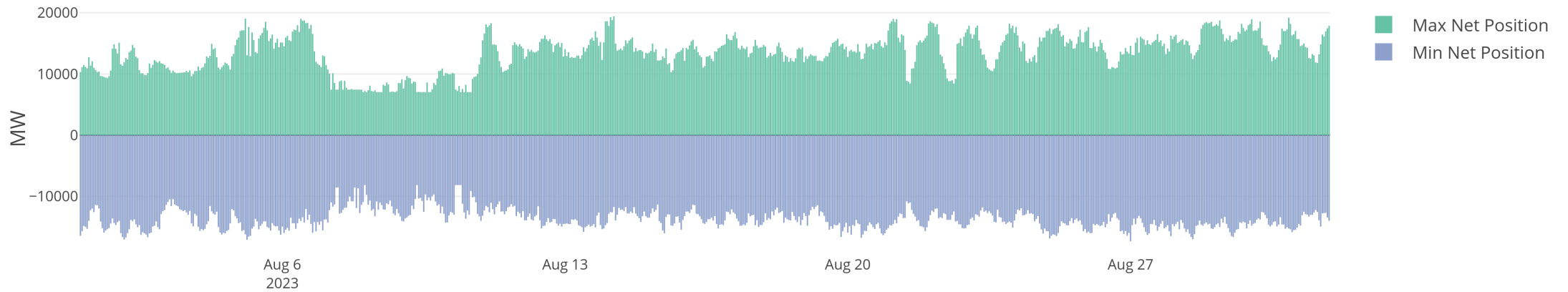
KPI 5: Min & max net positions per BZ hub



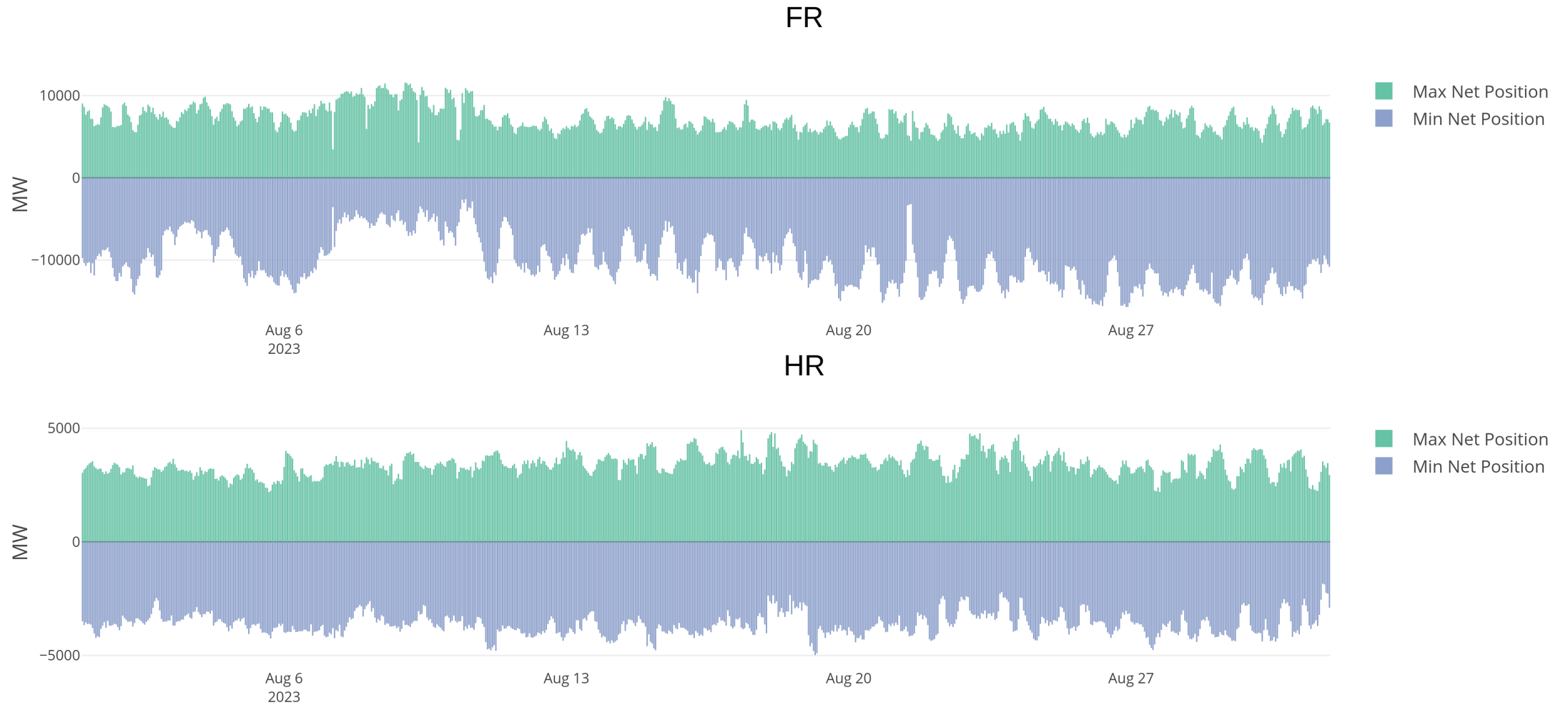
CZ



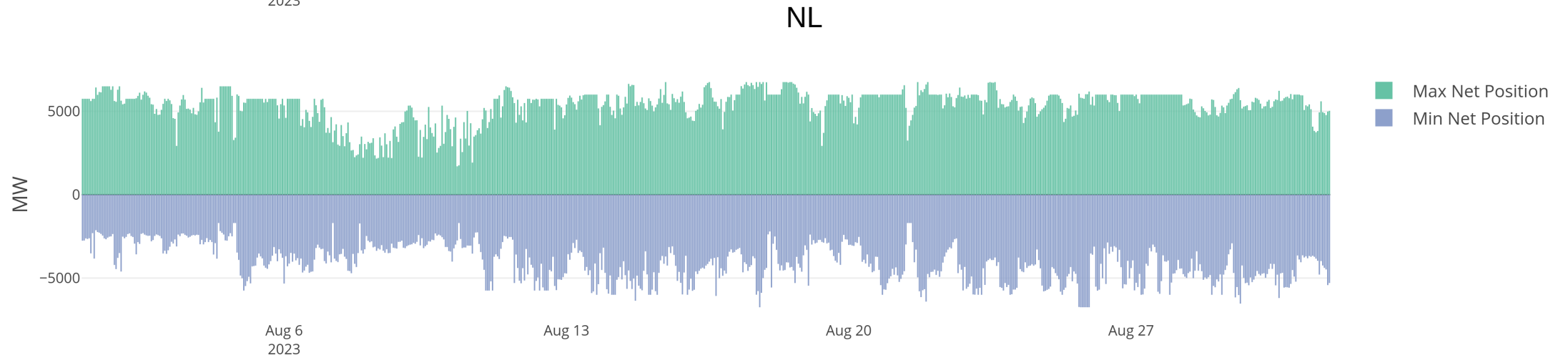
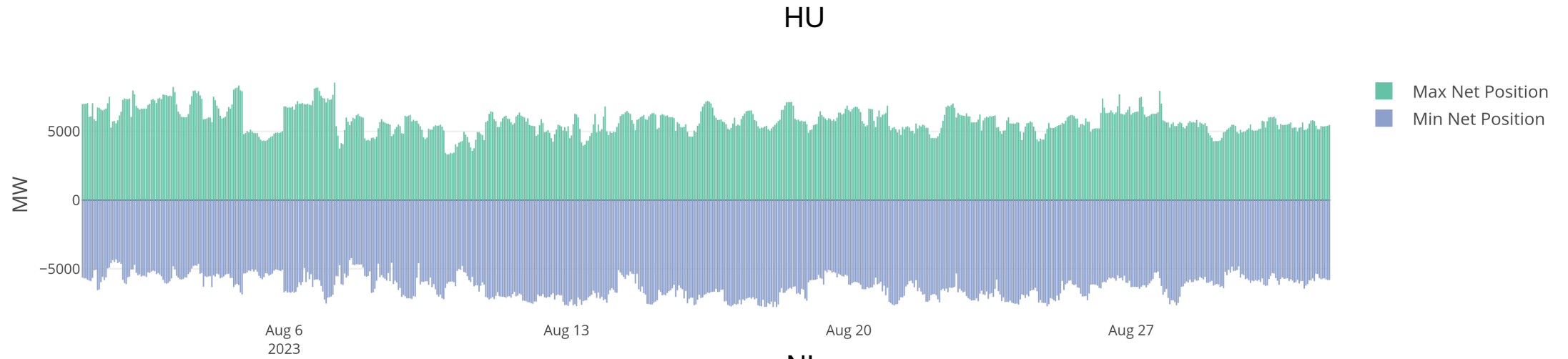
DE



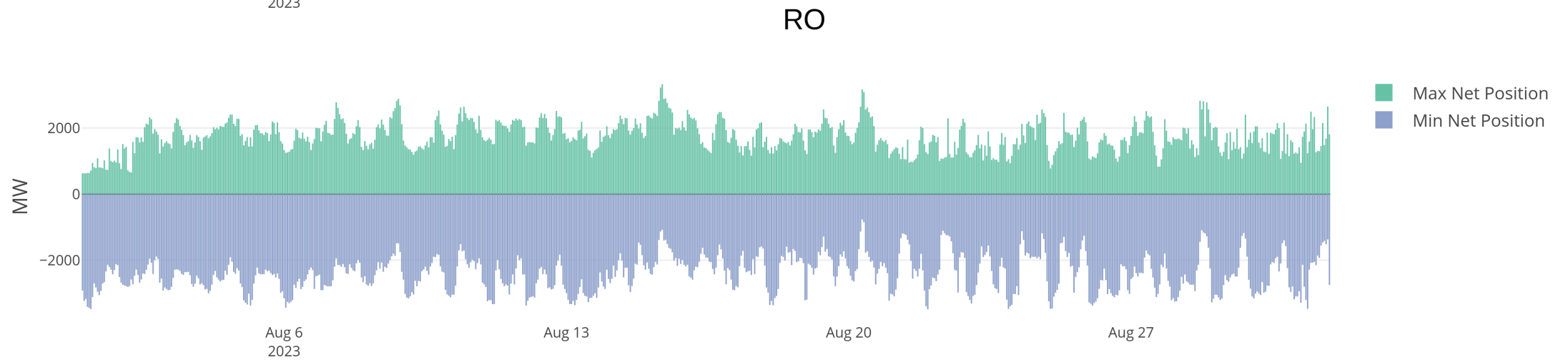
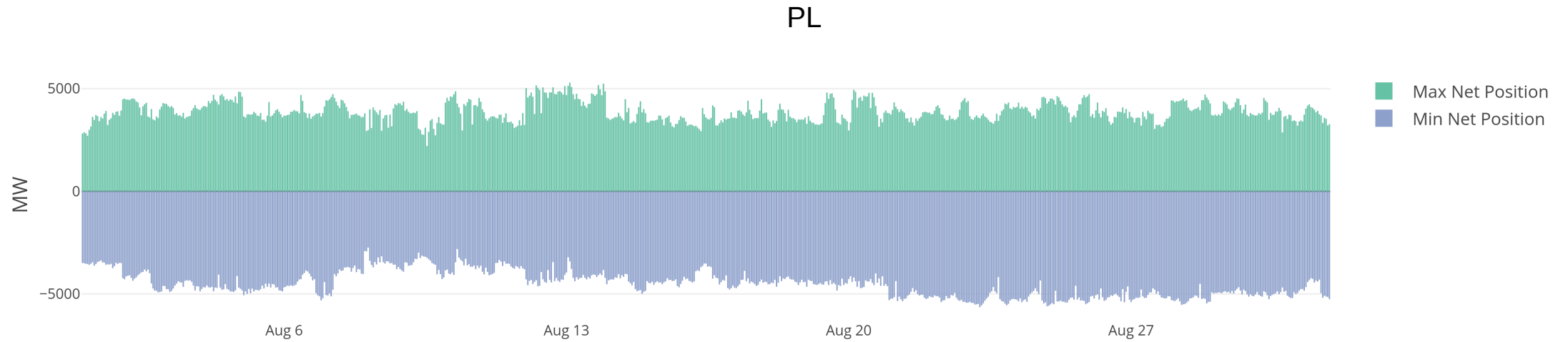
KPI 5: Min & max net positions per BZ hub



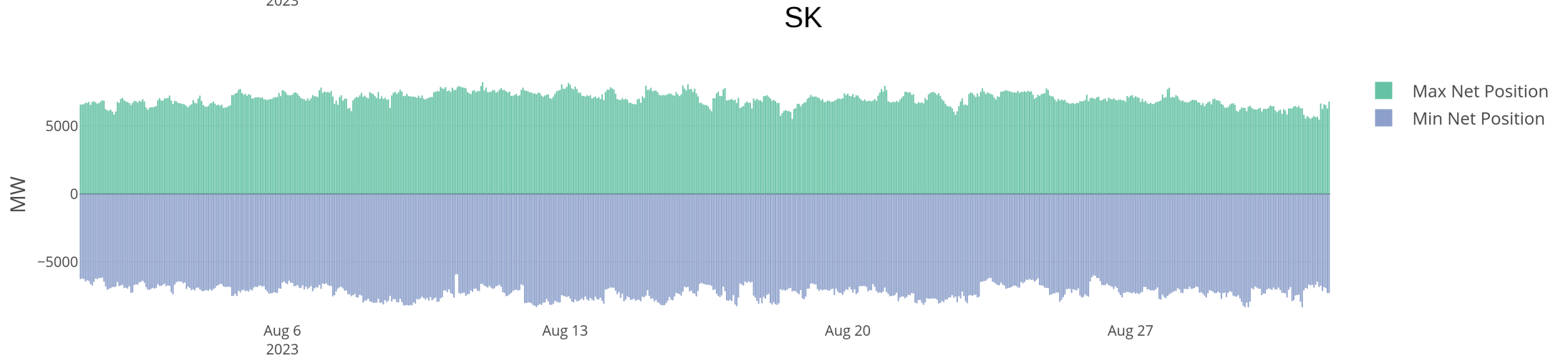
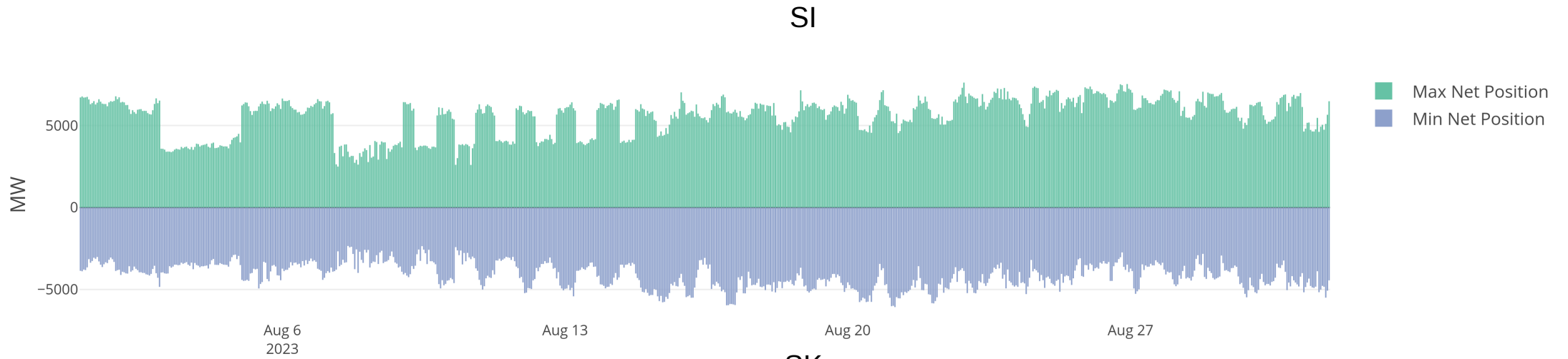
KPI 5: Min & max net positions per BZ hub



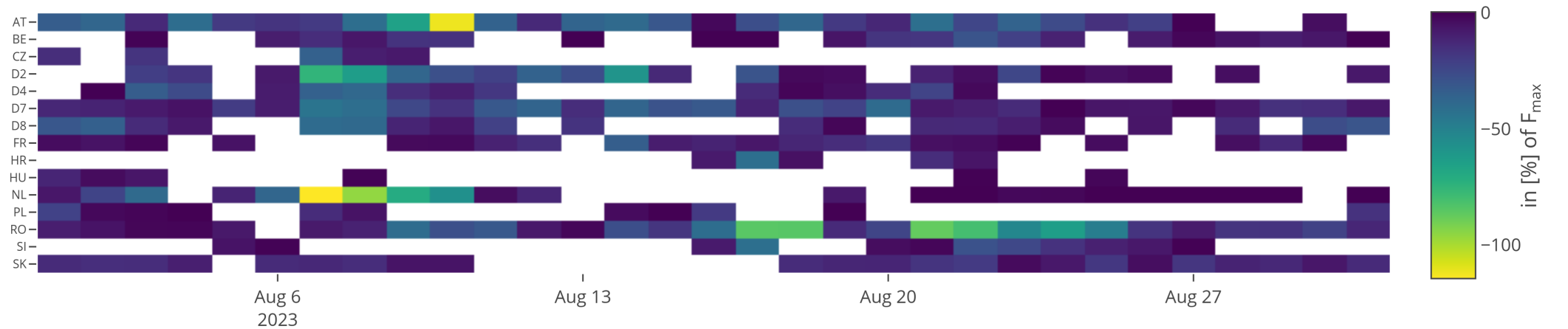
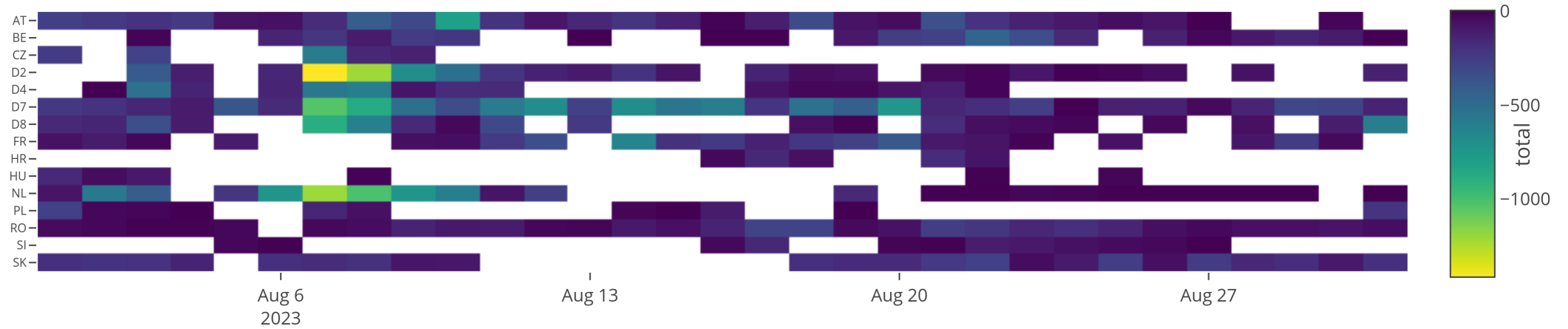
KPI 5: Min & max net positions per BZ hub



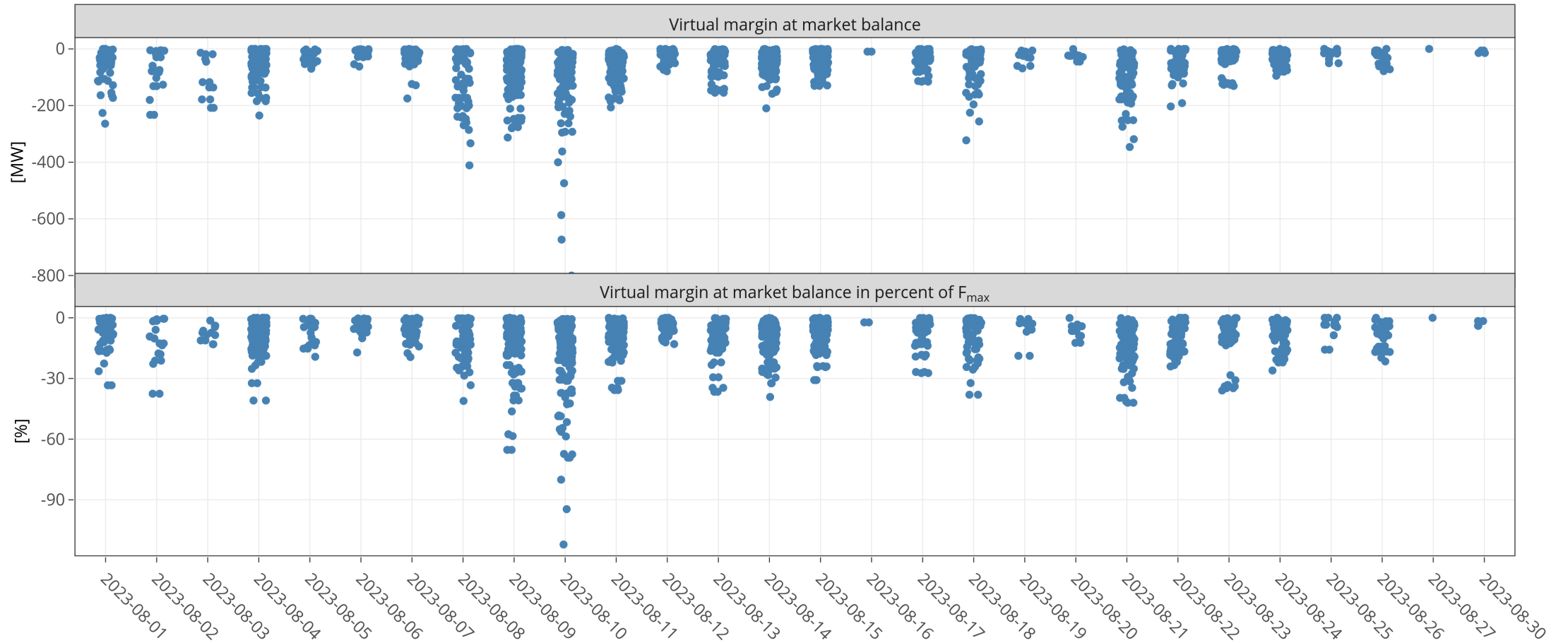
KPI 5: Min & max net positions per BZ hub



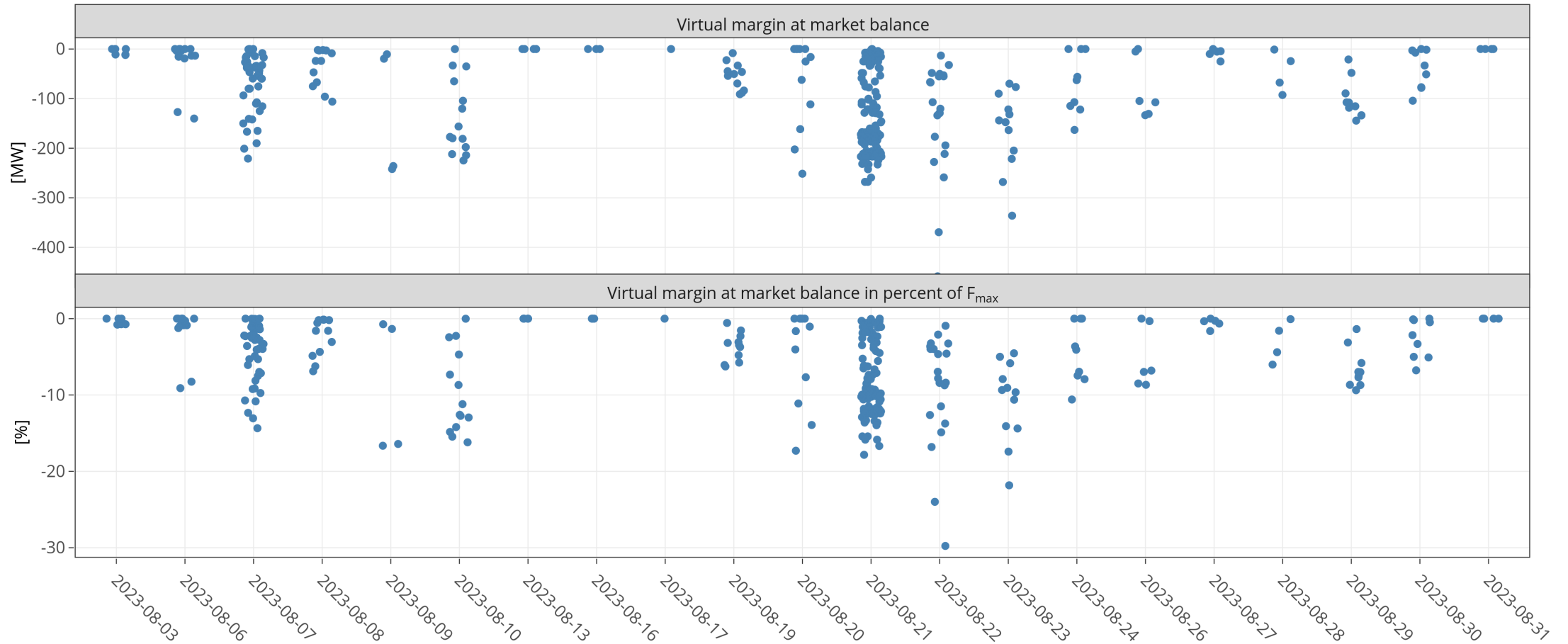
KPI 6a: Highest virtual margins at market balance for CORE TSOs



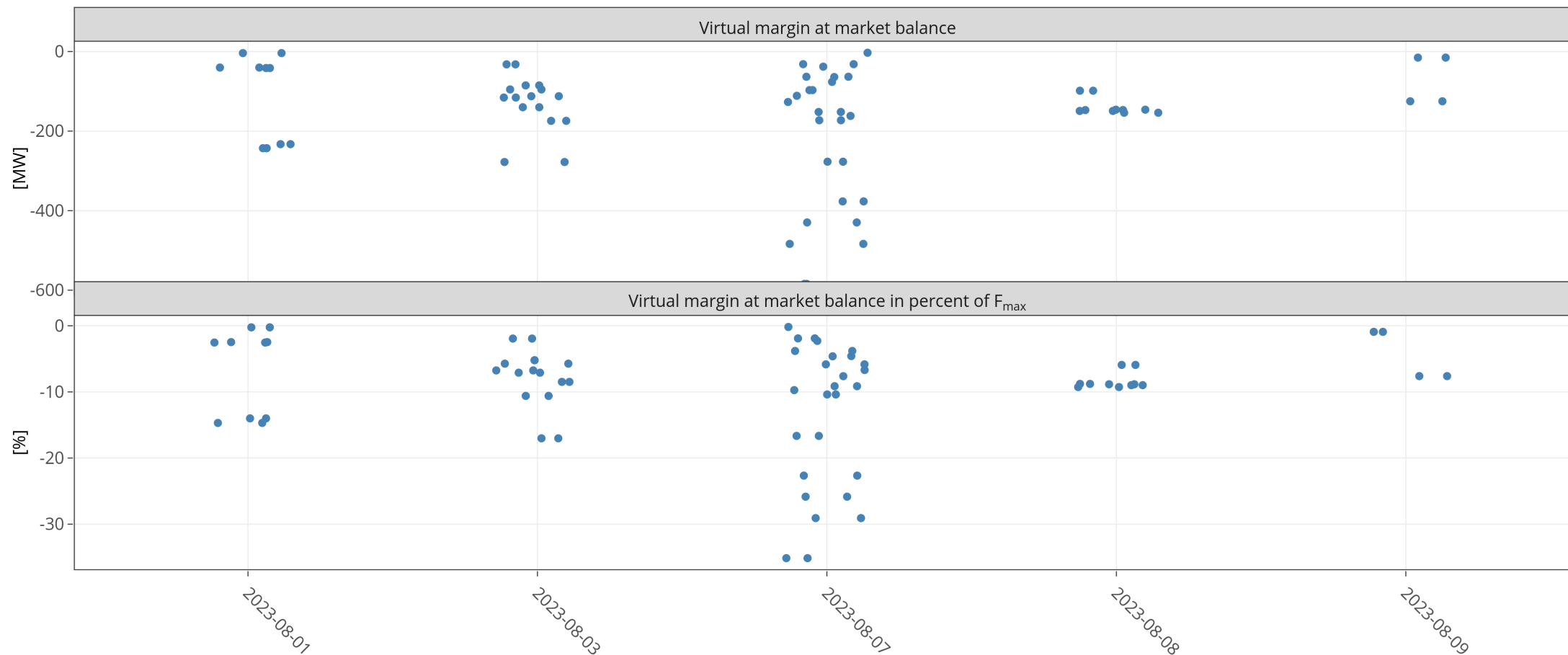
KPI 6b: Virtual margins at market balance AT



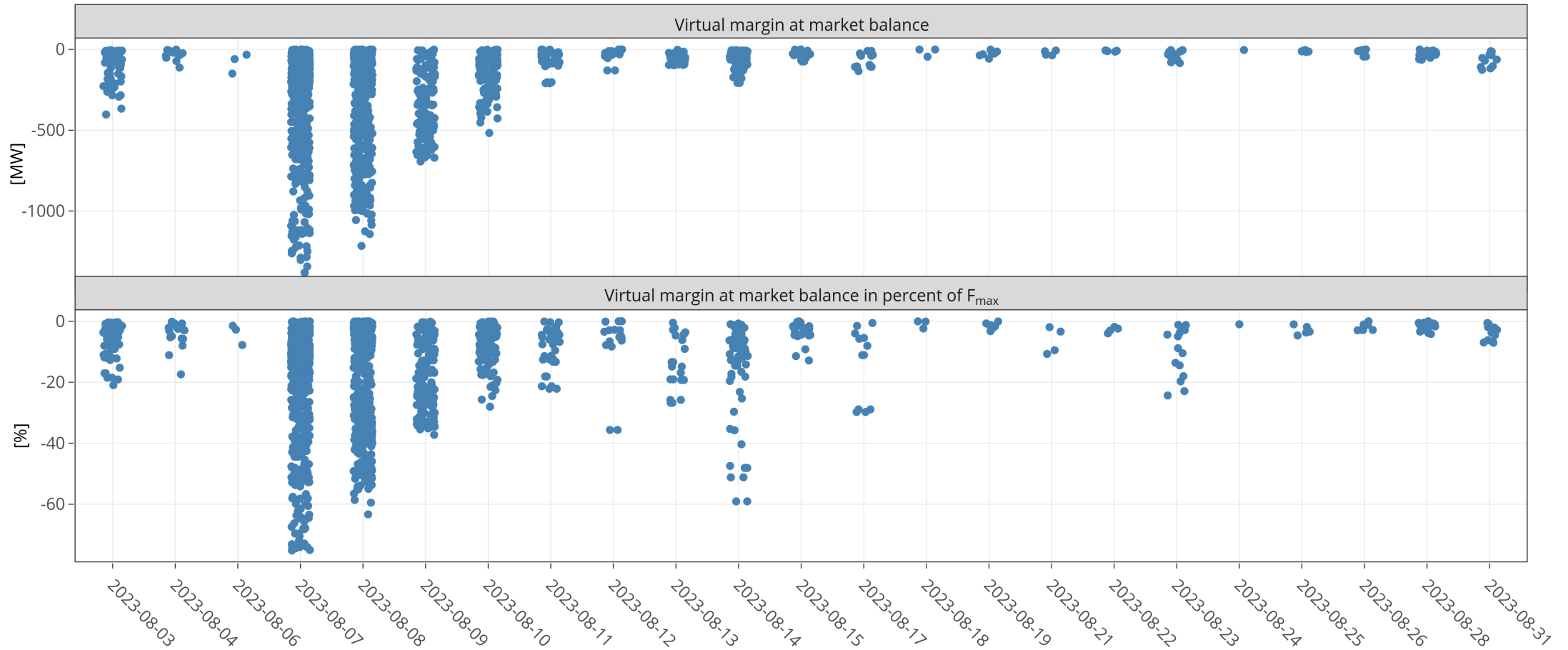
KPI 6b: Virtual margins at market balance BE



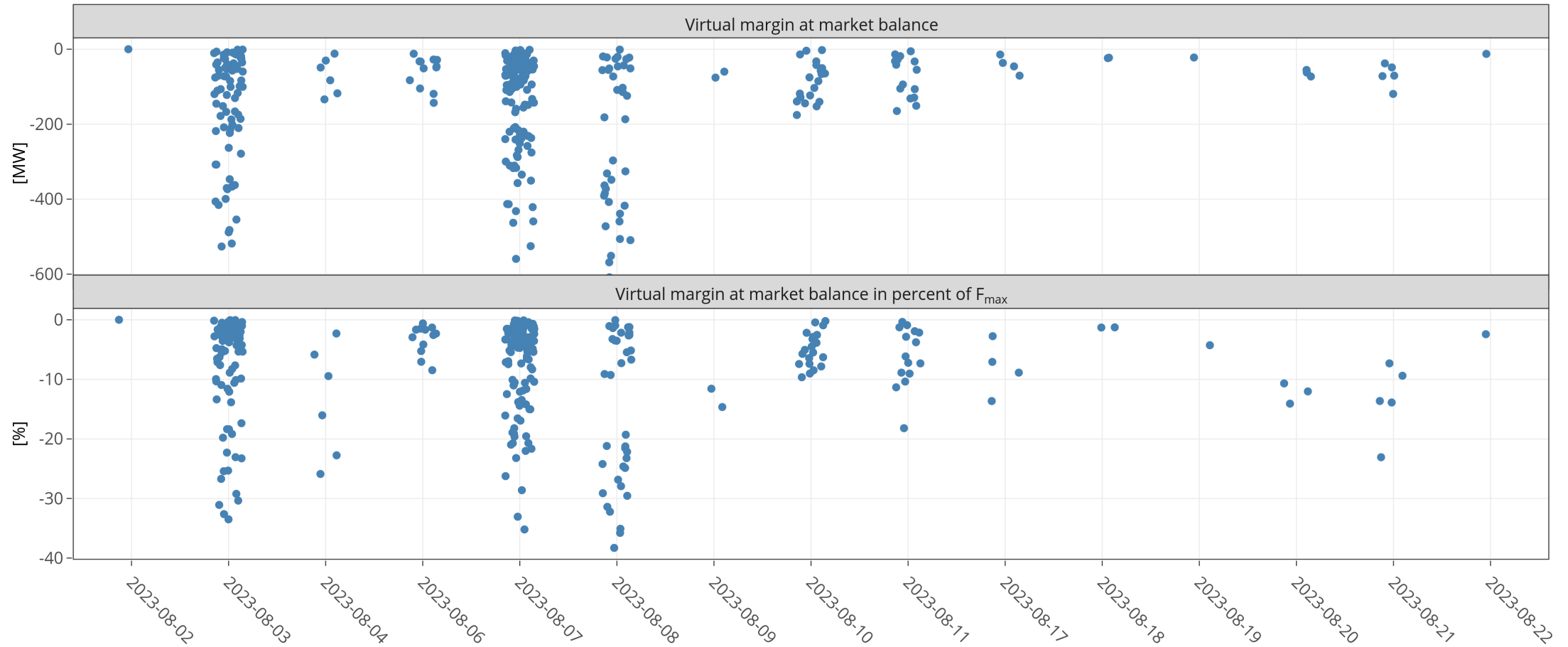
KPI 6b: Virtual margins at market balance CZ



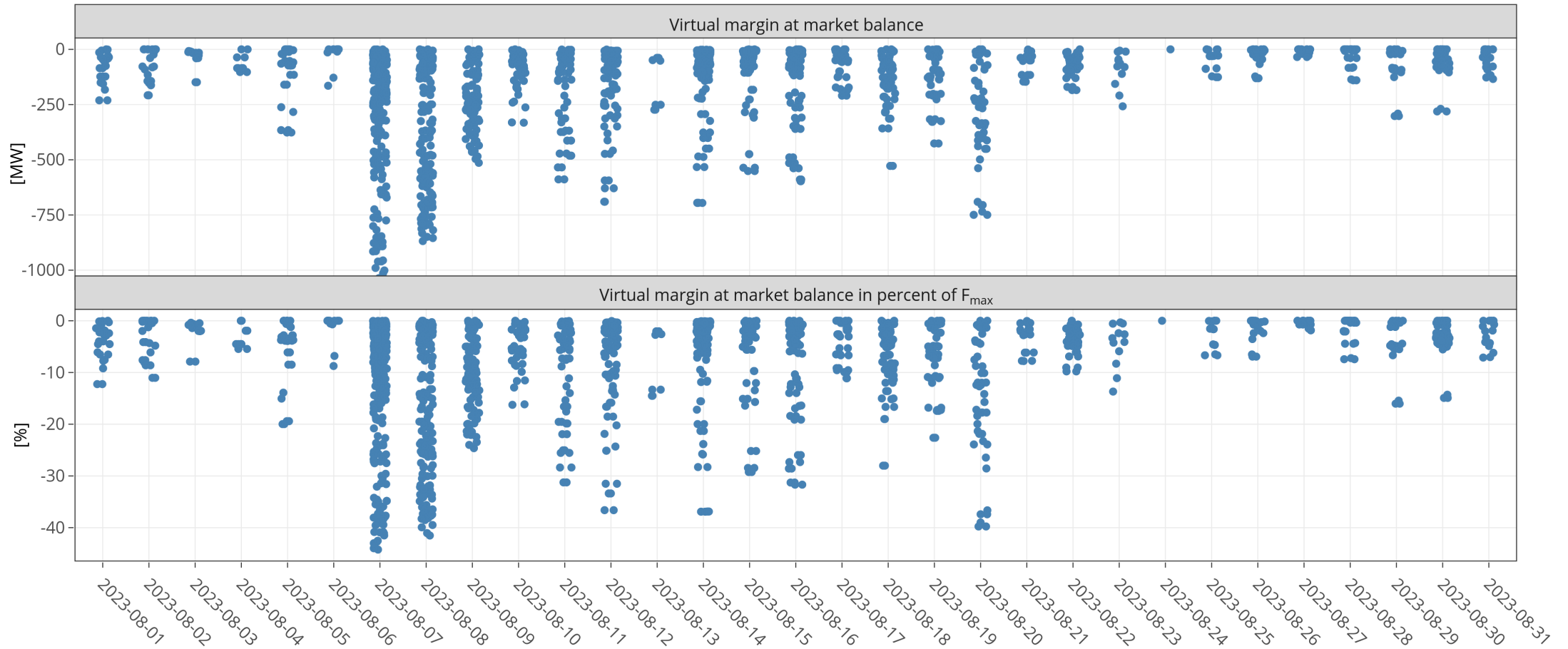
KPI 6b: Virtual margins at market balance D2



KPI 6b: Virtual margins at market balance D4



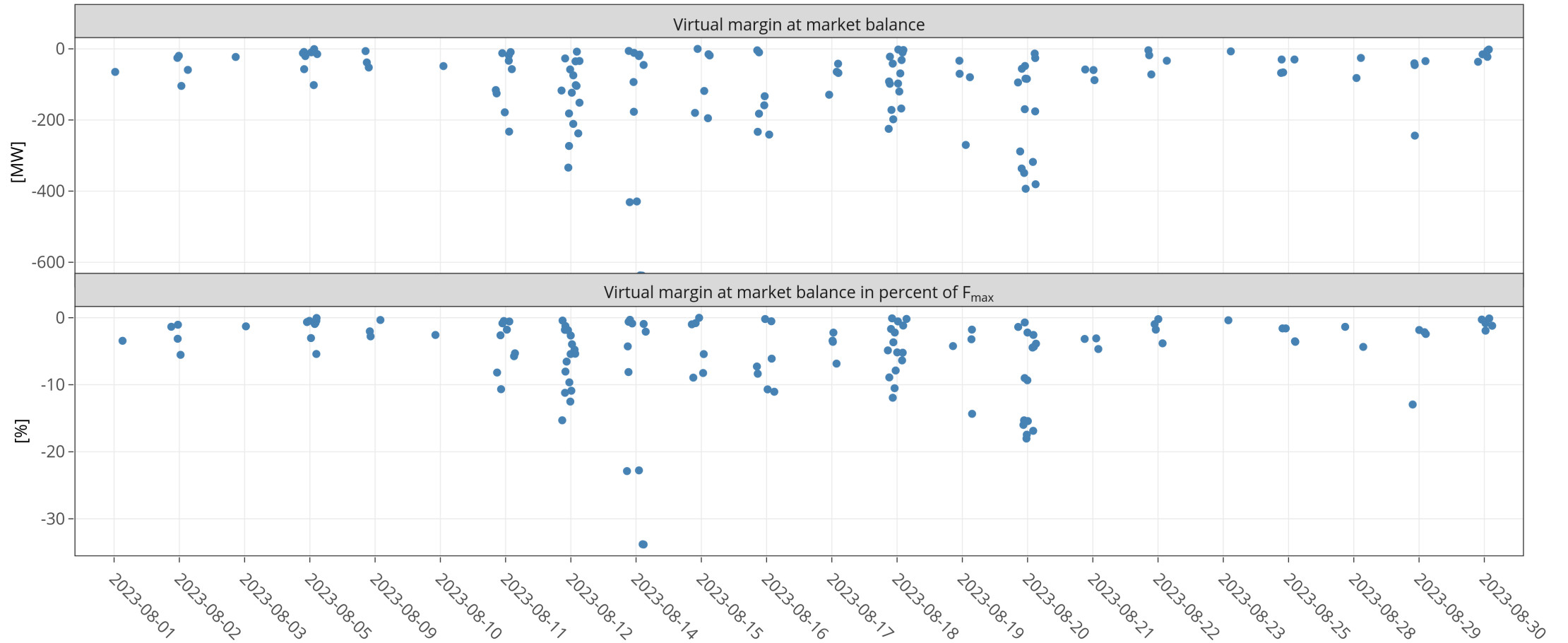
KPI 6b: Virtual margins at market balance D7



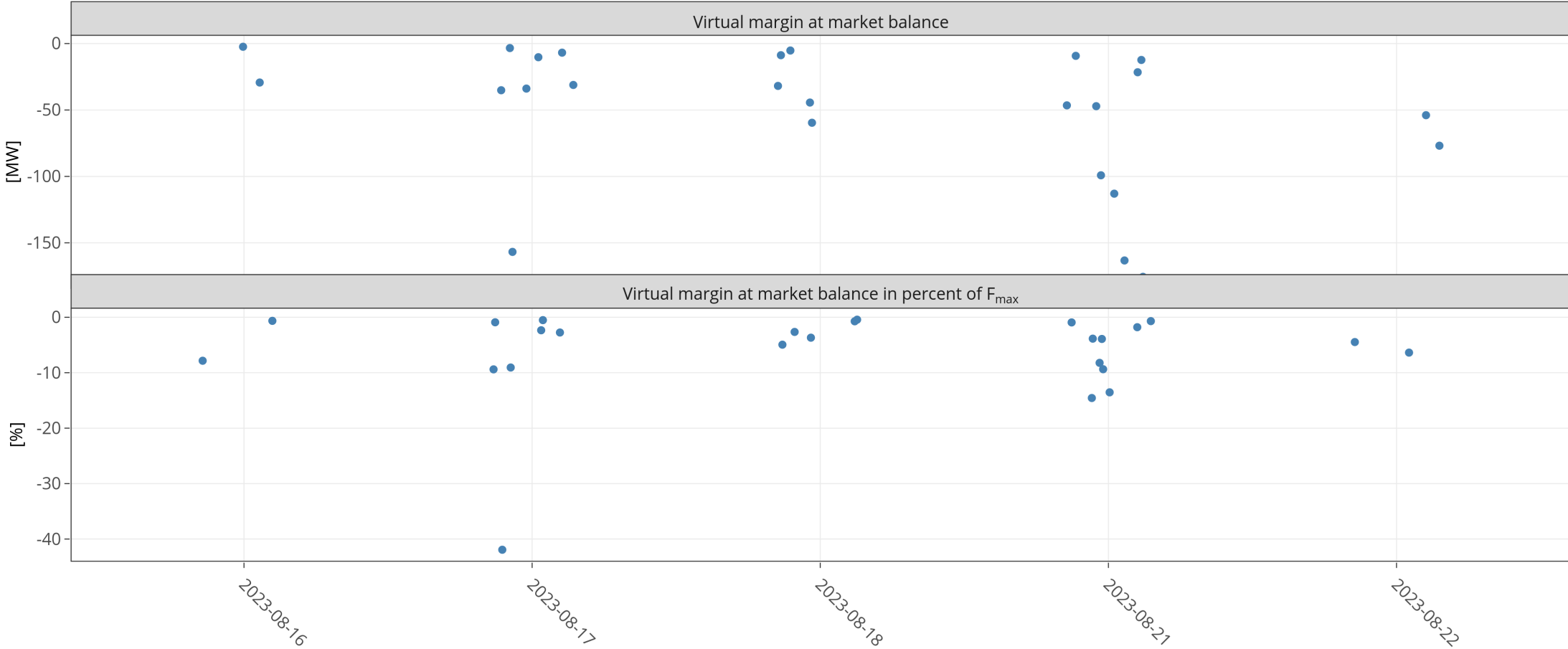
KPI 6b: Virtual margins at market balance D8



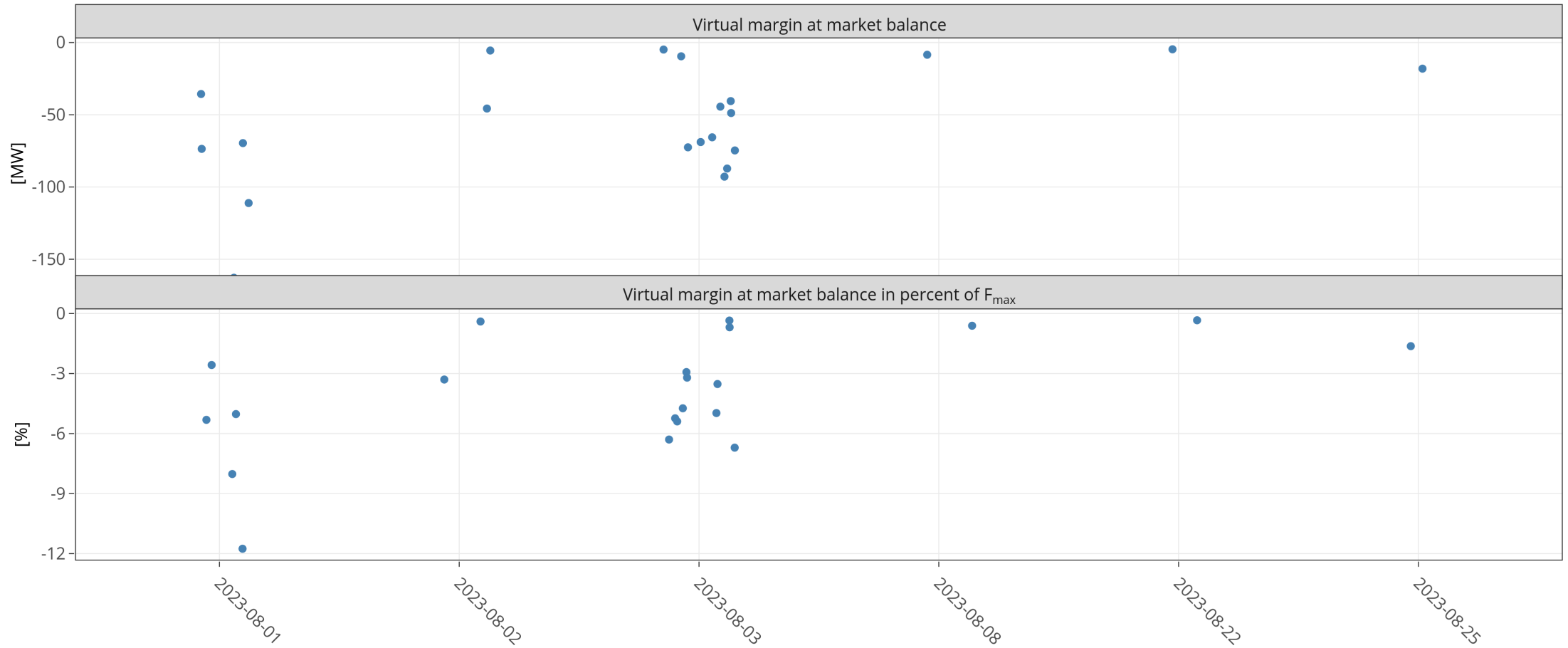
KPI 6b: Virtual margins at market balance FR



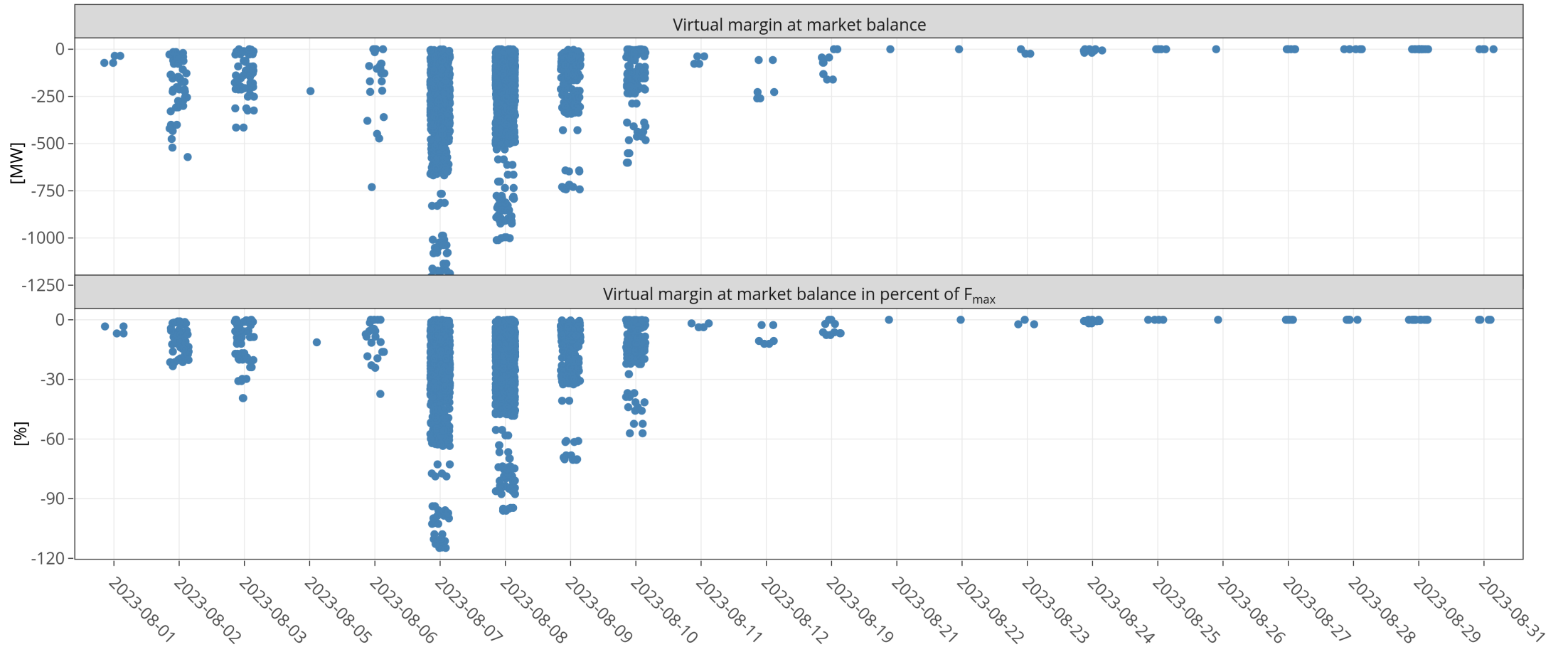
KPI 6b: Virtual margins at market balance HR



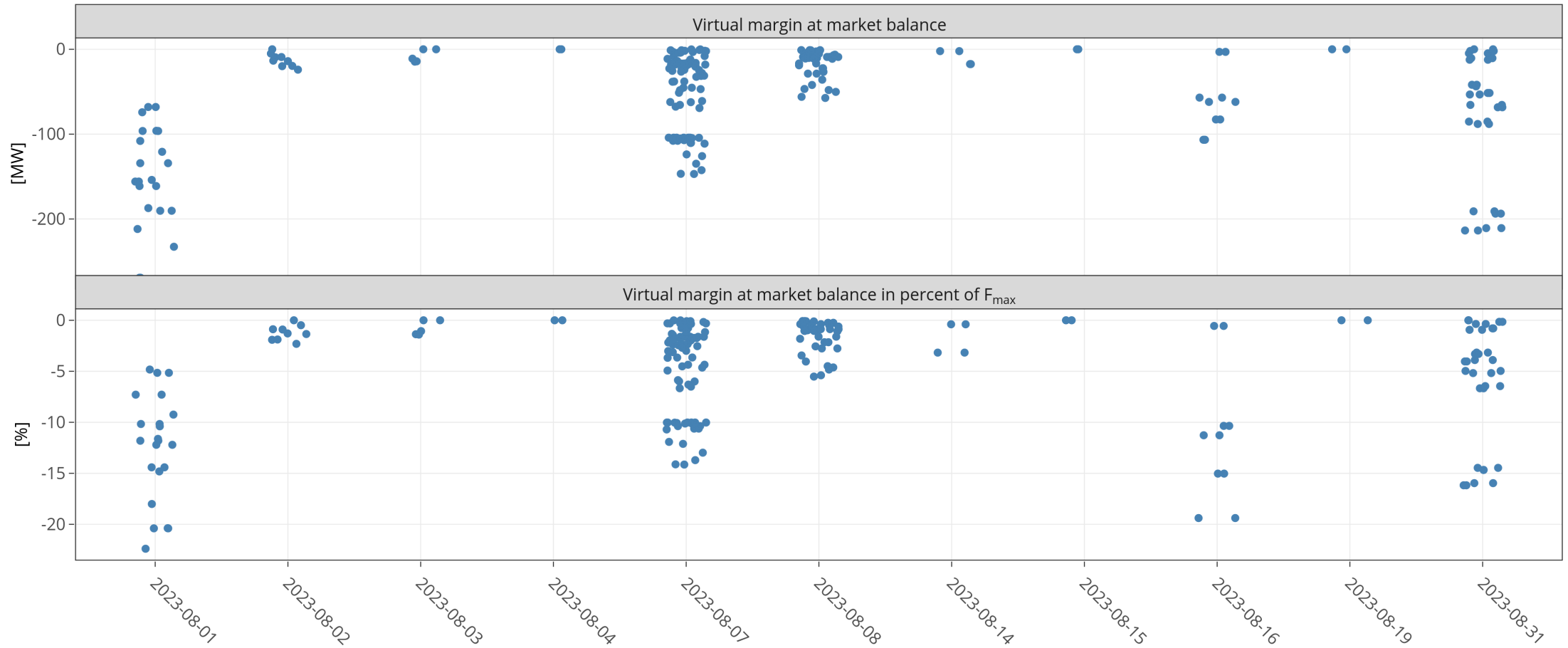
KPI 6b: Virtual margins at market balance HU



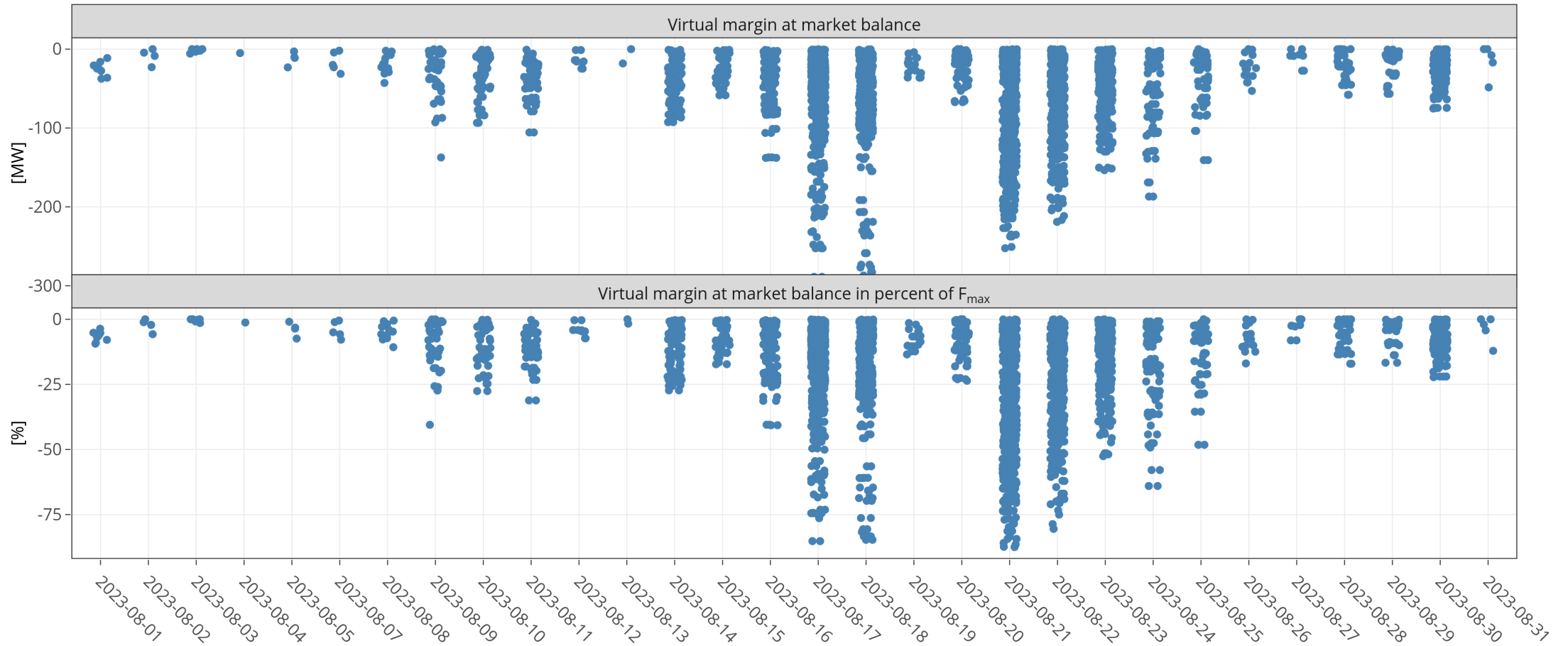
KPI 6b: Virtual margins at market balance NL



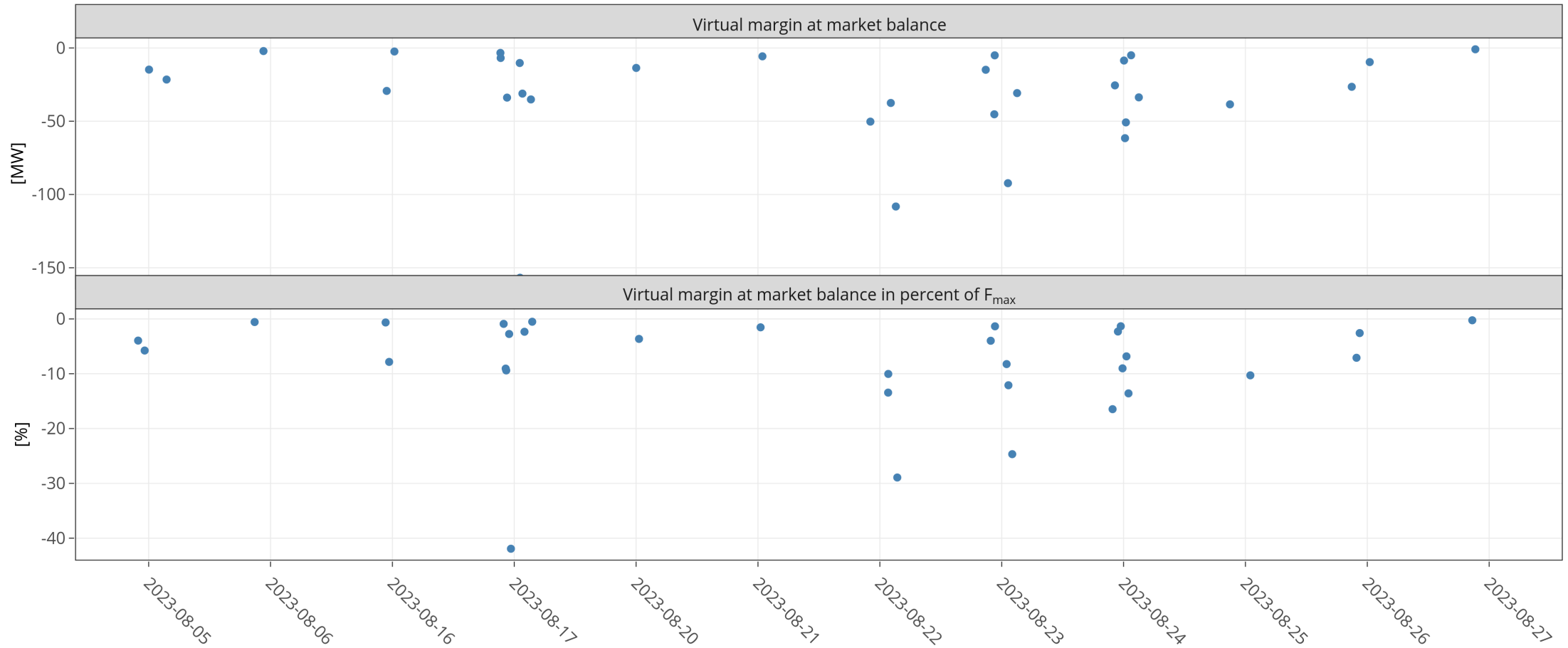
KPI 6b: Virtual margins at market balance PL



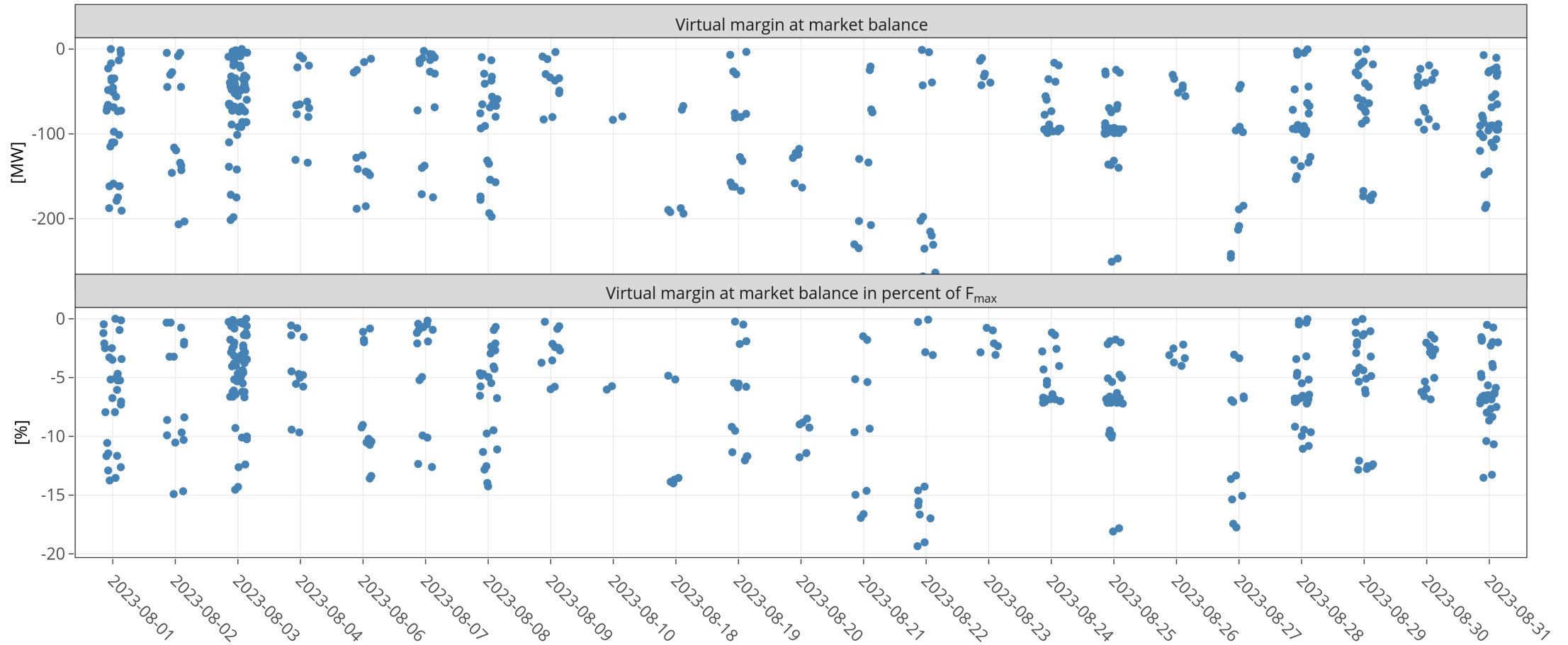
KPI 6b: Virtual margins at market balance RO



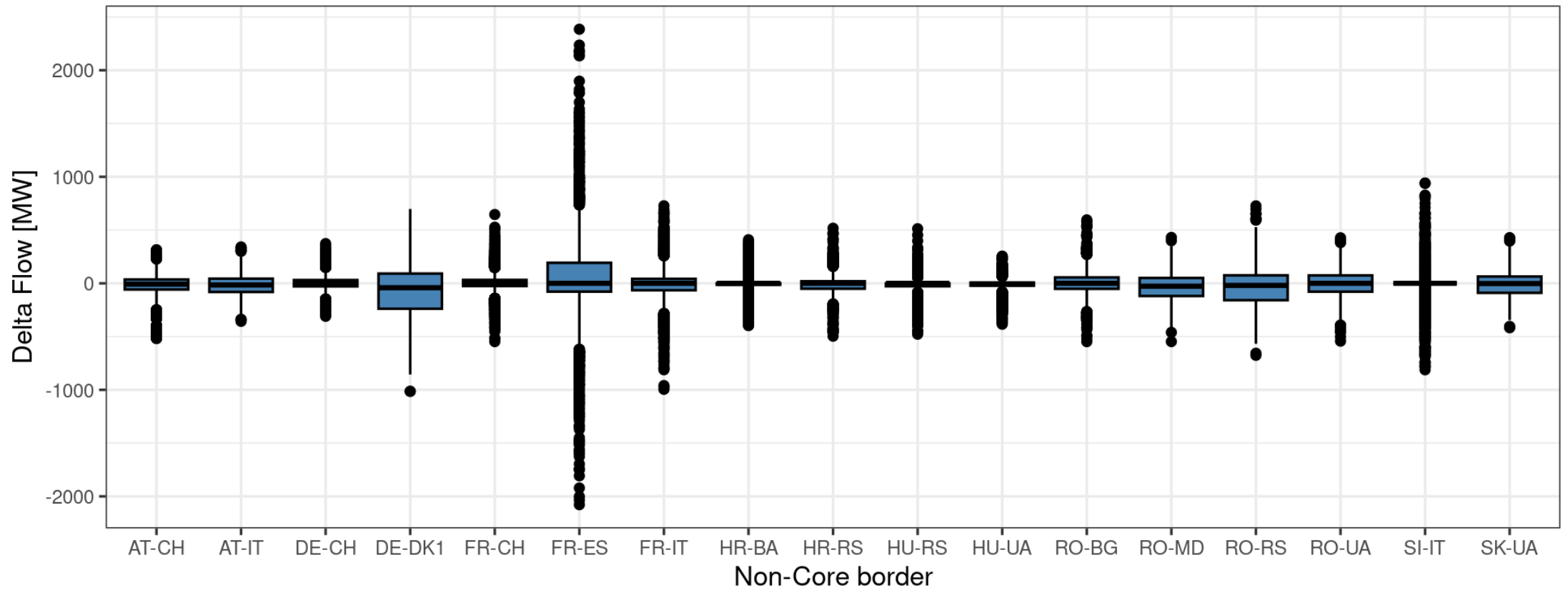
KPI 6b: Virtual margins at market balance SI



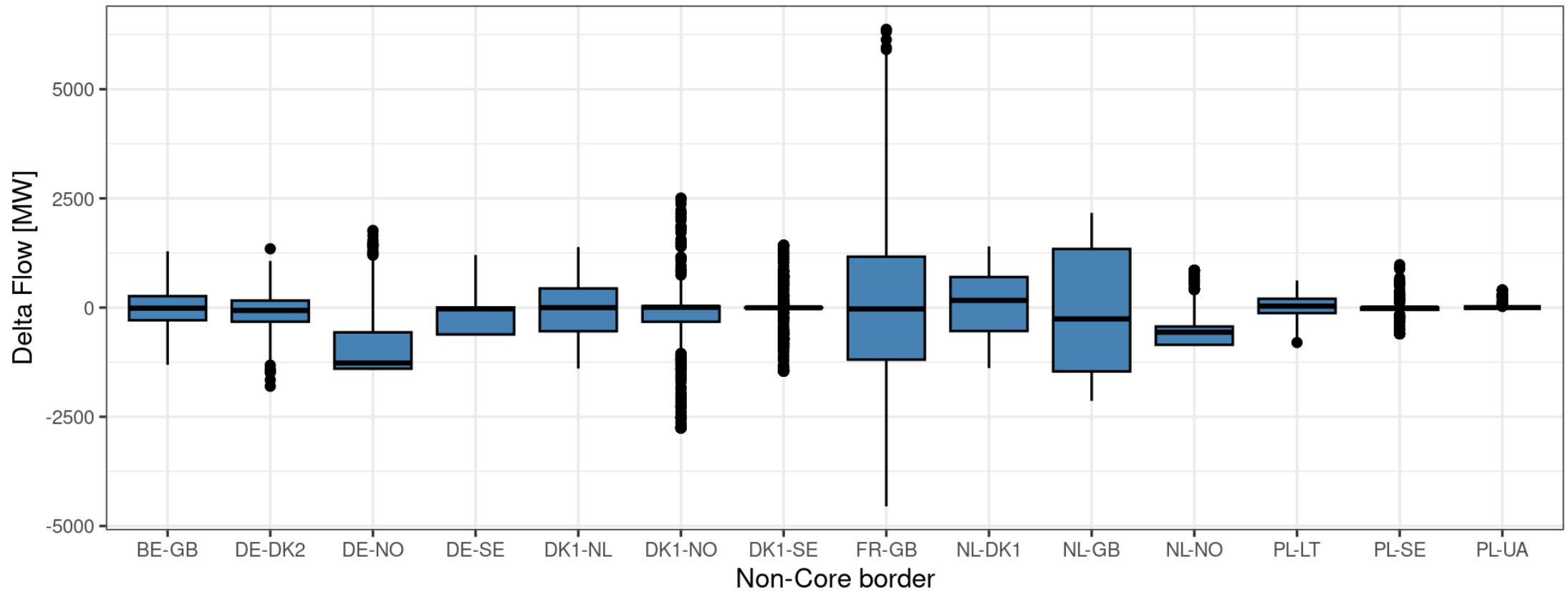
KPI 6b: Virtual margins at market balance SK



KPI 7: Non-Core exchanges AC delta flow



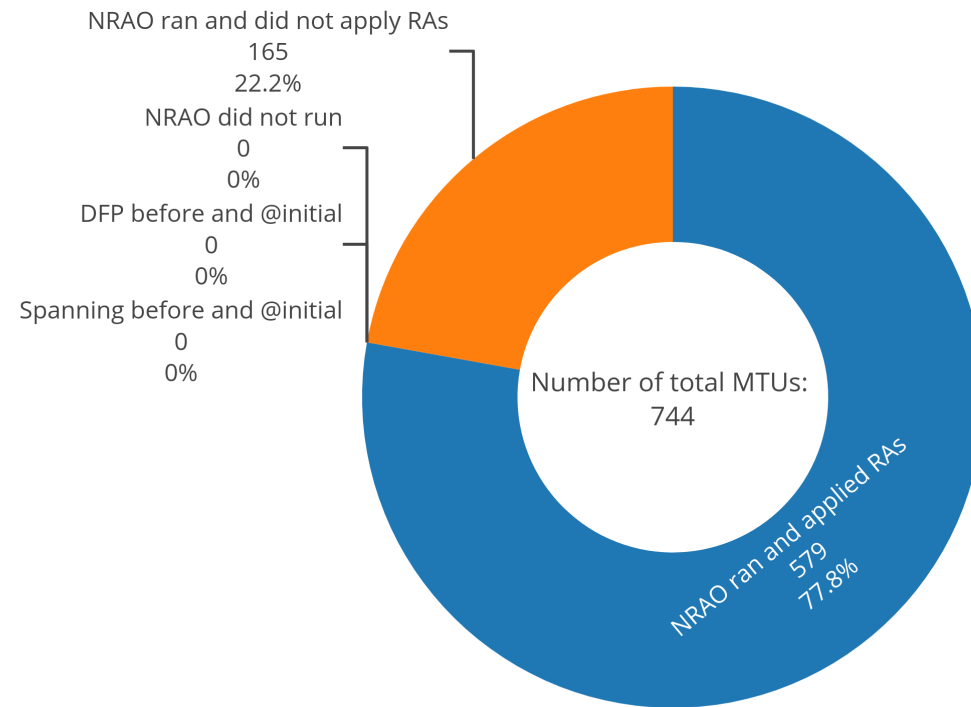
KPI 7: Non-Core exchanges DC delta flow



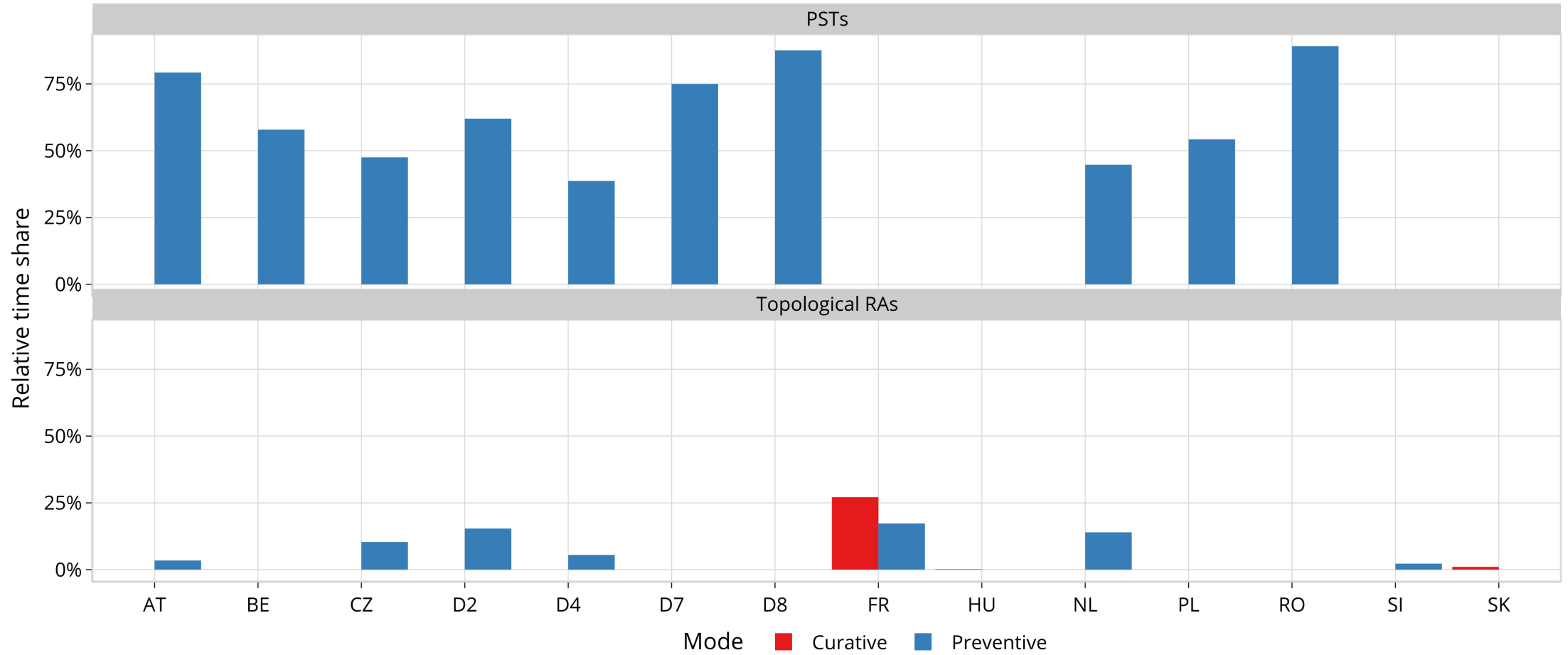
KPI 8: NRAO – Applied Remedial Action



In the following plots, the relative time share relates to the hours labeled 'NRAO Ran and Applied RAs'.

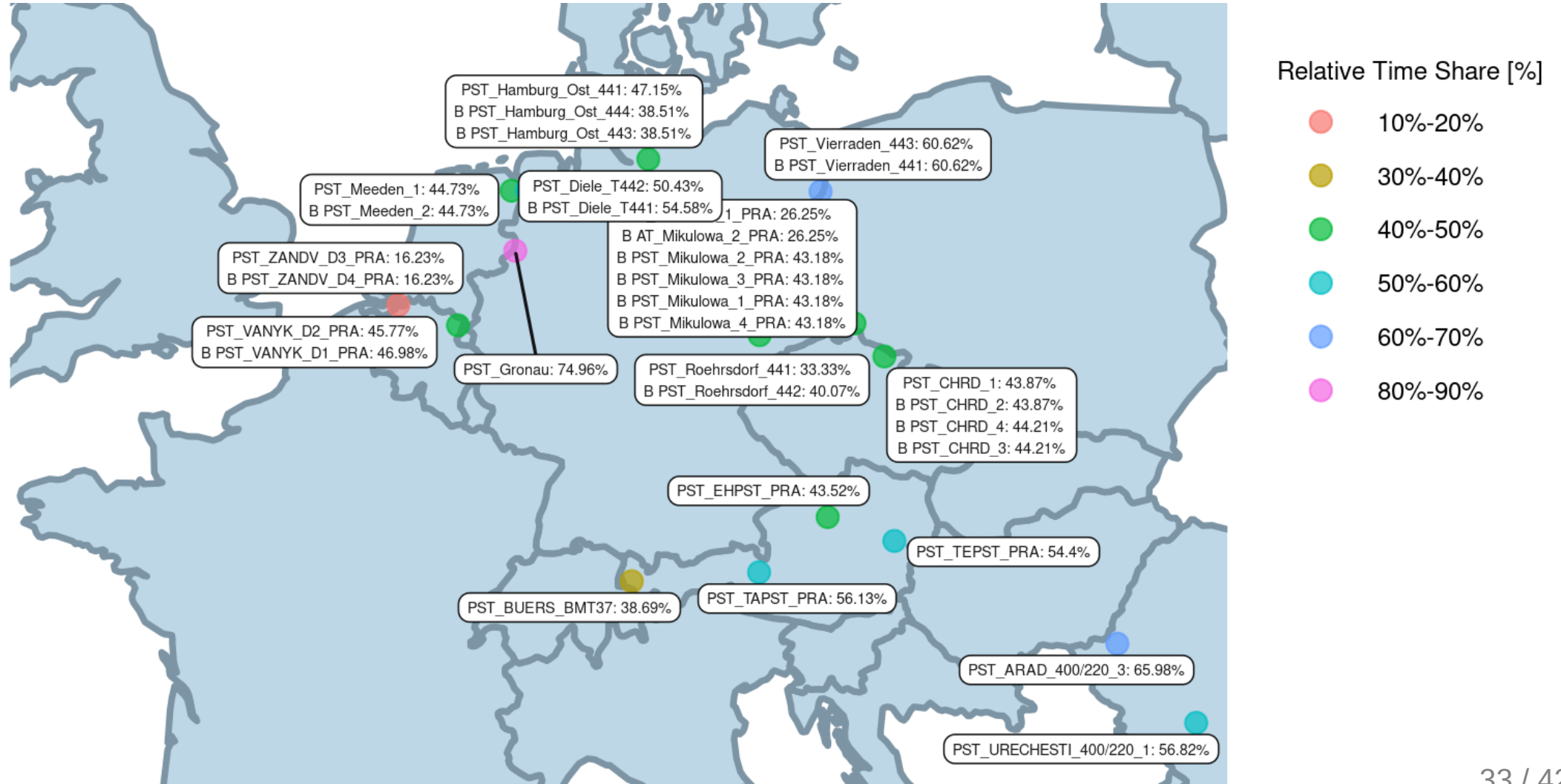


KPI 8: Relative Time Share of Applied RAs, by TSO, Type and Mode



KPI 8: Relative Time Share of Applied RAs, by TSO, Type and Mode

Relative Time Share of Applied PSTs in Preventive Mode



KPI 8: Relative Time Share of Applied RAs, by TSO, Type and Mode

Relative Time Share of Applied PSTs in Curative Mode



KPI 8: Relative Time Share of Applied RAs, by TSO, Type and Mode

Relative Time Share of Applied Topological RAs in Preventive Mode

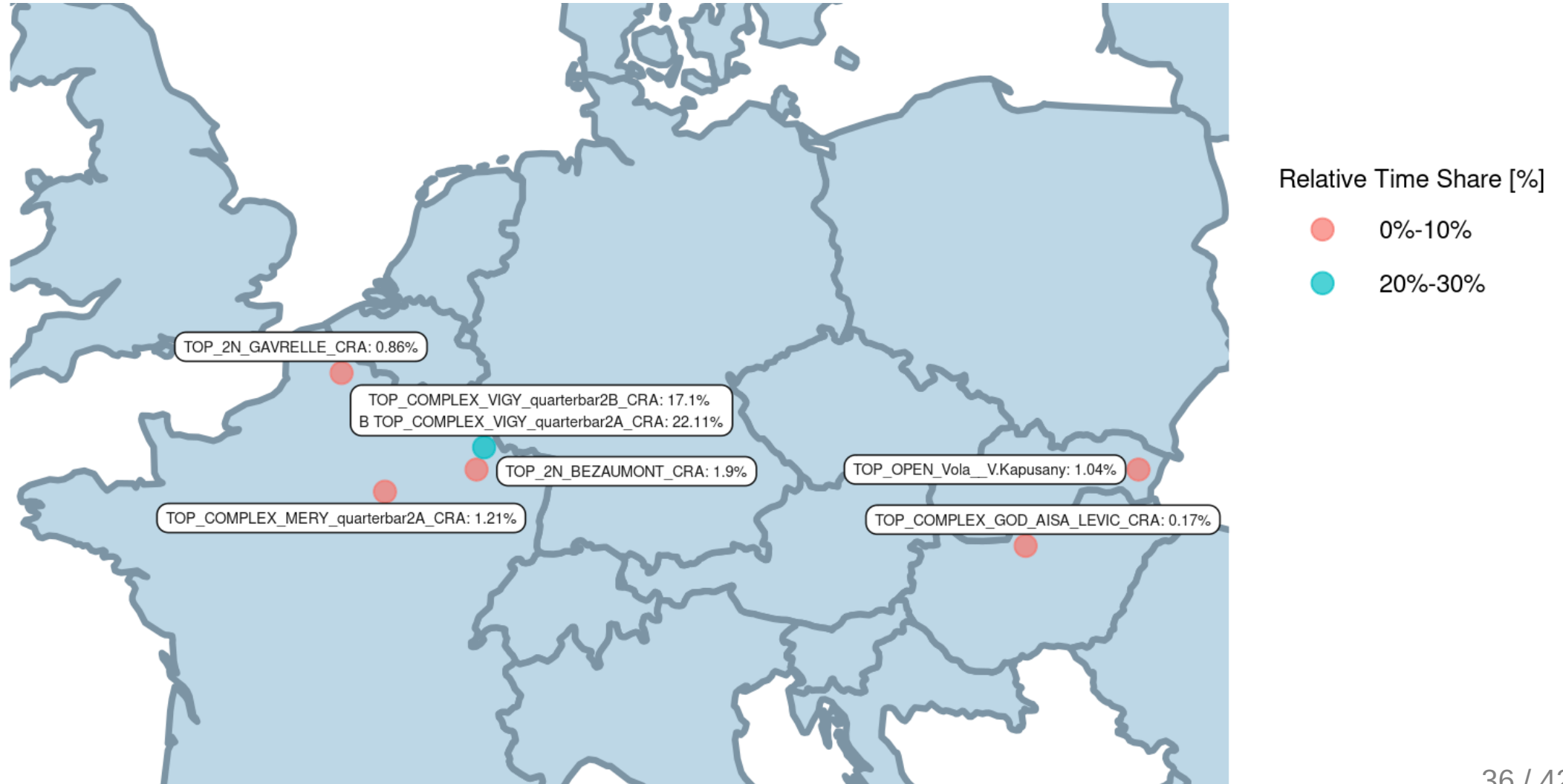


Relative Time Share [%]

- 0%-10%
- 10%-20%

KPI 8: Relative Time Share of Applied RAs, by TSO, Type and Mode

Relative Time Share of Applied Topological RAs in Curative Mode

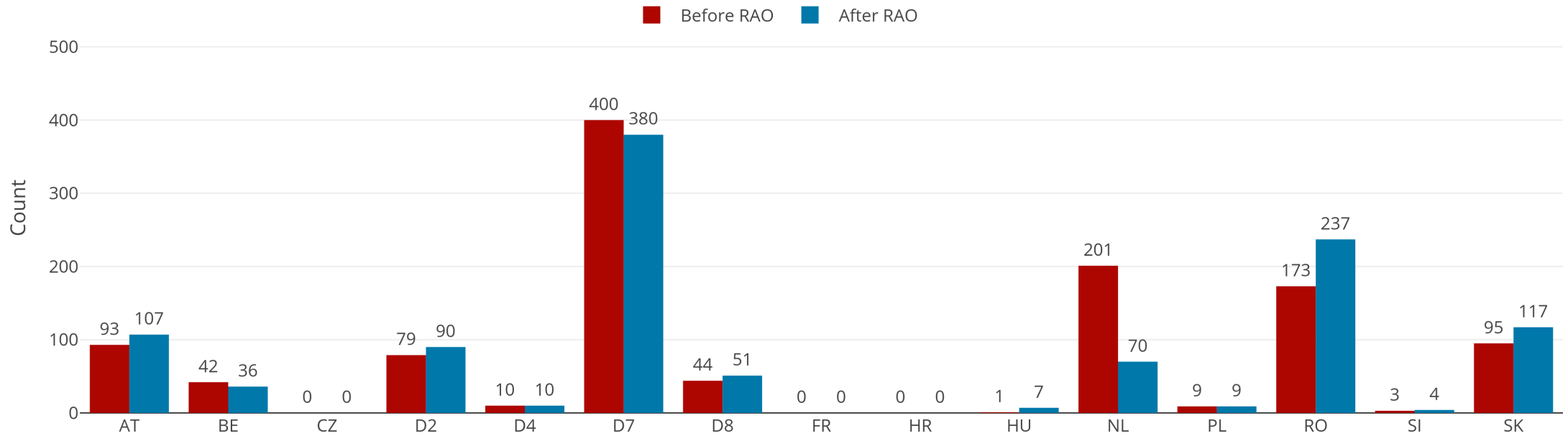


KPI 9: Most limiting CNEC per TSO (NRAO)



The graph below shows the distribution of CNECs which are the most limiting from NRAO perspective, these are the CNECs with lowest relative RAM per MTU

Distribution of Limiting CNECs per TSO



As expected, there is redistributing of the most limiting CNECs. This is because the application of Remedial Actions does not eliminate flows but re-routes, reducing the flows on some limiting CNECs and increasing the load on others, which at the end impacts also the RAM values.

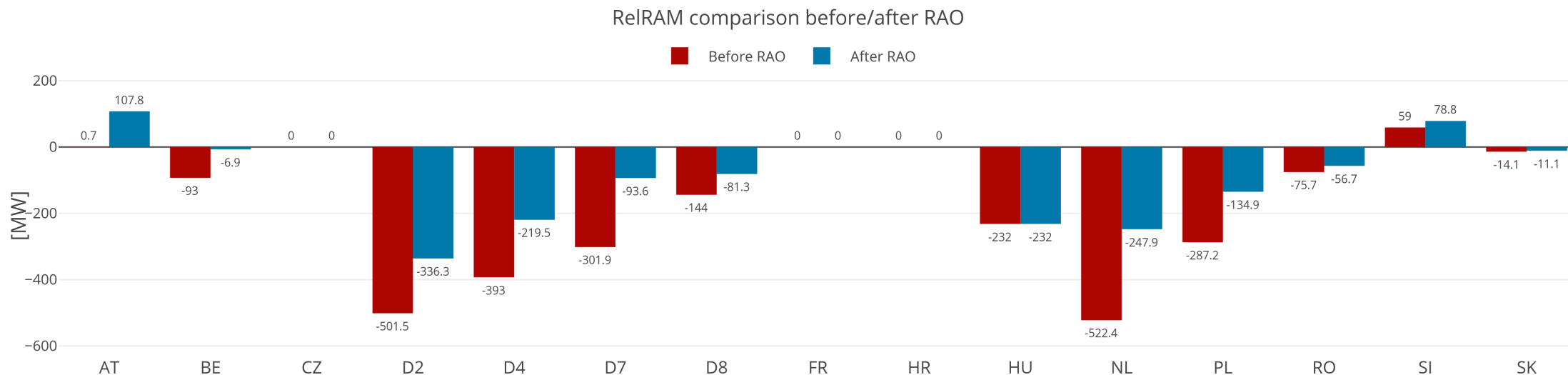
KPI 10: Average variation of relative RAM before and after NRAO



The graph shows average values of relative RAM before and after NRAO, per TSO on the most limiting CNECs from NRAO perspective. Selected CNECs before RAO are the same as after RAO, and average computed for MTUs when was used further in the process.

- Most limiting element from NRAO perspective is the one which has the lowest relative RAM per MTU
- To determine value of relative RAM, the following formula was used

$$RAM_{rel} = \begin{cases} \frac{RAM_{nrao}}{\sum_{(A,B) \in \text{neighbouring Core bidding zones pairs}} |PTDF_{A \rightarrow B, nrao}|}, & \text{if } RAM_{nrao} \geq 0 \\ RAM_{nrao}, & \text{if } RAM_{nrao} < 0 \end{cases}$$



KPI 11: Most often presolved CNEs (top 20)



| CNE | Distinct hours CNE was presolved | Count of presolved CNECs | Avg RAM/Fmax | Min RAM/Fmax | Max RAM/Fmax | Max z2zPTDF | Max sum z2zPTDF |
|---|----------------------------------|--------------------------|--------------|--------------|--------------|-------------|-----------------|
| [HR-SI] 220kV Pehlin - Divaca [OPP] [HR] | 744 | 983 | 101.84% | 61.23% | 209.89% | 0.2139 | 0.5862 |
| [HR-SI] 220kV Pehlin - Divaca [DIR] [HR] | 743 | 755 | 75.91% | 13.64% | 119.52% | 0.2139 | 0.5862 |
| [SK-CZ] Krizovany - Sokolnice [OPP] [SK] | 742 | 890 | 89.11% | 69.41% | 106.64% | 0.3824 | 1.5753 |
| [CZ-SK] Sokolnice - Stupava [DIR] [SK] | 736 | 736 | 78.69% | 65.87% | 93.22% | 0.376 | 1.5229 |
| [AT-SI] Obersielach - Podlog 247 [DIR] [AT] | 731 | 2096 | 61.43% | 19.78% | 145.73% | 0.2283 | 0.6767 |
| [PL-PL] Krosno Iskrzynia - Rzeszow [OPP] | 727 | 727 | 63.79% | 39.00% | 94.56% | 0.317 | 1.1068 |
| [SK-SK] V.Dur - Levice 1 [DIR] | 723 | 723 | 42.89% | 20.56% | 61.33% | 0.2414 | 1.1122 |
| [AT-AT] Westtirol 1 - Westtirol 2 WTRHU41 [OPP] | 722 | 1552 | 56.32% | 19.80% | 157.60% | 0.2817 | 1.1945 |
| [BE-FR] Achene - Lonny 380.19 [OPP] [BE] | 721 | 3064 | 73.99% | 19.83% | 151.43% | 0.2948 | 0.728 |
| [SK-SK] Gabcikovo - P.Biskupice [DIR] | 719 | 719 | 78.72% | 64.87% | 103.10% | 0.3103 | 1.184 |
| [CZ-SK] Liskovec - P. Bystrica [OPP] [CZ] | 709 | 709 | 90.15% | 62.93% | 127.80% | 0.0848 | 0.2908 |
| [AT-SI] Obersielach - Podlog 247 [OPP] [AT] | 690 | 1497 | 110.34% | 15.70% | 195.05% | 0.2283 | 0.6767 |
| [CZ-PL] Wielopole - Nosovice [DIR] [PL] | 681 | 686 | 62.04% | 33.33% | 83.36% | 0.3166 | 1.1089 |
| [D8-PL] Mikulowa PST1 [OPP] [PL] | 674 | 674 | 55.45% | 22.65% | 91.74% | 0.4676 | 1.695 |
| [AT-D2] St. Peter 2 - Pleinting 258 [DIR] [AT] | 670 | 962 | 71.57% | 19.63% | 146.55% | 0.1653 | 0.6 |
| [SI-HU] Cirkovce - Heviz [OPP] [HU] | 668 | 668 | 78.20% | 46.75% | 108.01% | 0.3064 | 1.2409 |
| [SI-HU] Cirkovce - Heviz [DIR] [HU] | 652 | 652 | 100.68% | 72.92% | 135.83% | 0.3064 | 1.2409 |
| [FR-D7] Vigy - Ensdorf VIGY2 S [DIR] [D7] | 649 | 680 | 40.30% | 19.85% | 92.99% | 0.2574 | 0.7003 |
| [AT-HU] Neusiedl - Gyoer 246B [OPP] [AT] | 645 | 645 | 92.03% | 20.94% | 123.93% | 0.0785 | 0.3177 |
| [SK-UA] V.Kapusany - Mukachevo (WPS) [OPP] [SK] | 641 | 652 | 96.88% | 64.89% | 149.82% | 0.2953 | 1.0608 |

Note 1: The shown z2zPTDF values do not correspond to the maximum zone-to-zone PTDFs according to equation 5 of the Day-ahead CCM and hence are not the ones used for the CNEC Selection. The z2zPTDFs are calculated only between neighbouring BZs. See KPI reading guide on JAO.

Note 2: RAM for Core exchanges can be higher than 100% due to the relieving effect of Fuaf: $RAM_{Core} = CEP_{target} - Fuaf$. So if Fuaf is very negative you can get above 100%.

KPI 12: Most limiting CNEs (top 20)



| CNE | Distinct hours CNE has shadow price | Count of CNECs with shadow price | Max shadow price [€/MW] | Avg RAM/Fmax | Min RAM/Fmax | Max RAM/Fmax | Max z2zPTDF |
|--|---|--|----------------------------|--------------|--------------|--------------|-------------|
| [FR-D7] Vigy - Enseldorf VIGY2 S [DIR] [D7] | 270 | 270 | 331.63 | 31.80% | 19.85% | 83.33% | 0.2574 |
| [SK-SK] V.Dur - Levice 1 [DIR] | 110 | 110 | 1526.99 | 36.78% | 21.93% | 51.95% | 0.2166 |
| [AT-D2] St. Peter 2 - Pleinting 258 [DIR] [AT] | 81 | 88 | 509.24 | 52.75% | 19.63% | 102.05% | 0.165 |
| [RO-RO] TR Rosiori 400/220 1 [DIR] | 81 | 81 | 827.6 | 28.00% | 19.00% | 43.75% | 0.1139 |
| [NL-D7] Maasbracht - Siersdorf SELFK SW [DIR] [D7] | 70 | 70 | 122.58 | 57.63% | 34.64% | 87.41% | 0.2865 |
| [AT-SI] Obersielach - Podlog 247 [DIR] [AT] | 70 | 74 | 419.2 | 37.44% | 19.78% | 82.98% | 0.2283 |
| [BE-FR] Achene - Lonny 380.19 [OPP] [BE] | 69 | 69 | 53.77 | 39.86% | 19.87% | 78.70% | 0.2555 |
| [NL-D2] Meeden-Diele 380 Z [OPP] [NL] | 62 | 62 | 629.82 | 21.33% | 19.94% | 43.59% | 0.25 |
| [RO-RO] Resita - Timisoara c1 [DIR] | 60 | 62 | 389.16 | 30.25% | 20.21% | 58.41% | 0.1449 |
| [D8-PL] Mikulowa PST1 [OPP] [PL] | 60 | 60 | 140.27 | 43.33% | 22.65% | 74.39% | 0.445 |
| [NL-BE] Rilland-Zandvliet 380 W [DIR] [NL] | 56 | 57 | 259.57 | 52.44% | 20.03% | 114.95% | 0.5927 |
| [NL-D2] Meeden-Diele 380 Z [DIR] [NL] | 55 | 55 | 488.35 | 62.89% | 30.20% | 125.07% | 0.2366 |
| [BE-BE] Achene - Gramme 380.10 [OPP] | 48 | 48 | 305.74 | 65.34% | 19.94% | 99.93% | 0.2942 |
| [NL-D7] Maasbracht - Oberzier SELFK WS [DIR] [D7] | 44 | 48 | 159.29 | 41.73% | 19.98% | 70.55% | 0.3276 |
| [AT-AT] Tauern - Weissenbach 221 [OPP] | 44 | 44 | 965.8 | 46.67% | 19.75% | 132.60% | 0.0936 |
| [AT-AT] Westtirol 1 - Westtirol 2 WTRHU41 [OPP] | 40 | 41 | 127.43 | 39.32% | 19.80% | 96.50% | 0.2757 |
| [AT-AT] Strass - Thaur 273B [DIR] | 32 | 32 | 110.13 | 66.14% | 19.86% | 117.26% | 0.1319 |
| [D8-D8] Pasewalk - Vierraden 306 [DIR] | 31 | 31 | 827.49 | 32.78% | 19.90% | 44.12% | 0.1292 |
| [BE-FR] Achene - Lonny 380.19 [DIR] [BE] | 30 | 32 | 435.2 | 38.54% | 19.90% | 59.68% | 0.2941 |
| [CZ-SK] Liskovec - P. Bystrica [OPP] [CZ] | 28 | 28 | 323.07 | 77.34% | 63.32% | 88.03% | 0.0797 |

Note 1: The RAM values (expressed as % of Fmax) should not be interpreted as "the capacities offered by the Core TSOs to the market coupling". Indeed, since the introduction of Ext LTA inclusion Euphemia performs an optimization where it takes a portion of the FB domain and a portion of the LTA domain to maximize welfare. The RAM value shown in this KPI report correspond to the "portion of the FB domain" resulting from this optimization

Example:

- RAM = 500MW
- Portion of FB Domain = 40%
- RAM offered by Core TSOs = $400\text{mW}/0.4 = 1250\text{MW}$

KPI 13a: Allocation Constraints - Belgium



| | # MTUs |
|--|--------|
|--|--------|

AC was Limiting MC 0

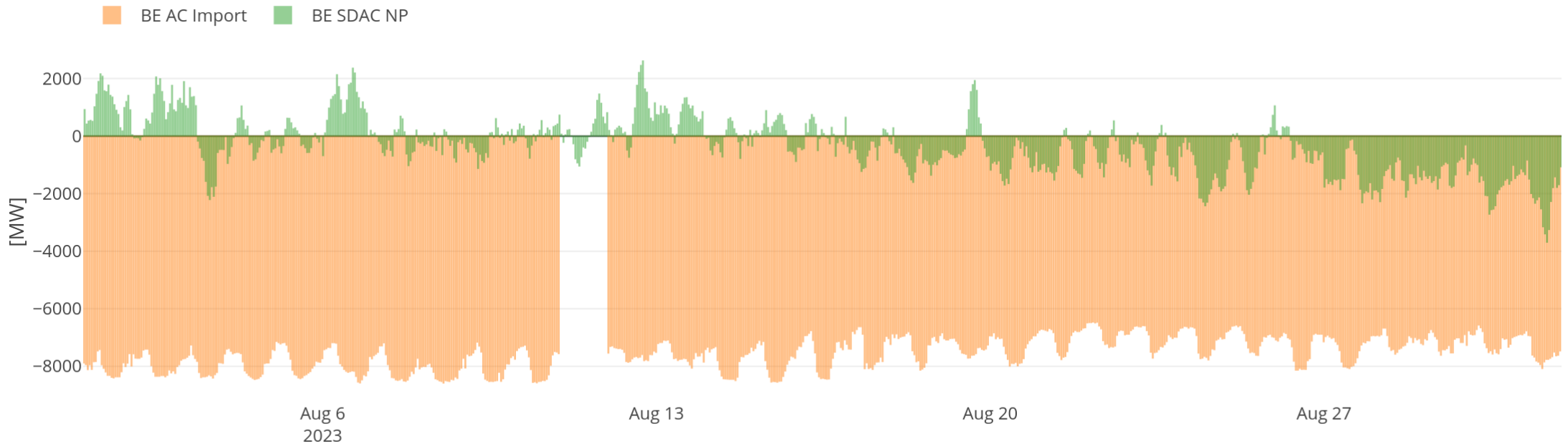
| | BE AC Import [MW] |
|--|-------------------|
|--|-------------------|

Avg. -7545.51

Min. -8579.00

Max. -6463.00

Belgium only uses import allocation constraints



KPI 13b: Allocation Constraints - Poland



| | # MTUs |
|--------------------|--------|
| AC was limiting MC | 401 |
| AC < 0 MW | 131 |
| AC = 0 MW | 264 |
| AC > 0 MW | 6 |

| | PL AC Import [MW] | PL AC Export [MW] |
|------|-------------------|-------------------|
| Avg. | -1206.77 | 2483.86 |
| Min. | -8992.00 | 0.00 |
| Max. | 0.00 | 9037.00 |

