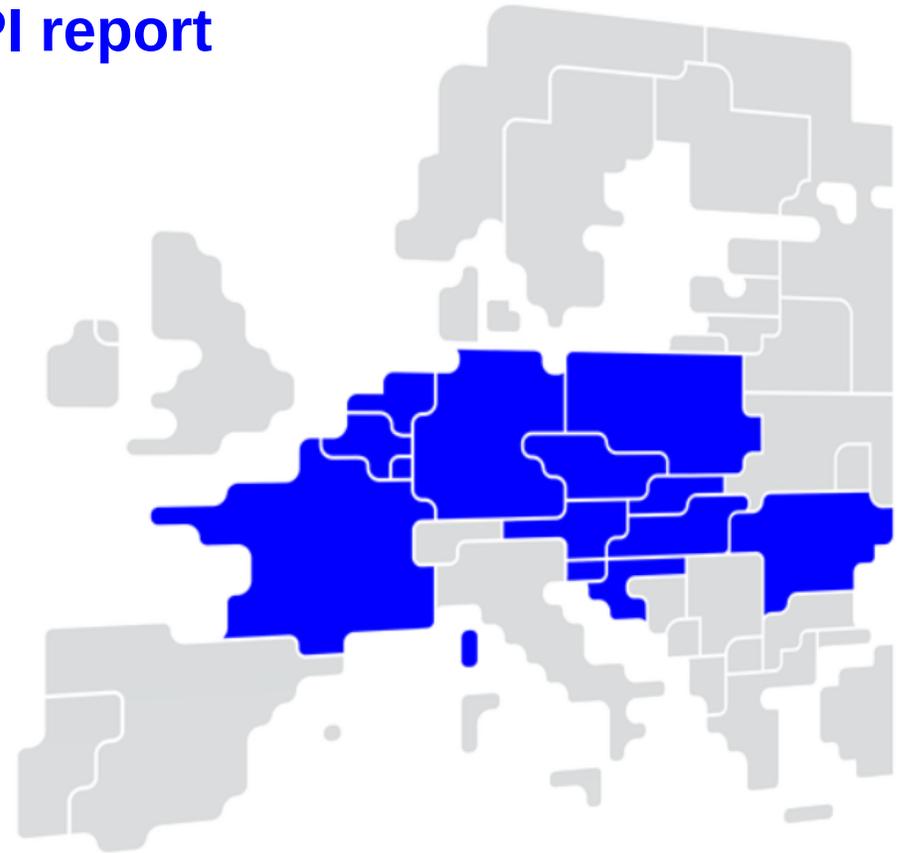


# Core FB MC Operational KPI report

September 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
- KPI 9: Most limiting CNEC per TSO (NRAO)
- KPI 10: Average variation of relative RAM before and after NRAO

## 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)

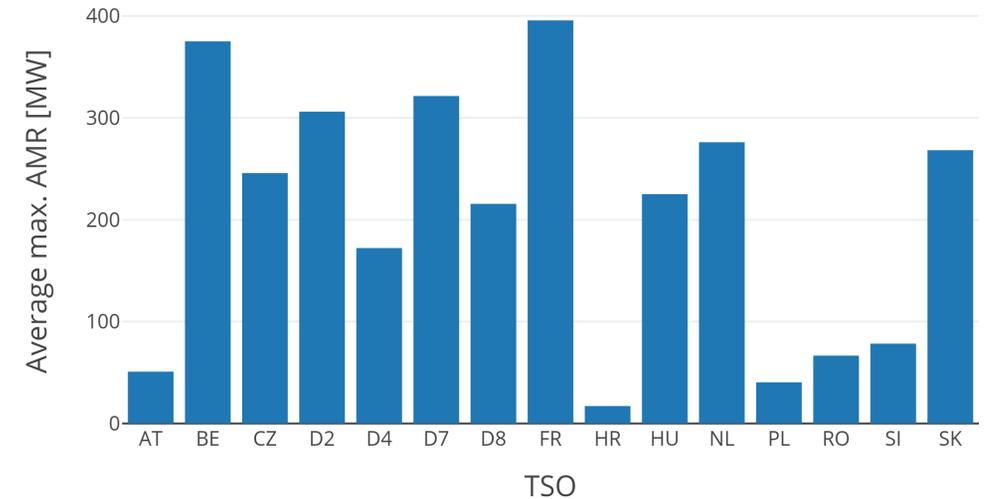
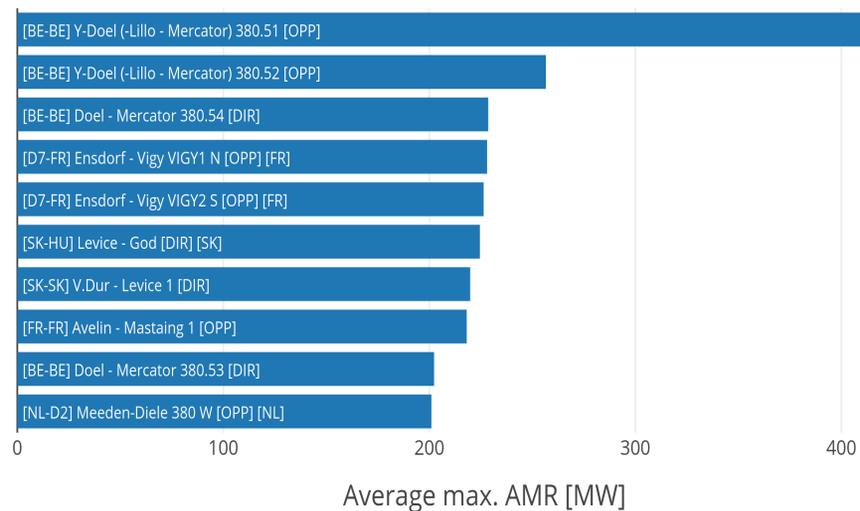
# KPI 2: Average maximum AMR per TSO



| CNE   | Average Maximum AMR (MW) | AMR as % of Fmax |
|---|--------------------------|------------------|
| [BE-BE] Y-Doel (-Lillo - Mercator) 380.51 [OPP] | 430.93                   | 17.28%           |
| [BE-BE] Y-Doel (-Lillo - Mercator) 380.52 [OPP] | 256.61                   | 8.72%            |
| [BE-BE] Doel - Mercator 380.54 [DIR]            | 228.60                   | 14.64%           |
| [D7-FR] Ensdorf - Vigy VIGY1 N [OPP] [FR]       | 228.04                   | 12.05%           |
| [D7-FR] Ensdorf - Vigy VIGY2 S [OPP] [FR]       | 226.38                   | 11.95%           |
| [SK-HU] Levice - God [DIR] [SK]                 | 224.56                   | 16.20%           |
| [SK-SK] V.Dur - Levice 1 [DIR]                  | 219.83                   | 15.56%           |
| [FR-FR] Avelin - Mastaing 1 [OPP]               | 218.16                   | 12.25%           |
| [BE-BE] Doel - Mercator 380.53 [DIR]            | 202.31                   | 12.95%           |
| [NL-D2] Meeden-Diele 380 W [OPP] [NL]           | 201.01                   | 19.09%           |

| TSO | Average maximum AMR per TSO |
|-----|-----------------------------|
| AT  | 50.79                       |
| BE  | 375.06                      |
| CZ  | 245.83                      |
| D2  | 306.07                      |
| D4  | 172.22                      |
| D7  | 321.44                      |
| D8  | 215.58                      |
| FR  | 395.67                      |
| HR  | 17.05                       |
| HU  | 225.12                      |

| TSO | Average maximum AMR per TSO |
|-----|-----------------------------|
| NL  | 276.09                      |
| PL  | 40.44                       |
| RO  | 66.55                       |
| SI  | 78.39                       |
| SK  | 268.30                      |



# KPI 3: Share of MTUs with intervention per TSO



Total BDs  
**30**

Total MTUs  
**720**

MTUs without IVA  
**217**

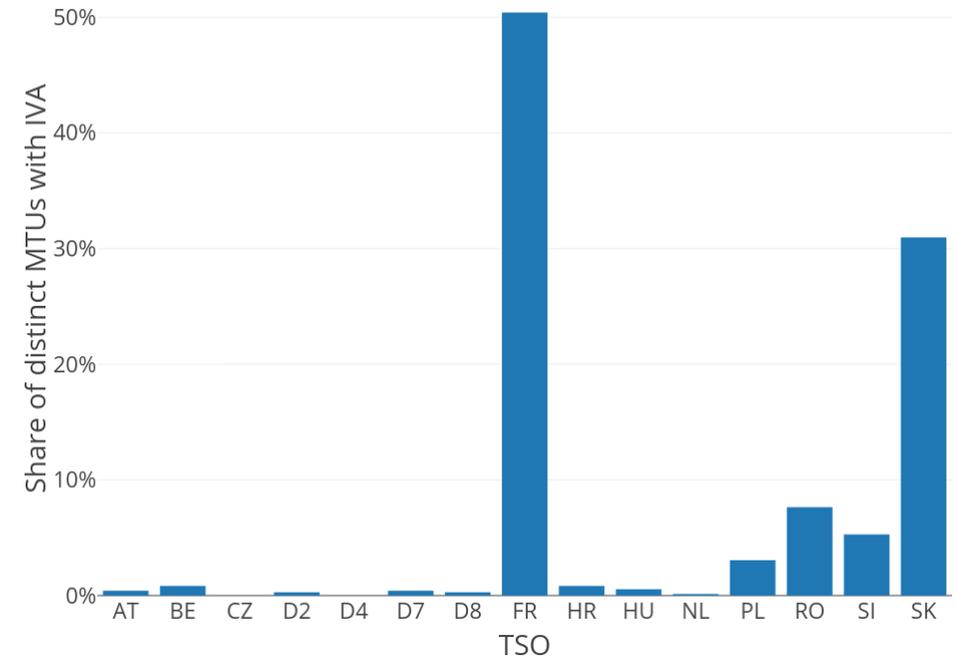
Share of distinct  
MTUs without IVA  
**30.14%**

MTUs with IVA  
**503**

Share of distinct  
MTUs with IVA  
**69.9%**

| TSO | Share of distinct MTUs with IVA | Distinct MTUs with IVA |
|-----|---------------------------------|------------------------|
| CZ  | 0.00%                           | 0                      |
| SI  | 5.28%                           | 38                     |
| AT  | 0.42%                           | 3                      |
| D7  | 0.42%                           | 3                      |
| D8  | 0.28%                           | 2                      |
| D2  | 0.28%                           | 2                      |
| PL  | 3.06%                           | 22                     |
| D4  | 0.00%                           | 0                      |
| SK  | 30.97%                          | 223                    |
| HU  | 0.56%                           | 4                      |

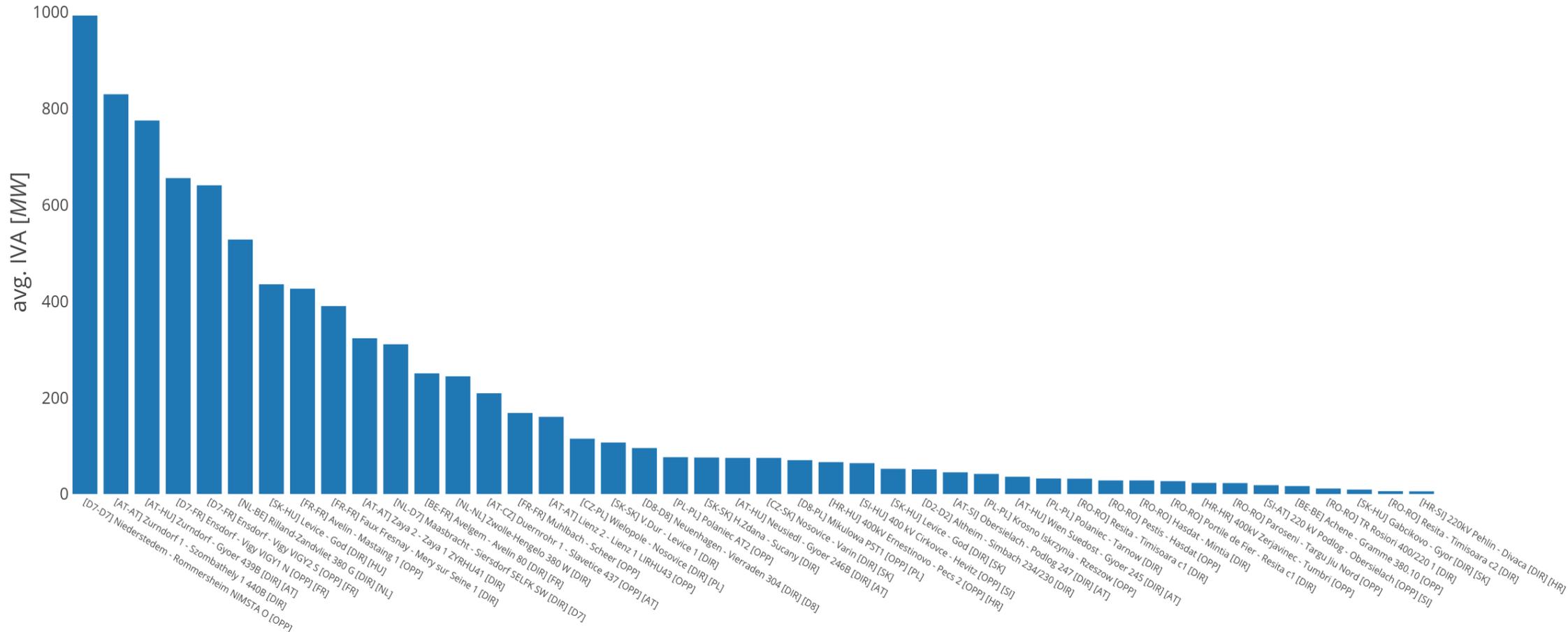
| TSO | Share of distinct MTUs with IVA | Distinct MTUs with IVA |
|-----|---------------------------------|------------------------|
| BE  | 0.83%                           | 6                      |
| NL  | 0.14%                           | 1                      |
| FR  | 50.42%                          | 363                    |
| RO  | 7.64%                           | 55                     |
| HR  | 0.83%                           | 6                      |



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



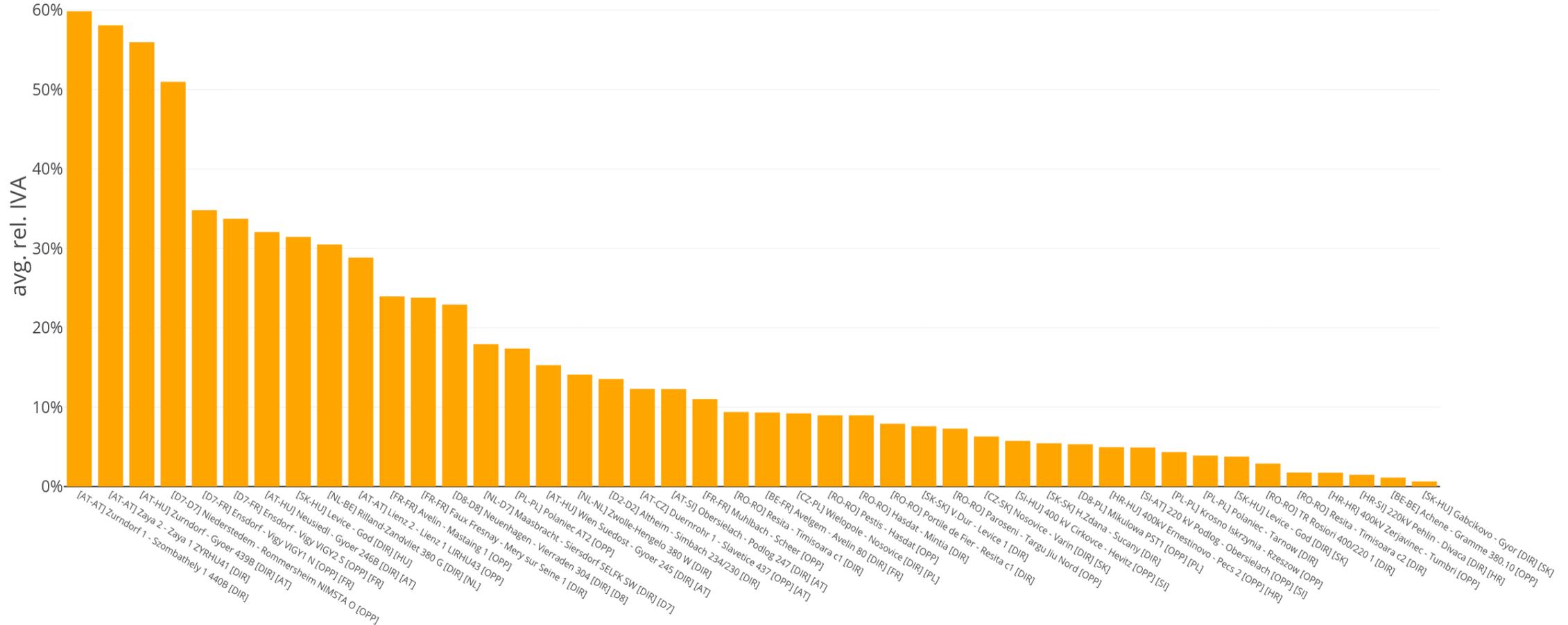
$$\text{avg. IVA}_{CNE} = \frac{1}{\#(CNEC, MTU)[IVA_{CNEC, MTU} > 0]} \sum_{MTU, CNEC} IVA_{CNEC, MTU} [IVA_{CNEC, MTU} > 0]$$



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



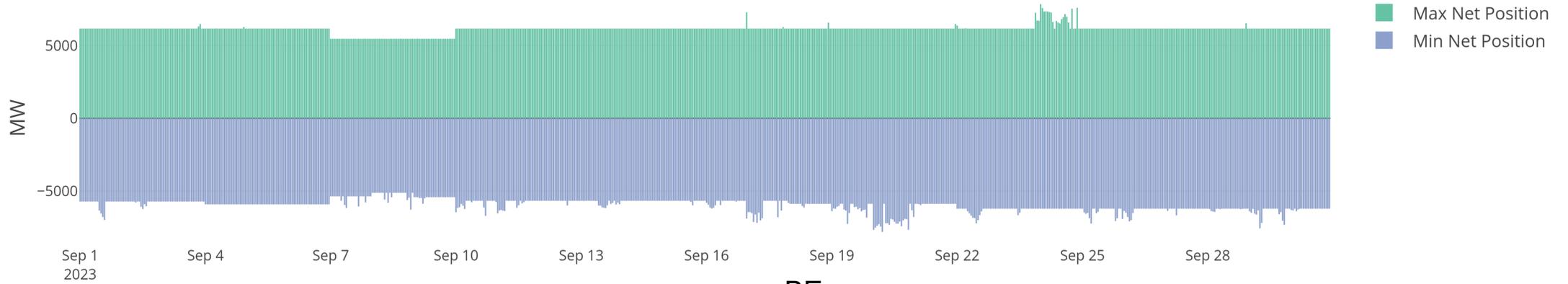
$$\text{avg. rel. IVA}_{CNE} = \frac{1}{\#(CNEC, MTU)[IVA_{CNEC, MTU} > 0]} \sum_{MTU, CNEC} \frac{IVA_{CNEC, MTU}[IVA_{CNEC, MTU} > 0]}{F_{max_{CNEC, MTU}[IVA_{CNEC, MTU} > 0]}}$$



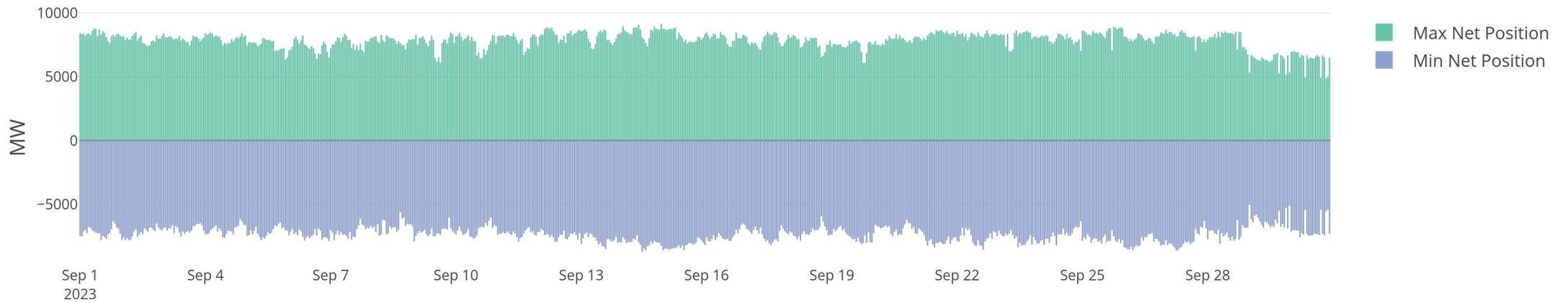
# KPI 5: Min & max net positions per BZ hub



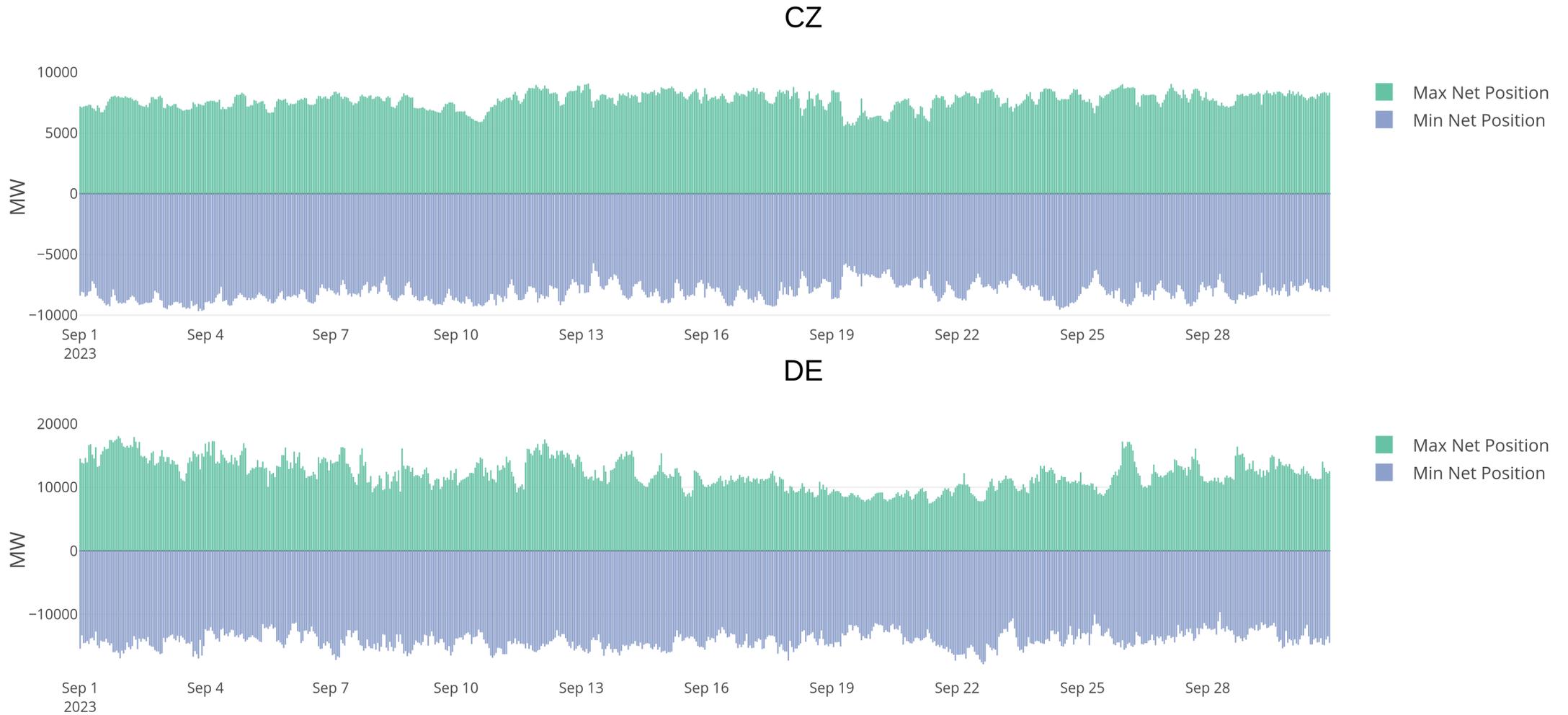
AT



BE



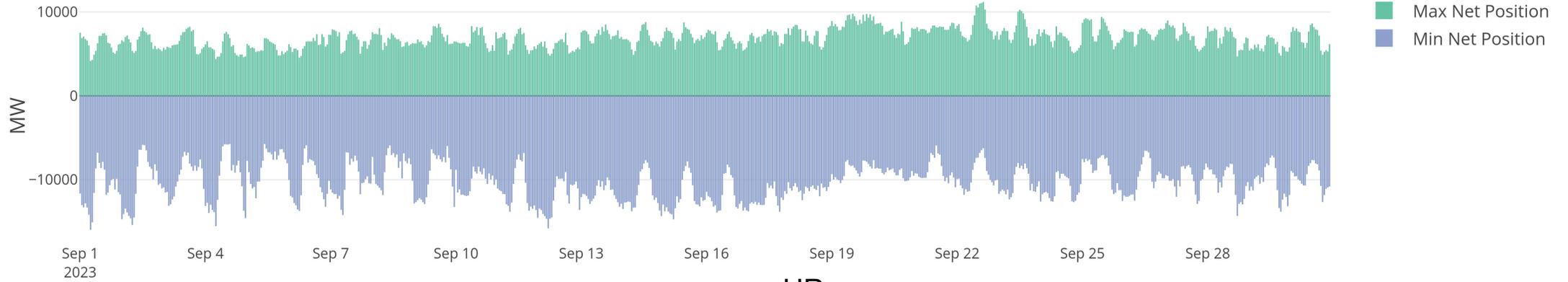
# KPI 5: Min & max net positions per BZ hub



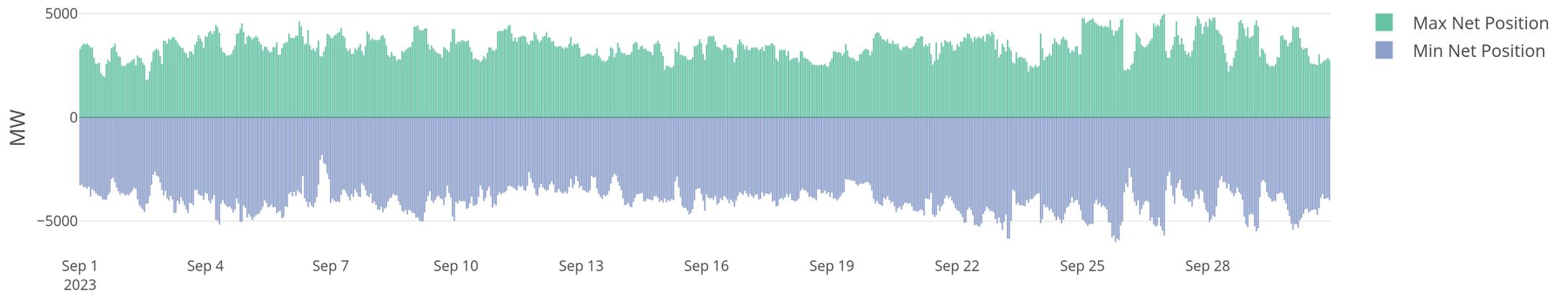
# KPI 5: Min & max net positions per BZ hub



FR



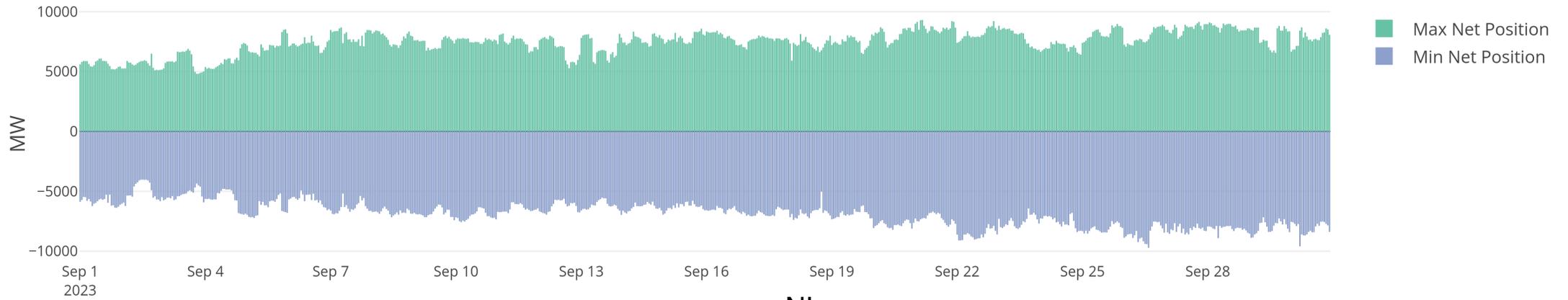
HR



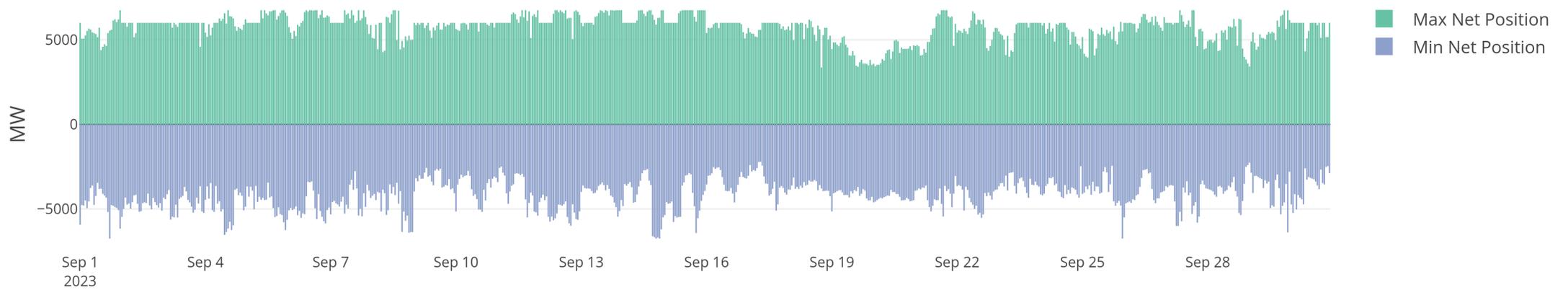
# KPI 5: Min & max net positions per BZ hub



## HU



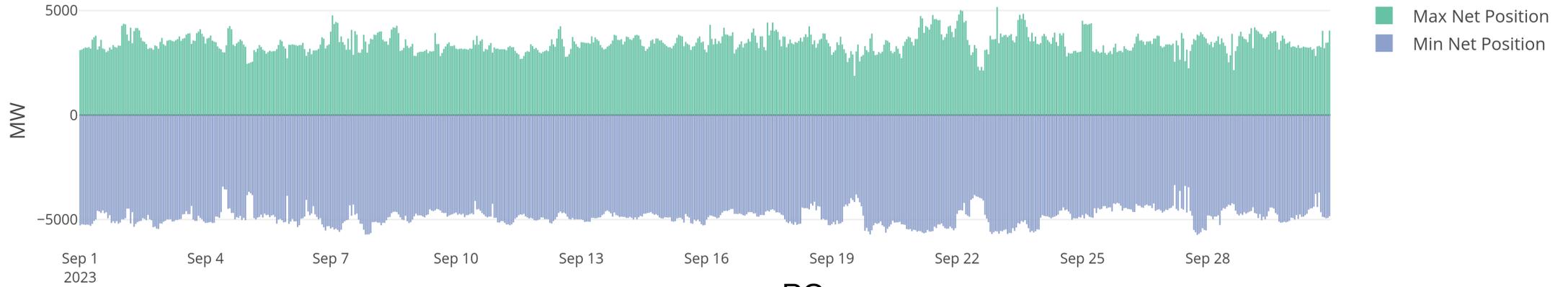
## NL



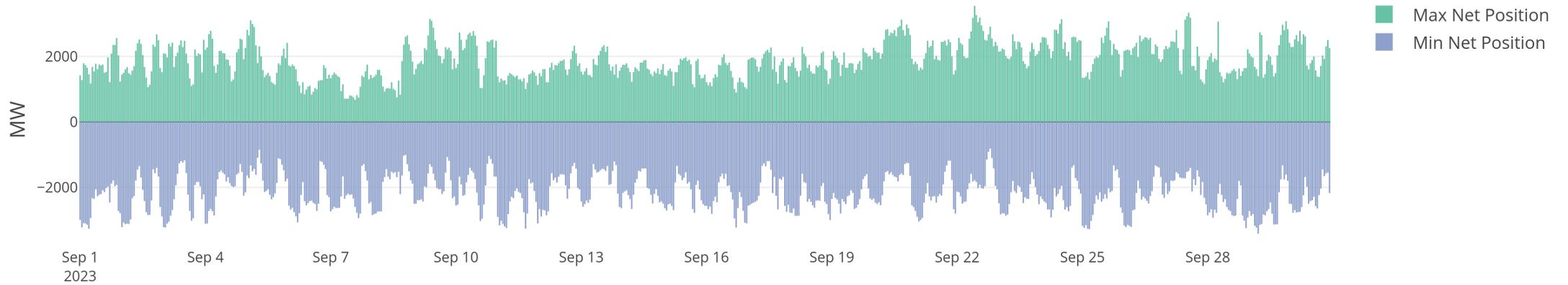
# KPI 5: Min & max net positions per BZ hub



PL



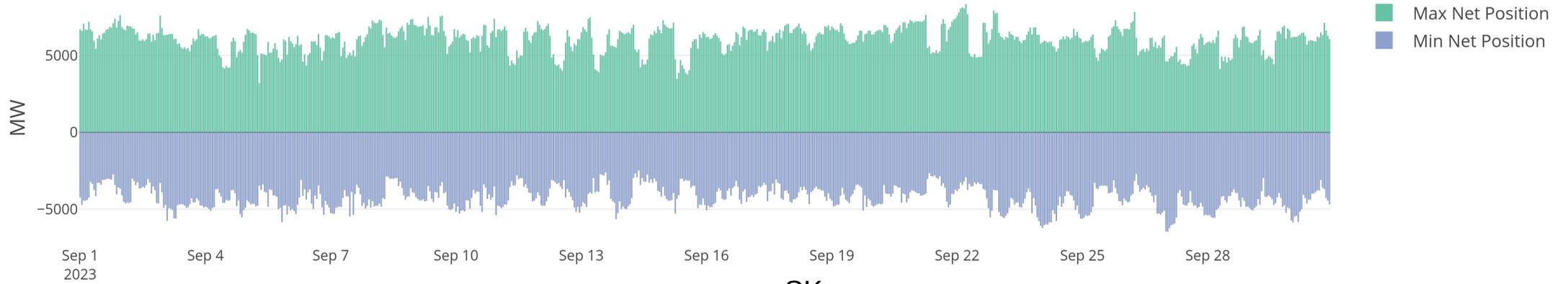
RO



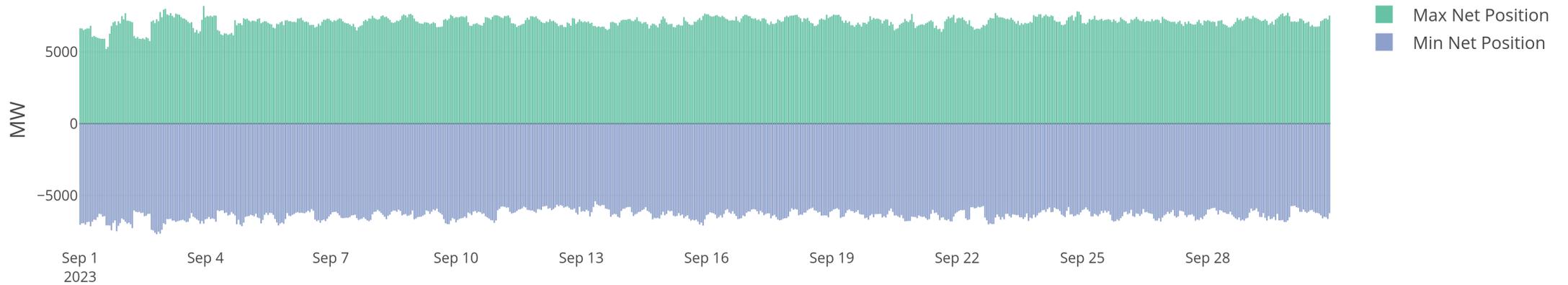
# KPI 5: Min & max net positions per BZ hub



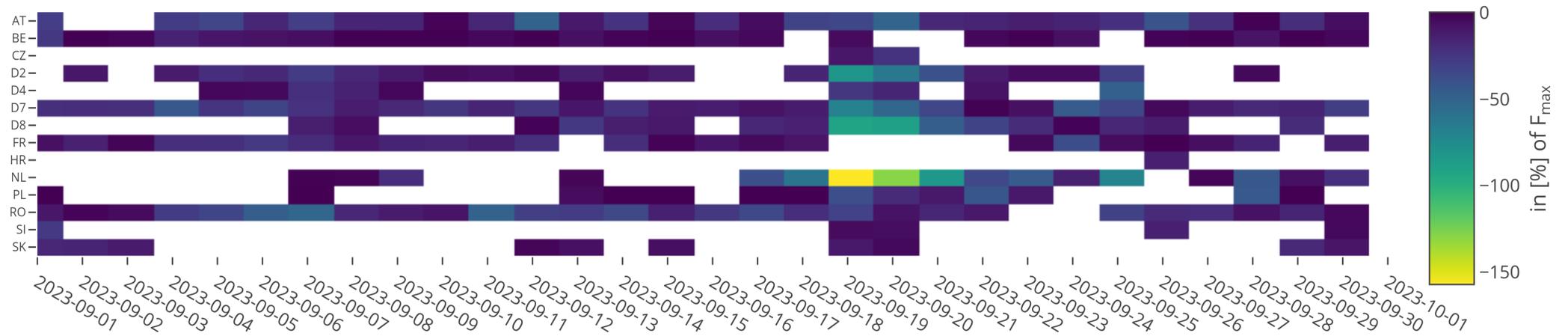
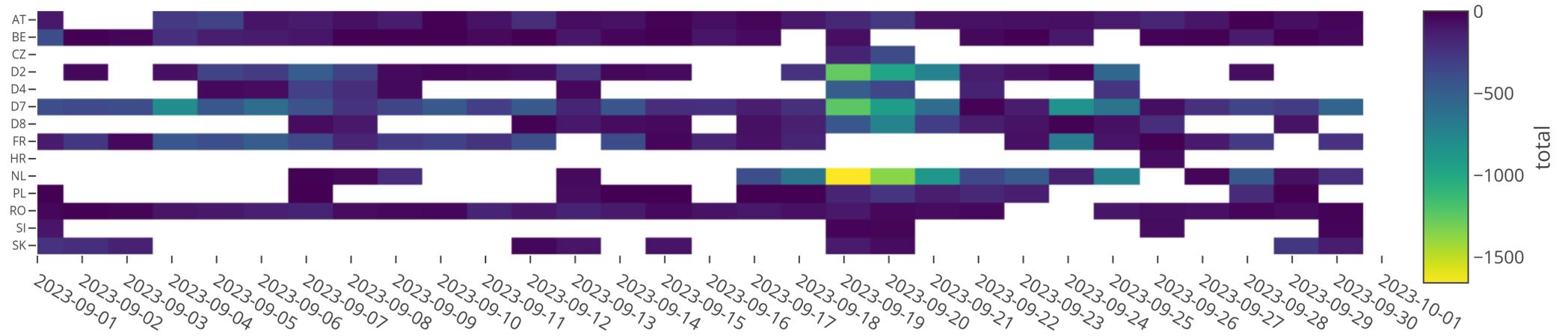
SI



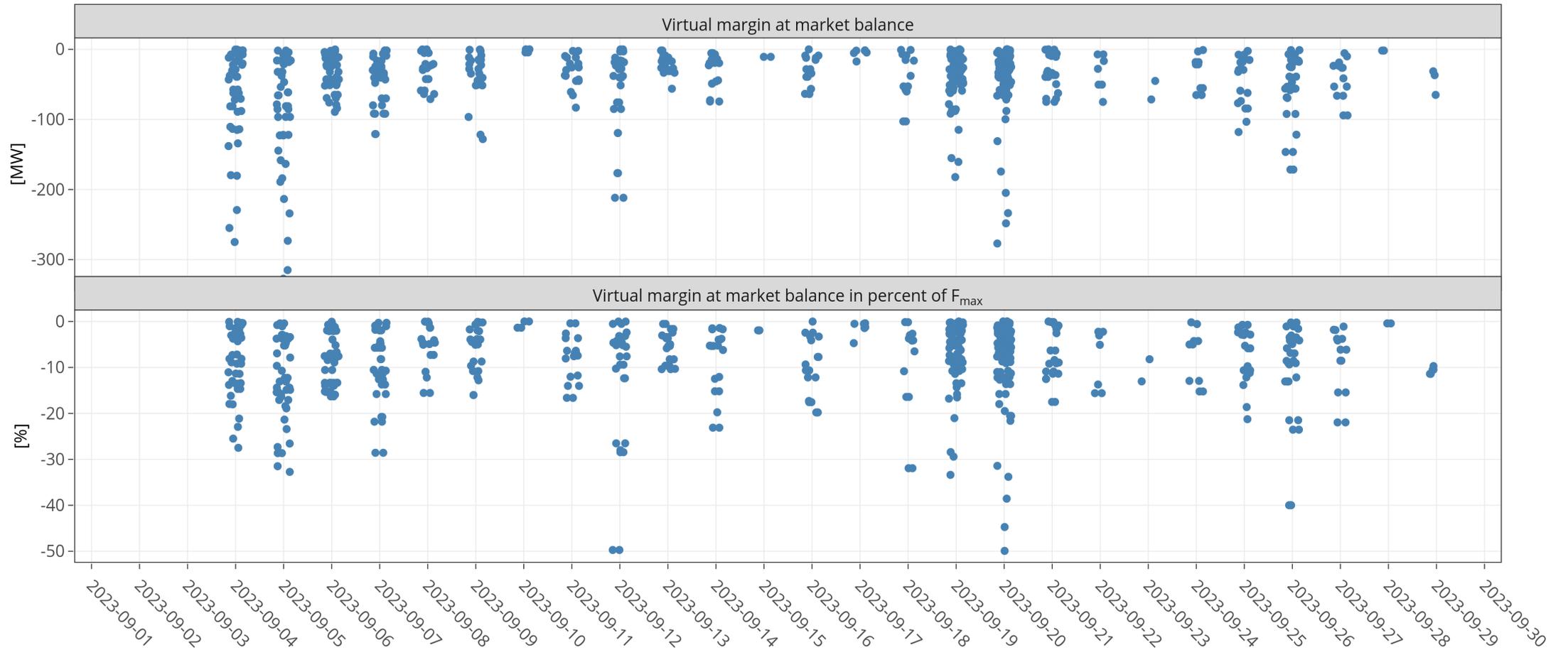
SK



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



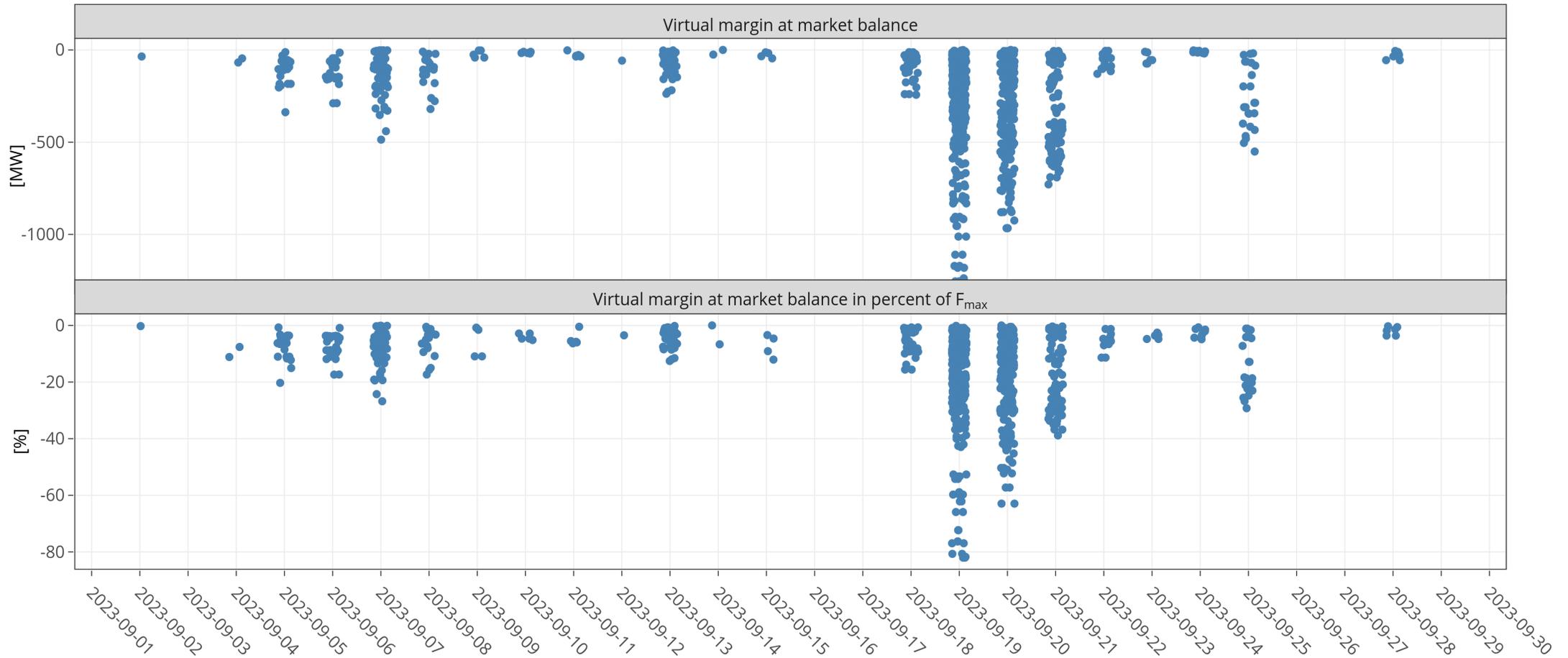
# KPI 6b: Virtual margins at market balance AT



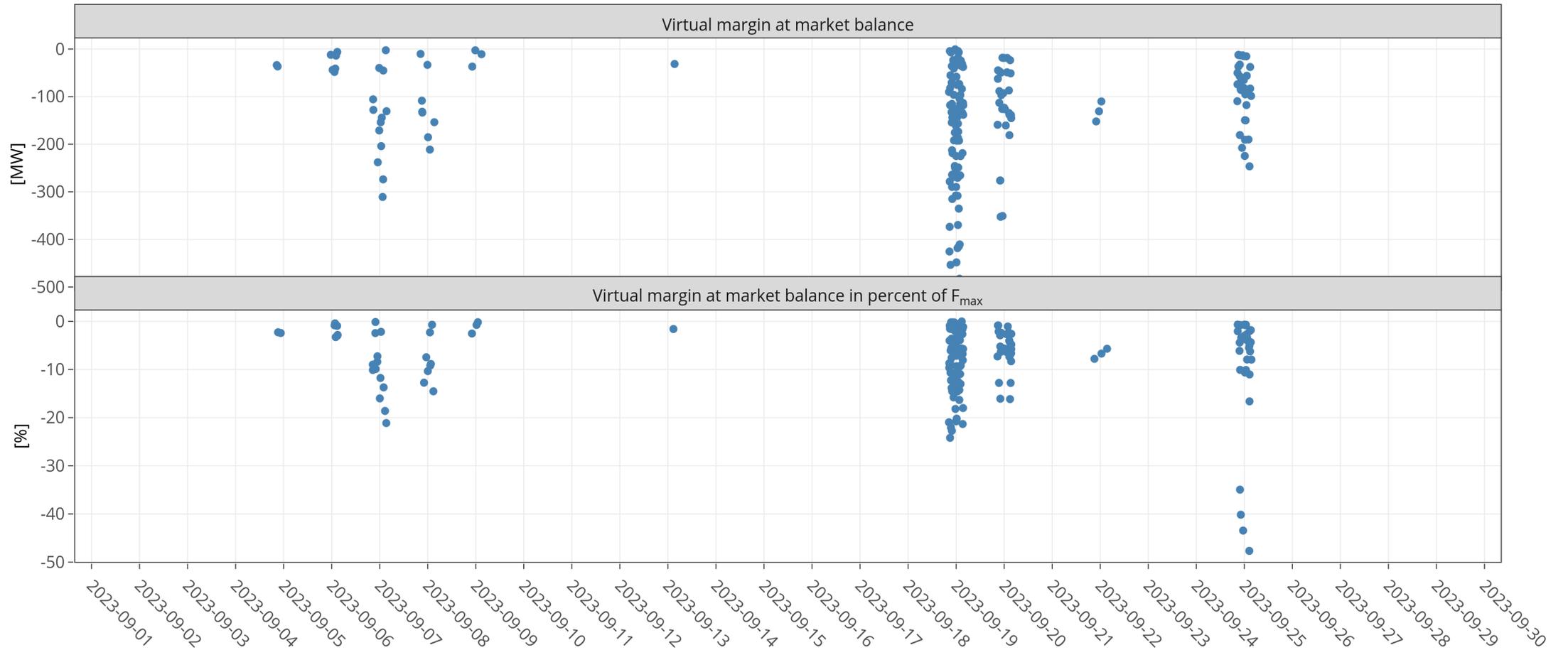




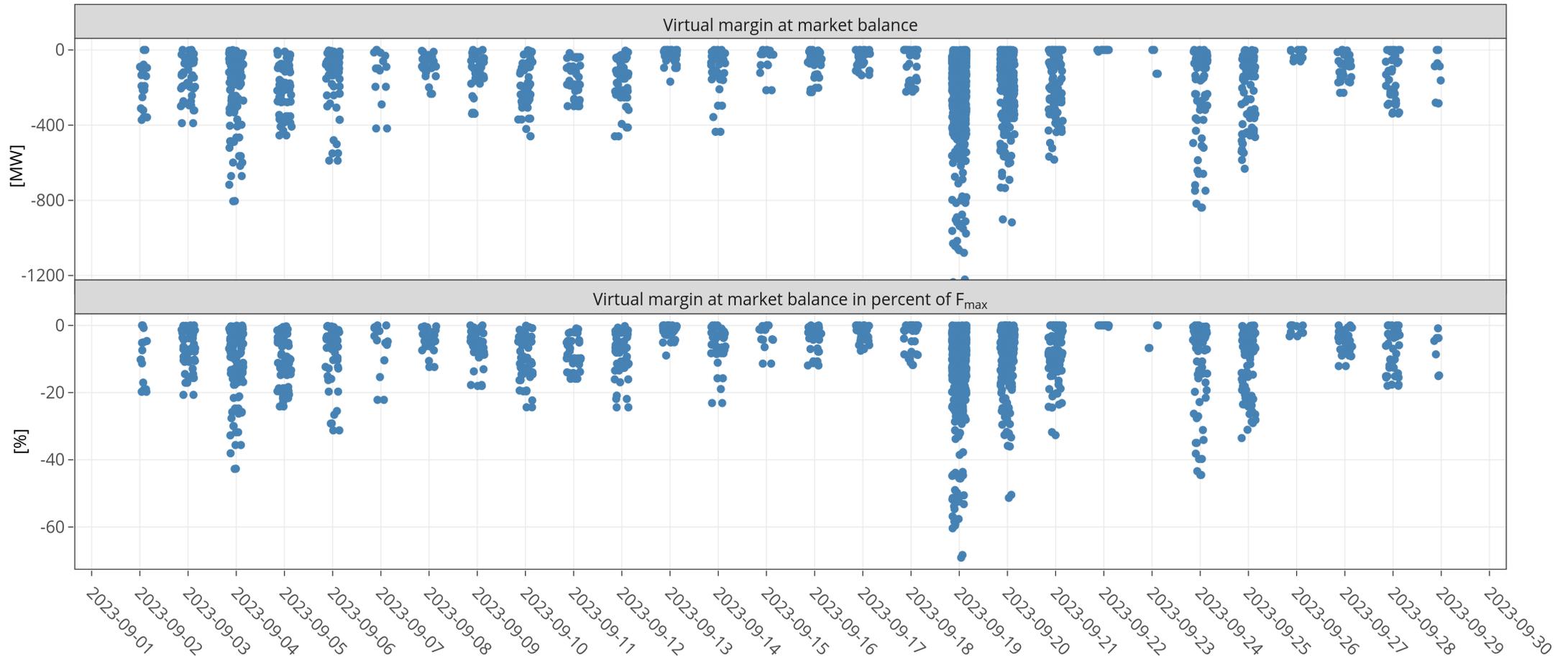
# KPI 6b: Virtual margins at market balance D2



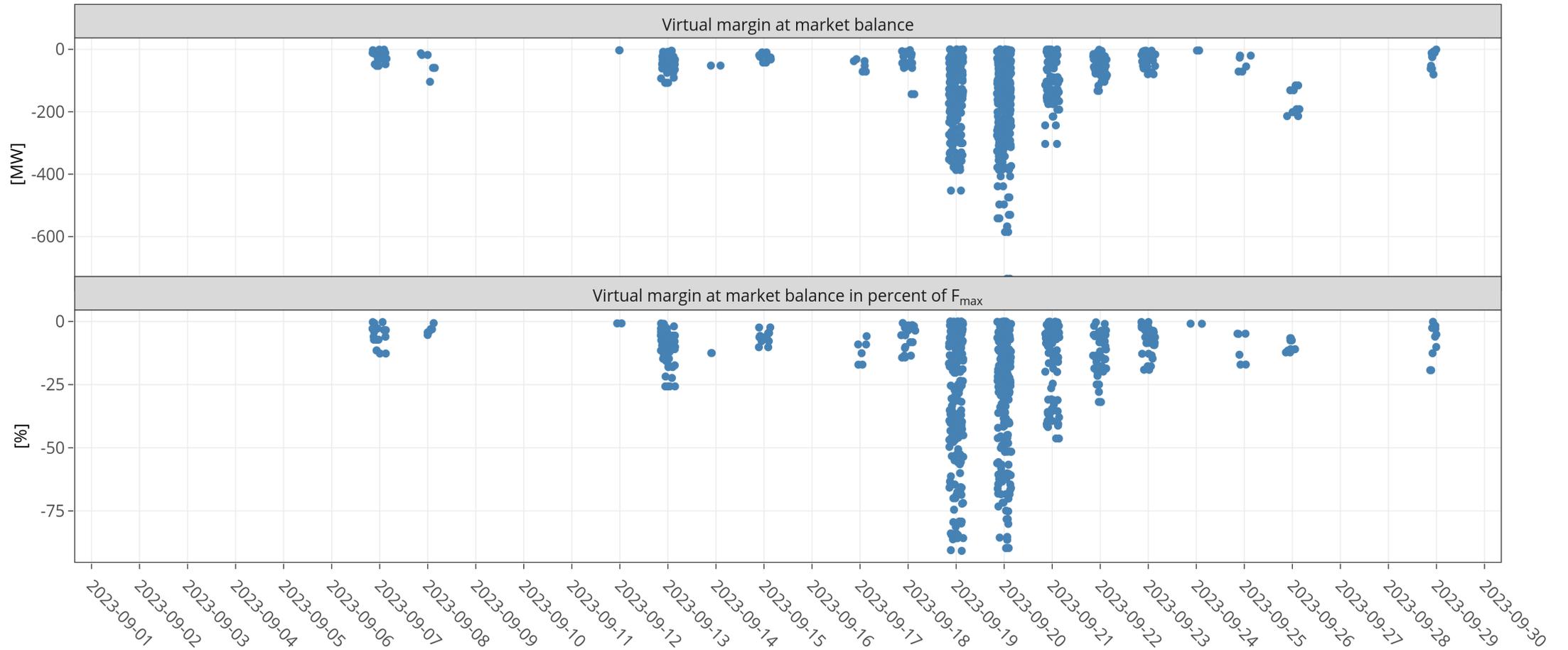
# KPI 6b: Virtual margins at market balance D4



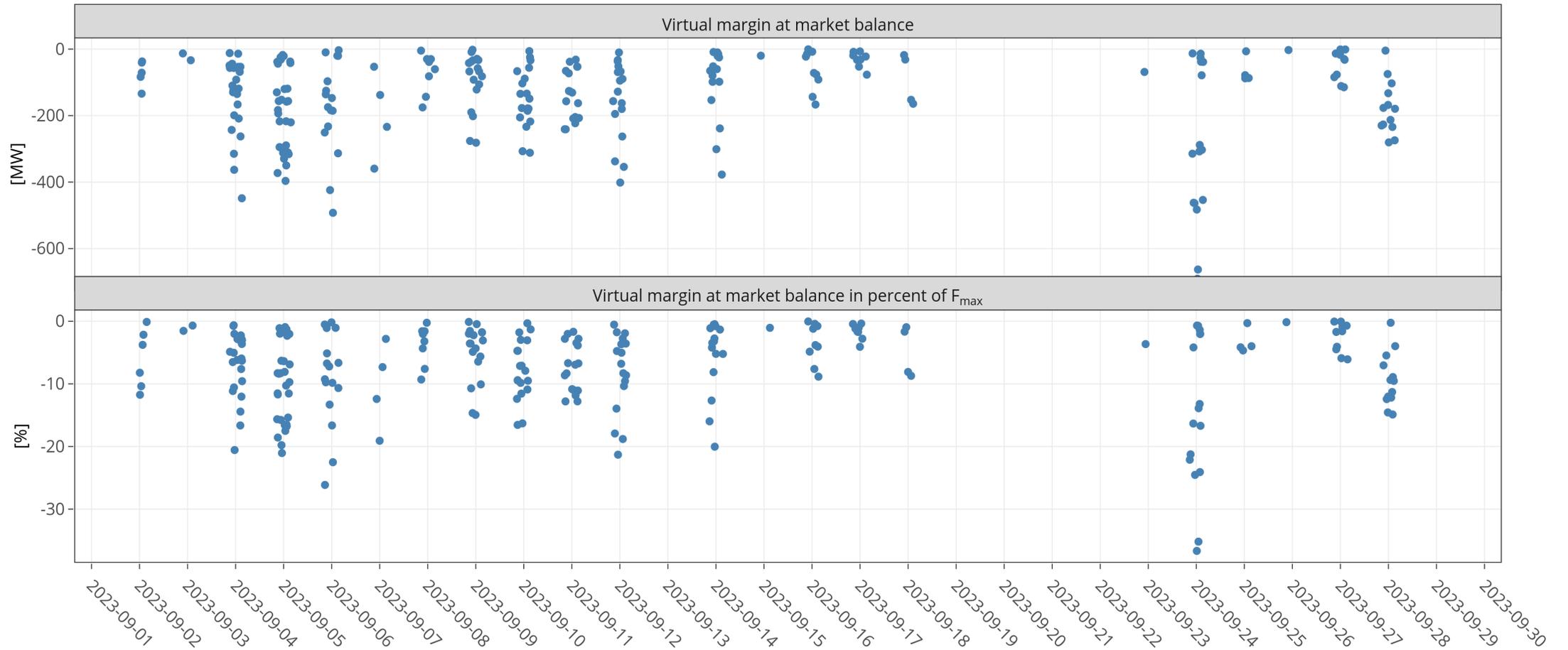
# KPI 6b: Virtual margins at market balance D7



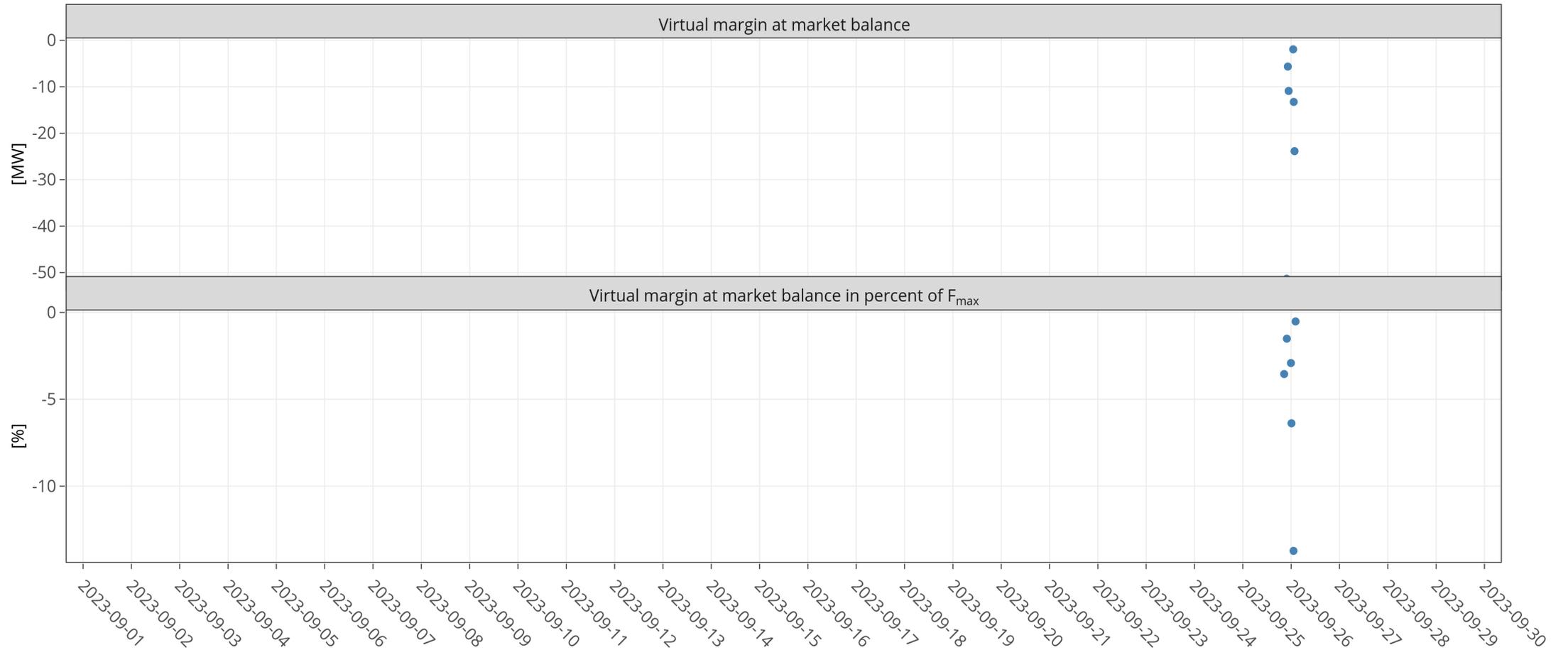
# KPI 6b: Virtual margins at market balance D8



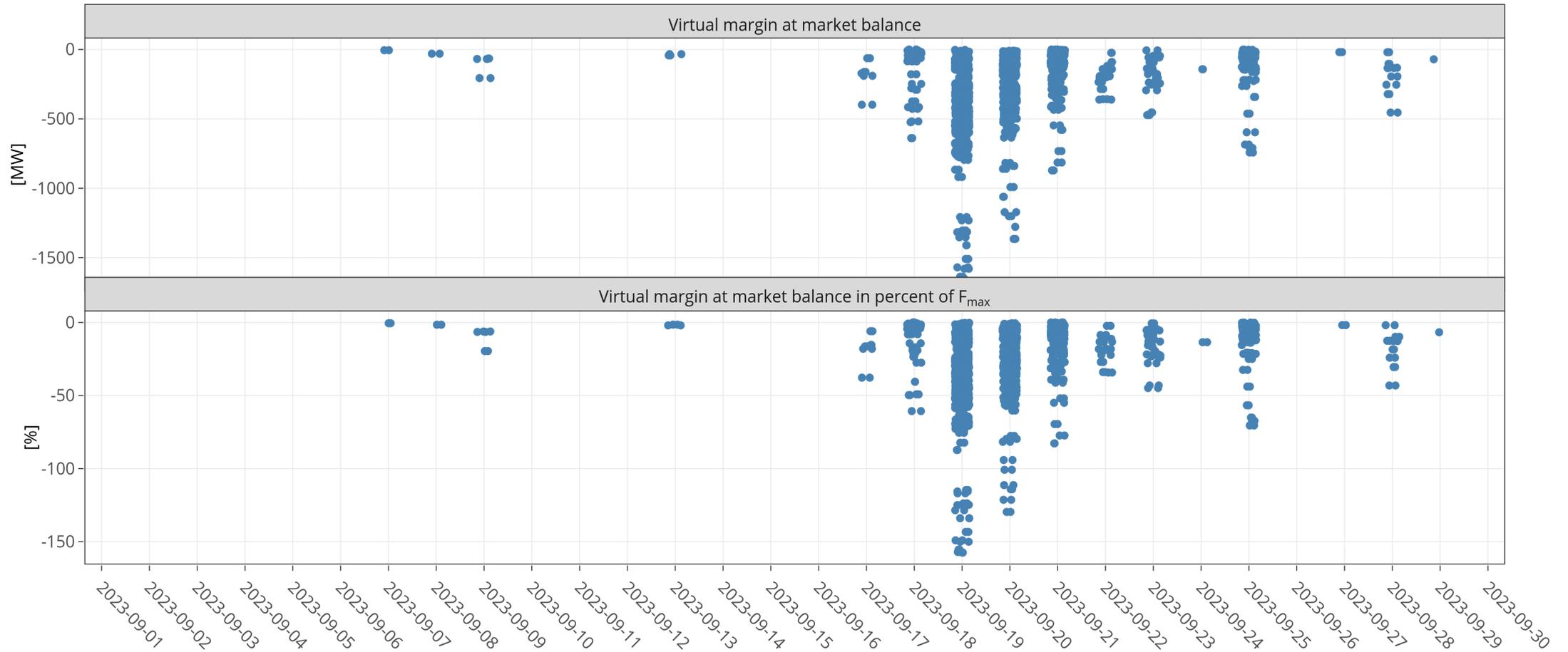
# KPI 6b: Virtual margins at market balance FR



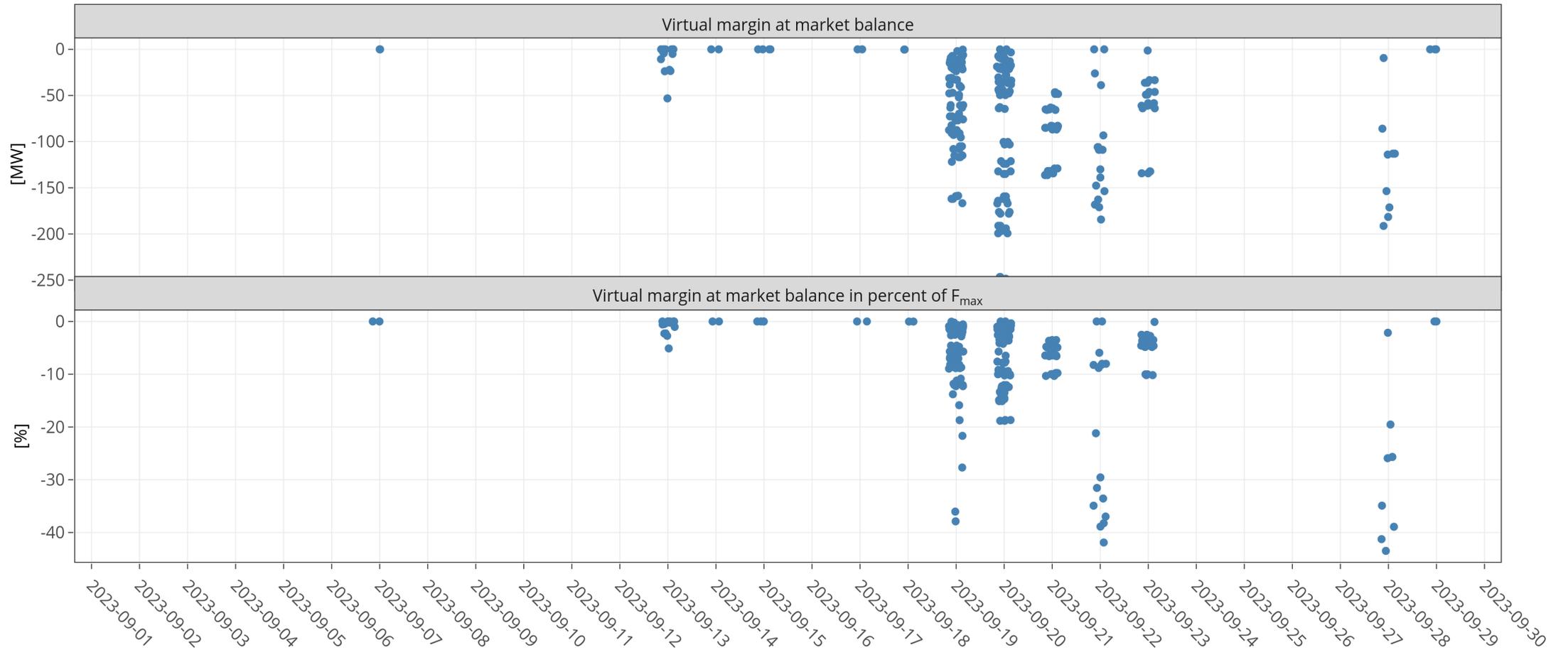
# KPI 6b: Virtual margins at market balance HR



# KPI 6b: Virtual margins at market balance NL



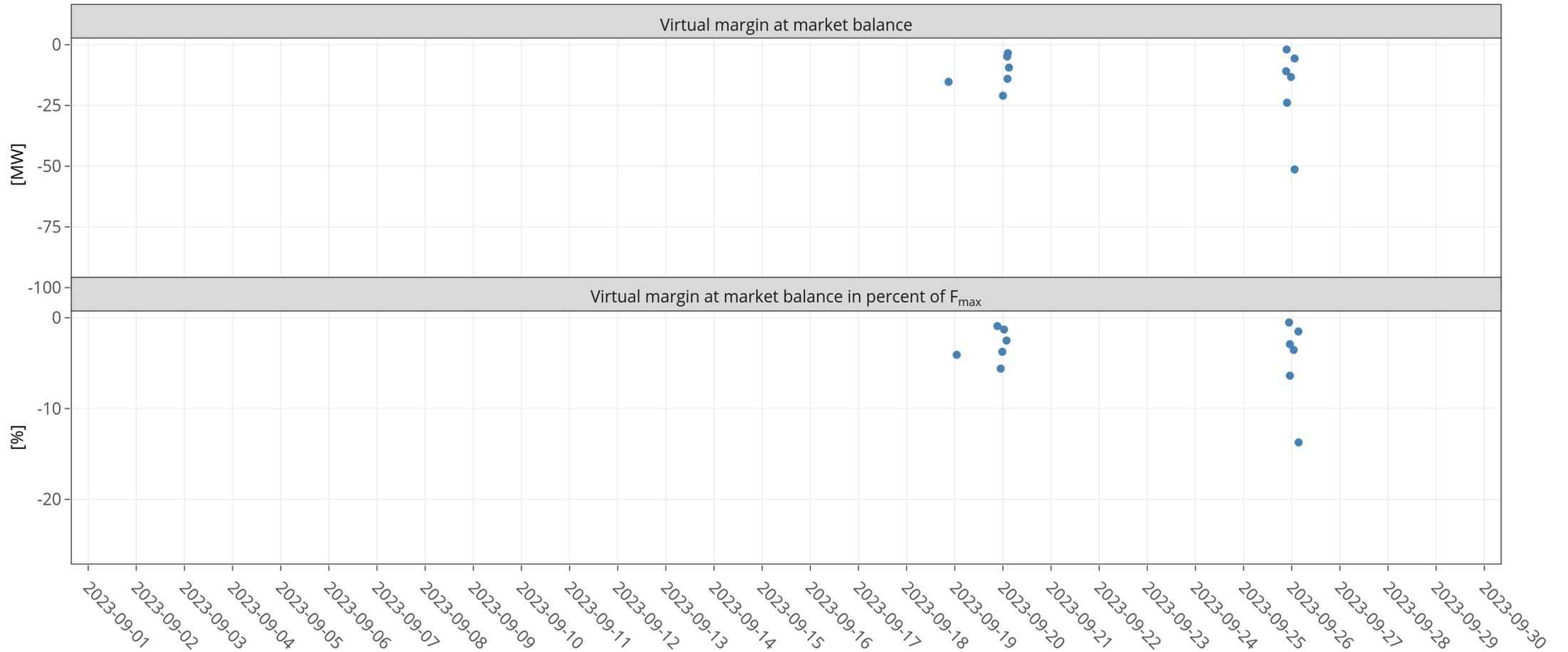
# KPI 6b: Virtual margins at market balance PL



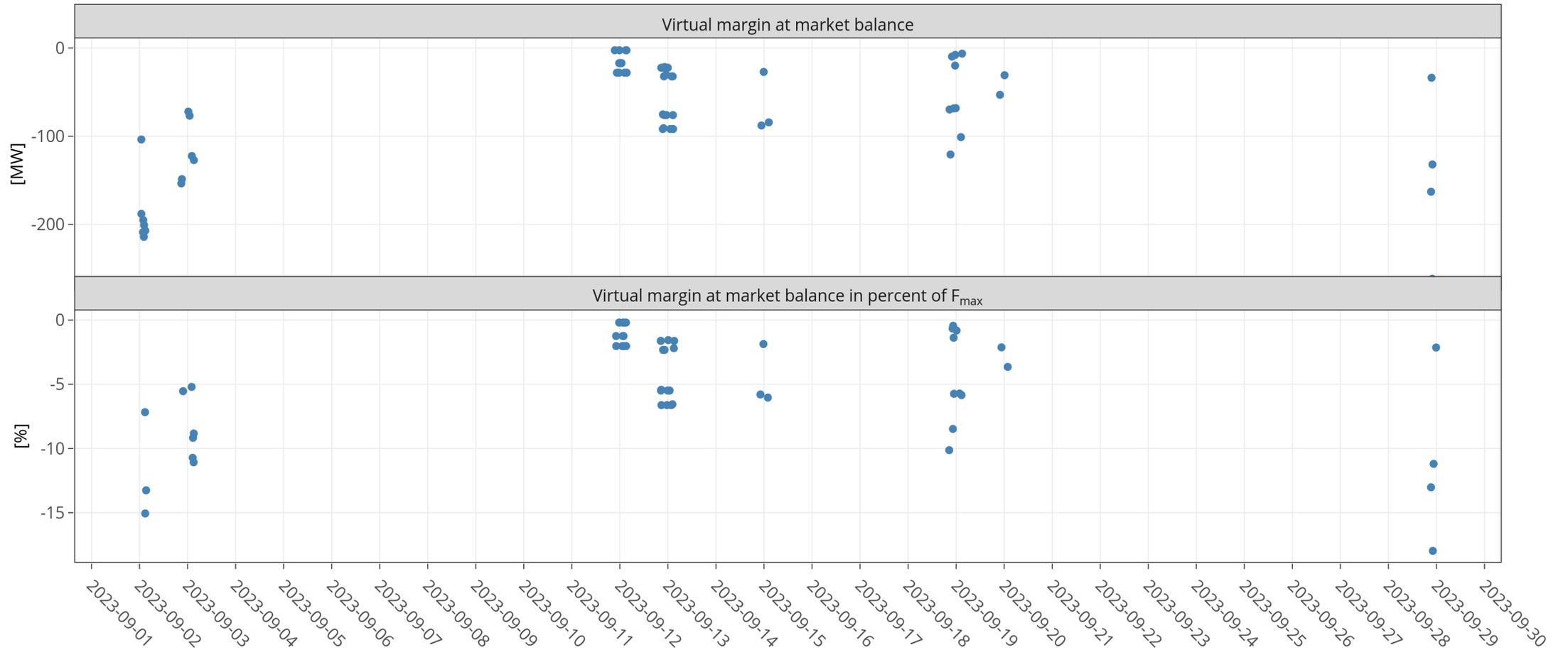
# KPI 6b: Virtual margins at market balance RO



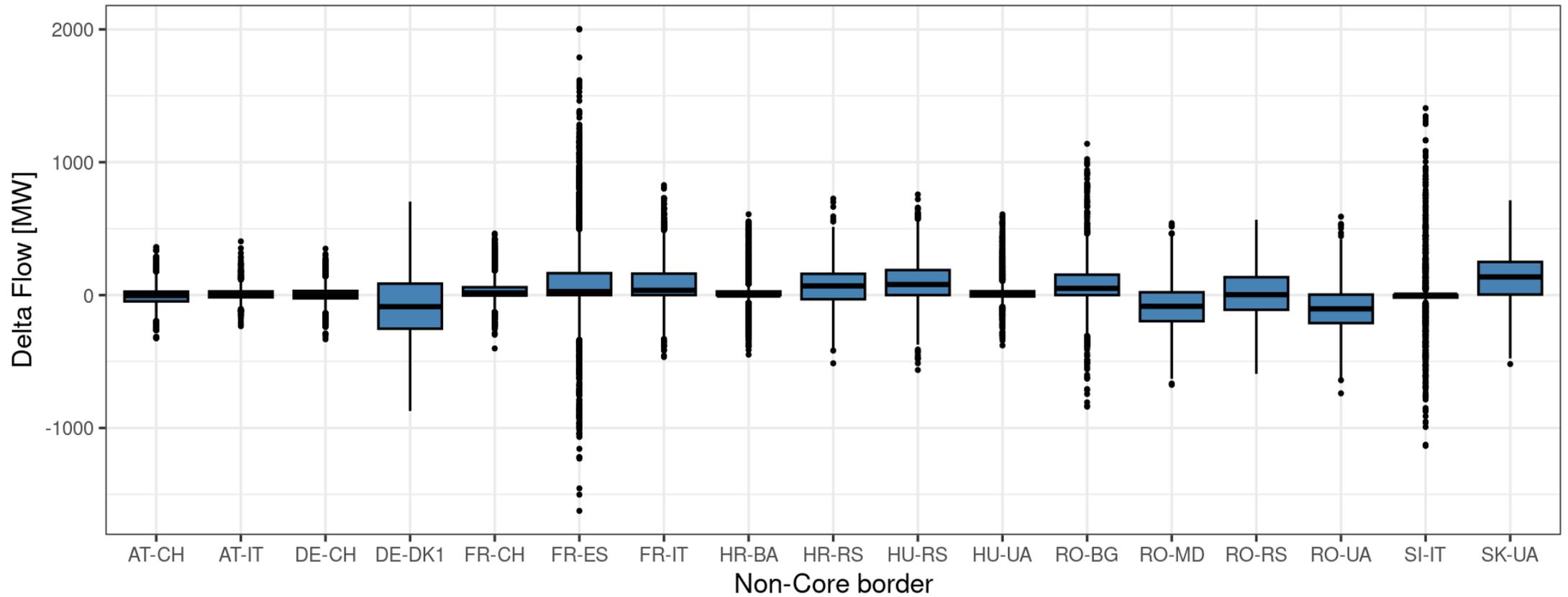
# KPI 6b: Virtual margins at market balance SI



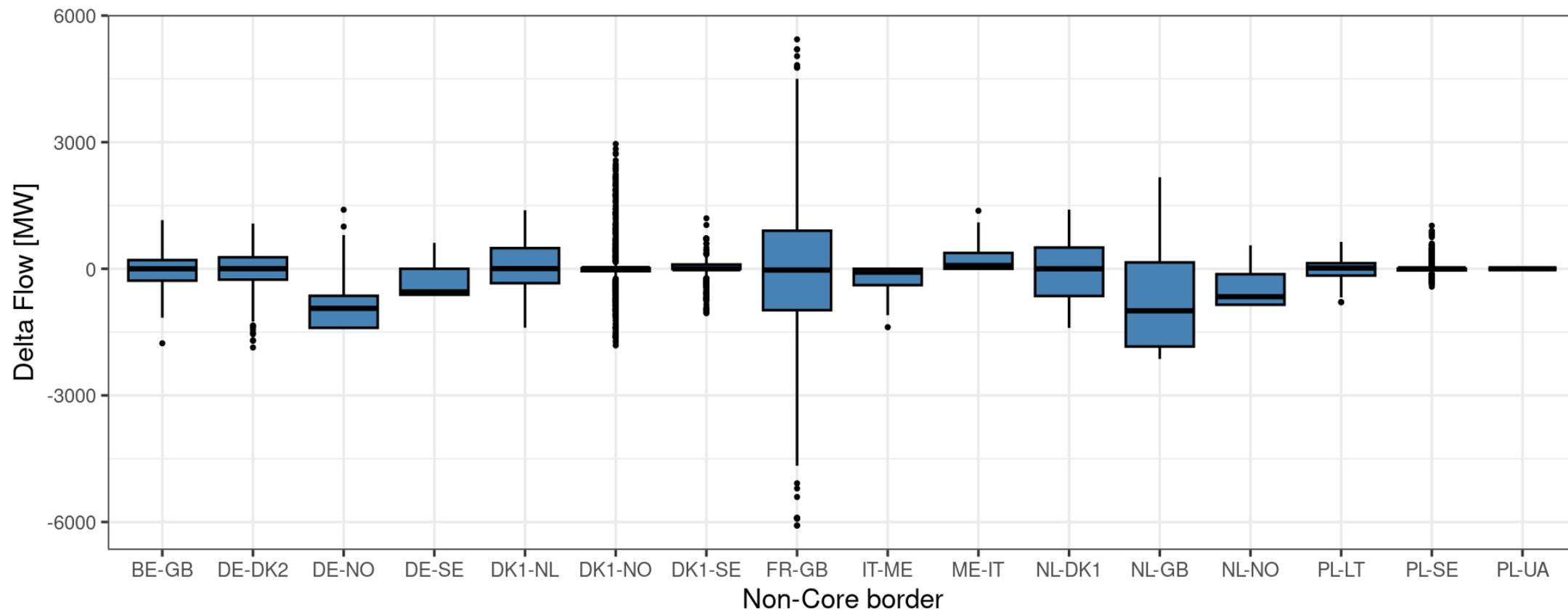
# KPI 6b: Virtual margins at market balance SK



# KPI 7: Non-Core exchanges AC delta flow



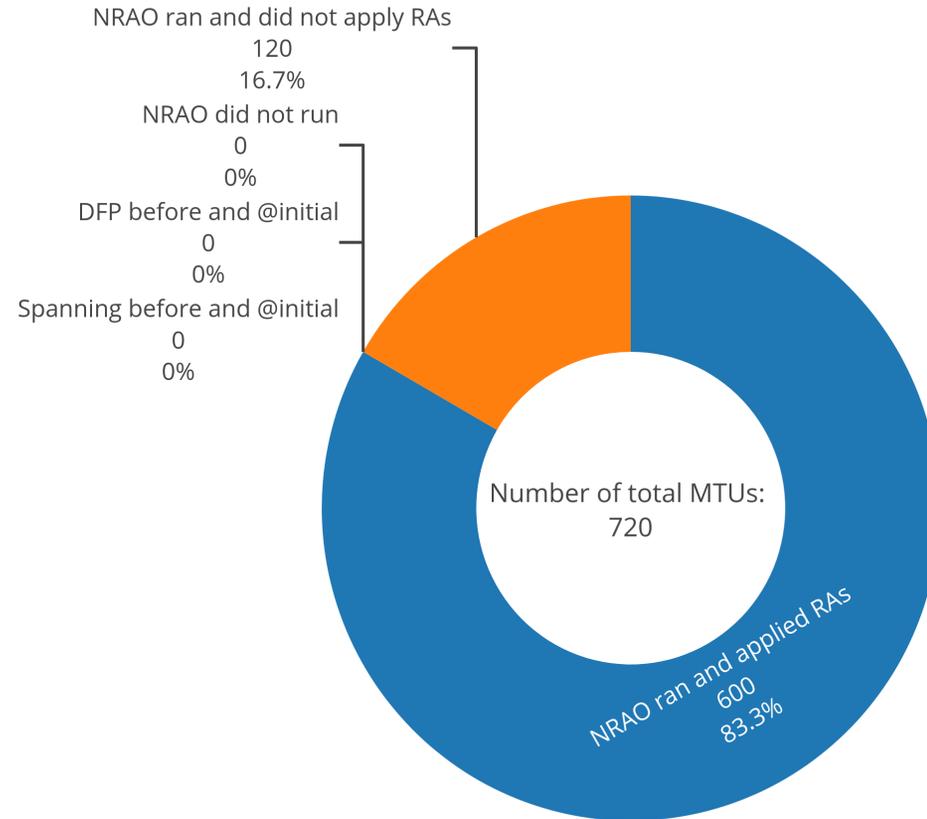
# KPI 7: Non-Core exchanges DC delta flow



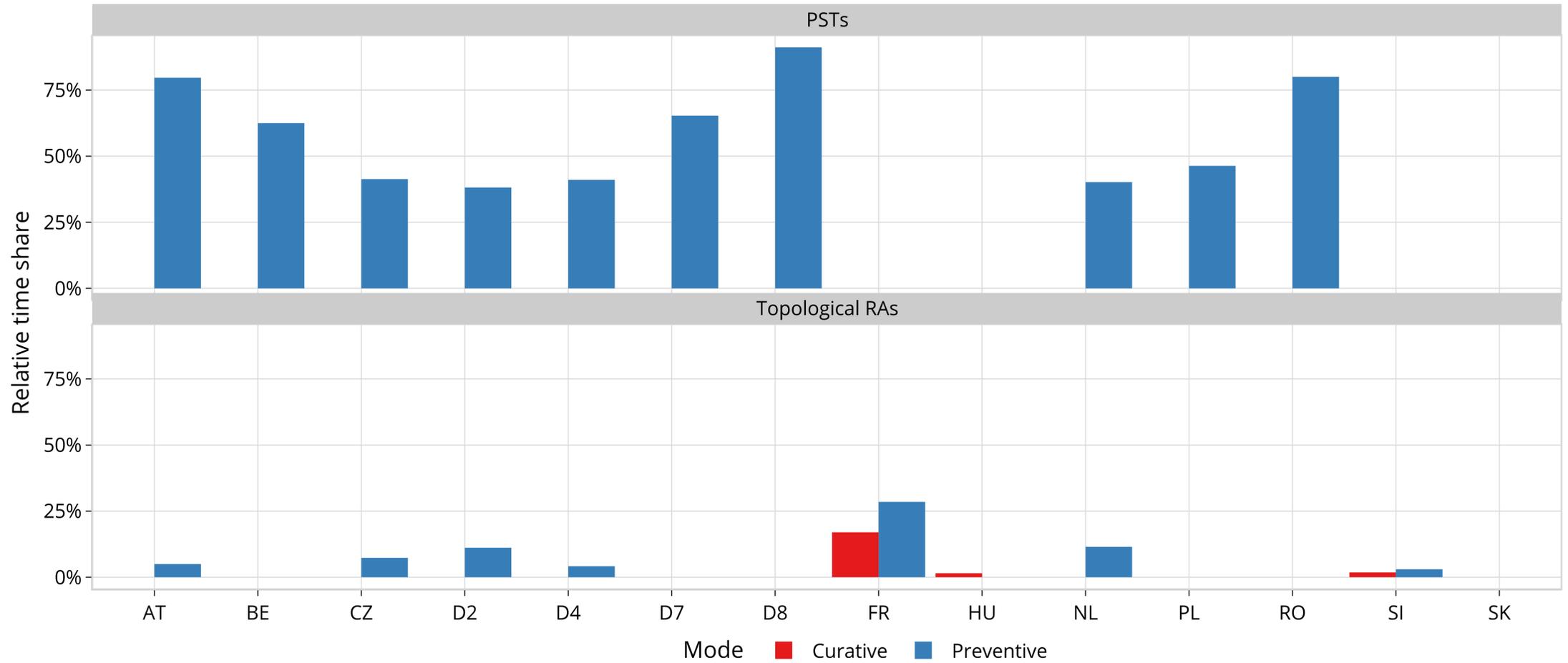
# KPI 8: NRAO – Applied Remedial Action



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

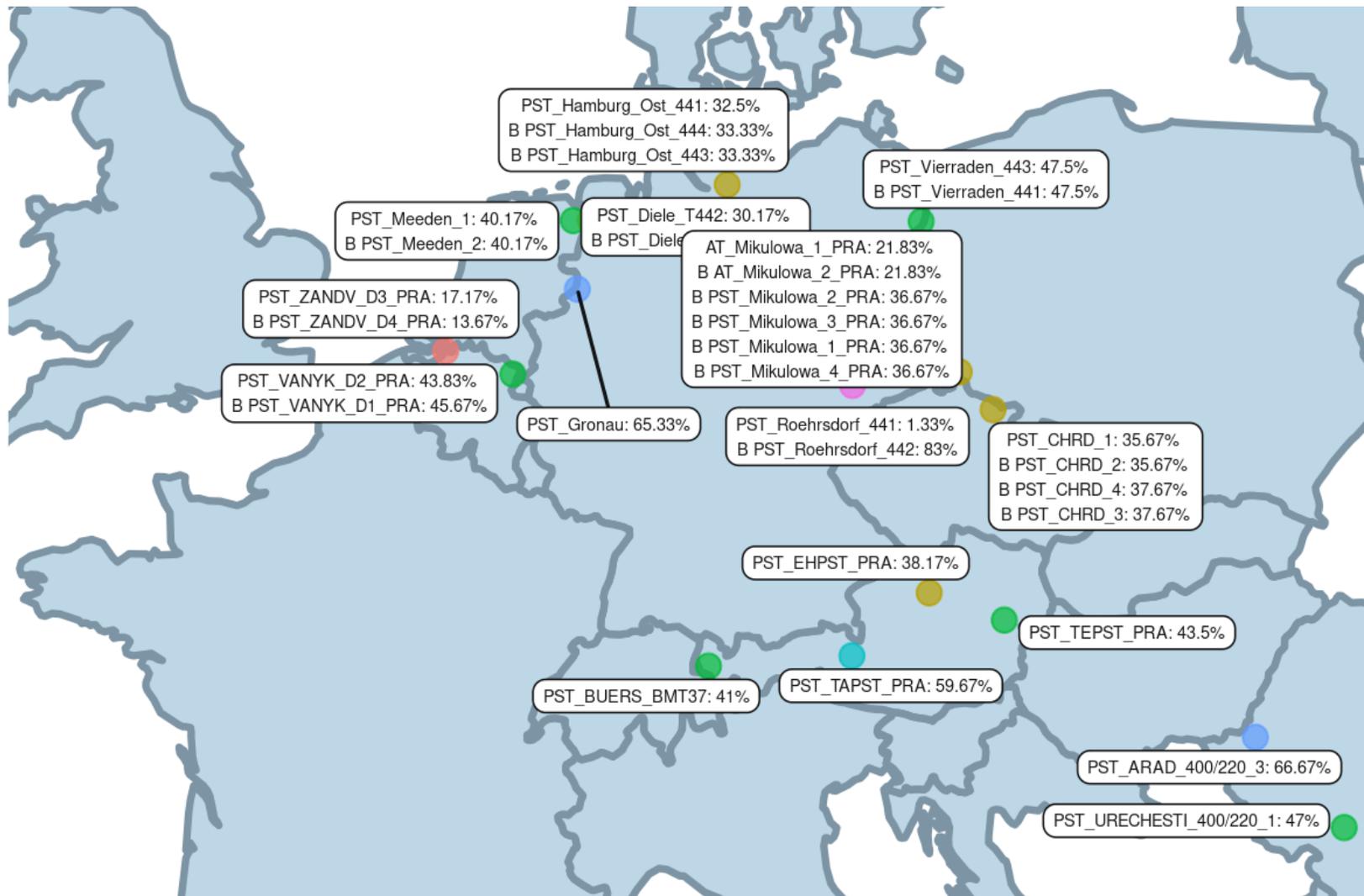


# KPI 8: Relative Time Share of Applied RAs, by TSO, Type and Mode



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

## Relative Time Share of Applied PSTs in Preventive Mode



Relative Time Share [%]

- 10%-20%
- 30%-40%
- 40%-50%
- 50%-60%
- 60%-70%
- 80%-90%

# 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

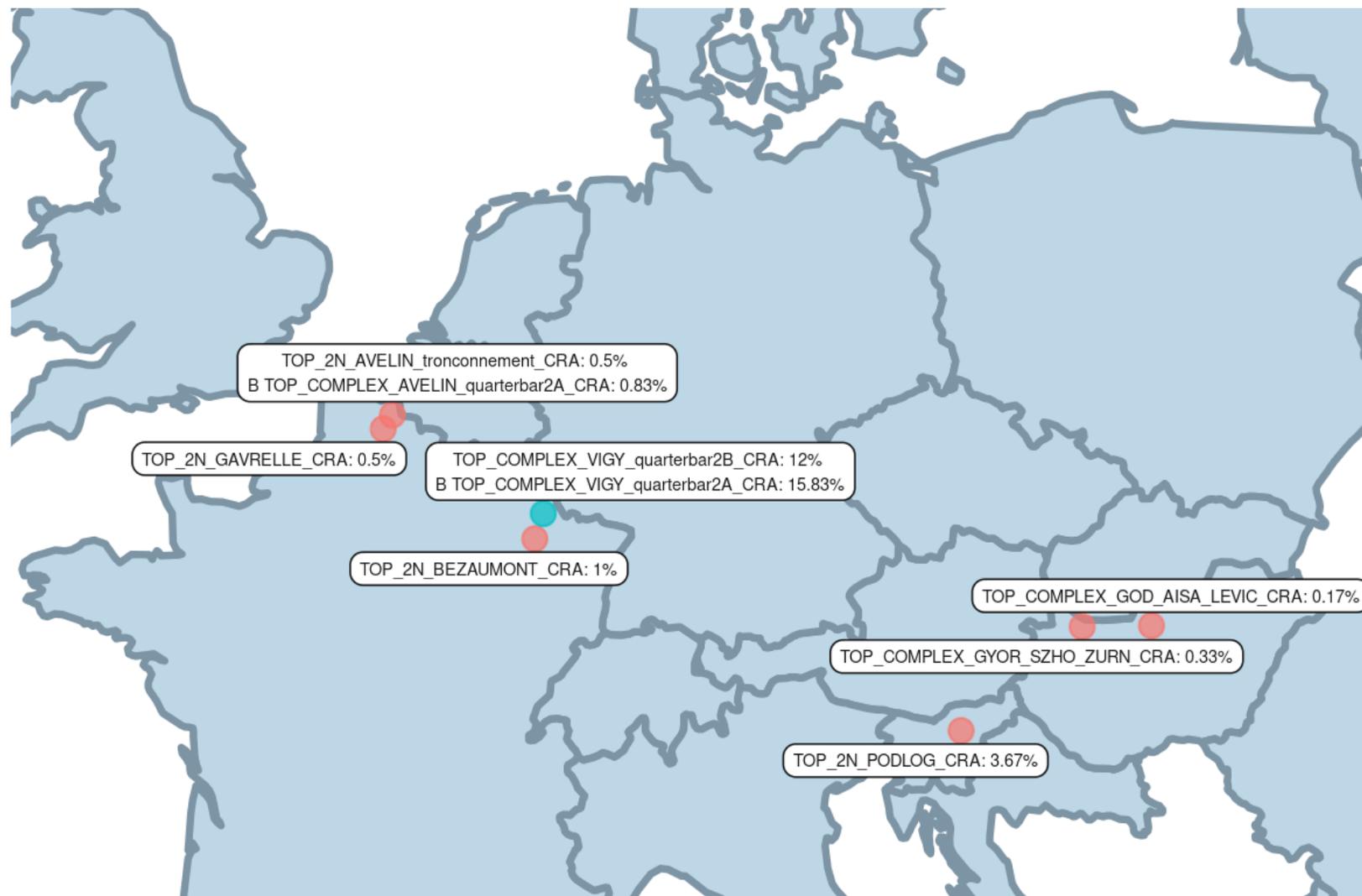


Relative Time Share [%]

- 0%-10%
- 20%-30%

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

## Relative Time Share of Applied Topological RAs in Curative Mode

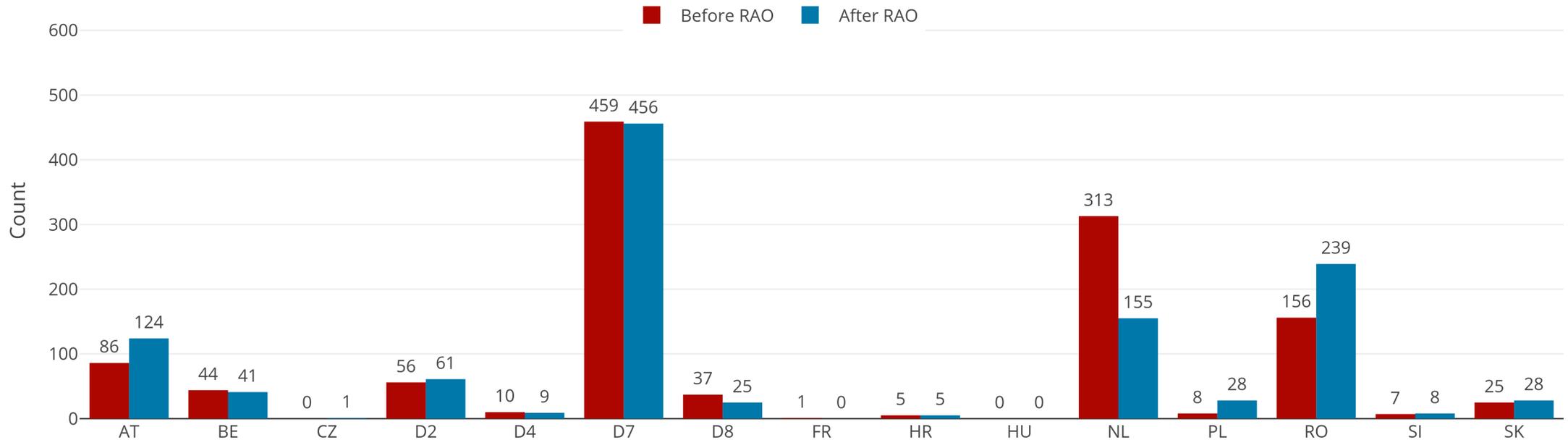


# KPI 9: Most limiting CNEC per TSO (NRAO)



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.

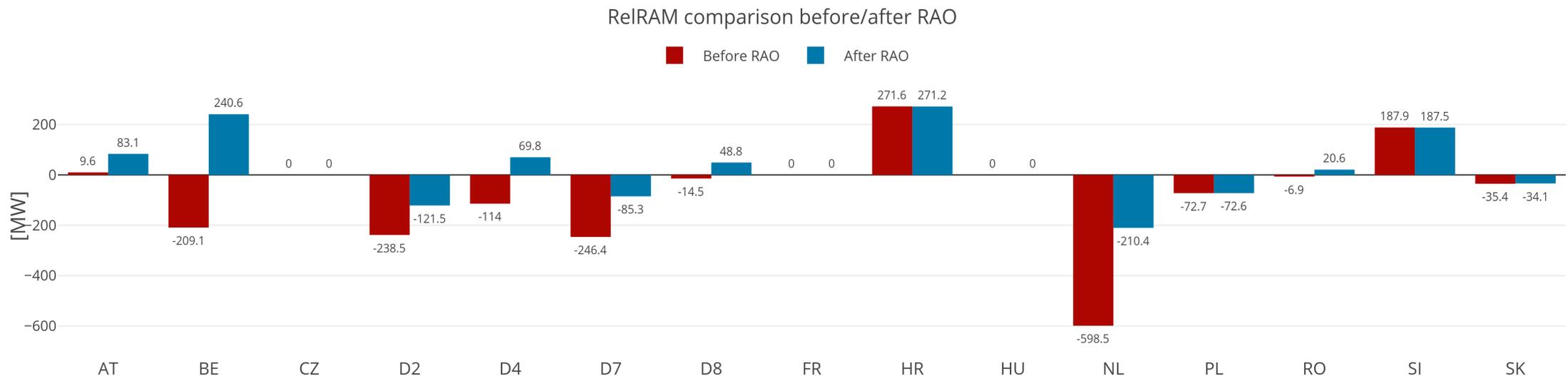
# KPI 10: Average variation of relative RAM before and after NRAO



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 |
|--|----------------------------------|--------------------------|--------------|--------------|--------------|-------------|-----------------|
| [CZ-SK] Liskovec - P. Bystrica [OPP] [CZ]          | 720                              | 720                      | 106.96%      | 75.29%       | 139.77%      | 0.0891      | 0.3164          |
| [SK-CZ] Krizovany - Sokolnice [OPP] [SK]           | 720                              | 720                      | 97.13%       | 75.97%       | 116.23%      | 0.4234      | 1.8518          |
| [HR-SI] 220kV Pehlin - Divaca [OPP] [HR]           | 720                              | 1111                     | 104.54%      | 70.05%       | 148.93%      | 0.2382      | 0.5849          |
| [HR-SI] 220kV Pehlin - Divaca [DIR] [HR]           | 720                              | 720                      | 69.94%       | 32.89%       | 110.70%      | 0.2382      | 0.5849          |
| [RO-RO] TR Rosiori 400/220 1 [DIR]                 | 715                              | 718                      | 45.24%       | 19.25%       | 100.50%      | 0.1298      | 0.246           |
| [SK-SK] V.Dur - Levice 1 [DIR]                     | 714                              | 759                      | 47.29%       | 29.22%       | 71.13%       | 0.2258      | 0.8844          |
| [BE-FR] Achene - Lonny 380.19 [OPP] [BE]           | 711                              | 2926                     | 75.09%       | 19.87%       | 131.88%      | 0.2579      | 0.7008          |
| [NL-D7] Maasbracht - Siersdorf SELFK SW [DIR] [D7] | 709                              | 4092                     | 63.14%       | 20.09%       | 106.18%      | 0.3196      | 0.6854          |
| [CZ-SK] Sokolnice - Stupava [DIR] [SK]             | 708                              | 708                      | 77.20%       | 64.57%       | 95.02%       | 0.4215      | 1.8167          |
| [CZ-CZ] TR Sokolnice 220/400 [DIR]                 | 708                              | 710                      | 70.76%       | 67.20%       | 78.00%       | 0.0997      | 0.4977          |
| [PL-PL] Mikulowa AT1 [OPP]                         | 707                              | 707                      | 73.96%       | 52.00%       | 120.00%      | 0.1652      | 0.5433          |
| [D8-PL] Mikulowa PST1 [OPP] [PL]                   | 703                              | 703                      | 54.44%       | 27.88%       | 86.82%       | 0.4045      | 1.3955          |
| [AT-SI] Obersielach - Podlog 247 [DIR] [AT]        | 702                              | 1798                     | 54.28%       | 20.44%       | 137.06%      | 0.24        | 0.6825          |
| [AT-SI] Obersielach - Podlog 247 [OPP] [AT]        | 702                              | 1462                     | 123.02%      | 41.96%       | 181.97%      | 0.24        | 0.6825          |
| [SK-UA] V.Kapusany - Mukachevo (WPS) [OPP] [SK]    | 700                              | 700                      | 95.21%       | 50.55%       | 131.62%      | 0.2471      | 0.9413          |
| [RO-RS] Portile de Fier - Djerdap [OPP] [RO]       | 698                              | 956                      | 75.94%       | 20.40%       | 141.36%      | 0.4709      | 0.7363          |
| [SK-SK] Gabcikovo - P.Biskupice [DIR]              | 696                              | 696                      | 93.29%       | 70.06%       | 113.73%      | 0.3309      | 1.3201          |
| [SK-HU] Gabcikovo - Gonyu [OPP] [HU]               | 693                              | 1593                     | 88.00%       | 69.96%       | 120.79%      | 0.3441      | 1.2515          |
| [SI-HU] 400 kV Cirkovce - Hevitz [OPP] [SI]        | 692                              | 1301                     | 79.02%       | 46.08%       | 100.18%      | 0.2276      | 1.0305          |
| [BE-BE] Achene - Gramme 380.10 [OPP]               | 682                              | 2045                     | 94.93%       | 41.73%       | 157.73%      | 0.2579      | 0.7008          |

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<br>CNE has shadow<br>price | Count of CNEs<br>with shadow<br>price | Max shadow<br>price [€/MW] | Avg RAM/Fmax | Min RAM/Fmax | Max RAM/Fmax | Max z2zPTDF |
|--|---|---------------------------------------|----------------------------|--------------|--------------|--------------|-------------|
| [FR-D7] Vigy - Ensdorf VIGY2 S [DIR] [D7]          | 326                                       | 326                                   | 785.31                     | 29.89%       | 19.80%       | 74.47%       | 0.249       |
| [BE-FR] Achene - Lonny 380.19 [OPP] [BE]           | 156                                       | 200                                   | 206.31                     | 60.85%       | 19.87%       | 101.23%      | 0.2548      |
| [D8-PL] Mikulowa PST1 [OPP] [PL]                   | 78  | 78                                    | 355.4                      | 42.56%       | 27.88%       | 64.02%       | 0.3415      |
| [AT-SI] Obersielach - Podlog 247 [DIR] [AT]        | 73  | 74                                    | 588.78                     | 40.04%       | 20.44%       | 78.00%       | 0.238       |
| [NL-D7] Maasbracht - Siersdorf SELFK SW [DIR] [D7] | 62  | 66                                    | 332.83                     | 55.36%       | 29.16%       | 81.00%       | 0.3034      |
| [RO-RO] TR Rosiori 400/220 1 [DIR]                 | 45  | 45                                    | 1027.75                    | 29.94%       | 19.25%       | 72.75%       | 0.1121      |
| [AT-D2] St. Peter 2 - Pleinting 258 [OPP] [AT]     | 39  | 39                                    | 297.03                     | 79.20%       | 43.43%       | 120.60%      | 0.1584      |
| [AT-AT] Lienz 2 - Lienz 1 LIRHU43 [OPP]            | 38  | 38                                    | 24.46                      | 63.85%       | 20.00%       | 116.40%      | 0.1685      |
| [AT-CZ] Duernrohr 1 - Slavetice 437 [OPP] [AT]     | 34  | 34                                    | 22.02                      | 61.14%       | 35.15%       | 73.74%       | 0.3078      |
| [RO-RO] Paroseni - Targu Jiu Nord [OPP]            | 32  | 34                                    | 1057                       | 33.29%       | 20.51%       | 57.37%       | 0.1253      |
| [D8-D8] Pasewalk - Vierraden 306 [DIR]             | 26  | 26                                    | 1654.49                    | 30.09%       | 19.66%       | 39.09%       | 0.07        |
| [D2-D2] Altheim - Simbach 234/230 [DIR]            | 19  | 19                                    | 680.26                     | 65.04%       | 54.73%       | 74.13%       | 0.0859      |
| [NL-BE] Rilland-Zandvliet 380 G [DIR] [NL]         | 19  | 19                                    | 53.47                      | 59.65%       | 38.45%       | 76.96%       | 0.5364      |
| [HR-SI] 220kV Pehlin - Divaca [DIR] [HR]           | 19  | 19                                    | 186.18                     | 67.65%       | 50.80%       | 101.60%      | 0.2268      |
| [SK-SK] V.Dur - Levice 1 [DIR]                     | 19  | 19                                    | 1085.12                    | 36.12%       | 29.29%       | 53.95%       | 0.1811      |
| [NL-BE] PST Zandvliet 3 [DIR] [BE]                 | 18  | 18                                    | 54.37                      | 80.70%       | 65.38%       | 95.16%       | 0.4286      |
| [NL-D2] Meeden-Diele 380 Z [OPP] [NL]              | 18  | 18                                    | 131.8                      | 22.55%       | 19.94%       | 39.51%       | 0.1971      |
| [BE-BE] Achene - Gramme 380.10 [OPP]               | 17  | 17                                    | 178.07                     | 62.97%       | 41.73%       | 88.37%       | 0.2393      |
| [AT-AT] Strass - Thaur 273B [DIR]                  | 14  | 14                                    | 336.91                     | 50.49%       | 21.36%       | 80.05%       | 0.1446      |
| [PL-PL] Mikulowa AT1 [OPP]                         | 14  | 14                                    | 239.12                     | 66.26%       | 57.45%       | 81.82%       | 0.1523      |

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.

-7523.85

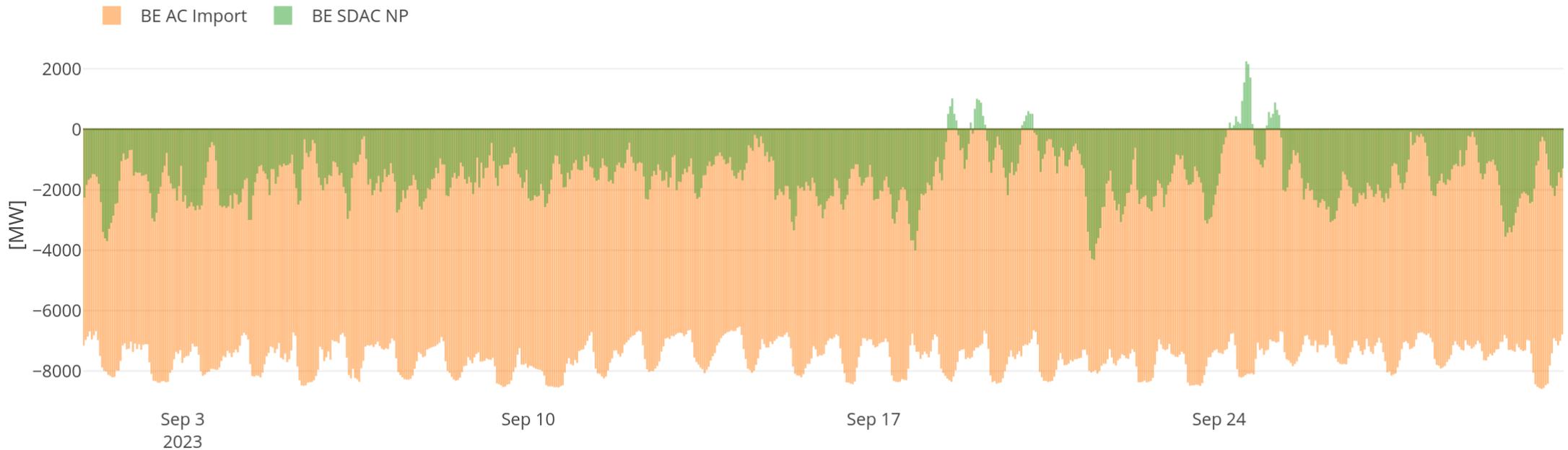
Min.

-8569.00

Max.

-6514.00

Belgium only uses import allocation constraints



# KPI 13b: Allocation Constraints - Poland



|                    | # MTUs |
|--------------------|--------|
| AC was limiting MC | 289    |
| AC < 0 MW          | 106    |
| AC = 0 MW          | 172    |
| AC > 0 MW          | 11     |

|      | PL AC Import [MW] | PL AC Export [MW] |
|------|-------------------|-------------------|
| Avg. | -1190.67          | 2143.75           |
| Min. | -8252.00          | 0.00              |
| Max. | 0.00              | 8669.00           |

