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2023 Assessment of available cross-zonal capacity for the Netherlands

In accordance with article 15(4) of Regulation (EU) 2019/943 of the European Parliament and the Council of 5 June 2019 on the internal market for electricity (recast)

Executive Summary

With the establishment of the Electricity Regulation - part of the Clean Energy package - several provisions entered into force which specify the minimum levels of capacity margins that TSOs need to make available for cross-zonal trade. More specifically, article 16(8) of the Electricity Regulation requires TSOs to ensure that at least 70% of the transmission capacity is offered for cross-zonal trade, while respecting operational security limits. However, the Electricity Regulation also allows Member States to adopt transitory measures, such as action plans or derogations, to reach gradually the minimum capacity margin available for cross-zonal trade (MACZT) by the end of 2025 at the latest.

For the Netherlands, an action plan has been adopted as transitory measure to reach gradually the minimum capacity margin of 70% on the critical network elements included in CORE flow-based day-ahead capacity calculation. Next to the action plan, for the year 2023 also a derogation applies.

As a consequence of the action plan, TenneT is obliged to assess on an annual basis whether the available cross-zonal capacity has reached the required minimum levels. **This report provides the results for the assessment on the transmission capacity made available for cross-zonal trade in the year 2023**. Furthermore the report contains an assessment of the transmission capacity made available on the bidding zone borders with Norway and Denmark, which are not part of the action plan, on which the target capacity margin of 70% already applies.

Because of the interplay between action plan, derogation and the CORE flow-based capacity calculation methodologies, it is not straightforward to assess whether the capacity made available was in accordance with all the applicable provisions. Within this report, TenneT clarifies what specific provisions related to minimum capacities apply for the Netherlands, how it implemented those specific provisions in operations and how it has monitored its compliance against those provisions.

For this assessment, TenneT has followed the approach and principles as set out by ACER and applied in ACER's EU MACZT monitoring report. In addition, this report provides more specific information for the Netherlands, as well as additional figures and results including the level of capacity made available on individual network elements. By doing so, TenneT aims to provide maximum transparency on its performance to its stakeholders.

For the **CORE region**:

- For **100%** of the time, **TenneT has provided capacity margins at or above the required minimum levels** on all its network elements

For the **HVDC bidding zone borders (NL-DK1, NL-NO2)**:

- For **99%** of the time**, TenneT has provided capacity margins at or above the required minimum level** of 70% of the net transmission capacity for the NL-DK1 and NL-NO2 bidding zone border.

TenneT expects that – with the applicable derogation for loopflows – for 2024 a continuation of the 2023 capacity margins is realistic.

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1. Introduction

In December 2019, the Ministry of Economic Affairs and Climate Policy of the Netherlands has established an action plan pursuant to Article 15 of the Electricity Regulation[1].

Article 15, paragraph 4 of the Electricity Regulation prescribes that on an annual basis, during the implementation of the action plan and within six months of its expiry, the relevant transmission system operators shall assess for the previous 12 months whether the available cross-border capacity has reached the linear trajectory.

This report provides the assessment of TenneT TSO B.V. (hereinafter "TenneT") of the cross-border capacity made available in the year 2023, and whether this was in accordance with the various provisions on minimum capacities that were applicable to TenneT in the year 2023.

It is the fourth report in its kind, and follows in general the structure as was applied before in the assessment of the cross-border capacity made available in 2020, 2021 and 2022 (2020 MACZT assessment report, 2021 MACZT assessment report and 2022 MACZT assessment report)[2,3,4]. The main difference between the years 2022 and 2023 is the transition from CWE area to the larger CORE region. On June 9, 2022 the go-live of CORE day-ahead market coupling took place successfully. Therefore the 2023 no longer contains CWE data.

The outline of the report is as follows:

- First in chapter 2, TenneT sets out the various obligations on minimum capacities that were applicable for TenneT in the year 2023
- Then in chapter 3, TenneT sets out how these various obligations have been implemented in its daily operations
- Chapter 4 describes the methodology applied behind the assessment as performed for this report
- Chapter 5 contains the results from the assessment
- Chapter 6 provides the main conclusions resulting from the assessment

Furthermore, five annexes with relevant background information are included to this report.

[1] Regulation (EU) 2019/943 of the European Parliament and of the Council of 5 June 2019 on the internal market for electricity (recast), available at: https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32019R0943&from=EN
[2] 2020 Assessment of available cross-zonal capacity for the Netherlands, approved by ACM on 26 August 2021 and available at: https://www.acm.nl/sites/default/files/documents/bijlage-bij-besluit-tennet.pdf
[3] 2021 Assessment of available cross-zonal capacity for the Netherlands, approved by ACM on 17 August 2022 and available at: https://www.acm.nl/system/files/documents/bijlage-1-beoordelingsverslag-tennet-2021.pdf
[4] 2022 Assessment of available cross-zonal capacity for the Netherlands, approved by ACM on 21 July 2023 and available at: https://www.acm.nl/system/files/documents/bijlage-1-beoordelingsverslag-tennet-2022.pdf

2. Obligations on TenneT TSO B.V. with respect to minimum capacities to be made available for cross-zonal trade

In the year 2023, several provisions related to the minimum levels of capacity margins that TenneT needs to make available for cross-zonal trade were applicable. This chapter sets out the relevant provisions from:

- The EU Electricity Regulation and the Action Plan established for the Netherlands
- The Derogation from the minimum level of capacity
- The CORE Flow-Based Day-ahead Capacity calculation methodology

2.1 The EU Electricity Regulation and the Dutch Action Plan

The Electricity Regulation article 16(8) requires TSOs to ensure that at least 70% of the transmission capacity is offered for cross-zonal trade, while respecting operational security limits. According to this Regulation, Member States may also adopt transitory measures, such as action plans or derogations, to reach gradually the minimum capacity margin available for cross-zonal trade (MACZT) by the end of 2025 at the latest.

In December 2019, the Ministry of Economic Affairs and Climate Policy of the Netherlands has established an action plan[5] pursuant to Article 15 of the Electricity Regulation. The action plan has established a linear trajectory for the minimum capacity available for cross-zonal trade to be compliant with Article 16(8) of the Electricity Regulation. The action plan establishes an individual linear trajectory for every Critical Network Element (CNE) which is included in CORE Flow-Based Day-Ahead Capacity Calculation (CORE FB DACC). CORE is a capacity calculation region (CCR) and further on referred to as Core CCR.

The other (HVDC-based) bidding zone borders of the Netherlands are not specifically included in the action plan and for these borders no linear trajectory is established. Therefore, for these borders the minimum value of 70% as established in article 16(8) of the electricity Regulation already applies per 1/1/2020.

Table 1 shows a full overview of the applicable target minimum capacity margins ($MACZT_{target}$) per Capacity Calculation Area/Region. Details on how the linear trajectory values have been determined can be found in the action plan itself[5]. The applicable values per Dutch CNE are included in annex 2.

Table 1: Overview of the $MACZT_{target}$ values from the linear trajectory per Area/Region for the year 2023

Relevant Capacity Calculation Area/Region	Bidding Zone Borders and/or CNECs	Point of linear trajectory for target minimum capacity ($MACZT_{target}$) in relative MACZT [%][6]
CORE CCR	NL-BE; NL-DE; and Dutch CNECs included in CORE FB DA CC	Differs per CNE. Minimum: 50% Maximum: 70% Mean: 53% Average: 54%
DK-NL (NL side)	NL-DK1	70% (as no linear trajectory established)

[5] The action plan has been published by the Ministry of Economic Affairs and Climate Policy on its website.
[6] Relative MACZT means the percentage of the MACZT relative to the maximum admissible flow (Fmax)

NL-NO (NL side)	NL-NO2 / NL-NO2a[7]	70% (as no linear trajectory established)

2.2 Derogation for the Netherlands

On July 28, 2022, TenneT applied for a derogation from the minimum level of capacity to be made available for cross-zonal trade in accordance with article 16(9) of the Electricity Regulation. This request for derogation was approved by the Dutch national regulatory Authority for Consumers and Markets (hereinafter "ACM") on December 22, 2022 for the duration of 1 year from January 1, 2023 up to and including December 31, 2023.[8]

The main element of the derogation are summarised in Table 2.

Table 2: Summary of derogation in accordance with article 16(9) of the Electricity Regulation applicable for NL in 2023

Reason for derogation	Remedy	Duration
Loop flows on Dutch CNECs that cannot be contained to an acceptable level	Application of a methodology to reduce the $MACZT_{target}$ values in case loop flows exceed a certain predefined threshold.	1 year

In accordance with article 16(9) of the Electricity Regulation, in June 2023 TenneT sent a report on methodologies and projects that shall provide a long-term solution to the operational security risks which the derogation granted to TenneT seeks to address.[9]

In the following subsection, the methodology applied to reduce the $MACZT_{target}$ values in case loop flows exceed a certain threshold is described in more detail.

2.2.1 Applied methodological approach to deal with Loop Flows above an acceptable level

Article 4(4) of the request for derogation[10] contains the following formula to determine the minimum capacity margin that TenneT needs to make available for cross-zonal trade ($MACZT_{min}$) on a CNEC in CORE FB DA CC:

$$(1) \qquad MACZT_{min}^{CNEC} = MACZT_{target}^{CNEC} - max\left(0; LF_{calc}^{CNEC} - LF_{accept}^{CNEC}\right)$$

Where:

[7] Statnett has implemented a virtual market area 'NO2a', which has gone live per BD 10/11/21. The NorNed interconnector connects to this area per that BD. For the sake of simplicity, this report refers to NO2 as the bidding zone border to which the NorNed interconnector connects.
[8] The approval of the derogation including the derogation itself is available at: https://www.acm.nl/nl/publicaties/besluit-verlening-derogatie-lusstromen-aan-tennet-voor-2023
[9] Available at: https://www.acm.nl/nl/publicaties/rapport-methodologieen-en-projecten-tennet-mbt-derogatie-lusstromen-2023
[10] The request for derogation is available at: https://www.acm.nl/nl/publicaties/derogatieverzoek-tennet-artikel-16-negende-lid-van-verordening-2019-943

- $MACZT_{target}^{CNEC}$ is the level of minimum capacity to be made available for cross-zonal trade on the given CNEC according to the linear trajectory, given in % of the maximum flow on the CNEC (F_{max}^{CNEC})
- LF_{calc}^{CNEC} is the loop flow on the CNEC in % of F_{max}^{CNEC}
- LF_{accept}^{CNEC} is the threshold value of "acceptable" loop flows in % of F_{max}^{CNEC},, which differs per CNE:
    - LF_{accept}^{CNEC} is 30%-FRM^{CNEC} for cross-zonal CNEs
    - LF_{accept}^{CNEC} is 0.5*(30%-FRM^{CNEC}) for internal CNEs

  With FRM^{CNEC} being the Flow Reliability Margin of the CNEC

As result of the methodology applied in the derogation, the methodological minimum level of the MACZT ($MACZT_{min}$) can thus lead in certain hours to capacities lower than the target values as prescribed by the linear trajectory ($MACZT_{target}$).

Further details about the calculation of the loop flows and the process followed, can be found in annex 5.

2.3 The Flow-Based Day-Ahead Capacity Calculation Methodology

In CORE Flow-based Market Coupling the formal obligation on a minimal margin from the coordinated capacity calculation process is described by the CORE day-ahead capacity calculation methodology[11]. The following provisions are part of this methodology:

- In Article 17 it is prescribed that as part of the intermediate flow-based calculation the CORE CC tool shall guarantee the minRAM for each CNEC according to the linear trajectory or applied derogations on the action plan. Therefore, the term minRAM in CORE FB DACC is equal to the $MACZT_{min}$. The minRAM provision is mathematically fulfilled during the intermediate flowbased computation.
- The definition of minRAM in CORE FB DACC is provided in article 17(5) as follows: $RAM + F_{uaf} \geq minRAM$.

  The flow that results from exchanges outside the CCR (F_{uaf}) factor is added to fulfil the minRAM inequality requirement in CORE FB DACC. This has the following consequence on the interpretation of minRAM in the context of MACZT: minRAM = $MACZT_{min}$
- Article 17(7) ensures that the RAM in CORE FB DACC can never go below 20% of F_{max} during the intermediate flow-based computation. Since the determined $MACZT_{min}$ values that result from the application of the derogation on the Netherlands (NL) linear trajectory action plan are input for the intermediate flowbased computation, TenneT ensures the minRAM/$MACZT_{min}$ for NL CNECs to not drop below 20% of F_{max}. Translating this obligation to a formula leads to the following equation:

$$MACZT_{min} = 20\% \quad (2)$$

  In practice this implies that in CORE FB DACC there always is a minimum of 20% of Fmax available on each CNEC for cross zonal capacity.

[11] CORE day-ahead capacity calculation methodology, see: https://www.acm.nl/system/files/documents/bijlage-3-geconsolideerde-versie-day-ahead-capaciteitsberekening-core.pdf

3. Implementation of minimum capacity obligations by TenneT TSO B.V.

3.1 Implementation of minimum capacities in the CORE Capacity Calculation Region

As set out in chapter 2, TenneT simultaneously needs to comply with several provisions related to the minimum levels of capacity margins that TenneT needs to make available for cross-zonal trade (MACZT). The obligations as set out in formula (1) and (2) are the relevant formulas determining the capacity margins that TenneT needs to make at minimum available for cross zonal trade within CORE FB DACC.

As set out in ACER recommendation No 01-2019, for AC network elements the MACZT consists of both a margin from capacity calculation *within* a capacity calculation area/region (MCCC), as a margin from non-coordinated capacity calculation *outside* the capacity calculation area/region (MNCC):

$$(3)\ MACZT = MCCC + MNCC$$

Formula 3 applies to calculate available cross zonal capacities on network elements in the CORE region. In this context, the Remaining Available Margin (RAM) made available within CORE FB DACC is to be regarded as MCCC made available in the CCR of CORE. Flows on CNEs resulting from exchanges outside the CORE region are to be regarded as MNCC in the CORE region.

Within the CORE FB DACC process, the MCCC and MNCC are outputs which are calculated by the central TSO CORE Capacity Calculation tool (CCCt). TenneT needs to comply to both equation (1) and (2) minimum amount of capacity margin that needs to be made available by TenneT. Combining equation (1) and (2) results in a minimum available cross zonal trade ($MACZT_{min,CORE}$) to be made available by TenneT in CORE FB MC:

$$(4)\ MACZT^{CNEC}_{min,CORE} = max\,\{20;\ MACZT^{CNEC}_{target} - max\left(0; LF^{CNEC}_{calc} - LF^{CNEC}_{accept}\right)\}$$

Where

- $MACZT^{CNEC}_{target}$ is the level of minimum capacity to be made available for cross-zonal trade on the given CNEC according to the linear trajectory, corrected for those MTUs with IVA application, given in % of the maximum flow on the CNEC (F^{CNEC}_{max})
- LF^{CNEC}_{calc} is the loop flow on the CNEC in % of F^{CNEC}_{max}
- LF^{CNEC}_{accept} is the threshold value of "acceptable" loop flows on the CNEC in % of F^{CNEC}_{max}
- F^{CNEC}_{max} is the maximum flow on the CNEC

Since 9/6/2022, this formula is implemented in the daily operation within CORE FB MC. In case RAM (MCCC) + F_{uaf} (MNCC) within CORE FB DA CC is lower than the $MACZT^{CNEC}_{min,CORE}$, an Adjustment for Minimum RAM (AMR) is calculated in the minRAM process. This AMR is then added to the RAM of the CNEC to fulfil the required minRAM/$MACZT^{CNEC}_{min,CORE}$.

MACZT compliance is the figure after the minRAM inclusion step. In practice the value can be lower due to the individual validation process that checks operational security (see DA CCM article 20(5)[11]). Therefore, the $MACZT_{target}^{CNEC}$ is adjusted for specifically those MTUs for which the action plan target values are out of reach for reasons of operational security. The application of IVAs does not conflict with the minimum available margins from a regulatory perspective. Therefore, TenneT adjusts the $MACZT_{target}^{CNEC}$ of MTUs with IVA to represent this in the Clean Energy Package compliance. A hypothetical example of this adjustment: in case the MACZT of a CNEC is 50% while the $MACZT_{target}^{CNEC}$ is set at 45%, an IVA of 10% will reduce both MACZT and $MACZT_{target}^{CNEC}$ to 40%. Consequently, the $MACZT_{target}^{CNEC}$ is reduced by 5% from 45 to 40%.

3.2 Implementation of minimum capacities on HVDC bidding zone borders

In line with ACER recommendation 01-2019, the (oriented) Net Transfer Capacity (NTC) that is made available for the HVDC bidding zone borders is to be considered fully as the MACZT made available on these bidding zone borders. Therefore, no additional tooling/calculations had to be implemented to be able to determine the level of MACZT on these interconnectors.

In a planned or unplanned outage situation, the grid capacity is reduced and flows on the remaining critical network elements increase compared to the grid situation where the outage is not present. It can occur, that in such situations some internal network elements do not have sufficient capacity to facilitate an expected level of internal flows, loop flows, cross-zonal flows via AC interconnectors as well as the maximum level of cross-zonal flows over the HVDC interconnectors.

When one or more critical network elements are in outage, TenneT aims to still respect the minimum capacity to be made available for cross-zonal trade as defined by the relevant obligations as set out in chapter 2, by using if needed non-costly and costly remedial actions. However, in case operational security limits cannot be respected due to a lack of available effective remedial actions when one or more critical network elements are in outage, TenneT is allowed to reduce capacity available for cross-zonal trade to a level that respects operational security limits.

In practice, TenneT has implemented the following process to make this evaluation:

1. If during the week-ahead grid security assessment,
    a. it becomes apparent that operational security limits are expected to be violated due to planned outages for required maintenance or grid enforcements, or due to longer duration unexpected outages; and/or
    b. the application of redispatching during the day-ahead and intraday timeframe as remedial actions is not expected to be sufficient or appropriate to resolve the expected violations of security limits, because amongst others:
        i. The application of redispatching before D-1 as only remedial action would exhaust redispatch potential in the day-ahead and intraday timeframe, such that insufficient remedial actions would remain available to solve potential later violations of security limits; or
        ii. There is expected to be insufficient upward redispatching potential for the required redispatching volume in the day-ahead or intraday timeframe; or
        iii. Restrictions on generation due to other operational security aspects, such as dynamic stability of the system, voltage control or obligations on generators to generate a certain amount of short circuit power for adequate detection of short circuits;

       and
    c. a reduction of capacity made available for cross-zonal trade is deemed an effective measure to reduce or resolve the violation of the operational security limits;

   then a set of remedial actions including a reduction of available capacity for cross-zonal trade on some critical network elements (incl. HVDC interconnectors) is prepared. The set will then consist of a combination of the application of one-sided redispatch prior to the DA market coupling for the respective region (via negotiated restriction agreements with some generators[12]) and reductions of available cross-zonal capacity proportionate to the impact of prepared (costly) remedial actions but limited to the extent needed to safeguard grid security.

2. During the operational security assessments performed day-ahead and intraday after the DA market coupling, the applied remedial actions from the week-ahead grid security assessment are taken into account on the basis of updated forecasts integrated in the day-ahead resp. intraday congestion forecasts.[13] If this assessment indicates that operational security limits are still expected to be violated, more RAs (for example redispatching) will be applied. If the application of RAs is not possible or sufficient, additional reductions of available capacity for cross-zonal trade on some critical network elements is applied to the extent needed to safeguard grid security.

3.3 Consideration of flows with third countries

The MNCC on a Core CNEC contains the flows that result from exchanges with non-Core biddingzone borders. Among the list of non-Core biddingzone borders are also biddingzone borders with third countries, that do not participate in SDAC. For the Netherlands the most influential biddingzone border with respect to MNCC on Core CNECs is UK-NL, also known as the BritNed cable. As the exchange of electricity with the UK uses grid capacity TenneT must include these exchanges in the day-to-day operations. The capacities on the BritNed cable are used by market parties to trade electricity between the UK and the Netherlands. Therefore, electricity exchanges with third countries will contribute to overall capacity margins made available for cross-zonal trade. TenneT includes these third country flows within the MNCC. All figures in this report are based on data that do consider exchanges with third countries.

In annex 5 it is specified which countries are regarded as third countries. Flows with Norway are not considered as third country flows, because TenneT and Statnett have agreed on a coordinated capacity calculation process for the NL-NO2 bidding zone border. The existence of this process has also been acknowledged by Core NRAs.

[12] Besides the application of redispatch, TenneT also resolves congestion problems through restriction agreements with market participants in the case of insufficient bids or frequent congestion problems in a specific area. The involved market participants limit their electricity generation or offtake in a specific region when called upon by TenneT, in return for a negotiated compensation.

[13] This step is part of the regular operational security assessments, taking place on the basis of the day-ahead Congestion Forecast (DACF) and IntraDay Congestion Forecast (IDCF) network models.

4. Methodology of the assessment

4.1 Introduction of parameter $MACZT_{margin}$

As set out in chapter 2, the minimum MACZT that TenneT needs to make available on a CNEC differs per CNEC and per MTU, depending on the individual $MACZT_{target}$ values of the CNECs and the level of loop flows (see also formula (1)). Therefore, the absolute levels of MACZT made available on CNECs cannot be used to assess whether the minimum capacity margins have been met.

In order to allow for an easy and intuitive way to assess whether sufficient MACZT was made available on an individual CNEC, TenneT introduced the parameter $MACZT_{margin}$:

$$(5)\quad MACZT_{Margin}^{CNEC} = MACZT^{CNEC} - MACZT_{min}^{CNEC}$$

where $MACZT_{Margin}^{CNEC}$ is the amount of MACZT made available above or below the minimum level, given in % of F_{max}^{CNEC}.

$MACZT_{margin}$ serves as indicator whether sufficient MACZT was made available for a CNEC for a specific MTU:

- <u>If $MACZT_{margin}$ > 0%</u>, more than the minimum required amount of cross zonal capacity was made available;
- <u>If $MACZT_{margin}$ = 0%</u>, exactly the minimum required amount of capacity was made available; and
- <u>If $MACZT_{margin}$ < 0%</u>, less capacity was made available than is at minimum required.

4.2 Assessment of MACZT compliance in the CORE CCR

4.2.1 Compliance with action plan and derogation

In order to assess whether TenneT complied with the applicable provisions related to the minimum levels of capacity margins that TenneT needs to make available for cross-zonal trade (MACZT) within the CORE CCR, following from the action plan and derogation, TenneT performed the following steps.

For each MTU:

1) Calculate $MACZT_{min}^{CNEC}$ for each CNEC per direction, based on formula (1)
2) Calculate $MACZT^{CNEC}$ for each CNEC per direction, based on formula (3)
3) Calculate $MACZT_{margin}^{CNEC}$ for each CNEC per direction, based on formula (5)
4) Evaluate the $MACZT_{margin}^{CNEC}$ for each CNEC
    a. In case $MACZT_{margin}^{CNEC} \geq 0$ <u>for all</u> CNECs for both directions, the minimum capacity margins have been met for that MTU[14].

[14] In line with the approach as applied by ACER, the compliance assessment is based on whole percentages and TenneT rounds all results to two decimals in order to get whole percentages. As result, a CNEC with a $MACZT_{margin}$ between -0.49% and 0% qualifies as $MACZT_{margin} \geq 0\%$

   b. In case $MACZT_{margin}^{CNEC} < 0$ for one or more CNECs in that MTU, TenneT potentially did not meet the minimum capacity margin obligations and a more detailed analysis needs to be performed.

4.2.2 Compliance with 20% minRAM

In order to assess whether TenneT complied with the applicable provision to make a minimum level of MACZT available of 20% in the CORE CCR, TenneT performed the following steps specifically for business days in CORE FB DACC.

For each MTU:

1. Select the CNEC which has the lowest $MACZT^{CNEC}$
2. Compare this lowest $MACZT^{CNEC}$ to the $MACZT_{min}$ target value of 20%
   - In case the lowest $MACZT^{CNEC} \geq 20\%$, TenneT has been compliant for that MTU;
   - In case the lowest $MZCZT^{CNEC} < 20\%$, one needs to evaluate whether the reduction was appropriate for reasons of operational security. For this purpose, in CORE FB DACC it is allowed to lower the RAM by means of IVA. If that was the case, TenneT was compliant for that MTU;
   - In case the lowest $MACZT^{CNEC} < 20\%$, and the reduction was not appropriate for reasons of operational security, TenneT was not compliant for that MTU.

4.3 Assessment of compliance of HVDC bidding zone borders

In order to assess whether TenneT complied with the applicable provisions related to the minimum levels of capacity margins that TenneT needs to make available for cross-zonal trade (MACZT) on the HVDC bidding zone borders, TenneT performed the following steps.

For each MTU:

1) Calculate $MACZT^{BZB}$ for each bidding zone border for both directions, by dividing the Net Transfer Capacity (NTC) of the bidding zone border per direction as offered by TenneT by the available physical capacity (Fmax) of the interconnector forming the bidding zone border:

$$MACZT^{BZB} = \frac{NTC_{TenneT}^{BZB}}{Fmax^{BZB}}$$

2) Compare $MACZT^{BZB}$ with $MACZT_{min}^{BZB}$ for both directions[15]
   a. In case $MACZT^{BZB} \geq MACZT_{min}^{BZB}$ for both directions TenneT has been compliant for that bidding zone border for that MTU.
   b. In case $MACZT^{BZB} < MACZT_{min}^{BZB}$ for one or both of the directions, then go to step 3
3) In case the MACZT is below the target level for one of both of the direction, the cause for that needs to be assessed:

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[15] In case the interconnector itself was not available because of an outage or maintenance, the Fmax of that interconnector is put to 0. In such a situation, providing 0 NTC capacity is regarded as being compliant for that interconnector for that MTU.

a. In case the reduction was not triggered by TenneT, but by 'the other' TSO (i.e. Statnett for NL-NO2 or Energinet for NL-DK1), TenneT was considered compliant for this MTU.
b. In case the reduction is triggered by TenneT due to a lack of remedial actions when the grid is in an outage situation, TenneT was compliant for that MTU.
c. In case the reduction is triggered by TenneT because of a disturbance in the NL grid, maintenance in the NL grid and/or another reason while other remedial actions could have been taken, TenneT was not compliant for that MTU.

4.4 Differences in methodology compared to the ACER MACZT monitoring

Within this report, TenneT has generally followed the approach and principles as ACER has set out in its Recommendation No 01-2019 and which have also been used in ACER's MACZT monitoring reports.

A notable distinction is that TenneT makes use of the parameter $MACZT_{margin}$ as defined in formula (5) to evaluate whether the MACZT made available met the minimum requirements. TenneT considers this a helpful parameter because next to the binary conclusion on compliance it is also possible to see the extent to which the MACZT deviates from the $MACZT_{min}$ targets.

Another notable difference is the treatment of IVA with respect to the $MACZT_{min}$. ACER’s recommendation does not foresee to adjust the $MACZT_{min}$ in case IVA is to be applied for reasons of grid security, while TenneT sees the need to adjust the $MACZT_{min}$ because this will still allow assessment of compliancy on the remaining capacity. In 2023 in a total of 155 MTUs IVA was applied on at least one Dutch CNEC. In 83% of those MTUs (128 hours) IVA triggered an adjustment of the $MACZT_{min}$ for one or more CNECs. In 17% of MTUs IVAs did not reduce the MACZT below the initial $MACZT_{min}$. Any MACZT compliance differences between this report and ACER’s reporting can be explained partly or fully by these two different approaches on IVA treatment.

5. Results

In this chapter, the results of the MACZT assessment will be described. The chapter is divided into three sections:

- Results of the MACZT compliance assessment for CORE CCR
- Additional assessments of the MACZT offered in CORE CCR
- Results of the MACZT compliance assessment for the HVDC bidding zone borders

5.1 Results of the MACZT compliance assessment for the CORE CCR

For CORE, the evaluation from 4.2.2 has been performed, for which the outcomes are presented below.

5.1.1 Assessment of the MACZTmargin

Figure 1 presents the overall percentage of time when the minimum capacity margins in CORE CCR have been met in 2023. The figure shows that for 100% of the time, the minimum capacity margins have been met for all CNECs. Compared to the 97% performance in 2022 this is an improvement. In 76% of the MTUs the MACZT target was met exactly, hence the MACZTmargin equals zero (large lightgreen part). Figure 2 contains a more detailed monthly representation of the lowest MACZTmargin. For an informative purpose TenneT also included the resulting MACZTmargin in case flows that result from exchanges with third countries are excluded from the MNCC (annex 5, Figure 16).

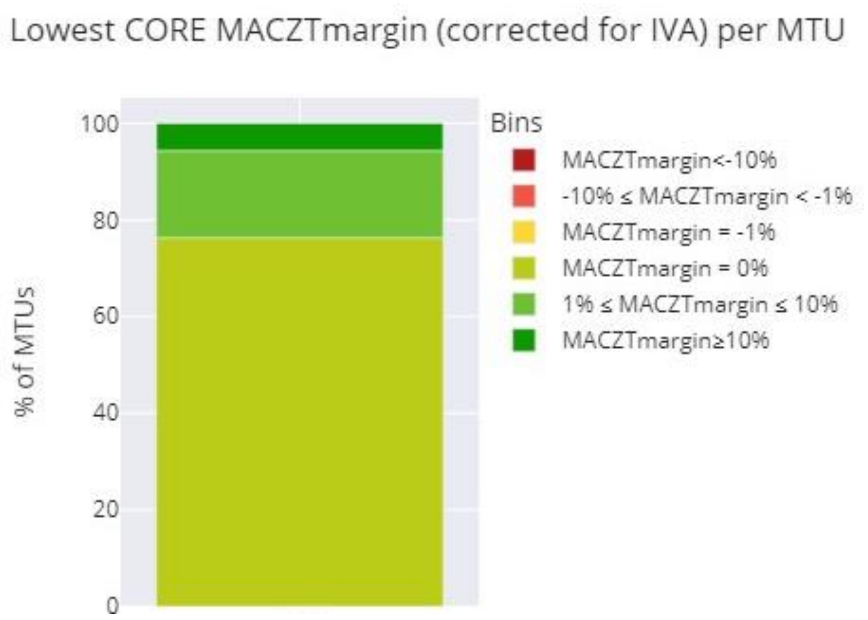

Figure 1: Percentage of time when the minimum capacity margins[16] have been met (green), and how much capacity was provided above or below the minimum margin. For each MTU, the CNEC with the lowest $MACZT_{margin}$

[16] Zero percent indicates that Tennet exactly complies to the minimum capacity requirement

was selected and categorised to one of the ranges. CORE CCR.

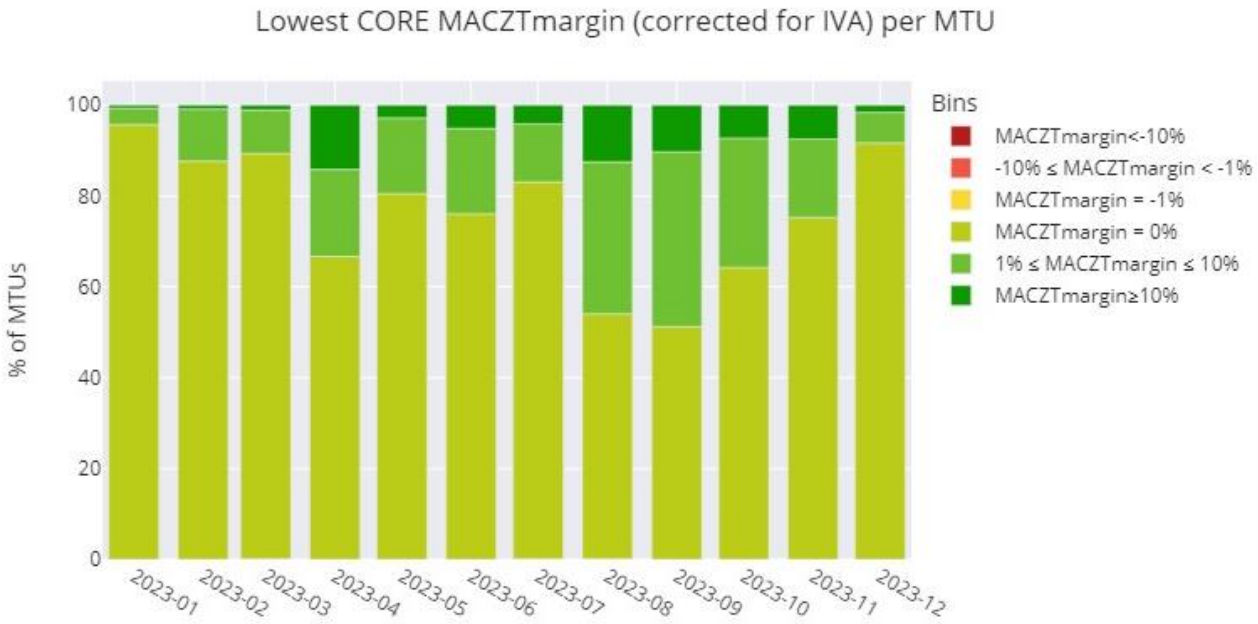

Figure 2: Percentage of time when the minimum capacity margins[16] have been met (green), and how much capacity was provided above or below the minimum margin, per month of 2023. For each MTU, the CNEC with the lowest $MACZT_{margin}$ was selected and categorised to one of the ranges.

5.1.2 Assessment of the offered MACZT

The figures of $MACZT_{margin}$ are helpful to evaluate the compliance of TenneT, but as such do not provide information on the level of MACZT which was provided. Therefore, also the ‘standard’ categorisation as introduced by ACER showing the percentage of time when the relative MACZT was within a certain range, is given in Figure 3. Please note that this figure cannot be used as basis to assess the compliance, as this figure does not take into account the linear trajectory of the action plan and derogation applicable in NL. The most significant category for all months is ranging from a MACZT value of 20% up to 50%. Only for some month a small portion of the MTUs was categorized with a MACZT < 20%. IVA application is the reason why MACZT values are lower than 20%. As of September 2023 calculated IVA values are capped to guarantee the minimum MACZT of 20% at all times.

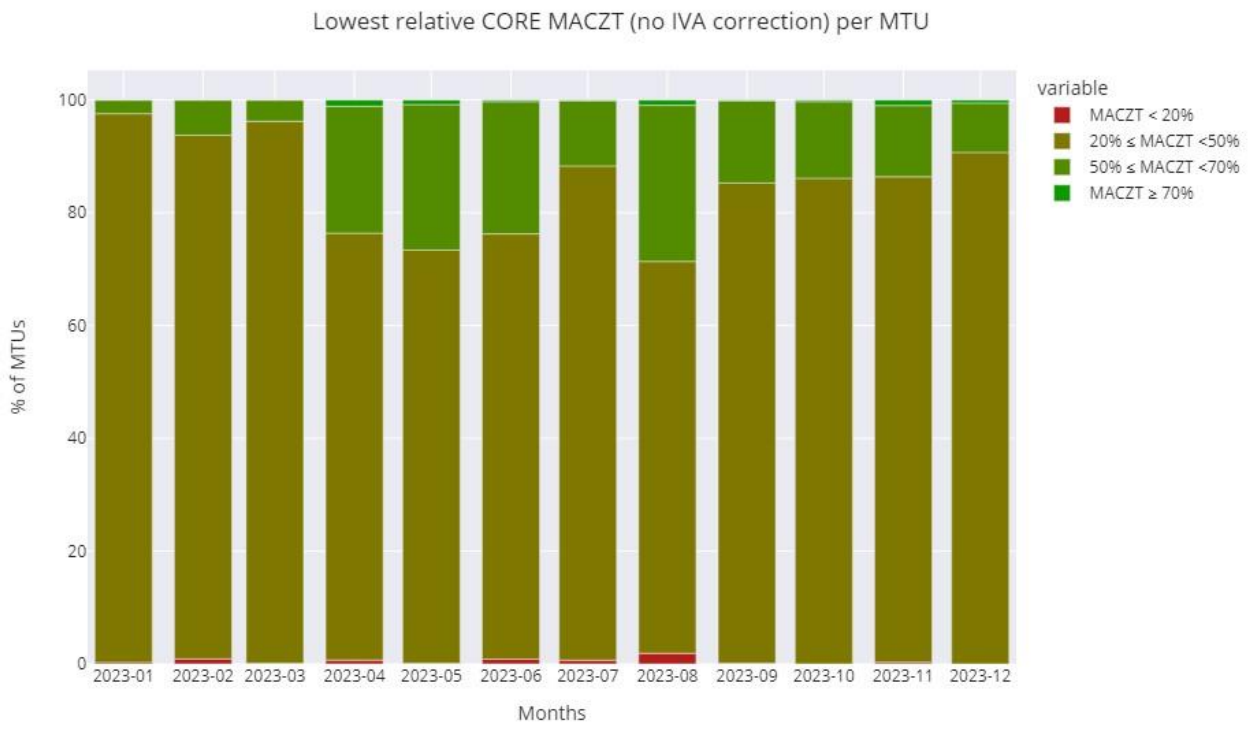

Figure 3: Percentage of time when the minimum MACZT in CORE CCR is met on all CNECs. For each MTU, the CNEC with the lowest relative MACZT was selected and categorised to one of the ranges.

5.1.3 Assessment of the offered MCCC

In Figure 4 the distribution of the lowest relative MCCC (or RAM) per MTU is given. Although there is no regulatory compliance towards the offered MCCC, the Core DACC methodology includes a 20% RAM floor to avoid CNECs with very low capacity or even zero capacity to severely limited the FB domain. The application of IVA is the single reason for the MCCC to drop below 20%. In Figure 6 a distribution of MACZT (MCCC + MNCC) is presented, to get a visual view on the impact of MNCC.

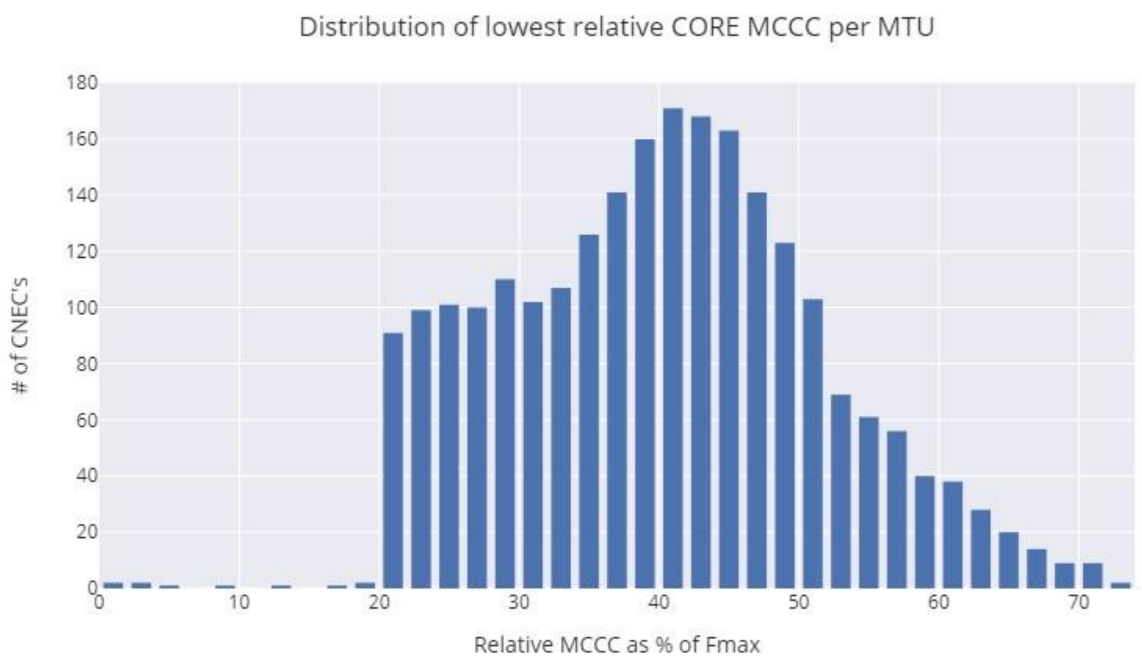

Figure 4: Distribution of the lowest hourly relative MCCC of the Netherlands for the CORE CCR.

5.2 Additional assessment of the MACZT offered in CORE CCR

Next to the main assessments required to evaluate the compliance with the minimum capacity margins that needed to be made available CORE CCR, this section contains some additional assessments which have been carried out on the basis of the MACZT data. The data from this section is not strictly required to assess the compliance, but it provides some additional insights in the amount of MACZT that has been provided on the Dutch CNECs included in CORE FB DA CC.

5.2.1 Distributions of MACZT for all CNECs

The figures in the previous section each looked at the least performing CNEC, with respect to either $MACZT_{margin}$ or MACZT, and classified this into large categories. In this subsection, histograms are included with the results of:

- Lowest hourly relative MACZT for all MTUs in 2023: Figure 5 for CORE CCR
- Relative MACZT of all CNECs for all MTUs in 2023: Figure 6 for CORE CCR
- $MACZT_{margin}$ of all CNECs for all MTUs in 2023: Figure 7 for CORE CCR

The CNEC with lowest relative MACZT shows a clear cut-off point at a MACZT of 20% (Figure 5). This can be explained as the CCCt ensures that the minRAM/$MACZT_{min}$ on a CNEC can never go below 20% of Fmax during the AMR inclusion of the intermediate flowbased computation (as explained in paragraph 2.3). Some very small fractions of data are below 20%, representing those MTUs for which the lowest relative MACZT was lowered due to IVA application (128 hours in 2023).

When looking at all CNECs (Figure 6), it can be observed that the majority of CNECs actually have a much higher relative MACZT. The average relative MACZT of all CNECs is 90%, which is significantly above the Electricity Regulation target of 70%, and the peak of the distribution for all CNECs also lies around a relative MACZT of 90%,

Furthermore, Figure 7 shows that all CNECs have had a zero or positive $MACZT_{margin}$, and thus comply with the minimum margins for cross-zonal trade that have to be offered.

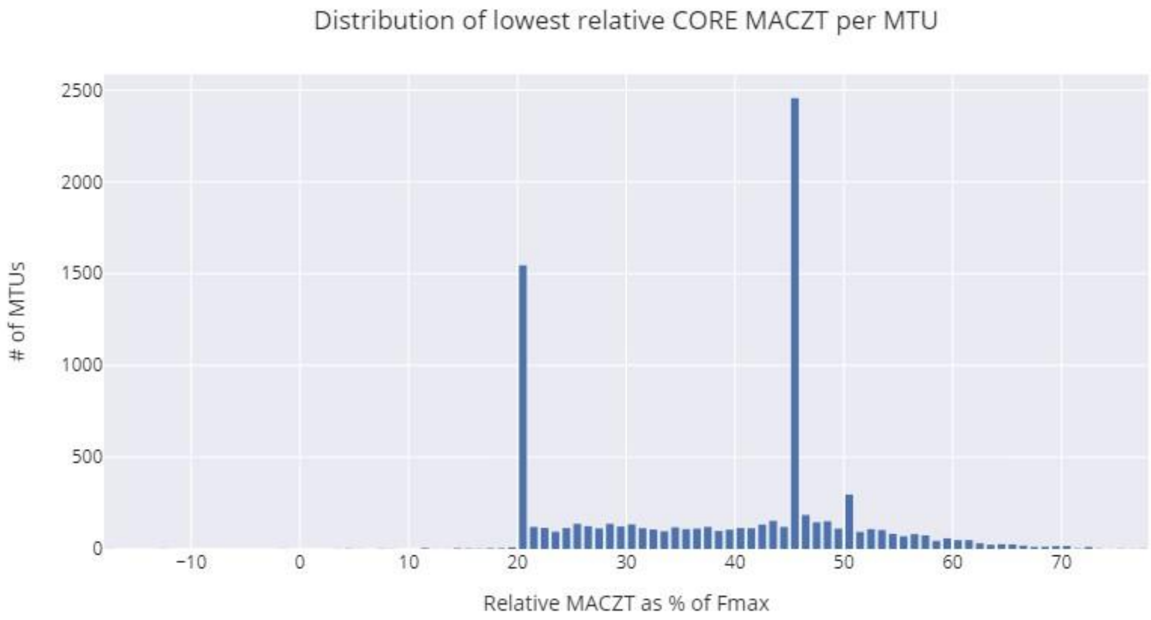

Figure 5: Distribution of the lowest hourly relative MACZT of the Netherlands for the CORE CCR.

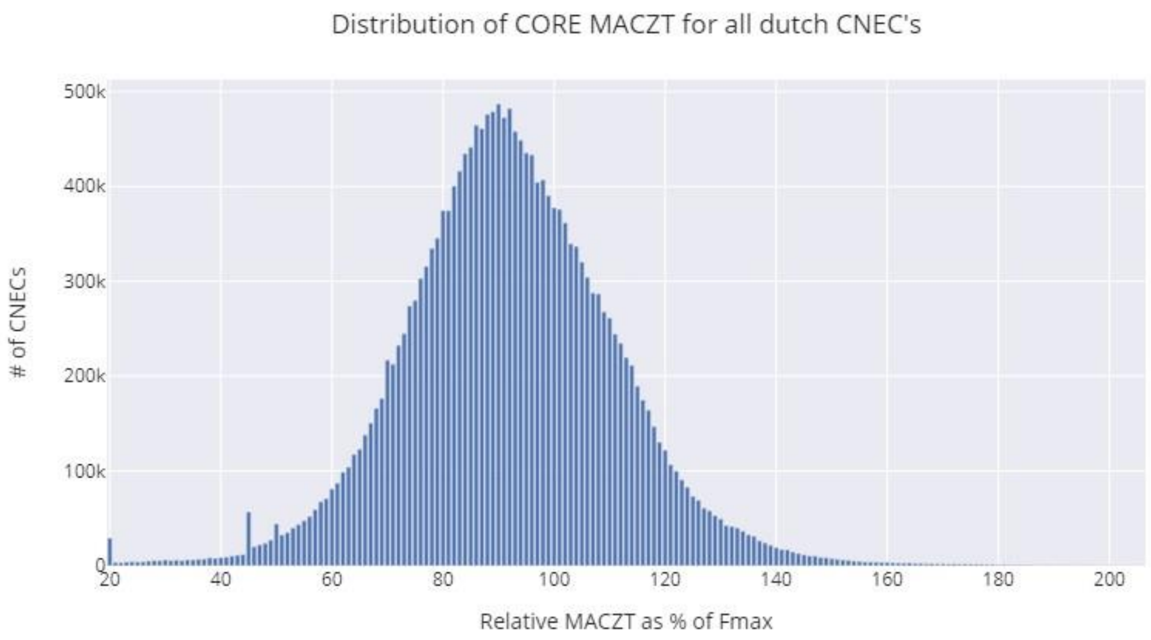

Figure 6: Distribution of the relative MACZT for all CNECs and MTUs of the Netherlands for the CORE CCR.

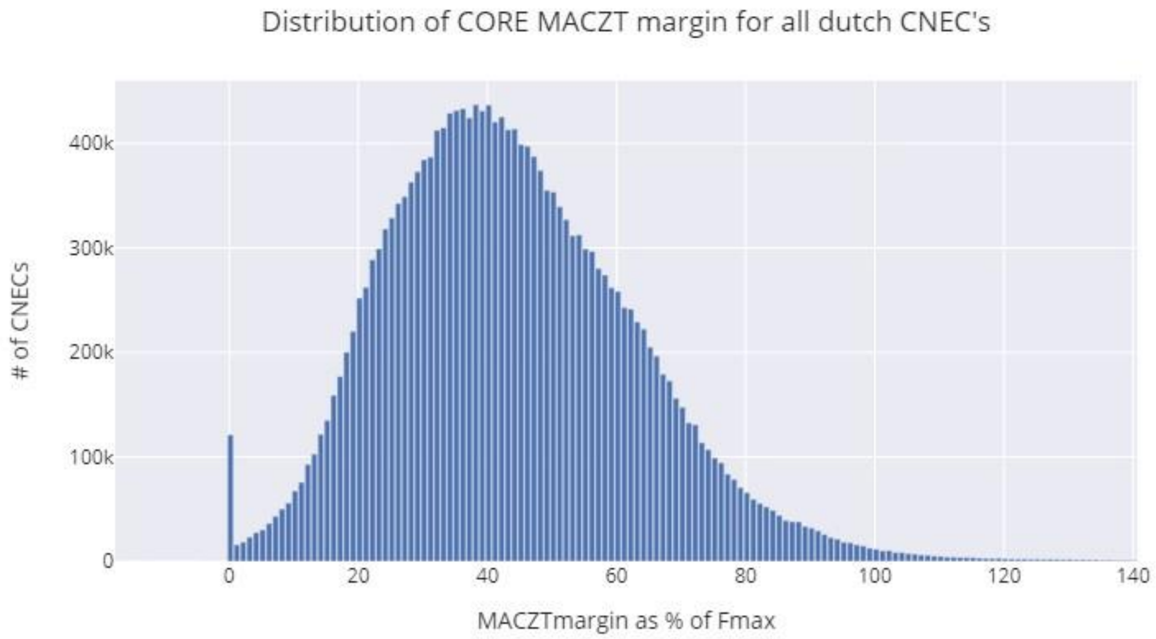

Figure 7: Distribution of the $MACZT_{margin}$ for all CNECs of the Netherlands for the CORE CCR.

5.2.2 MACZT breakdown per CNE

Based on the action plan, individual $MACZT_{target}$ values have been established per CNE. In order to provide more insight into what level of capacity is made available per CNE, a breakdown of the lowest hourly relative MACZT per CNE per direction is given in Figure 8 and Figure 9. An explanation how to read the figures is given in the box below the figures. A list with the full names of the network elements is given in Table 4 of annex 3. Most of the time, between two high voltage substations there are pairs of high voltage lines, where the individual lines have the same names but are denoted with a different suffix ('W', 'Z' etc.). Each high voltage line is individually included as CNE in the CORE FB DA CC, and therefore also individually depicted in Figure 8 and Figure 9. Typically, these CNEs are connected in parallel between the same substations and have the same grid characteristics, and therefore the flows and MACZT for both CNEs are also very comparable.

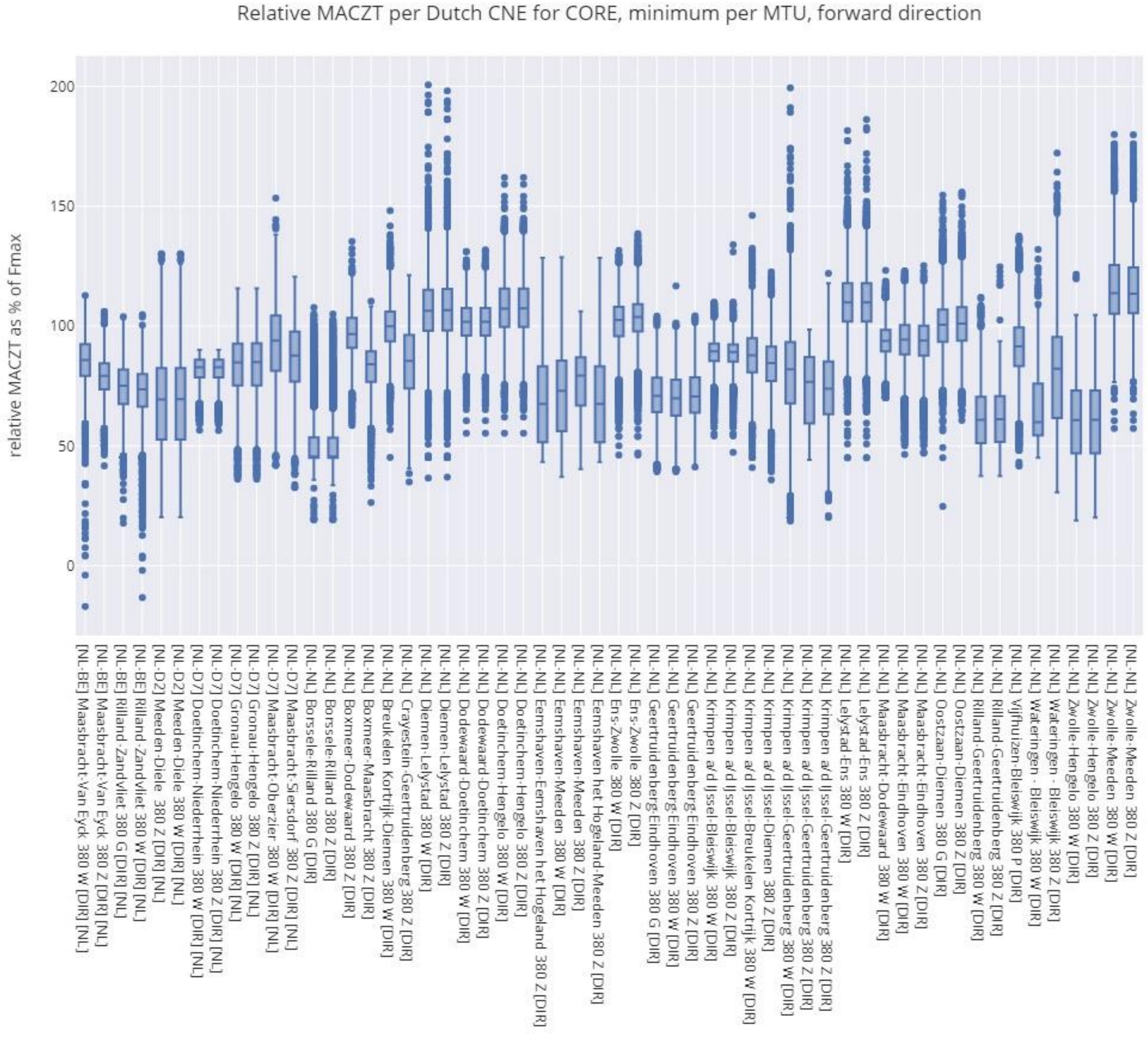

Figure 8: Relative MACZT per Dutch CNE included in CORE CCR in the forward direction, based on the lowest relative MACZT per CNE per MTU.

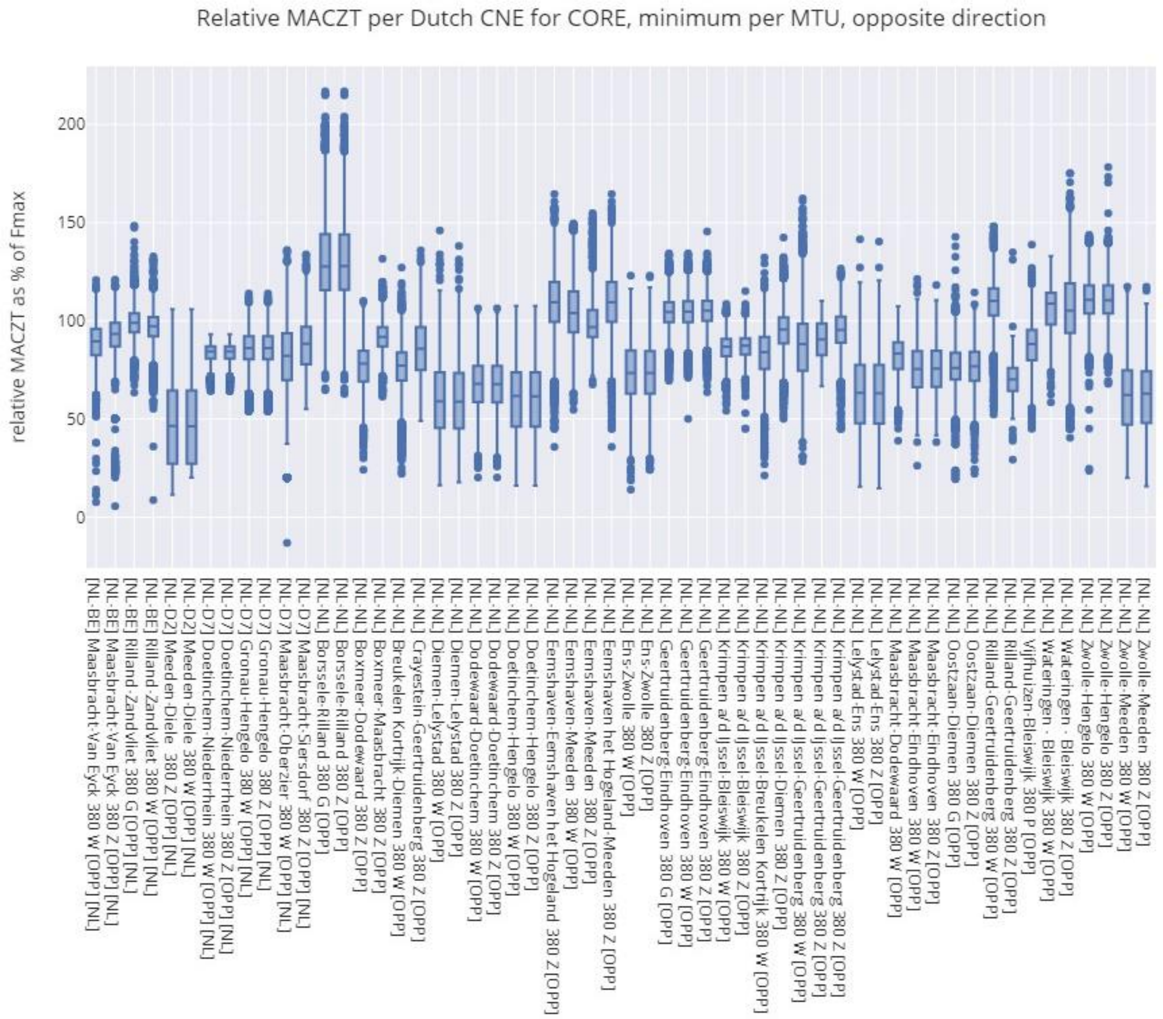

Figure 9: Relative MACZT per Dutch CNE included in CORE CCR in the opposite direction, based on the lowest relative MACZT per CNE per MTU.

Box plot explanation

- Each box + whiskers represent the data for a single CNE. For each CNE per direction, the CNEC with the lowest relative MACZT per MTU is taken.
- The box shows the range of the first quartile (Q1) to third quartile (Q3) of the data. (thus 25% - 75% of the data points is included in the box
- The blue horizontal line per CNE is the median of the data (the line which splits the dataset in half)
- Whiskers show the total range of the data, capped to a maximum of 1.5 * IQR from Q1 to Q3, where IQR is the inter-quartile range of Q3-Q1. Outliers are plotted as separate dots.

5.2.3 Overview of least performing CNECs w.r.t MACZT and MACZTmargin

Figure 10 shows what percentage of time a certain CNE has been the least performing CNE with respect to $MACZT_{margin}$, including whether they had a positive $MACZT_{margin}$ (green bar) or a negative $MACZT_{margin}$ (red bar). These are the elements which have actually set the performance with respect to $MACZT_{margin}$, as shown in Figure 1 and Figure 2.

Three network elements in particular pop up. The CNE Rilland-Geertruidenberg 380 Wit, Borssele-Rilland 380 Grijs en Borssele-Rilland 380 Zwart are the most defining CNEs with respect to the $MACZT_{margin}$. For Rilland-Geertruidenberg the occurrence in 14% of the year 2023 can be explained by the physical capacity of this CNE, as this it is not yet upgraded to the latest 4 kA conductor technology. Despite its significance as least performing CNE for MACZT performance, this element was not an active constraint in the day-ahead market coupling in a single hour in 2023. The black and white Borssele-Rilland CNEs each represent the least performing CNE around 13% of the hours in 2023, which originate from generation infeed in the Borssele 380 kV substation. Only Borssele-Rilland 380 G was an active constraint for three hours hours in the day-ahead market coupling.

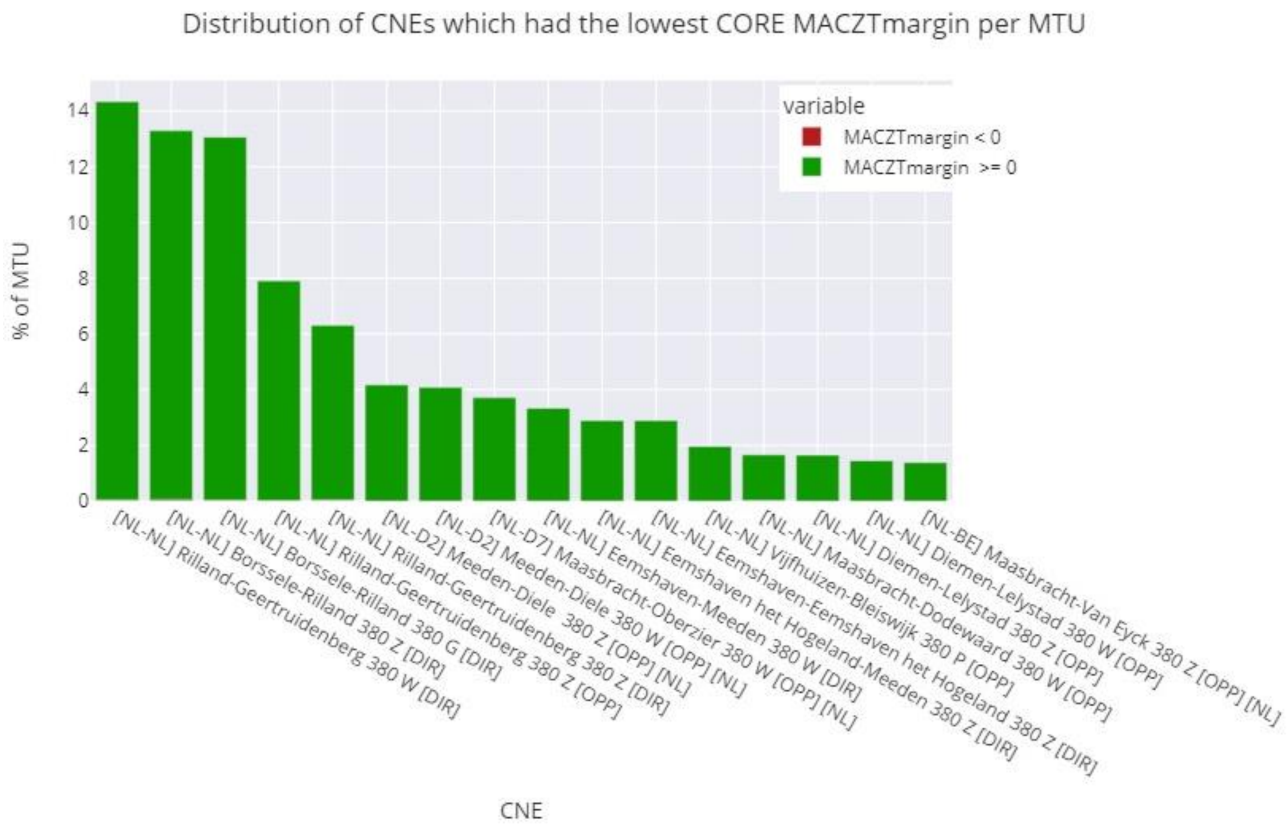

Figure 10: Overview of least performing CNEs in CORE CCR w.r.t. MACZTmargin. It has been determined what percentage of time an individual CNE has been the CNEC with the lowest $MACZT_{margin}$ per MTU. The green part of the bar indicates the percentage of time that the CNE had a positive $MACZT_{margin}$ the red part indicates the time that the CNE had a $MACZT_{margin}$ <0. All CNEs occurring <1% of the time are excluded from the graph.

Figure 11 shows what percentage of time a certain CNE has been the least performing CNE with respect to MACZT. With respect to the lowest level of MACZT, the cross-border CNEs Meeden-Diele 380 Wit and Zwart are together the most defining elements with respect to MACZT for around 14-16% of the time. This is not surprising, given that these CNEs have a relatively low Fmax (1053 MW) and typically carry a high amount of loop flows, which is shown in the next subsection.

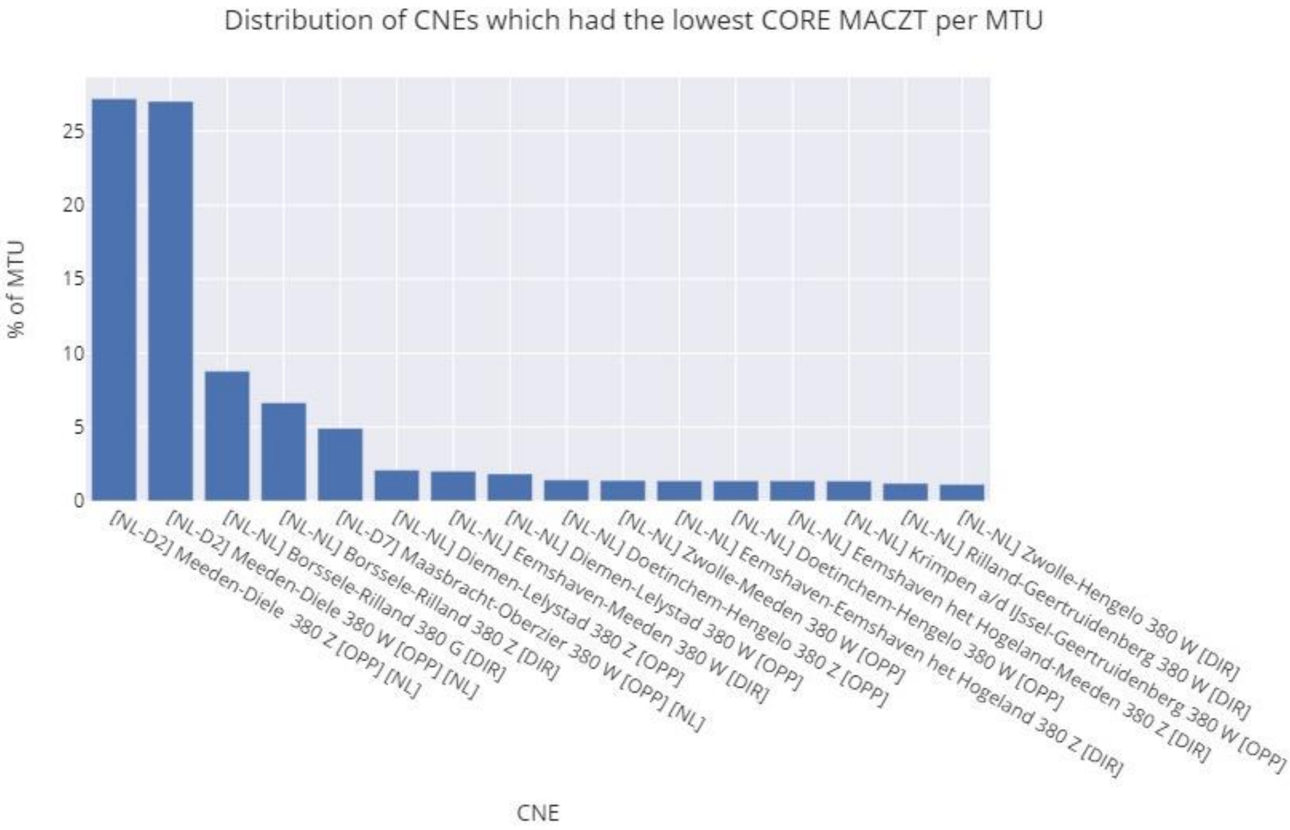

Figure 11: Overview of least performing CNEs in CORE CCR w.r.t. MACZT. It has been counted how often individual CNEs have been the CNEC with the lowest MACZT per MTU. All CNEs occurring <0,8% of the time are excluded from the graph.

5.2.4 Loop flow breakdown per CNE

One of the key elements from the applicable derogation is that it reduces the minimum margins that TenneT needs to make available for cross-zonal trade, in case loop flows exceed a certain predefined threshold (see section 2.2). In order to make the impact of this derogation more clear, a breakdown of the calculated loop flows per CNE is given in Figure 12. There is no figure included for the opposite direction, as the figure contains average loop flows and the average loop flows in the opposite direction would just be a mirror of this picture.

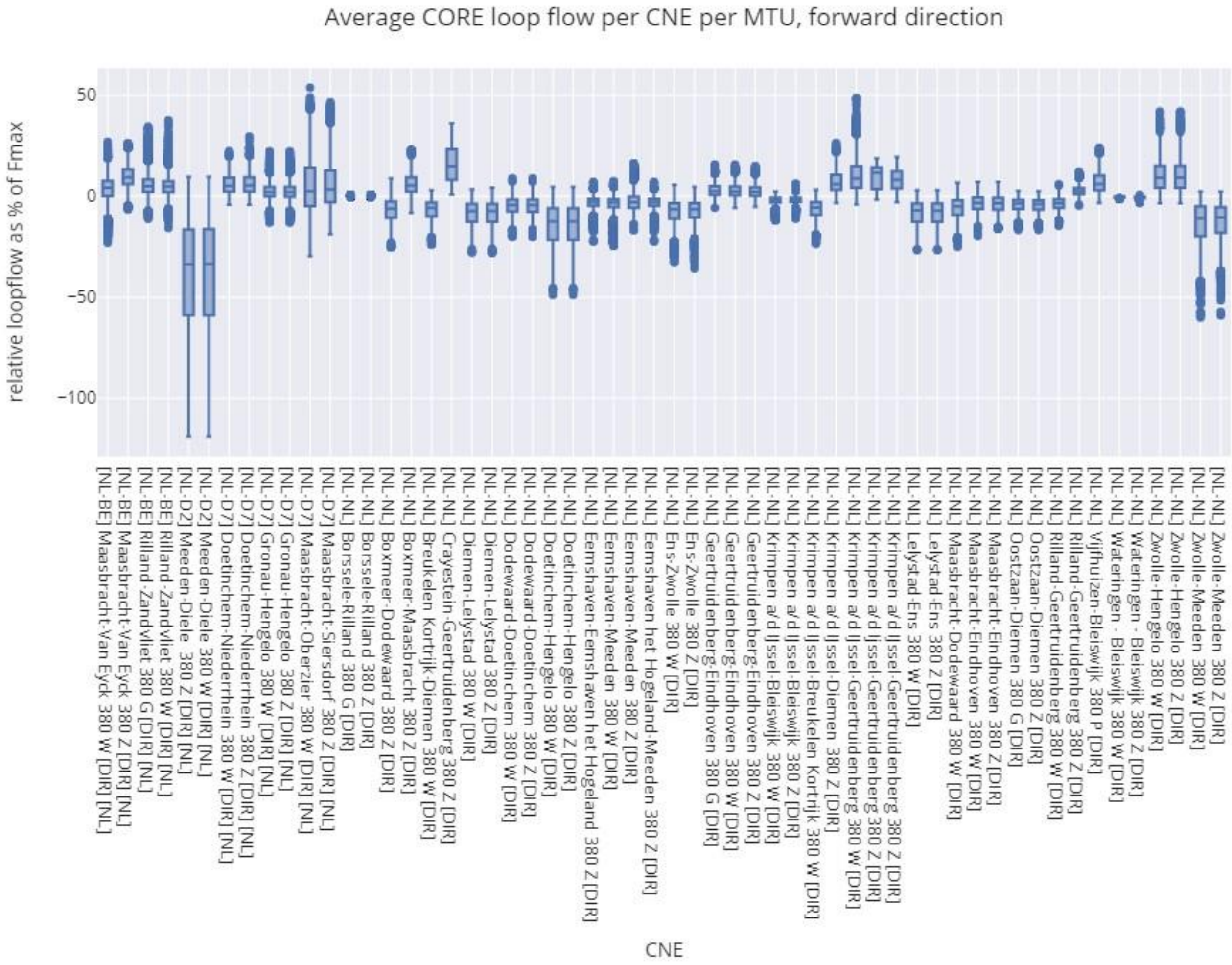

Figure 12: Average relative loop flow per Dutch CNE per MTU. Positive values indicate loop flows in the forward direction, negative values indicate loop flows in the opposite direction.

Most noteworthy are the very high level of loop flows on the cross-border CNE Meeden-Diele 380 W and Z. These CNEs stand out because they have a relatively low amount of Fmax (1053 MW), and their geographical location in the grid allows for a relatively high amount of loop flows which typically originate from wind in Northern Germany and flow to loads in southern Germany via the Dutch transmission network. The variability of wind can also be seen in the variability of the loop flow, as the bar is also relatively long for these CNEs. In operations, TenneT deals with these loop flows via the operation of Phase Shifting Transformers (PSTs) which are installed at the substation of Meeden and which can reduce the amount of loop flows. But even with the operation of PSTs, a significant amount of loop flows remain in the system, which is why the loop flow derogation is crucial for TenneT to be able to respect the minimum capacity margins and maintain operational security.

When looking at the other network elements, it can generally be observed that loop flows enter the Netherlands from Germany at the substation of Meeden and then flow to Zwolle. At Zwolle, the loop flows separate in two paths:

- A path southwards via the eastern part of the TenneT 380 kV transmission network via Zwolle → Hengelo → Doetinchem → Dodewaard → Maasbracht. A significant share of the loop flows on this path exit the Netherlands again via the interconnectors Doetinchem-Niederrhein or Maasbracht-Siersdorf / Maasbracht-Oberzier, but there is also a part that flows to Belgium via Maasbracht – van Eyck.
- The second path is via the western part of the TenneT 380 kV transmission network via the path Zwolle → Ens → Lelystad → Diemen and then southwards to exit the Netherlands via the interconnector Rilland – Zandvliet towards Belgium and eventually back to Germany.

5.3 HVDC Bidding Zone borders

5.3.1 Result of the MACZT compliance assessment for the HVDC bidding zone borders

For the HVDC bidding zone borders, the process for evaluation as set out in section 4.3 has been followed. In Figure 13 the percentage of time when the relative MACZT is above 70%, is given for the HVDC bidding zone borders. The figure shows that for the large majority of hours in 2023 when the HVDC cables were in operation, TenneT offered a MACZT equal or larger than the required minimum level of 70% for both HVDC bidding zone borders.

However, within 2023 TenneT has still at times reduced the NTC capacity on HVDC bidding zone borders during significant and longer duration outage situations on critical network elements in order to prevent violation of operational security limits in the Dutch transmission network. For the majority of MTUs these reductions did not lead to a MACZT below 70%. For Cobra and NorNed a subset of MTUs are subject to NTCs reductions below the minimum MACZT of 70%. On Cobra cable for both directions the MACZT target was met in 100% (rounded value) of the 2023 MTUs, although for some hours reductions below 70% were registered. NorNed scored a 99% compliance with the 70% MACZT target for the NL-NO direction, while for the NO-NL direction a slightly lower score of 98% compliance is noted. A more in depth overview on the reductions is given in the next subsection.

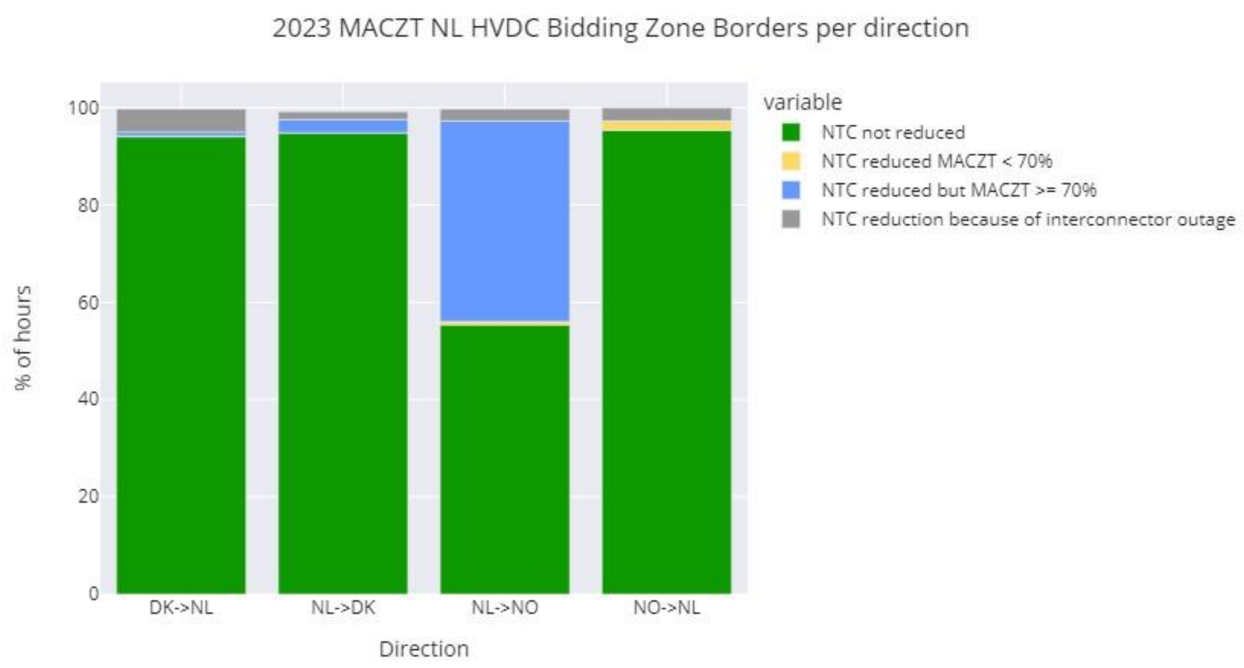

Figure 13: Percentage of the time when the relative MACZT is above 70% on the NL HVDC borders, per direction, for the full year 2023

5.3.2 Overview of reductions applied on the HVDC bidding zone borders

A detailed overview of the available NTC per bidding zone border as offered throughout the year is given in Figure 14 and Figure 15. The majority of the capacity reductions on Cobra and NorNed took place during larger maintenance periods, for which most hours the minimum MACZT of 70% was available. It is TenneT's intention to respect the minimum MACZT level, nonetheless during some occasions reductions below the minimum MACZT of 70% have been registered. This sections will elaborate on when and why these reductions below the minimum MACZT of 70% occurred.

For the DK->NL direction on Cobra a total of 14 hours contain NTC reductions below 70% MACZT. These reductions can be grouped and explained as:

- On September 12 and 13 for a total of 11 hours the NTC was reduced for maintenance purposes however slightly below the minimum MACZT target.
- For three hours a reduction was noted due to a misaligned duration of the maintenance period. This occurs when the NTC value was accidentally reduced for one or two more hours after the maintenance interval was finished.

In the direction NL-DK the NTC was reduced below 70% MACZT in five hours:

- For three hours a reduction was noted due to a misaligned duration of the maintenance period. This occurs when the NTC values was accidentally reduced for one or two more hours after the maintenance interval was finished.
- During two hours the NTC was reduced slightly below the minimum MACZT of 70%. TenneT cannot point to the exact reason for these reductions.

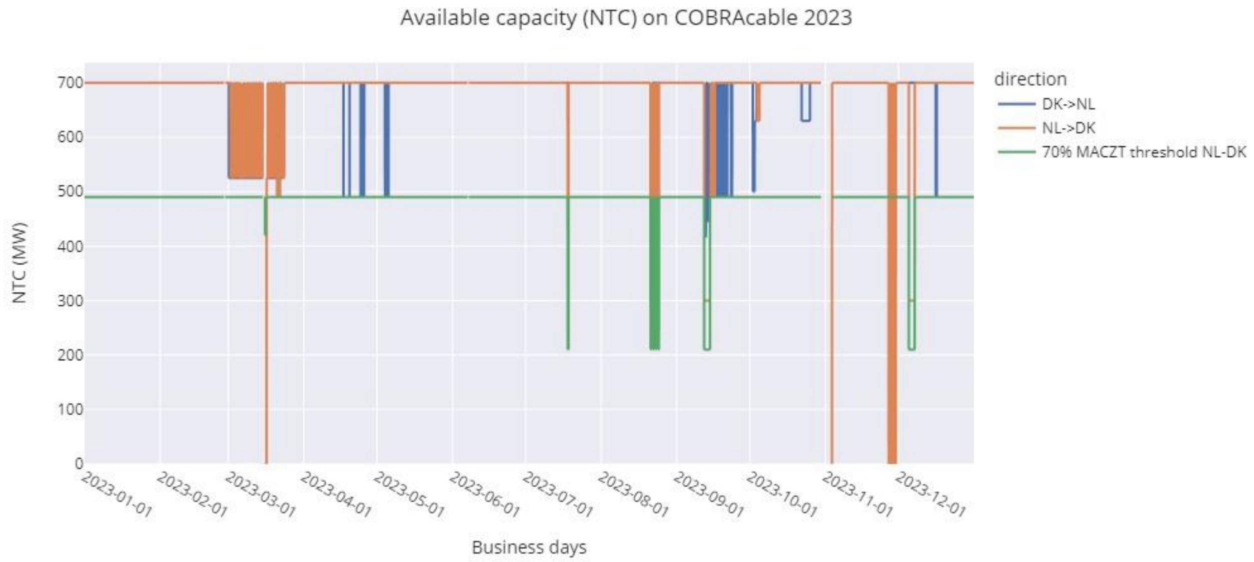

Figure 14: Available capacity (NTC) on the NL-DK1 bidding zone border. Outages are filtered out of the dataset.

For the NO-NL direction the NTC was reduced in 172 hour below 70% MACZT target. In 169 hours the MACZT performance was unintentionally below 70%, with a MACZT score of 68%. The NTC was set at 420 MW, instead of 435MW, which is just below the minimum MACZT of 70%.

The direction NL-NO contains 61 hours with NTC reductions below the 70% MACZT target. In these 61 hours the MACZT performance was unintentionally set below 70%, with a MACZT score of 68%. The NTC was set at 420 MW, instead of 435MW, which is just below the minimum MACZT of 70%.

Figure 15: Available capacity (NTC) on the NL-NO2 bidding zone border. The values as included in the figure are including a correction for the application of implicit loss handling. Outages are filtered out of the dataset.

6. Conclusions

Based on the results as set out in chapter 5, TenneT has arrived at the following conclusions for the relevant capacity calculation areas/regions:

For the **CORE region**:

- For **100%** of the time, **TenneT has provided capacity margins at or above the required minimum levels** on all its network elements

For the **HVDC bidding zone borders (NL-DK1, NL-NO2)**:

- For **99%** of the time**, TenneT has provided capacity margins at or above the required minimum level** of 70% for the NL-DK1 and NL-NO2 bidding zone border.

TenneT expects that – with the applicable derogation for loopflows – for 2024 a continuation of the 2023 capacity margins is realistic.

7. Annex 1: List of Abbreviations

Acronym	Meaning
AC	Alternating Current
ACER	Agency for the Cooperation of Energy Regulators
ACM	the Dutch national regulatory Authority for Consumers and Markets
BD	Business Day, meaning the day for which the (capacity calculation) results are applicable
BE	(the Bidding Zone of) Belgium
CACM	Capacity Allocation and Congestion Management (electricity)
CCA	Capacity calculation area
CCM	Capacity calculation methodology
CCR	Capacity calculation region
CEP	Clean Energy (for all Europeans) Package
CNE	Critical Network Element
CNEC	Critical Network Element with contingencies
cNTC	Coordinated Net Transfer Capacity
CORE DA CCM	The day-ahead flow-based capacity calculation methodology for the Core Capacity Calculation Region.
CORE FB DACC	The day-ahead capacity calculation process taking place in the CORE region
CWE	Central West Europe (electricity region)
D2CF	Two Day ahead Congestion Forecast
DACF	Day-Ahead Congestion Forecast
DC	Direct Current
DE	(the Bidding Zone of) Germany
DK1	Bidding Zone DK1 in Denmark
EC	European Commission
EEA	European Economic Area
ENTSO-E	European Network of Transmission System Operators for Electricity
EU	European Union
FB	Flow-based
FLD	Full Line Decomposition (methodology)
Fmax	Maximum admissible flow on critical network elements, respecting operational security limits
FRM	Flow Reliability margin applied on a CNEC in flow-based capacity calculation
GB	(the Bidding Zone of) Great Britain
GSK	Generation Shift Key
HVDC	High-voltage direct current
LF	Loop Flow

LTA	Long-Term Allocated Capacities
MACZT	Margin available for cross-zonal trade
$MACZT_{margin}$	The amount of MACZT made available above or below the minimum level of MACZT
$MACZT_{min}$	Minimum level of MACZT
$MACZT_{target}$	Target minimum level of MACZT
MCCC	Margin from coordinated capacity calculation
$MCCC_{min}$	Minimum level of MCCC
minRAM	Minimum Remaining Available Margin
MNCC	Margin from non-coordinated capacity calculation
MS	Member State
MTU	Market Time Unit. In this report, 1 hour given that the MTU for the day-ahead market in 2020 was 1 hour.
NL	(the Bidding Zone of) The Netherlands.
NO2	Bidding Zone NO2 in Norway
NTC	Net Transfer Capacity
PST	Phase shifting transformer
PTDF	Power Transfer Distribution Factor
RAM	Remaining Available Margin
TSO	Transmission System Operator

8. Annex 2: Linear Trajectory

Table 3: Overview of $MACZT_{target}$ values per Dutch CNE of the linear trajectory as set by the Dutch Action plan. See Table 4 of Annex 3 for full names of the abbreviations, used in the CNE name.

CNE	type	2020	2021	2022	2023	2024	2025	2026
BKK-DIM380	internal	20%	28%	37%	45%	53%	62%	70%
BMR-DOD380	internal	20%	28%	37%	45%	53%	62%	70%
BSL-GT380	internal	25%	33%	40%	48%	55%	63%	70%
BSL-RLL380	internal	20%	28%	37%	45%	53%	62%	70%
CST-KIJ380	internal	20%	28%	37%	45%	53%	62%	70%
DIM-LLS380	internal	20%	28%	37%	45%	53%	62%	70%
DOD-DTC380	internal	20%	28%	37%	45%	53%	62%	70%
DTC-HGL380	internal	20%	28%	37%	45%	53%	62%	70%
DTC-NDR380	cross-border	58%	60%	62%	64%	66%	68%	70%
EEM-EOS380	internal	20%	28%	37%	45%	53%	62%	70%
EEM-EHH380 / EEM-MEE380 / EEH-MEE380 / EHH-MEE380[17]	internal	20%	28%	37%	45%	53%	62%	70%
ENS-ZL380	internal	21%	30%	38%	46%	54%	62%	70%
GNA-HGL380	cross-border	39%	44%	49%	54%	60%	65%	70%
GT-EHV380	internal	29%	36%	43%	50%	56%	63%	70%
KIJ-BKK380	internal	20%	28%	37%	45%	53%	62%	70%
KIJ-BWK380	internal	20%	28%	37%	45%	53%	62%	70%
KIJ-GT380	internal	20%	28%	37%	45%	53%	62%	70%
KIJ-OZN380	internal	20%	28%	37%	45%	53%	62%	70%
LLS-ENS380	internal	20%	28%	37%	45%	53%	62%	70%
MBT-BMR380	internal	20%	28%	37%	45%	53%	62%	70%
MBT-DOD380	internal	70%	70%	70%	70%	70%	70%	70%
MBT-EHV380	internal	30%	37%	44%	50%	57%	63%	70%
MBT-OBZ380	cross-border	30%	36%	43%	50%	57%	63%	70%
MBT-SDF380	cross-border	41%	46%	50%	55%	60%	65%	70%
MBT-VYK380	cross-border	29%	36%	43%	50%	56%	63%	70%
MEE-DIL380	cross-border	20%	28%	37%	45%	53%	62%	70%
OZN-DIM380	internal	20%	28%	37%	45%	53%	62%	70%
RLL-GT380	internal	29%	36%	43%	50%	56%	63%	70%
RLL-ZVL380	cross-border	20%	28%	37%	45%	53%	62%	70%
VHZ-BWK380	internal	20%	28%	37%	45%	53%	62%	70%
ZL-HGL380	internal	20%	28%	37%	45%	53%	62%	70%
ZL-MEE380	internal	20%	28%	37%	45%	53%	62%	70%

[17] In December 2020, the CNE of EEM-MEE380 was split into 2 when a transformer was looped into the high voltage line at substation Eemshaven het Hogeland. This substation was initially abbreviated as EEH, and per 26/12/20 as EHH.

9. Annex 3: Full names of abbreviations used in network element names

A network element is depicted by its name from a certain substation to another substation. In general, the following notation for CNEs is used throughout this report:

[substation A] – [substation B] [Voltage level] [Circuit symbol]

Where:

- Typically, three letter abbreviations for the substation names are used. In Table 4, the full names for the substations (nodes) belonging to the abbreviations is given.
- The voltage level is in kV, and in this report only 380 kV network elements are included
- A symbol is used to identify individual circuits, where:
    - 'W' stands for 'Wit' (white)
    - 'Z' stands for 'Zwart' (black)
    - 'P' stands for 'Paars' (purple)
    - 'O' stands for 'Oranje' (orange)
    - 'G' or 'GS' stands for 'Grijs' (grey)

Within the report, also the term 'direction' is used to denote whether flows / capacity is from substation A to substation B, or vice versa

- In case of 'forward direction', the (capacity for) flows in the direction from 'substation A' to 'substation B' are meant.
- In case of 'opposite direction', the (capacity for) flows in the direction from 'substation B' to 'substation A' are meant.

Table 4: Full names for the abbreviations of substations as used in the network element names

Abbreviation	Full name	Remarks
BKK	Breukelen Kortrijk	
BMR	Boxmeer	
BSL	Borssele	
BWK	Bleiswijk	
CST	Crayestein	
DIL	Diele	German substation
DIM	Diemen	
DOD	Dodewaard	
DTC	Doetinchem	
EHH	Eemshaven Het Hogeland	
EHV	Eindhoven	
ENS	Ens	
GNA	Gronau	German substation
GT	Geertruidenberg	
HGL	Hengelo	
KIJ	Krimpen aan den IJssel	

LLS	Lelystad	
MBT	Maasbracht	
MEE	Meeden	
NDR	Niederrhein	German substation
OBZ	Oberzier	German substation
OZN	Oostzaan	
RLL	Rilland	
SDF	Siersdorf	German substation
VHZ	Vijfhuizen	
VYK	Van Eyck	Belgian substation
ZL	Zwolle	
ZVL	Zandvliet	Belgian substation

10. Annex 4: Source data

This annex clarifies what data is used to perform the MACZT assessment for the Netherlands as included in this report.

10.1 CORE Capacity Calculation Region

10.1.1 Source data

In overview is given what data is used to assess the compliance for the CORE CCR. This data is also publicly available via the JAO Publication Tool[18].

Table 5: Source data used for assessing compliance of the CORE Capacity Calculation region

Data	Name under which this is published in JAO Publication Tool	Source file
CNE name and EIC code	CriticalBranchName	F316
Contingency name and EIC code	OutageName	F142
Fmax	Fmax	F316
Minimum MACZT		F316
$MCCC^{CNEC}$	RemainingAvailableMargin (MW)	F316
$MNCC^{CNEC}$	Fuaf	F316
LF_{calc}^{CNEC}	LFcalc inside minramjustification	Internal minRAM application tool
LF_{accept}^{CNEC}	LFaccept inside minramjustification	
PTDFs	PTDFs	F316
Shadow prices		F249
Data on IVA application	Validation Reductions	F310

10.1.2 Missing data and timestamps

In 2023 the Core CC tool failed to produce full results for in total 4 MTUs. This was caused because during those MTUs in operation, either:

- Default flow-based parameters have been applied when data for a full Business Day or several MTUs could not be calculated; or
- 'Spanning' was applied to interpolate flow-based results when data for some MTUs was missing.

In both cases, not all data from the Core CC tool that is necessary as input for the local tooling was available.

[18] https://publicationtool.jao.eu/core/

And as result, not all the necessary data from the local tooling to assess compliance could be determined. Therefore, these MTUs (Table 6) were excluded from the assessment performed in this report.

Table 6: Business days in CORE CCR excluded from the NL MACZT assessment

MTU (UTC)	Reason
31-03-2023 16:00	Spanning
23-10-2023 19:00	Spanning
24-10-2023 01:00	DFP
26-10-2023 06:00	Spanning

10.1.3 Other Data corrections

In order to on time have the 2024 $MACZT_{target}$ values from the linear trajectory of the action plan in operation, the $MACZT_{target}$ values were already adjusted to the 2024 values per Business Day 23/12/2023.[19] For the assessment in this report, the data has been adapted to take into account the applicable 2023 $MACZT_{target}$ values.

10.2 HVDC bidding zone borders

Table 7 provides an overview what data is used to assess the compliance of the HVDC bidding zone borders NL-DK1 and NL-NO2:

Table 7: Source data used for assessing compliance of the HVDC bidding zone borders

Data	Source description
Hourly NTC values	Export of historical NTC data for the bidding zone borders from the PCR Simulation Facility Tool. This data is also available as 'Implicit Allocations – Day-Ahead' on the ENTSO-E Transparency Platform[20]
Cause for reductions	In order to determine what was the cause for reductions, information was gathered from internal systems as well as information published in operational messages which party triggered a reduction and for what cause.
Hourly Fmax	This parameter was manually determined, based on the hourly NTC values and explanations published for reductions via TenneT Operational Messages[21] and unavailability published on ENTSO-E Transparency Platform[22] The following principle was followed for reconstructing the Fmax: • Fmax was set at 0, if NTC was 0, as reductions of NTC capacity to 0 MW

[19] https://www.jao.eu/news/implementation-linear-trajectory-cep-action-plan
[20] https://transparency.entsoe.eu/transmission-domain/r2/implicitAllocationsDayAhead/show
[21] https://www.tennet.org/english/operational_management/Operationalreports.aspx
[22] https://transparency.entsoe.eu/outage-domain/r2/unavailabilityInTransmissionGrid/show

	typically only takes place in case the HVDC link and/or their convertor stations are in outage. • For other time stamps with NTC >0, the Fmax was set at the maximum technical capacity of the HVDC interconnectors (i.e. 700 MW for the COBRAcable and 613 MW for NorNed), unless there was a specific technical reason why only part of the physical capacity was available on the HVDC interconnector.

11. Annex 5: Loop flows calculation and third countries

11.1 Loop Flows

The loop flow LF_{calc}^{CNEC} on each CNEC included in CORE FB DACC is calculated by applying the Full Line Decomposition (FLD) methodology[23] on the $\vec{F}_{0,CORE}$ network model. The FLD methodology applies the following calculation steps:

- The $\vec{F}_{0,CORE}$ load flow serves as input.
- A nodal power exchange matrix for the full network is determined based on flow-tracing.
- Node-to-node PTDFs are calculated for all CNECs.
- The nodal power exchange matrix multiplied with the node-to-node PTDFs provides the flow over each CNEC as result of each nodal exchange.
- The nodal exchanges within the same zone, but different than the zone where the CNEC is located, result in loop flow over the considered CNEC.
- Aggregating the nodal results define the total loop flow over each CNEC.
- For each CNEC, LF_{calc}^{CNEC} is equal to the loop flow computed following the above, divided by the Fmax of that CNEC.

NB: the FLD methodology is developed to calculate all ENTSO-E flow types (internal flows, loop flows, import/export flows and transit flows) as well as flows caused by PSTs (PST cycle flow) and HVDC connections (HVDC cycle flow), but in this particular application of FLD only loop flow is of relevance.

11.2 Third countries

The following countries are considered as third countries:

RU - BY - UA - MD - RS - BA - ME - KS - AL - TR - CH - MK – UK

In addition to Figure 1, the below figure shows the lowest $MACZT_{margin}$ per MTU in case flows on CNECs that results from exchanges with third countries are excluded.

[23] A detailed explanation of the FLD method is published in "CIGRE Science & Engineering, issue 9 (CSE 009)"

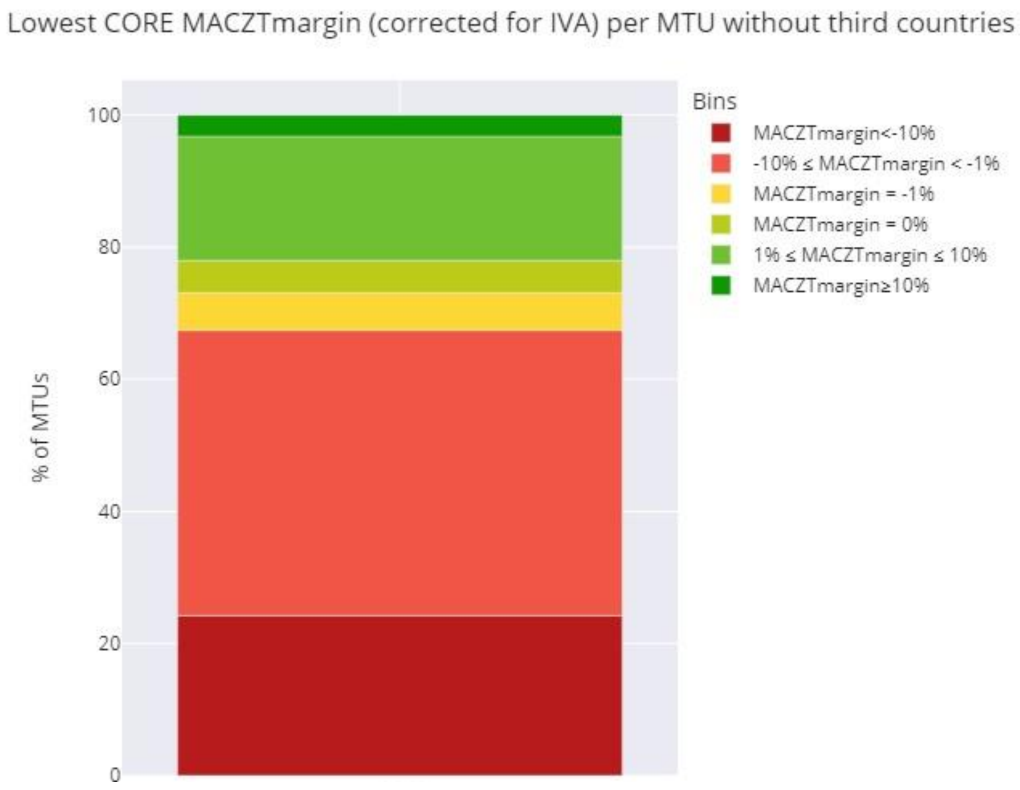

Figure 16: Percentage of time when the minimum capacity margins, excluding third country flows, have been met (green). For each MTU, the CNEC with the lowest $MACZT_{margin}$ was selected and categorised to one of the ranges. MACZTmargin is based on the MNCC that does not include flows that result from exchanges with 3rd countries.