REPORT OF THE GERMAN TRANSMISSION SYSTEM OPERATORS ON AVAILABLE CROSS-ZONAL CAPACITY FOR THE YEAR 2022 PURSUANT TO ARTICLE 15(4) INTERNAL MARKET FOR ELECTRICITY REGULATION (EU) 2019/943

AS OF: 21/03/2023

CREATED BY

THE GERMAN TRANSMISSION SYSTEM OPERATORS WITH CONTROL AREA RESPONSIBILITIES

IN COLLABORATION WITH THE TRANSMISSION SYSTEM OPERATOR WITHOUT CONTROL AREA RESPONSIBILITY

Table of Contents

SUMMARY

The EU Electricity Market Regulation (EU) 2019/943, which entered into force on 04/07/2019, prescribes a minimum value for the capacity to be available for cross-zonal electricity trading of 70% as of 01/01/2020. With its “Bidding Zone Action Plan”[1], Germany is applying a transitional arrangement provided in Art. 15 of the EU Electricity Market Regulation and is increasing the capacity for cross-zonal electricity trading from the level of before 2020 by a linear trajectory to a minimum of 70% by 31/12/2025. Implementation of an action plan is associated with an obligation to carry out annual evaluations of compliance with the minimum values for cross-zonal electricity trading by the involved transmission system operators. The present report has been produced to meet this obligation by the transmission system operators with control area (cTSO) 50Hertz Transmission GmbH (50Hertz), Amprion GmbH (Amprion), TransnetBW GmbH (TransnetBW) and TenneT TSO GmbH (TenneT) as well as the transmission system operator without control area responsibility Baltic Cable AB (BCAB). In accordance with the requirements of the EU Electricity Market Regulation, the methodology and data basis of the present report had been submitted to the national regulatory authority Bundesnetzagentur (Federal Network Agency for Electricity, Gas, Telecommunications, Post and Railways, BNetzA) for approval.

The minimum values for cross-zonal electricity trading at the borders Germany – Denmark 1, Germany – Denmark 2, Germany – Norway 2 and Germany – Poland/Czech Republic were fulfilled at all times during 2022 by the transmission system operators with control area 50Hertz and TenneT. At the border Germany – Sweden 4, a lower deviation of the minimum value in the north bound direction occurred in 170 hours due to planned outage of network elements in the TenneT control area (including the distribution network level) in accordance with Art. 16(3) of the EU Electricity Market Regulation to ensure system security.

On the network elements of the CWE region (until 08/06/2022) and the Core region (from 09/06/2022), the cTSOs complied with the requirements according to Art. 16 of the EU Electricity Market Regulation in all hours, although in a few hours a lower deviation of the currently applicable minimum value of 31% occurred. In these hours, the lower deviation was necessary to ensure system security. This took place in accordance with the requirements of Art. 16(3) of the EU Electricity Market Regulation at all times.

In summary, 50Hertz, Amprion, TransnetBW, TenneT and BCAB complied with the statutory requirements for cross-zonal electricity trading pursuant to Art. 15 and 16 of the EU Electricity Market Regulation at all times during the year 2022.

[1] https://www.bmwi.de/Redaktion/DE/Downloads/A/aktionsplan-gebotszone.pdf?__blob=publicationFile&v=10

1. LEGAL BACKGROUND

The EU Electricity Market Regulation (EU) 2019/943, which entered into force on 04/07/2019, stipulates that transmission system operators (TSOs) may not restrict the cross-zonal transmission capacity to eliminate congestion within a bidding zone. This requirement is considered met if a minimum value of 70% is achieved for the cross-zonal electricity trading. Specifically, this means that as of 01/01/2020, at least 70% of the border transmission capacity of borders with NTC[2] capacity calculation and at least 70% of the transmission capacity of the critical network elements of borders with flow-based capacity calculation (in consideration of system stability) must be offered for cross-zonal electricity trading (cf. Art. 16(8)).

For Member States that have identified structural grid congestion, the EU Electricity Market Regulation opens the possibility of submitting an action plan to reduce this congestion (cf. Art. 15(1)). In this case, the minimum value for cross-zonal trade capacity is to be raised annually in steps during the period from 01/01/2021 through 31/12/2025 until reaching 70%, starting from the average level of the past three years or the maximum of these years (cf. Art. 15(2)) as a minimum value in 2020.

Against this backdrop and after consultation with stakeholders and Member States, the Federal Republic of Germany submitted the Bidding Zone Action Plan on 28/12/2019 to the European Commission (EC) and the Agency for the Cooperation of Energy Regulators (ACER). The Bidding Zone Action Plan contains concrete measures by which Germany will counteract the structural congestion described above and raise the minimum capacity for cross-zonal electricity trading in stages up to 70% by 31/12/2025.

Implementation of an action plan is associated with an obligation to carry out annual evaluations of compliance with the minimum values for cross-zonal trade capacity by the involved TSOs. The data basis for these evaluations must be approved by the corresponding national regulatory authority (NRA), in this case by the BNetzA.

On this basis, the first evaluation was submitted to the relevant NRA BNetzA and to ACER (cf. Art. 15(4)) as the 2020 Compliance Report dated 18/05/2021. This report was approved by the BNetzA by a decision dated 01/06/2021. The present report was produced by the TSOs control area responsibility (cTSO) 50Hertz Transmission GmbH (50Hertz), Amprion GmbH (Amprion), TransnetBW GmbH (TransnetBW) and TenneT TSO GmbH (TenneT), as well as the TSO without control area responsibility Baltic Cable AB (BCAB), to comply with the obligations under Art. 15(4) EU Electricity Market Regulation for the year 2022.

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[2] NTC (net transfer capacity) refers both to a capacity calculation method for determining border-specific transmission capacity and to its result.

2. LINEAR TRAJECTORY OF THE GERMAN ACTION PLAN

In accordance with the Bidding Zone Action Plan, the Federal Ministry for Economic Affairs and Climate Action (BMWK, formerly known as BMWi) has instructed the German TSOs to calculate the initial values for the linear trajectory pursuant to Art. 15(2) of the EU Electricity Market Regulation.

Based on the principles for calculating and reporting the initial values provided by the BNetzA[3], the German TSOs 50Hertz, Amprion, TransnetBW and TenneT[4] have calculated and published[5] the initial values for the German bidding zone borders[6] and critical network elements. The principles for calculating the initial values stipulate, amongst other rules, that a common average be calculated and defined as the initial value for all bidding zone borders and critical network elements that are part of the flow-based market coupling in the capacity calculation region (CCR) Core. Starting from this initial value, a staged linear trajectory of minimum values is to be determined for the intervening years until reaching the target level of 70% on 31/12/2025. Until the implementation of the Core flow-based market coupling (Core FBMC) on 08/06/2022, the minimum values determined in this way were applied within the flow-based market coupling in the Central Western European region (CWE) and at the NTC borders that will be part of the Core FBMC in the future.

This report examines the German borders of the CCR Core according to the flow-based market coupling method for the time after 09/06/2022.

An initial value must be determined and applied for each of the borders in the capacity calculation region Hansa Germany – Denmark 1 (DE-DK1), Germany – Denmark 2 (DE-DK2) and for the borders of Germany – Sweden 4 (DE-SE4) and Germany – Norway 2 (DE-NO2), which will presumably be assigned to this region in the future. The minimum capacities and the linear trajectory will be applied at the border DE-NO2 based on the general principle of equal treatment and on European competition law. As part of the European Economic Area, Norway is treated as an EU Member State in these cases although it is not directly subject to the EU Electricity Market Regulation (EU) 2019/943 unless it chooses to adopt this regulation. These calculations result in the initial values and the corresponding linear trajectories, as shown below.

[3] https://www.bundesnetzagentur.de/DE/Sachgebiete/ElektrizitaetundGas/Unternehmen_Institutionen/HandelundVertrieb/EuropMarktkopplung/MarketCoupling_node.html
[4] The initial value for the border DE-SE4 was determined by TenneT.
[5] https://www.netztransparenz.de/EU-Network-Codes/CEP-Startwerte
[6] This refers to the Germany-Luxembourg bidding zone. To improve readability, the term “German bidding zone” is used below.

CCR Core

Border	% of capacity per critical network element (CNE)						
	2020	**2021**	**2022**	**2023**	**2024**	**2025**	**As of 31/12/2025**
Core region	11.5	21.3	31.0	40.8	50.5	60.3	70.0

The minimum remaining available margin introduced for the CWE region in April 2018 (CWE-MinRAM) of 20% will continue to apply in the CCR Core as well if this is possible without sacrificing system stability.

CCR Hansa

Border	% of capacity per border						
	2020	**2021**	**2022**	**2023**	**2024**	**2025**	**As of 31/12/2025**
DE-SE4	41.4	46.2	50.9	55.7	60.5	65.2	70.0
DE-DK1	23.9	31.6	39.4	47.0	54.6	62.3	70.0
DE-NO2	0	11.7	23.3	35.0	46.7	58.3	70.0
DE-DK2[7] Kontek → KF CGS[8] →	70.0 0.0	70.0 11.7	70.0 23.3	70.0 35.0	70.0 46.7	70.0 58.3	70.0

TenneT's Commitment regarding the minimum value on the border DE-DK1 resulting from the „Commission Decision of 07/12/2018 […] Case AT.40461 – DE/DK Interconnector" remain unaffected.

[7] For interconnectors commissioned after January 1st, 2020, the BNetzA has stipulated that these have a starting value of 0% in the year of commissioning and that this value increases to up to 70% annually. Therefore, the minimum value for the DE-DK2 border is made up of the individual values of the two interconnectors located on the border.
[8] The minimum value in percent is applied to the available transmission capacity after deducting the forecast feed-in from the offshore wind farms.

3. MONITORING METHODOLOGY

The methodology for monitoring compliance with the minimum values for cross-zonal electricity trading pursuant to the EU Electricity Market Regulation and the stipulations of the BNetzA is described in the following. The minimum value must be respected by the offered capacity within every market time unit (MTU), in other words every hour, and in both directions. The minimum value defines the minimum capacity to be offered. The first step of evaluating compliance with the minimum values is based on the capacities offered in the day-ahead capacity calculation. The offered capacity is also referred to below as the “trade margin”.

The trade margin consists of two components. The first is the coordinated trade margin which represents the offered capacity at the border or borders in question that participate in the capacity coordination. The second is the uncoordinated trade margin. This represents the consequences of the trade capacities offered to other borders not participating in the capacity coordination, if data are available. Third countries that are not EU members are treated as EU Member States.[9] This ensures a consistent method for calculating the initial values for the German TSOs.

If the minimum values are not met according to the standard method described above, further special analysis is required. Additional components of relevance to compliance are then taken into account, such as offered capacity in the long-term[10] and intraday (ID) timeframe as well as capacities reserved for cross-border balancing power, just like the consideration of other European borders in calculating the uncoordinated trade margin.[11] Such conclusive compliance evaluations are described in the results section below. In case the minimum values are not met, an analysis of whether this caused a restriction to cross-border electricity trading is triggered. Such restrictions are considered situations in which the capacity was fully utilised, and a market price difference remained such that an additional exchange would have been cost-efficient.[12] [13]

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[9] In this respect, this methodology differs from the approach taken by ACER in their Report on the Result of Monitoring the Margin Available for Cross-Zonal Electricity Trade in the EU.
[10] Within the scope of the methodology monitoring for the Core flow-based capacity calculation region, the long-term capacity is already included in the coordinated trade margin in advance. In this case, no further consideration takes place at this point.
[11] In this respect, this methodology differs from the approach taken by ACER in their Report on the Result of Monitoring the Margin Available for Cross-Zonal Electricity Trade in the EU
[12] In this respect, this methodology differs from the approach taken by ACER in their Report on the Result of Monitoring the Margin Available for Cross-Zonal Electricity Trade in the EU.
[13] In the case of HVDC interconnectors with implicit loss procurement, the relative price difference must be greater than the applied loss factor of the interconnector, as a further increase of the exchange would otherwise not be economic.

3.1 Core region

As described in Chapter 2, a common initial value and linear trajectory of the minimum value to be maintained on each critical network element (CNE), considering the respective critical outage combinations (CNEC), was calculated for all German borders that are part of the CCR Core.

On 08/06/2022, the commissioning of the Core FBMC took place for the following delivery day. Therefore, this report separates the time periods before and after that date. Until 08/06/2022, the NTC capacity calculation method was used for the borders Germany - Czech Republic (DE-CZ) and Germany - Poland (DE-PL), while a flow-based method was used for all borders included in the CWE region. Due to this difference, the technical implementation of the monitoring is different and is therefore described separately for this period in the following. For the time period from 09/06/2022, the German borders of the CCR Core will be assessed using the flow-based methodology.

3.1.1 NTC border Germany – Poland and the Czech Republic

The transmission capacity of the bidding zone borders DE-CZ and DE-PL is determined by the TSOs 50Hertz, TenneT and the Czech TSO Czech Transmission System Operator (CEPS) as a combined value DE–PL&CZ based on the NTC capacity calculation method. The TSOs carry out independent NTC capacity calculations, exclusively taking into account their CNECs. The lowest result per MTU (harmonisation) represents the NTC DE–PL&CZ. Half of this is allocated to the NTC DE-CZ, while the other half remains as the technical profile DE–PL&CZ. The technical profile capacity is allocated among the two bidding zone borders DE-CZ and DE-PL based on demand and in accordance with the goal of optimising welfare. 50Hertz treats PL and CZ as a single bidding zone in the capacity calculation for determining the technical profile. The monitoring method applied by 50Hertz and TenneT is described below.

<u>Calculating the offered trade margin</u>

As described previously in this section, the offered trade margin consists of two components. When applying an NTC method, only the limiting CNEC[14] is relevant for determining compliance because this determines the coordinated trade margin in connection with the capacity calculation. The same applies for the uncoordinated trade margin as well, which is also based solely on the limiting CNEC.

[14] Multiple CNECs may also simultaneously act as limits for a given MTU.

Determining the coordinated trade margin

The coordinated trade margin at the limiting CNEC corresponds to the share of the determined cross-zonal transmission capacity that induces a load on the limiting CNEC (share calculated via PTDF[15]). For the borders DE–PL&CZ, the TSO on the German side provides the limiting CNEC, which contributed the lower capacity to the harmonisation with CEPS. This capacity is used for calculating the coordinated trade margin.

Calculating the uncoordinated trade margin

The uncoordinated trade margin at the limiting CNEC corresponds to the load-inducing impact of the capacities offered at adjacent borders that was offered for these borders at the limiting CNEC in each direction (the share is calculated via PTDF)[16]. This is accomplished by estimating the capacities offered at adjacent borders based on the information available at the time of the day-ahead (DA) capacity calculation. The result is a value for the uncoordinated trade margin per CNEC for each MTU and direction.

TenneT data sources

Parameter	**Input data**	**Source**
Relative trade margin	F_{max}	D2CF CGM
Coordinated trade margin	NTC	Internal alternating current (AC) load flow calculation based on D2CF-CGM[17]
Coordinated trade margin Uncoordinated trade margin	PTDF	Internal calculation from D2CF CGM
Uncoordinated trade margin	NTC	Forecasted day-ahead capacity (Art. 11.1 EU Regulation 543/2013) from ENTSO-E Transparency Platform

50Hertz data sources

Parameter	**Input data**	**Source**
Coordinated trade margin	F_{ref}, F_{max}, PTDF and phase shift distribution factor (PSDF)	Internal Direct Current (DC) load flow calculation and optimisation based on D2CF-CGM[18]
Uncoordinated trade margin	PTDF	DC load flow calculation
Uncoordinated trade margin	NTC	Forecasted long-term capacity (Art. 11.1 EU regulation 543/2013) from ENTSO-E Transparency Platform

3.1.2 Flow-Based Methodology for Monitoring of the CWE region and the CCR Core

In the following, the methodology of the monitoring is described, which was applied by the TSOs Amprion, TenneT, and TransnetBW in the CWE region until 08/06/2022 and by the TSOs 50Hertz, Amprion, TenneT, and TransnetBW in the CCR Core from 09/06/2022 onwards.

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[15] PTDF (power transfer distribution factors) translate a cross-border exchange into the corresponding load flows at the CNEC.

[16] In this respect, this methodology differs from the approach taken by ACER in their Report on the Result of Monitoring the Margin Available for Cross-Zonal Electricity Trade in the EU.

[17] D-2 congestion forecast common grid model (CGM) as per SO GL Regulation Art. 67 and Art. 70.

[18] In this respect, this method differs from the approach taken in the ACER Report on the Result of Monitoring the Margin Available for Cross-Zonal Electricity Trade in the EU by the Agency for the Cooperation of Energy Regulators.

Calculating the offered trade margin

The offered trade margin is determined according to the EU Electricity Market Regulation for each CNEC. As described above, the offered trade margin is the sum of the coordinated and uncoordinated trade margins. The resulting offered trade margin is given as a percentage. This value is calculated as the trade capacity offered at the CNEC (sum of the coordinated and uncoordinated shares) divided by its physical capacity (F_{max}). For all MTUs, the value for F_{max} used in the calculations for compliance monitoring is equivalent to the physical limit applied in the capacity calculation. In the special case of determining the trade margin at the bidding zone or control area border, the lower offered capacity of the two participating TSOs applies. When applying default flow-based parameters (DFPs) or spanning[19] due to technical problems in the flow-based capacity calculation, it is not possible to determine the relative offered trade margin. MTUs where DFPs or spanning were applied are therefore excepted from the compliance evaluation.

Determining the coordinated trade margin

The reported coordinated trade margin corresponds firstly to the remaining available margin (RAM) offered for the cross-zonal trading within the day-ahead capacity calculation, which is published daily on www.JAO.eu. The impact of long-term capacities offered on CWE borders was not taken into account. Therefore, the actual capacity offered in CWE for cross-zonal electricity trading can partly exceed the reported values.

For the monitoring of the Core FBMC from 09/06/2022, the long-term allocations were considered. For this purpose, the maximum impact of the long-term capacities (LTAs) allocated within the scope of the coordinated capacity calculation on the respective CNEC is calculated. This is made possible by the following procedure, which is explained in a simplified representation in Figure 1.

[19] The application of DFP and spanning are fallback procedures according to Art. 22 of Core DA CCM. Capacities allocated when DFPs are applied correspond at least to the allocated cross-zonal long-term capacities. Spanning interpolates missing flow-based parameters of up to two consecutive MTUs based on the available parameters of the previous and subsequent MTU.

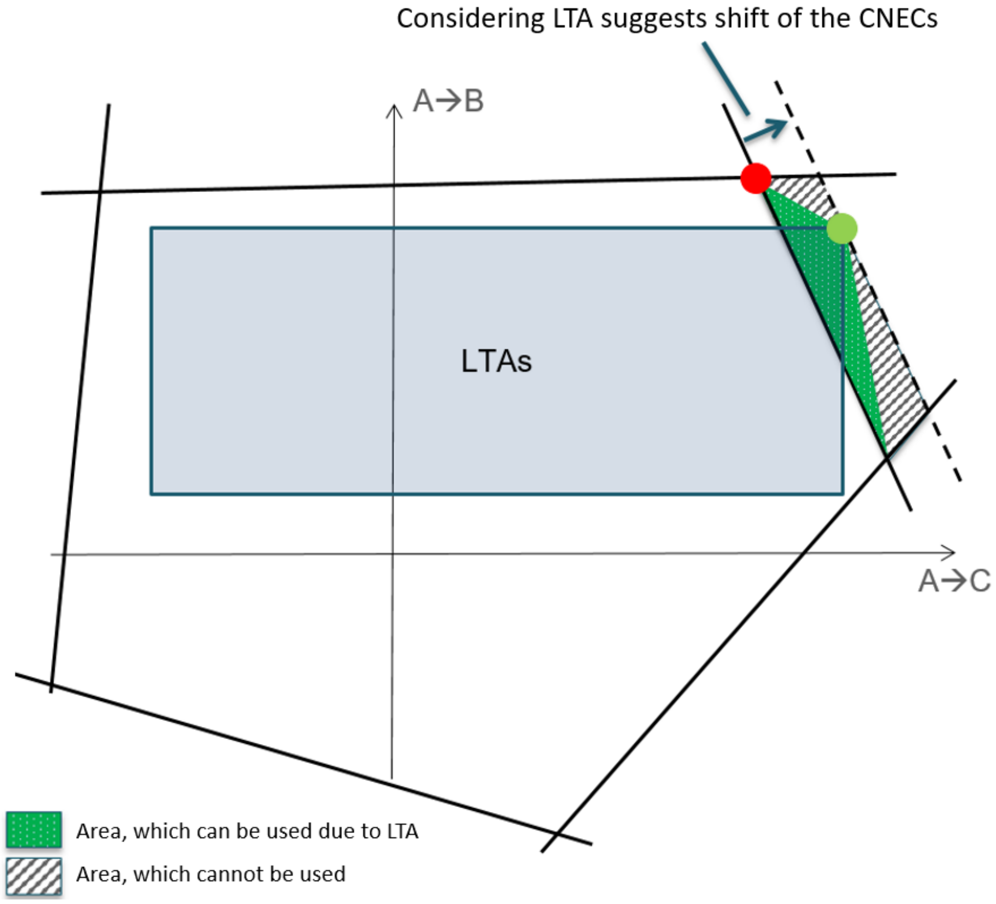

Figure 1: Consideration of allocated long-term capacities in the coordinated trade margin (simplified representation)

Figure 1: Consideration of allocated long-term capacities in the coordinated trade margin (simplified representation)

1) Determination of the offered margin per CNEC before LTA inclusion (red dot) → $RAM_{CNEC\ i,MTU\ j}$
2) Determination of the maximum LTA impact on the CNEC (green dot)

$$F\_LTA_{\max CNEC\ i,MTU\ j} = \sum LTA_{MTU\ j} \text{ x } PTDFpositive_{CNEC\ i,MTU\ j}$$

LTA is a vector containing all long-term capacities allocated within the respective capacity calculation region. $PTDFpositive$ describes a vector containing the positive (i.e., burdening) zone-to-zone PTDFs of the respective CNECs of the borders, where the long-term capacities were allocated.

3) Determination of the maximum of both values:

$$coordinated\ trade\ margin\ _{CNEC\ i,MTU\ j} = \max\ (\ RAM_{CNEC\ i,MTU\ j}\ ;\ F\_LTA_{max})$$

Calculating the uncoordinated trade margin

The influence of the cross-zonal trade capacity offered outside of the CWE region resp. CCR Core on the respective CNEC is determined for calculating the uncoordinated trade margin. Specifically, the corresponding load producing PTDFs are multiplied by the respective NTCs to determine the influence of the NTCs on the respective CNEC.[20]

The individual uncoordinated trade margins of the various NTC border directions are added up to determine the total uncoordinated trade margin of the CNEC.

$$Uncoordinated\ trade\ margin = \sum_{j,k;j\neq k} Uncoordinated\ trade\ margin_{j\rightarrow k}$$

This takes into account borders where the PTDF values in the reference programme are available within the day-ahead CWE resp. Core FBMC capacity calculation.[21]

Data sources for the CWE region

Parameter	Input data	Source
Uncoordinated trade margin	NTCs	At the time of the respective capacity calculation of the day-ahead[22] or, alternatively, month-ahead[23] forecasted transfer capacity accessed from the ENTSO-E Transparency Platform. If one of the two values was unavailable, default values based on annual capacities were used.
Uncoordinated trade margin	PTDFs of the CWE CNECs	CWE flow-based common system (partially publicly available at JAO.eu[24])
Coordinated trade margin	RAM	CWE flow-based common system (publicly available at JAO.eu[25])

[20] In this respect, this methodology differs from the approach taken by ACER in their Report on the Result of Monitoring the Margin Available for Cross-Zonal Electricity Trade in the EU

[21] The borders of the reference programme for CWE can be viewed in the JAO Utility Tool at the following link: https://www.jao.eu/implict-allocation. The borders of the reference programme for Core can be viewed in the JAO Publication Tool: https://publicationtool.jao.eu/core/refprog

[22] https://transparency.entsoe.eu/transmission-domain/ntcDay/show

[23] https://transparency.entsoe.eu/transmission-domain/r2/forecastedTransferCapacitiesMonthAhead/show

[24] https://www.jao.eu/marketdata/implicitallocation >> Utility Tool >> Virgin Flow-Based Domain

[25] https://www.jao.eu/marketdata/implicitallocation >> Utility Tool >> Virgin Flow-Based Domain

Data sources for the CCR Core

Parameter	Input data	Source
Uncoordinated trade margin	NTCs	day-ahead[26] Net Transfer Capacity requested from the ENTSO-E Transparency Platform
Coordinated and uncoordinated trade margin	PTDFs of Core CNECs	Core CC Tool (partly publicly available under JAO Publication Tool[27])
Coordinated trade margin	RAM	Core CC Tool (publicly available under JAO Publication Tool[28])
Coordinated trade margin	LTAs	Core CC Tool (publicly available under JAO Publication Tool[29])

Impact of individual validation on the trade margin offered

The capacity available on the CNECs for cross-border trading is increased by a flat rate to the respective minimum value if the minimum value was not reached as a result of the capacity calculation. Within the framework of the individual validation of the TSOs, probable market results are therefore checked to see whether potentially occurring overloads on the network elements can be mitigated through the use of secured available remedial actions (including redispatch, cross border redispatch, PST tapping and topological measures). If this is not the case, the capacity available for cross-border trade is reduced to avoid jeopardising operational security. The capacity reduction as a result of the validation does not necessarily lead to a lower deviation of the minimum values, as on most CNECs significantly more than the minimum trade margin is made available. Only in a few hours do the capacity reductions as a result of validation lead to values below the minimum values.

Special case of Core region internal DC interconnectors

DC interconnectors at Core region internal borders are integrated into the flow-based capacity calculation via the "Evolved Flow-Based Procedure". In this process, the converter stations function as so-called 'virtual hubs' having their own net positions, i.e., they represent either a load or a generation node. These virtual hubs thus also have PTDFs to map their influence on the CNECs.

Therefore, the virtual hubs of the DC interconnector compete with the other bidding zones for free capacity on the CNECs to enable cross-zonal electricity trading via the interconnector. The maximum net position of the virtual hubs is thereby usually limited by the maximum physical transmission capacity of the DC interconnector.

In the case of a DC interconnector with a physical transmission capacity of 1,000 MW, the possible net position of the virtual hub would consequently be between -1,000 MW and +1,000 MW. The maximum

[26] https://transparency.entsoe.eu/transmission-domain/ntcDay/show
[27] https://core-parallelrun-publicationtool.jao.eu/core/finalComputation
[28] https://core-parallelrun-publicationtool.jao.eu/core/finalComputation
[29] https://core-parallelrun-publicationtool.jao.eu/core/finalComputation

possible net position thereby also reflects the coordinated trade capacity offered on the DC interconnector. There is no uncoordinated trade margin, as the entire trading capacity of the DC interconnector is made available to cross-zonal electricity trading within the flow-based capacity calculation region. In the above example, a minimum capacity of 70% would be fulfilled provided that the offered maximum net position of the virtual hub is at least +/- 700 MW. If the exchange via the DC interconnector is restricted by Core AC CNEC, this does not change the offered coordinated trading capacity for the DC interconnector.

3.1.2.1 Validation within the framework of the Core capacity calculation

The four German TSOs with control area responsibilities, together with the Austrian TSO APG and the Dutch TSO TTN, have developed the DAVinCy procedure to perform individual validation within the Core day-ahead capacity calculation process. This procedure consists of several steps, which are briefly explained below:

- Determination of probable market outcomes: The outcome of the Core day-ahead capacity calculation is the capacity available for cross-border trading per CNEC. How the market will ultimately use the available capacity, i.e., which combination of cross-border trades will be realized, is not known at the time of the capacity calculation and individual validation. Therefore, eight likely market outcomes are determined for further assessment.
- Determination of congestion: For each of the eight market outcomes, the network elements (CNECs and internal network elements) that are congested are identified.
- Removal of congestions: Then, considering all assured available remedial actions (redispatch, cross-border redispatch, PST tapping, and topological measures), the congestions are relieved to the extent possible. The result is the remaining congestion that cannot be removed.
- Determination of the necessary capacity reduction: For this purpose, DAVinCy analyses to what extent the offered capacities must be reduced so that neither CNECs nor internal network elements are overloaded after all remedial actions have been applied. As a result, the capacity available on the CNECs for cross-border trading is reduced by means of so-called Individual Validation Adjustments (IVA).

The complexity of the IVAs in the context of DAVinCy results from the simultaneous consideration of possible market outcomes, the resulting network conditions as well as congestion management usage and its influence on the capacities for cross-zonal exchange. A joint validation of six TSOs leads to advantages. Important aspects are summarized below:

- Capacity reductions as a result of the DAVinCy process results are always justified by a potential threat to operational security. The Internal EU Electricity Market Regulation explicitly provides for this case as permissible. For each IVA application, it is published for which network element congestion is imminent after considering the assured available remedial actions.
- Overall, the joint validation leads to lower capacity reductions than if all six TSOs would perform the validation independently. On the one hand, this is due to the fact that the availability of remedial actions is greater in the consortium, and, on the other hand, the limitation of capacity can be designed more efficiently, in this case lower, due to the available CNECs.

- A capacity reduction or IVA application in a control area does not equate to the presence of congestion in the same control area. DAVinCy results very often show that congestion in one control area can be most efficiently addressed with an IVA application in an adjacent control area.

A capacity reduction is not the same as a lower deviation of the minimum values. As a result of the preliminary capacity calculation, capacity is often released for cross-zonal trading per CNEC that is significantly greater than the minimum value.

DAVinCy fallback

A so-called DAVinCy fallback is applied in the following two possible situations: 1. the results from the validation are not plausible for at least one MTU or 2. the validation calculation fails for at least one MTU. In these cases, the available coordinated trade margin for CCR Core-internal trades on DAVinCy TSOs' CNECs is reduced to 20%[30]. Long-term capacity will not be curtailed in the event of a fallback and will remain available to the market. This limitation, which can also lead to a lower deviation of the minimum values, is necessary because without validation the TSOs have no knowledge of whether their grid elements are being overloaded, which in turn creates a high risk for operational security.

3.2 Hansa region

As described in section 2, individual initial values and linear trajectories were calculated per bidding zone border in the CCR Hansa. Because an NTC capacity calculation takes place at all four borders, the values apply per border.

3.2.1 NTC borders Germany – Denmark 1 and Germany – Norway 2

The transmission capacities of the bidding zone borders DE-DK1 and DE-NO2 are determined using the coordinated NTC method (cNTC). This allows the individual minimum capacities of the borders to be applied to the respective critical network elements as minimum trade margins (share of the maximum permissible power flow). This calculation is based on a common grid model (CGM) according to Art. 67 and Art. 70 of Regulation (EU) 2017/1485 establishing a transmission system operation guideline (SOGL) for each import and export direction and for all MTUs. The individual minimum values were applied to the trade margins for the first time as of 17/12/2020, however, using the minimum values applicable for the year 2021. Since different minimum values apply for the borders DE-DK1 and DE-NO2 according to the Bidding Zone Action Plan, the transmission capacities are initially determined based on the lower trade margin (DE-NO2) to determine the transmission capacity of the associated border.

[30] When the Core FBMC was put into operation, in case of DAVinCy fallback, the sum of trading from outside and inside the CCR Core was capped at 20%. On 13/09/2022, a change was made to guarantee a coordinated trade margin for CCR Core internal trades of 20%.

The transmission capacity of the border with the higher minimum margin (DE-DK1) is then determined, considering the previously determined transmission capacity of the other border (DE-NO2). The transmission capacities of the two borders can therefore be determined by different CNECs. The monitoring method applied by TenneT is described below.

The NTC calculation for DE-NO2 and thus the monitoring of the minimum values refers to the receiving side of the bidding zone border.[31] Since the NordLink cable forming the DE-NO2 border is managed with implicit loss procurement, the transmission capacity on the sending side is not exclusively available for cross-border trading since they are also utilised by the implicitly procured power to cover losses.

Calculating the offered trade margin

As described above, the offered trade margin consists of two components, the coordinated and uncoordinated trade margin. When applying an NTC methodology, only the offered trade margins of the respective limiting CNECs are relevant for determining compliance since only these determine the respective transmission capacity. Accordingly, the uncoordinated trade margin is also only considered for the limiting CNECs. Because different minimum values apply for the borders DE-DK1 and DE-NO2 and different CNECs act as limits, the calculation and monitoring for the borders DE-DK1 and DE-NO2 take place separately.

Determining the coordinated trade margin

The coordinated trade margin at the limiting CNECs corresponds to the share of the determined transmission capacities that induces a load on the respective limiting CNEC (calculated based on NTC and PTDF values). For a cNTC methodology, no coordinated trade margin for a specific border is exclusively available. This is shared among the participating borders instead. The coordinated trade margin of the respective border is therefore the sum of the two multiplications of the respective NTC (DE-NO2 and DE-DK1) and the associated PTDF of the limiting CNEC of the border in question. This calculation is carried out once for the border DE-NO2 and once for the border DE-DK1 with the respective limiting CNEC and associated PTDF values. The coordinated trade margin of the respective CNEC therefore results from the contributions of both transmission capacities (DE-DK1 and DE-NO2).

Calculating the uncoordinated trade margin

The uncoordinated trade margin at the limiting CNECs corresponds to the load-inducing impact of the capacities offered at adjacent borders that must be offered at the limiting CNECs in each direction (the share is calculated via PTDF).[32] This is accomplished by estimating the capacities offered at adjacent borders based on the information available at the time of the DA capacity calculation. The result is a value for the uncoordinated trade margin per CNEC for each MTU and direction.

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[31] The terms "receiving side" and "delivering side" of a bidding zone boundary refer to the respective directions of the transmission capacities. Each direction always points from the energy-sending side (bidding zone) to the energy-receiving side (bidding zone).

[32] In this respect, this methodology differs from the approach taken by ACER in their Report on the Result of Monitoring the Margin Available for Cross-Zonal Electricity Trade in the EU.

Data sources

Parameter	Input data	Source
Relative trade margin	F_{max}	Calculation based on nominal voltage and I_{max} from the D2CF CGM
Coordinated trade margin	NTC	Internal AC load flow calculation based on D2CF-CGM
Coordinated trade margin	PTDF	Internal calculation from D2CF CGM
Uncoordinated trade margin	NTC	Forecasted day-ahead capacity (Art. 11.1 EU Regulation 543/2013) from ENTSO-E Transparency Platform

3.2.2 NTC border Germany – Denmark 2

The methodology applied by 50Hertz at the border DE-DK2 is described below.

Calculating the offered trade margin

Because only the interconnectors with direct current (DC) properties Kontek cable and, since 15/12/2020, KF CGS exist at the border DE-DK2, no unscheduled load flows occur, only the coordinated trade margin is to be determined.

Determining the coordinated trade margin

The coordinated trade margin corresponds to the transmission capacity offered at the border according to the DA capacity calculation. The transmission capacity increased overall when the hybrid interconnector KF CGS went into operation on 15/12/2020. The KF CGS connects the grid connections of the German offshore wind farms Baltic 1 and Baltic 2 to those of the Danish offshore wind farms Kriegers Flak DK, thereby establishing an interconnector between Germany and eastern Denmark. This transmission capacity arises from the total transmission capacity minus the forecasted offshore wind power infeed.

Data sources

Parameter	Input data	Source
Coordinated trade margin	NTC for the Kontek cable and for KF CGS	System management and grid control systems

3.2.3 NTC border Germany – Sweden 4

The transmission capacity of the bidding zone border DE-SE4 is determined by the transmission system operators Baltic Cable AB (BCAB), Svenska kraftnät and TenneT.

The TSOs carry out independent capacity calculations. TenneT determines the transmission capacity based on a validation of wind power infeed in the grid of Schleswig-Holstein Netz AG, as well as unavailability of network elements of TenneT and Schleswig-Holstein Netz AG based on a common limit value concept. BCAB determines the availability and restrictions of the transmission cable Baltic Cable.

The minimum capacity at the border DE-SE4 refers directly to the transmission capacity of the transmission cable Baltic Cable. An uncoordinated trade margin is not considered. For monitoring of the border DE-SE4, the offered capacity (referred to as receiving side) is compared to the minimum capacity relative to the maximum capacity of the Baltic Cable (600MW on the receiving side).[33]

Consideration of the receiving side arises from the fact that the interconnector Baltic Cable is managed with implicit procurement of power to compensate for transmission losses. The transmission capacities on the providing side are therefore not exclusively available for cross-border trading as they are also utilised by the implicitly procured power to cover losses.

<u>TenneT data sources</u>

Parameter	**Input data**	**Source**
Relative trade margin	F_{max}	Operational Handbook of Baltic Cable
Coordinated trade margin	NTC	Calculation according to the limit value concept plus load and infeed forecasts
Coordinated trade margin	Cable unavailability[34]	Baltic Cable AB / Operational Handbook of Baltic Cable

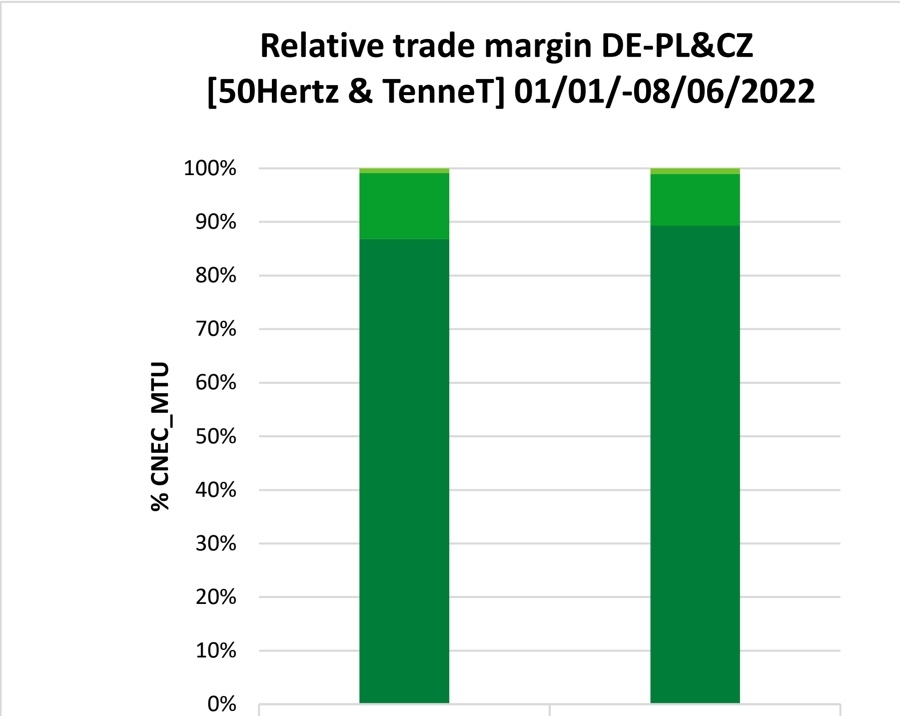
[33] The terms "receiving side" and "delivering side" of a bidding zone boundary refer to the respective directions of the transmission capacities. Each direction always points from the energy-sending side (bidding zone) to the energy-receiving side (bidding zone).
[34] The unavailability of individual items of equipment of the Baltic Cable generally leads to a transmittable capacity of 0 MW, meaning that these times are not considered operating hours. If the static VAR compensator fails, however, the Baltic Cable can still transmit 500 MW, meaning that these times are definitely considered as operating hours.

4. RESULTS

4.1 Core region

4.1.1 NTC border Germany – Poland and the Czech Republic (until go-live of Core FBMC)

For the borders DE-PL&CZ, the minimum of 31.0% was complied with for every MTU during the period from 01/01/2022 through 08/06/2022. The figure below shows the relative trade margin as the ratio of offered trade margin to physical transmission capacity per CNEC and for all MTUs at the borders DE-PL&CZ during the period from 01/01/2022 through 08/06/2022 for both trade directions.



	DE-PL&CZ	PL&CZ-DE
< 31 %	0.00%	0.00%
[31 - 50 %)	0.84%	0.99%
[50 - 70 %)	12.36%	9.69%
>= 70 %	86.80%	89.31%

Figure 2: Relative trade margin DE-PL&CZ [50Hertz and TenneT] during the period from 01/01/2022 through 08/06/2022 (minimum value 31.0%)

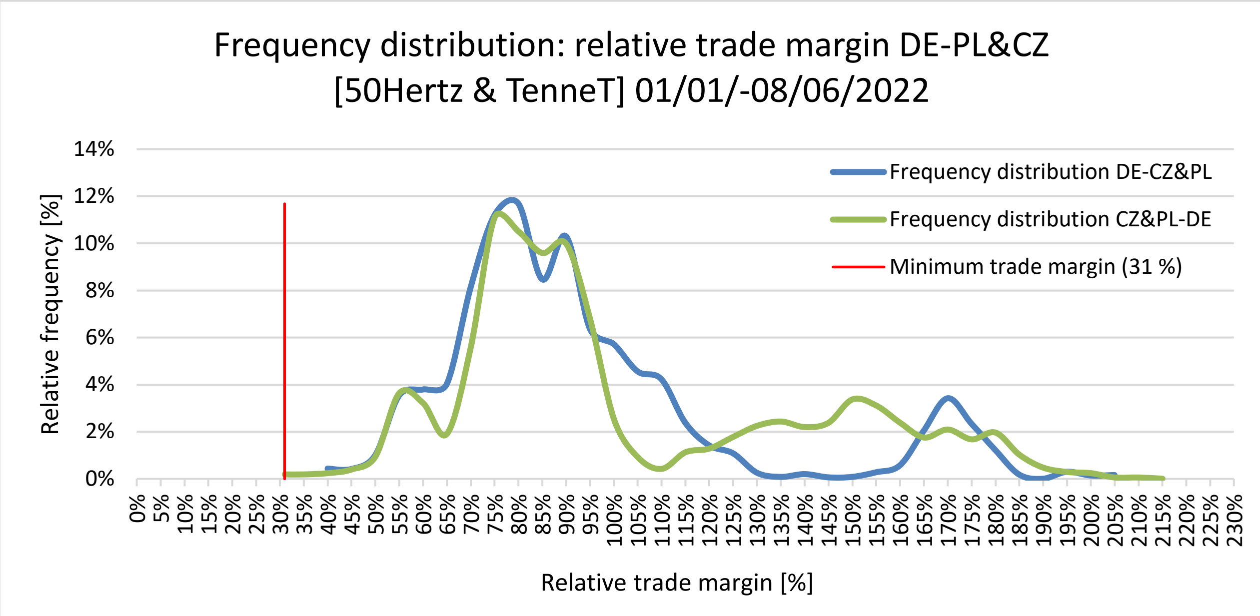


Figure 3: Frequency distribution: relative trade margin DE-PL&CZ [50Hertz & TenneT] during the period from 01/01/2022 through 08/06/2022 (minimum value 31.0%)

Figure 2 and 3 show that a trade margin of at least 31.0% with respect to the physical transmission capacity (F_{max}) per limiting CNEC was offered in all considered MTUs. Because the underlying NTC values are determined independently of each other for each direction, the directions are differentiated in the figure. All 3,815 hours during the period from 01/01/2022 through 08/06/2022 were taken into account for both directions. Because more than one CNEC per MTU limited the trade margin in some cases, the depiction of the export direction is based on 5,091 data points, while the import direction (PL&CZ-DE) is based on 3,827 data points. In addition, Figure 2 shows that at least a relative trade margin of 70% (trade margin relative to the physical transmission capacity) was made available at 86.8% of the limiting CNECs in the export direction and 89.3% in the import direction. In other words, the minimum value that will apply as of 31/12/2025 was already complied with in these cases.

4.1.2 Presentation of results of the CWE region and the Core FBMC

The results of the offered cross-zonal trade margin on the network elements of the CWE region and the CCR Core after go-live of the Core FBMC are depicted below. First, the methodology for evaluating the results is described.

As described in Art. 16(8)(b) of the EU Electricity Market Regulation for borders with flow-based capacity allocation[35], the offered trade margin per critical network element (CNE) is determined in consideration of the critical contingencies. This method is depicted in Figure 4 and described in more detail below.

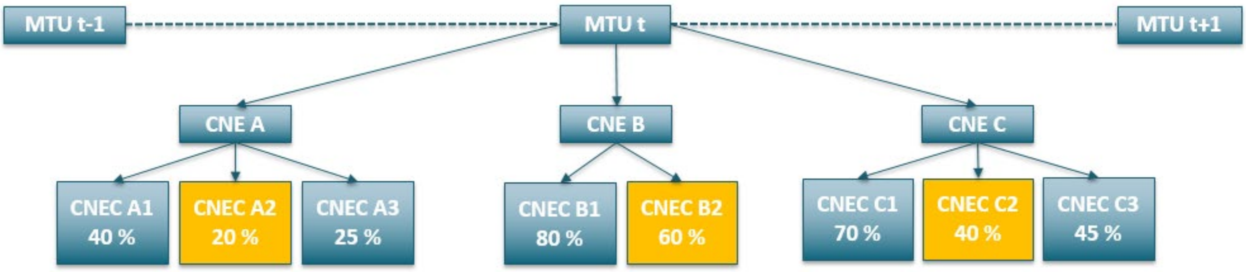


Figure 4: Example of determining the offered trade capacity per critical network element

Figure 4 shows an example of determining the offered trade capacity per critical network element in consideration of the critical contingency combinations as per Art. 16(8) of the EU Electricity Market Regulation. The percentile values correspond to the offered cross-zonal trade margin relative to the available physical capacity (F_{max}) per CNEC. The CNEC shown in orange defines the minimum offered trade margin of the respective CNE.

A CNE represents a real physical network element. In the operational capacity calculation process, various critical contingencies of other network elements are considered in each MTU per CNE. The combination of CNE and contingency forms a CNEC. The minimum trade margin that can be offered at one CNE is therefore determined by the CNEC that permits the lowest trade margin. Only the minimum offered trade margin per CNE is depicted below.[36] One value per CNE therefore enters the evaluation for each MTU[37]. This means that the subsequent figures depict only a (critical) subset of the data rather than all data determined for all CNECs. In a consideration of all CNECs, the relative share would still further increase with relatively high offered trade margins. The depiction focuses on the relative trade margin, which is defined as the ratio of offered trade margin to the available physical capacity (F_{max}). Exclusively considering the CNE with the lowest trade margin over the respective region per MTU is inappropriate, as only one value per MTU (of the network element or CNE with the lowest trade margin) would enter the depiction. This can theoretically result in the entire evaluation being determined by a single network element which exhibits continuously low offered trade margins over the time period in question.

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[35] C.f. Art. 16(8) of the EU Electricity Market Regulation: "*[…] for borders using a flow-based approach, the minimum capacity shall be a margin set in the capacity calculation process as available for flows induced by cross-zonal exchange. The margin shall be 70%* [Note: For Germany, the target values of the action plan apply here until 31/12/2025*] of the capacity respecting operational security limits of internal and cross-zonal critical network elements, taking into account contingencies, as determined in accordance with the capacity allocation and congestion management guideline adopted on the basis of Article 18(5) of Regulation (EC) No 714/2009. […]*"

[36] In this respect, this methodology differs from the approach taken by ACER in their Report on the Result of Monitoring the Margin Available for Cross-Zonal Electricity Trade in the EU.

[37] There is no differentiation here of the flow direction through the respective CNE. In other words, the minimum value is determined based on both flow directions per CNE.

CNEs where relatively high trade margins were offered would not be represented in such an analysis. As described above, this form of representation would also be insufficient for depicting the requirements of the EU Electricity Market Regulation since the minimum margins for cross-zonal trade capacity must be complied with at *all* critical network elements. In addition, such an analysis would also fail to achieve the monitoring goal of obtaining an overview of all physical network elements and the associated offered trade margins to allow for any necessary measures to satisfy future minimum requirements at all network elements.

4.1.2.1 Results for the CWE region

Spanning was applied on 06/03/2022 for 1 MTUs due to technical problems[38] in the flow-based capacity calculation.

Due to the lack of data, the MTU in question was excluded from the compliance review with respect to the CWE region, resulting in a total of 3,814 out of 3,815 total hours considered. Figure 5 graphically depicts this.

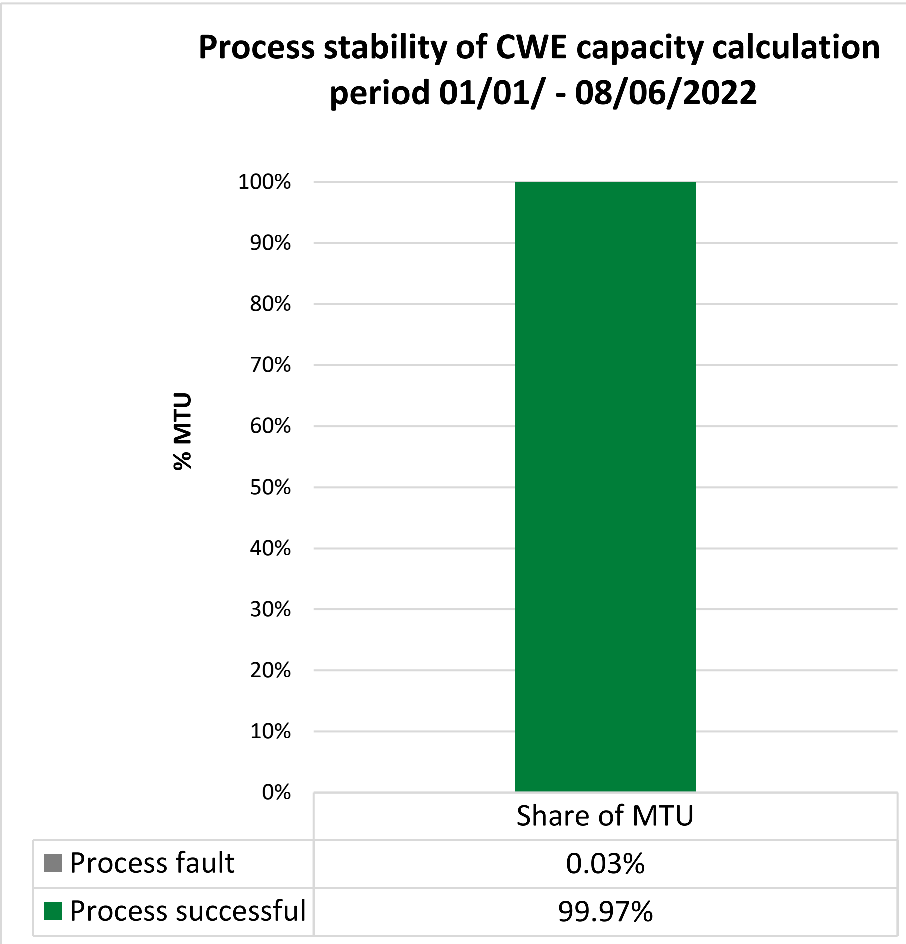
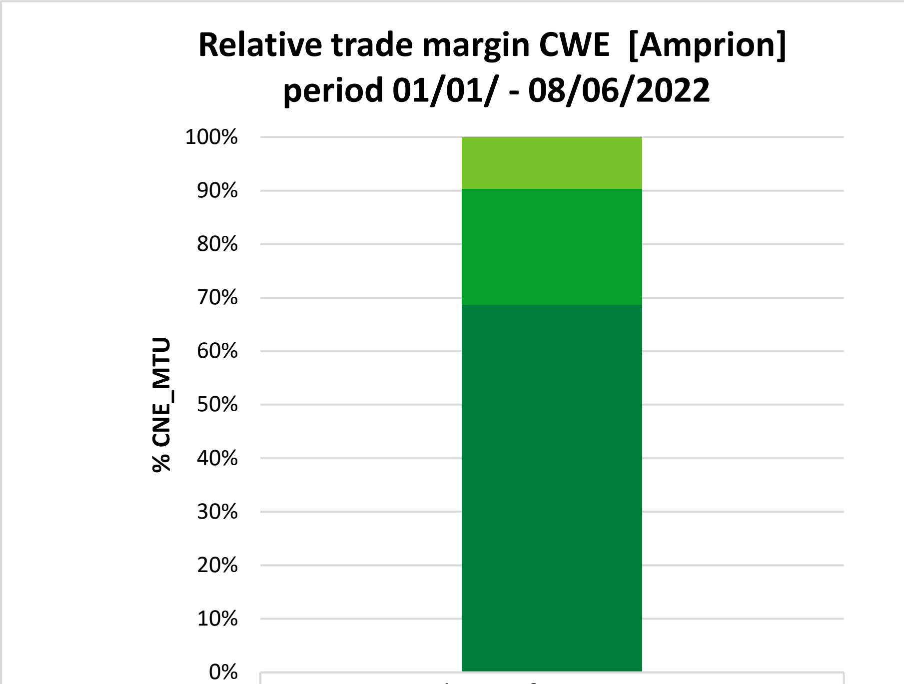


Figure 5: Stability of CWE capacity calculation process of all TSOs during the year 2022

[38] These technical problems were outside the TSO's sphere of influence.

Amprion control area



	Share of CNE_MTU
< 31 %	0.02%
[31 - 50 %)	9.58%
[50 - 70 %)	21.73%
>= 70 %	68.67%

Figure 6: Relative trade margin CWE [Amprion] during the period from 01/01/2022 through 08/06/2022 (minimum value 31.0%)

Figure 6 shows the distribution of the offered trade margin on the CNEs of the Amprion control area during the period from 01/01/2022 through 08/06/2022. On average, 59 CNEs of the Amprion control area per MTU were included in the CWE capacity calculation process in the year 2022. This means that 225,649 input data points were used to create the bar chart of Figure 6. The analysis shows that the minimum value according to the linear trajectory of the Bidding Zone Action Plan for 2022 (31.0%) was met on the CNEs within the Amprion control area during 99.98% of the data points in the observation period 01/01/2022 through 08/06/2022.

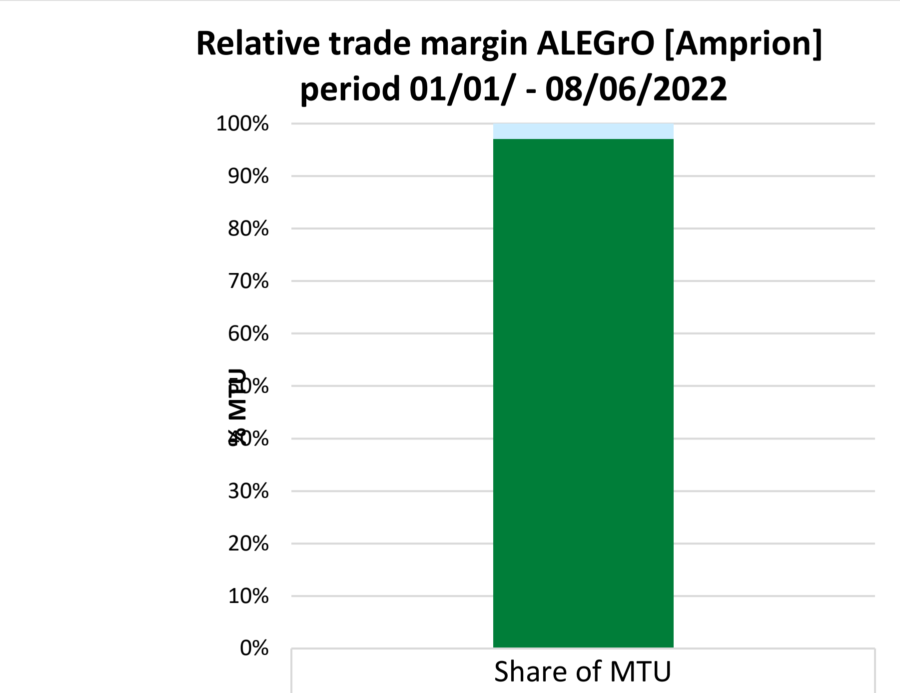
The minimum value was not met on 30/01/2022 in 34 cases (CNE per MTU) distributed over the three hours 12, 14 and 15, which corresponds to 0.02% of the CNE_MTU data points. The underlying reason was a critical grid situation, which led to a high utilization of the German transmission grid. In the three hours in question, the feed-in from wind (onshore and offshore) and photovoltaics in Germany totalled around 45 to 50 GW. During the same time, an export of around 10 GW from Germany to other countries was made possible.

In the joint validation process of the German CWE TSOs, overloads in the German transmission system were identified for the forecasted grid situation applying the minimum value in the (n-1) case, which could not have been solved even by taking all available remedial actions (topology change, redispatch) for these hours into account. To maintain system security, the application of the minimum value therefore had to be suspended for the three hours in question. All lower deviations of the minimum capacity were carried out in accordance with Art. 16(3) of the EU Electricity Market Regulation to ensure system security.

Further analysis shows that cases in which a relatively low trade margin was offered are locally concentrated among a relatively small number of network elements. These are primarily transmission lines in the north-western region of the Amprion control area, which must bear a high loading during times of high wind power infeed which needs to be transmitted to the southern European load centres. Providing additional capacity on these network elements for cross-zonal electricity trading then poses a great challenge. The currently reduced trade requirements of the linear trajectory defined by the Bidding Zone Action Plan are required for these particularly impacted network elements.

The first direct electricity interconnection between Germany and Belgium, 'ALEGrO', is integrated as a DC interconnection into the CWE capacity calculation and allocation via the "Evolved Flow-Based Methodology" and is thus subject to a special monitoring methodology. The relevant metric for monitoring the compliance of Amprion is the maximum transmission capacity provided in the Flow-Based Market Coupling process on the German Hub 'AL_DE' of ALEGrO.[39] This metric must be at least equal to the minimum percentage value according to the Action Plan multiplied by the available thermal capacity of ALEGrO. In the event of an outage or reduced thermal capacity of ALEGrO, the minimum value for cross-zonal trading capacity of ALEGrO will be reduced as well. Since congestions may occur in the AC grid, the actual trading capacity via ALEGrO may differ from the capacity offered directly on ALEGrO. However, this does not affect the monitoring results of ALEGrO.

[39] This is modeled within the framework of "Evolved Flow-Based" via so-called "virtual hubs" of the converter stations Lixhe and Oberzier. These form their own hubs with their own PTDFs in the capacity calculation and allocation. The maximum or minimum net positions of the virtual hubs are generally limited to the available thermal capacity of ALEGrO and thus also form the basis for the assessment for the present compliance monitoring.



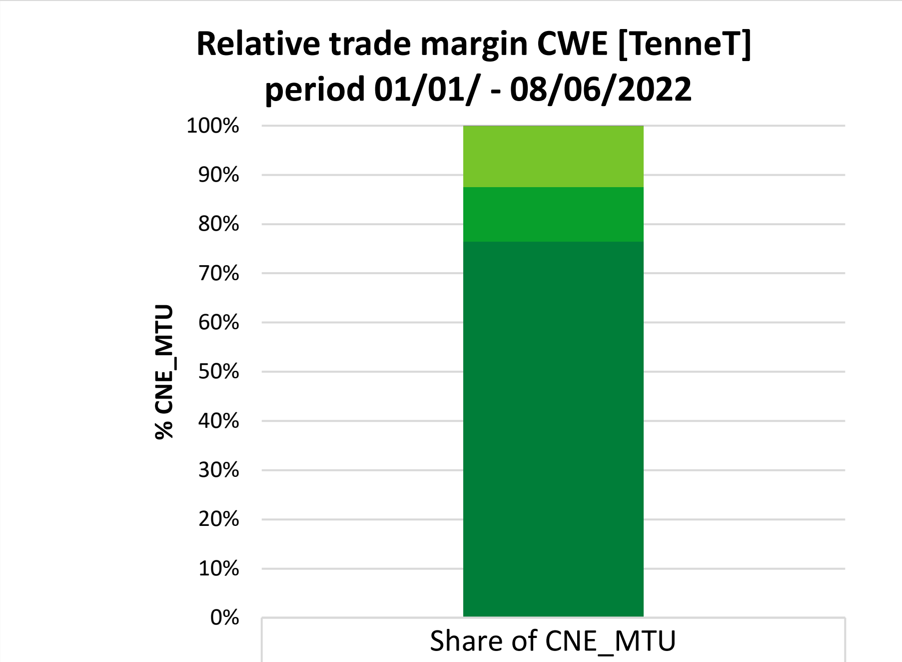
	Share of MTU
Out of operation	2.96%
< 31%	0.00%
[31 - 50 %)	0.00%
[50 - 70 %)	0.00%
>= 70 %	97.04%

Figure 7: Relative trade margin ALEGrO [Amprion] during the period from 01/01/2022 through 08/06/2022 (minimum value 31.0%)

Figure 7 shows the transmission capacity offered on of the German Hub 'AL_DE' of ALEGrO for cross-zonal electricity trading relative to ALEGrO's available thermal capacity. The graph was generated based on one value per hour (MTU). Amprion was able to offer 100% of the available thermal transmission capacity of 1,000 MW for cross-zonal electricity trading in 97% of the hours during the period from 01/01/2022 through 08/06/2022. During the period from 16/05/2022 at 08:00 through 20/05/2022 at 24:00 ALEGrO was taken out of operation due to the planned annual maintenance in coordination with the project partner Elia. Elia and Amprion had communicated this measure to the market in advance. During this period, the available thermal capacity dropped to 0 MW, so that no capacity had to be made available to cross-zonal electricity trading on ALEGrO.

In summary, Amprion complied with the statutory requirements for cross-zonal electricity trading pursuant to Art. 15 and 16 of the EU Electricity Market Regulation at all times in the CWE region during the period from 01/01/2022 through 08/06/2022.

<u>TenneT control area</u>



	Share of CNE_MTU
< 31 %	0.00%
< 31 % (acc. to validation)	0.04%
[31 - 50 %)	12.37%
[50 - 70 %)	11.15%
>= 70 %	76.44%

Figure 8: Relative trade margin CWE [TenneT] year 2022 (minimum value 31.0%)

Figure 8 shows the distribution of the relative offered trade margin on the CNEs of the TenneT control area in the year 2022 based on 121,327 values (one value per CNE and MTU). This means that 31.8 CNEs of the TenneT control area were considered on average per MTU in the graph. The minimum value according to the linear trajectory of the action plan for 2022 (31.0%) was not reached on 30.01.2022 in 49 cases (CNE_MTU) distributed over 9 hours from 08:00 to 17:00. This was due to a critical grid situation, which led to a high utilisation of the German transmission grid. In the hours in question, the feed-in of wind (onshore and offshore) and photovoltaics in Germany was around 45 to 50 GW. Meanwhile, an export of around 10GW from Germany to other countries was made possible. In the joint validation process of the German CWE TSOs overloads in the German transmission grid were identified in the (n-1) case for the forecast grid situation applying the minimum value, which could not have been resolved even with all the remedial actions available (topology change, redispatch). To maintain system security, the application of the minimum value therefore had to be suspended for the hours in question. All lower deviations from the minimum capacity were carried out in accordance with Art. 16(3) of the EU Electricity Market Regulation to ensure system security.

<u>TransnetBW control area</u>

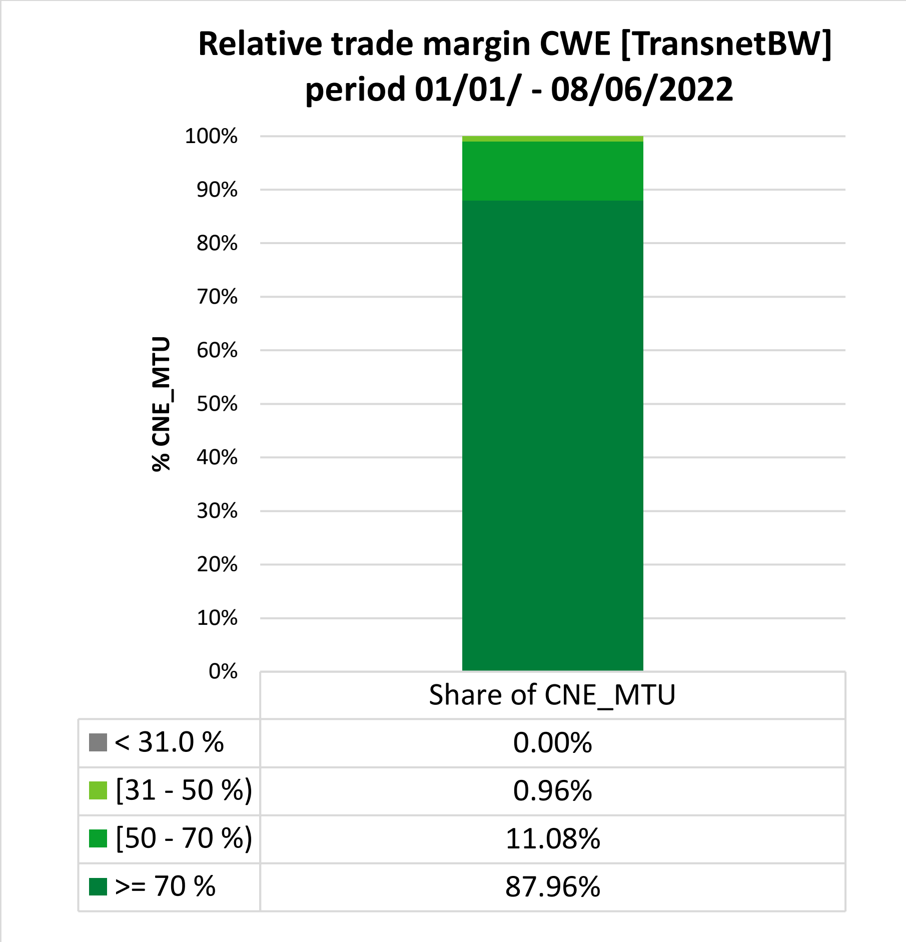


Figure 9: Relative trade margin CWE [TransnetBW] during the period from 01/01/2022 through 08/06/2022 (minimum value 31.0%)

Figure 9 shows the distribution of offered relative trade margin in 2022 at the CNEs of the TransnetBW control area. During the period from 01/01/2022 through 08/06/2022, the CWE capacity calculation process included an average of 23 CNEs of the TransnetBW control area. This means that 88,029 values entered the bar chart of Figure 9. The analysis shows that the minimum value according to the linear trajectory of the action plan for 2022 (31.0%) was complied with at all times at all critical network elements within the TransnetBW control area. The lowest offered trade margin at a TransnetBW CNE during the period from 01/01/2022 through 08/06/2022 was 32.6%, meaning the minimum capacity of the Bidding Zone Action Plan of 31.0% was exceeded during every hour. Many CNECs exhibit a high trade margin. In a given hour, a single CNEC with a lower trade margin can be sufficient to limit the market result. Providing additional capacity at these network elements for cross-zonal electricity trading therefore poses a great challenge. The currently reduced trade requirements of the linear trajectory defined by the Bidding Zone Action Plan are necessary for these particularly impacted network elements.

In summary, TransnetBW complied with the statutory requirements for cross-zonal electricity trading pursuant to Art. 15 and 16 of the EU Electricity Market Regulation at all times during the period from 01/01/2022 through 08/06/2022.

4.1.2.2 Results of the Core FBMC

The results of the Core FBMC are presented below. The method described in chapter 3.1.2 was applied for the period from 09/06/2022 through 31/12/2022. During this period 12 spanning or DFP MTU were applied due to technical problems in the flow-based capacity calculation. The technical problems were beyond the TSOs' control:

- 2 hours of spanning on 22/07/2022
- 1 hour of spanning on 24/08/2022
- 7 hours with DFPs on 07/11/2022
- 1 hour spanning on 22/12/2022
- 1 hour DFP on 25/12/2022

Figure 10 shows the share of MTUs, in which a process failure in the Core capacity calculation occurred. Because of the missing data base for the concerned MTUs in the CCR Core, the listed hours have been excluded from the compliance assessment. For this reason, 4,933 out of 4,945 hours were considered.

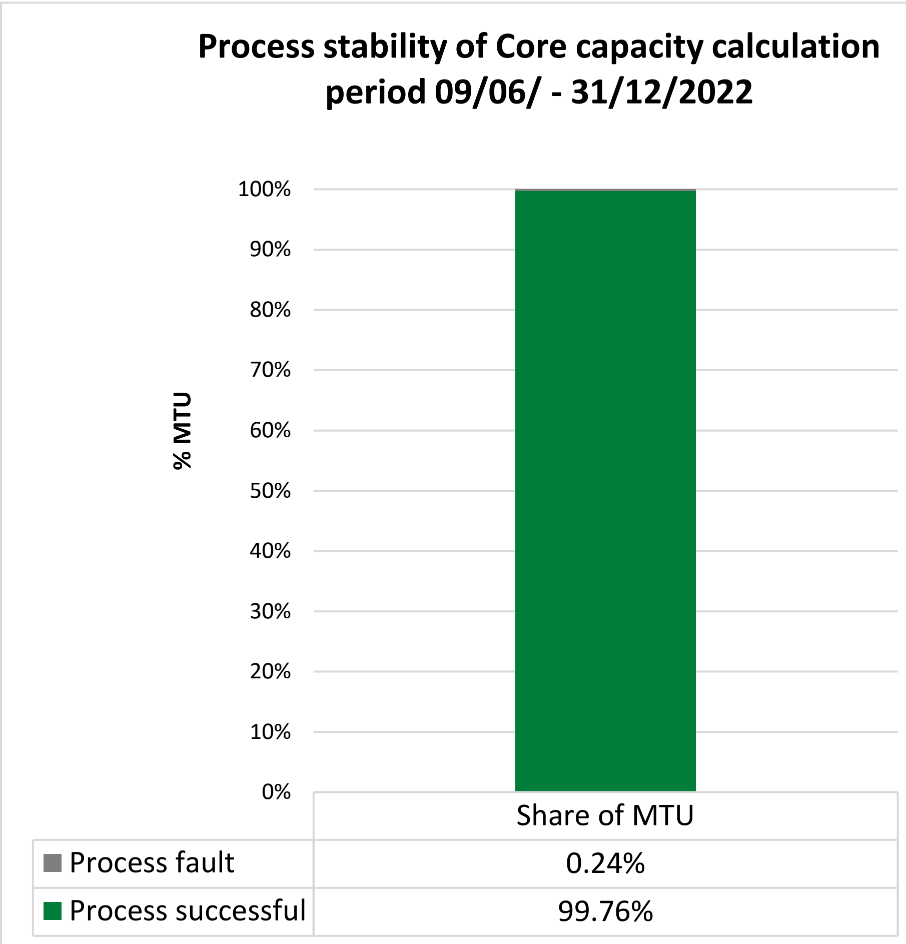


Figure 10: Process stability in CCR Core of all TSOs during the period from 09/06/2022 through 31/12/2022

Presentation of the results

In the following explanation, the results for the four German control areas are presented separately. The presentations of the bar charts are similar to the presentations of the bar charts for the CWE region. In addition, the distribution of the data points is shown in a frequency distribution graph for each control area.

The bar charts show values below the current 31.0% minimum value. This is due to the results of the described validation process in chapter 3.1.2.1 (with one exception[40]). As a result of the validation process IVAs are applied to reduce relative trade margins to ensure operational security. When considering the cases with IVA application, cause and effect must be differentiated. During the period from 09/06/2022 through 31/12/2022 IVAs were applied in 254 MTUs on German CNECs. In 185 MTUs the IVAs were necessary, as network elements were potentially overloaded despite considering all available remedial actions. These situations could only be remedied by the applied IVAs, which ensured operational security. In 69 of these MTUs, IVAs were required due to a DAVinCy fallback. In this situation, the validation could not be carried out in accordance with the pre-defined process and the offered trade margin was reduced as a precaution to ensure operational security. It is important to mention that not all IVA applications result in relative trade margins below the 31.0% minimum value. Only 53 out of 185 MTUs with IVA application fell below the minimum value as a result of an overload ('IVA (overload)' category in the following relative trade margin figures). As a result of the DAVinCy fallback with IVA application, the 31.0% minimum value was not met in 24 out of 69 MTUs (category "IVA (fallback)" in the following figures of the relative trade margin)[41]. For the cases of a lower deviation from minimum value due to a remaining congestion, Figure 11 shows in which countries the remaining congestion would have potentially occurred geographically.

[40] Furthermore, a special case was observed, which led to the falling below the minimum value of 31%. Details are presented in the illustration for the TenneT control area.
[41] By revising the DAVinCy fallback strategy, it is extremely unlikely that these cases will occur in the future.

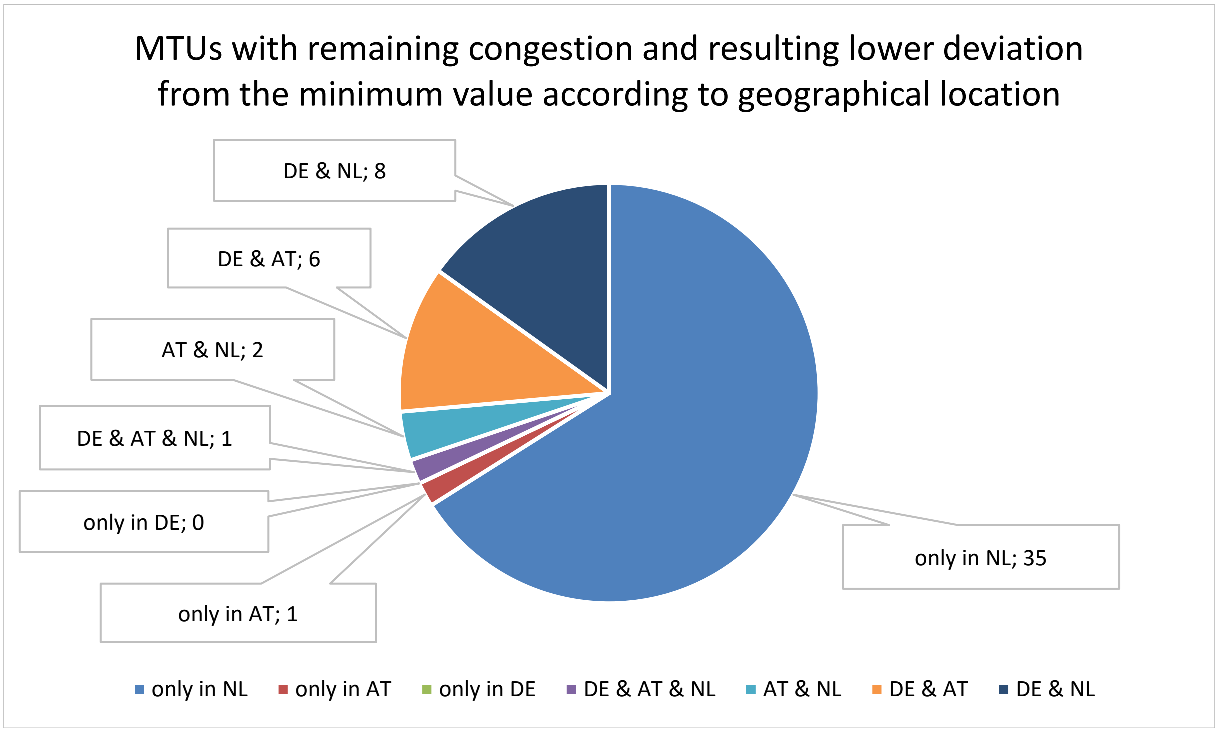
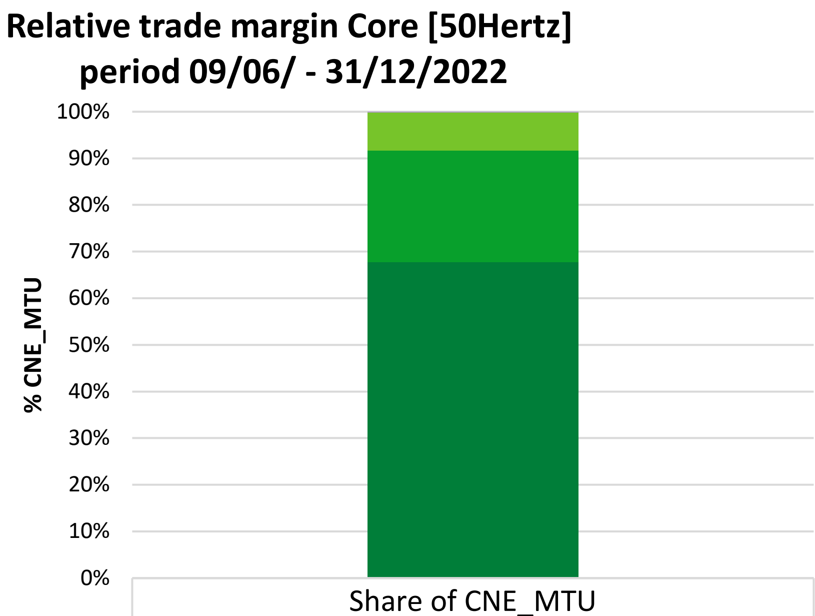


Figure 11: MTUs with remaining congestion and resulting lower deviation from the minimum value according to geographical location

Figure 11 shows that only in 15 hours an overload was expected on a German network element and network elements of other countries, which resulted in the reduction of the offered relative trade margin below the minimum value. Furthermore, there was no hour in which a potential overload was anticipated exclusively for a German network element, making an IVA application with a lower deviation from the minimum value necessary. Irrespective of the geographic location of possible overloads of network elements, the EU Electricity Market Regulation provides for the possibility of deviating below the minimum value to ensure operational security. In this respect, the hours set out above do not constitute a violation of the applicable legal requirements; therefore, the TSOs have complied with the statutory requirements during the period from 09/06/2022 through 31/12/2022.

<u>50Hertz control area</u>



	Share of CNE_MTU
< 31 % without IVA	0.00%
< 31 % IVA (fallback)	0.15%
< 31 % IVA (overload)	0.02%
[31 - 50 %)	8.11%
[50 - 70 %)	24.06%
>= 70 %	67.66%

Figure 12: Relative trade margin Core [50Hertz] during the period from 09/06/2022 through 31/12/2022 (minimum value 31.0%)

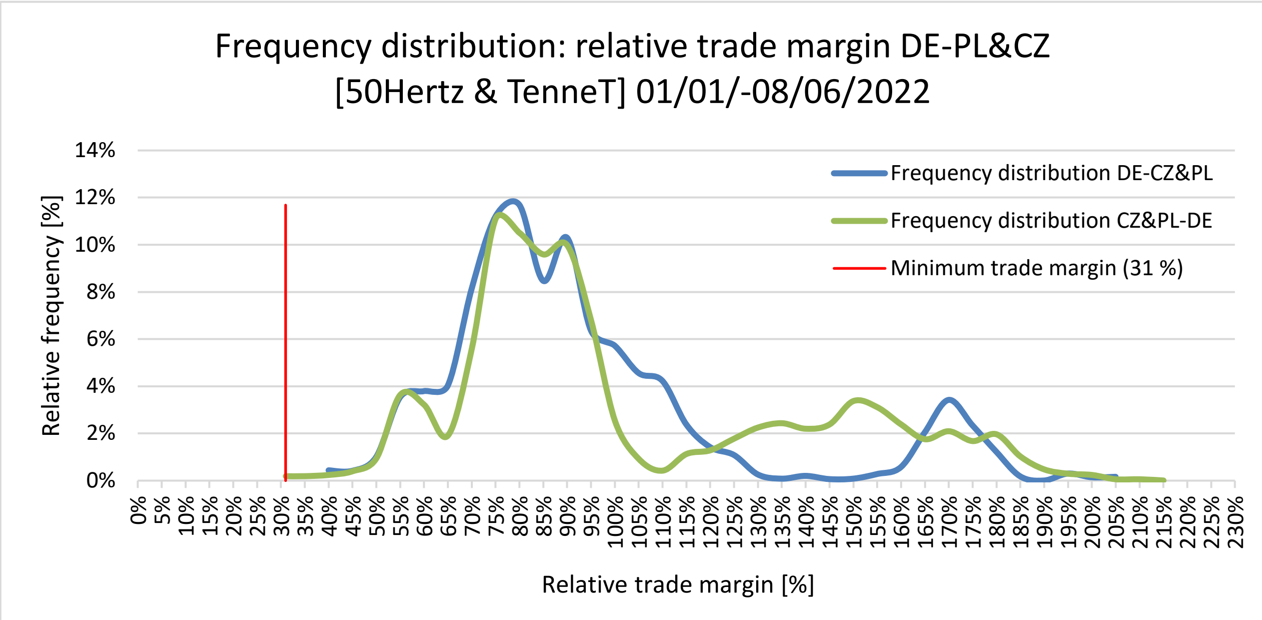
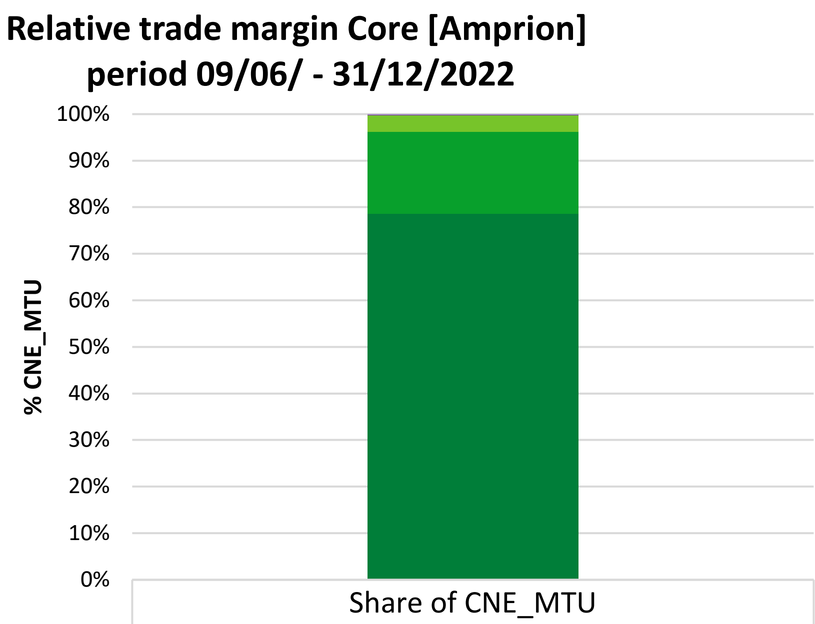


Figure 13: Frequency distribution Core [50Hertz] during the period from 09/06/2022 through 31/12/2022 (minimum value 31.0%)

Figures 12 and 13 show the distribution of the offered relative trade margin on the CNEs of the 50Hertz control area during the period from 09/06/2022 through 31/12/2022, based on 201,562 values (one value per CNE and MTU) in a total of 4,933 MTUs. The number of 50Hertz CNEs considered in the Core capacity calculation process varies as a result of switch offs and is thus partly different per day. The small proportion of CNE_MTUs in the data set that fall below the minimum values is the result of the validation process described at the beginning. Thus, all lower deviations of the minimum capacity are justified as a measure to ensure system security and thus meet the requirements of Art. 16(3) of the EU Electricity Market Regulation.

Amprion control area



	Share of CNE_MTU
< 31 % without IVA	0.00%
< 31 % IVA (fallback)	0.20%
< 31 % IVA (overload)	0.002%
[31 - 50 %)	3.58%
[50 - 70 %)	17.66%
>= 70 %	78.56%

Figure 14: Relative trade margin Core [Amprion] during the period from 09/06/2022 through 31/12/2022 (minimum value 31.0%)

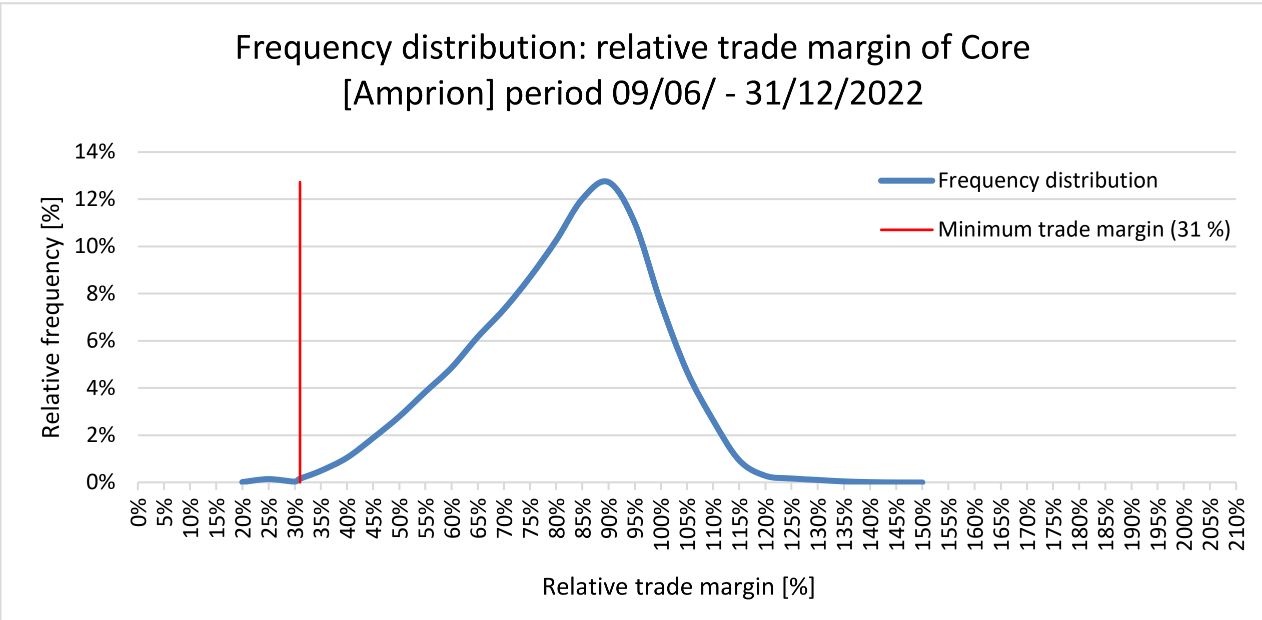
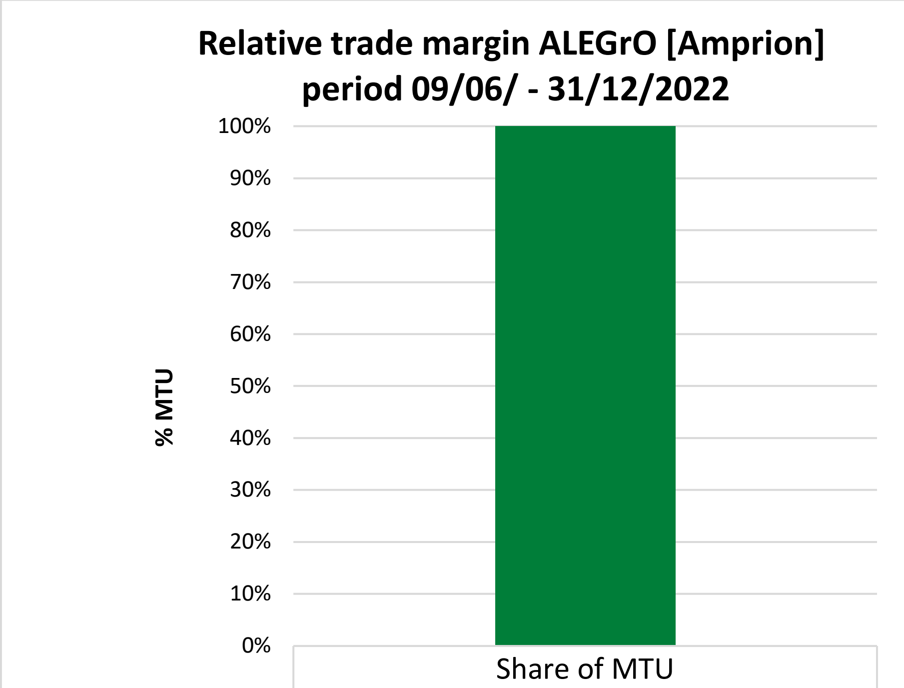


Figure 15: Frequency distribution Core [Amprion] during the period from 09/06/2022 through 31/12/2022 (minimum value 31.0%)

Figures 14 and 15 show the distribution of the offered relative trade margin on the CNEs of the Amprion control area during the period from 09/06/2022 through 31/12/2022 based on 604,696 values (one value per CNE and MTU) in a total of 4,933 MTUs. The small proportion of CNE_MTUs in the data set that show a lower deviation of the minimum values is the result of the validation process described above. Thus, all lower deviations of the minimum capacity are justified as a measure to ensure system security and thus meet the requirements of Art. 16(3) of the EU Electricity Market Regulation.



	Share of MTU
Out of operation	0.00%
< 31%	0.00%
[31 - 50 %)	0.00%
[50 - 70 %)	0.00%
>= 70 %	100.00%

Figure 16: Relative trade margin ALEGrO [Amprion] during the period from 09/06/2022 through 31/12/2022 (minimum value 31.0%)

Figure 16 shows the transmission capacity provided by Amprion on ALEGrO's German hub 'AL_DE' for cross-zonal power trading in relation to ALEGrO's available thermal capacity.[42] One value per hour or MTU considered is included in the graph, resulting in 4,933 data points. Amprion was able to offer 100% of the available thermal transmission capacity of 1,000 MW to cross-zonal trading in all MTUs of the period under consideration from 09/06/2022 through 31/12/2022. For obvious reasons, a frequency distribution does not add any value due to the data structure, which is why it has not been presented here.

[42] A detailed description of the monitoring methodology for ALEGrO can be found in chapters 3.1.2 (special case Core-internal DC interconnectors) and 4.1.2.1 (Amprion control area).

As a DC network element, ALEGrO is not included in the Core capacity calculation as a CNEC and cannot be overloaded. Therefore, compared to the AC network elements of the CCR Core, the differentiation of the category for lower deviations of the minimum value of 31.0% is omitted.
On the Belgian side of ALEGrO there was an unplanned outage on 19/06/2022 for 7:45 hours as well as on 20/07/2022 for 8 hours, so that no capacity could be offered on the virtual hub "AL_BE" and therefore no capacity could be allocated on ALEGrO during this period. However, as this was beyond Amprion's control, these incidents do not affect the evaluation of the offered trade margin on the hub 'AL_DE'.

In summary, Amprion has complied with the legal requirements for cross-zonal electricity trading in accordance with Art. 15 and 16 of the Electricity Single Market Regulation in the CCR Core at all times during the period under review from 09/06/2022 through 31/12/2022.

<u>TenneT control area</u>

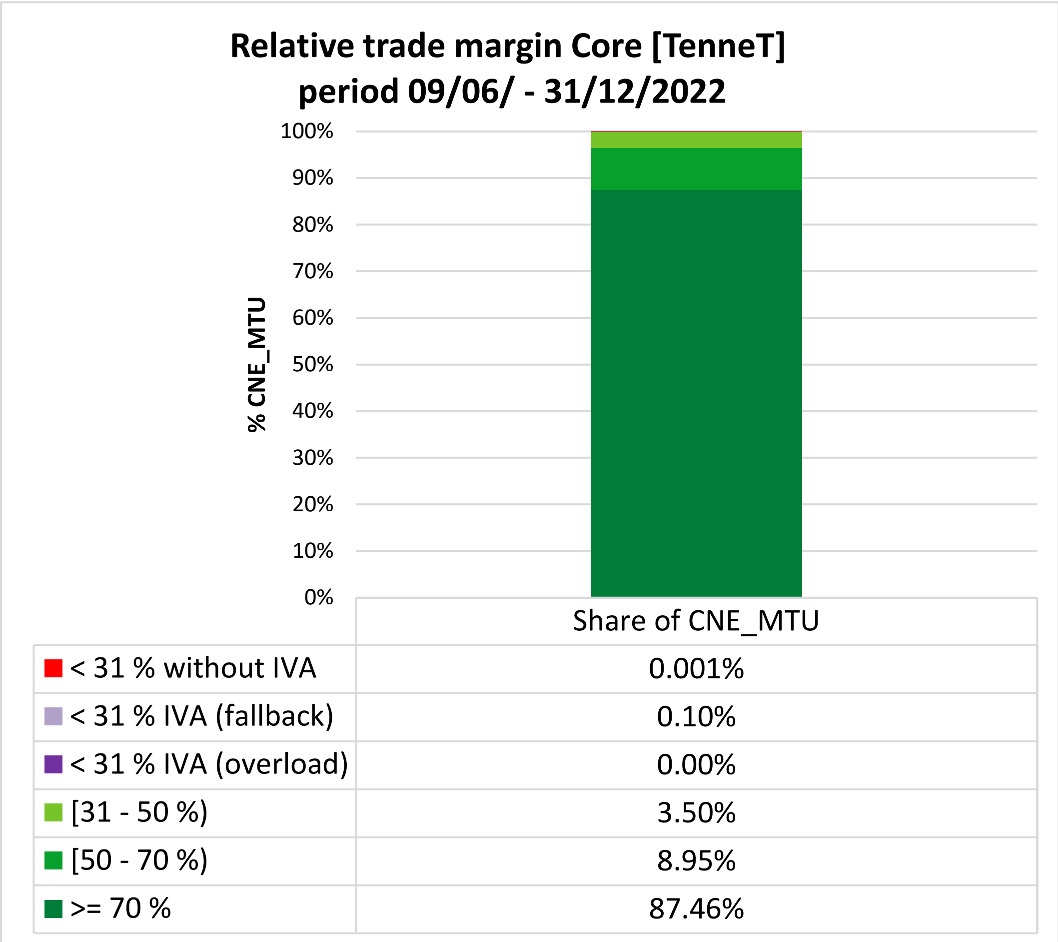


Figure 17: Relative trade margin Core [TenneT] during the period from 09/06/2022 through 31/12/2022 (minimum value 31.0%)

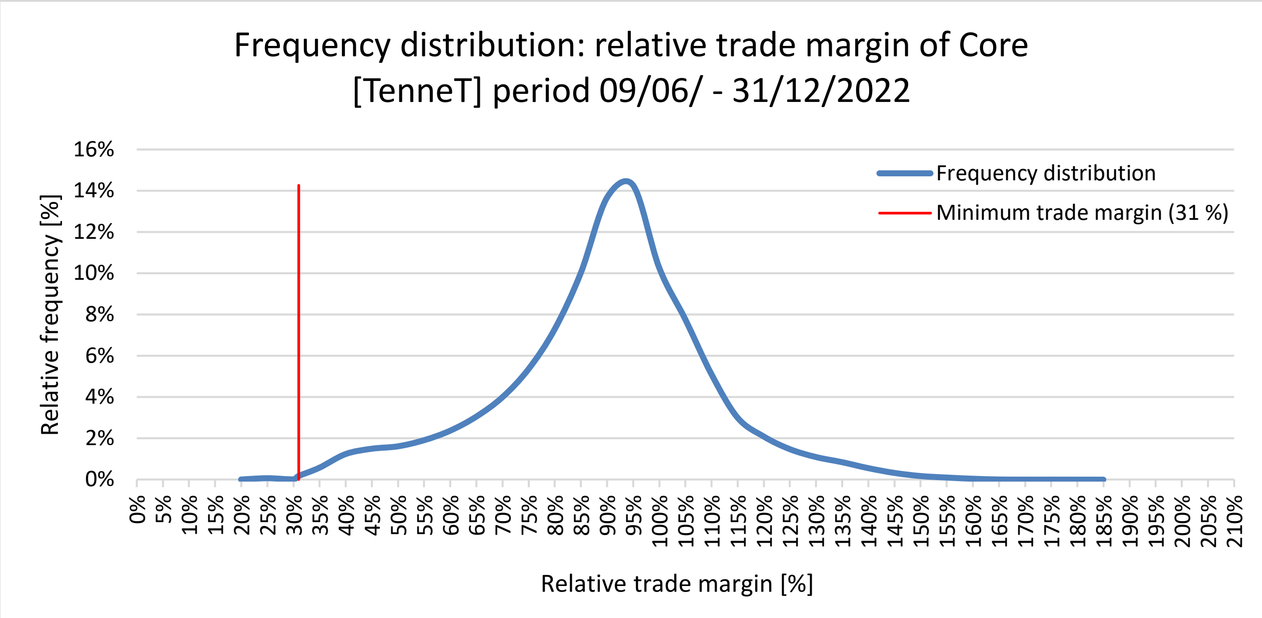
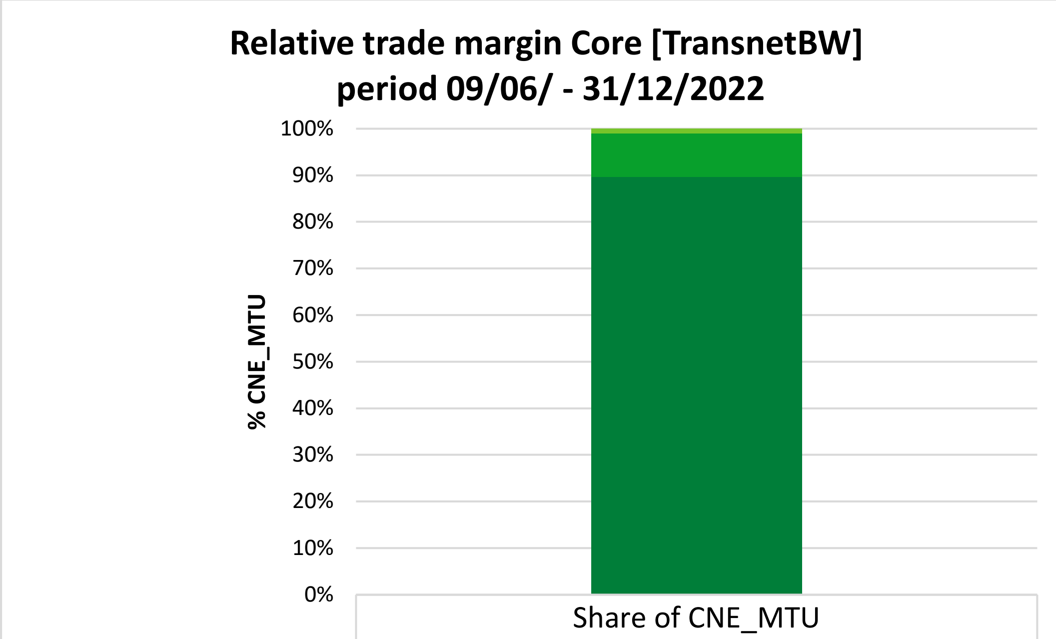


Figure 18: Frequency distribution Core [TenneT] during the period from 09/06/2022 through 31/12/2022 (minimum value 31.0%)

Figures 17 and 18 show the distribution of the offered relative trade margin on the CNEs of the TenneT control area in the year 2022 based on 169,060 values (one value per CNE and MTU) in a total of 4,933 MTUs. Thus, an average of 34.3 CNEs of the TenneT control area were taken into account per MTU in the graphs.

The minimum value according to the linear trajectory of the action plan for 2022 (31.0%) was not reached in 2 cases (CNE_MTU) on 15/11/2022 in hour 21. The reason for the lower deviation is the different calculation of the uncoordinated trade margin according to the BNetzA in the context of this monitoring and the Core Capacity Calculation. The Core capacity calculation increases the coordinated trade margin depending on the expected uncoordinated trade margin, which is based on forecasted schedules. The monitoring methodology is based on actual offered capacity (ex post retrieval of the forecasted day-ahead capacity from the ENTSO-E Transparency Platform (see section 3). In the present case, the Core capacity calculation assumed a higher uncoordinated trade margin than could be applied according to the monitoring methodology. The Core capacity calculation assumed a forecast schedule value of 700 MW for the Cobra cable, whereas the Monitoring Methodology assumed the actual NTC, which was zero (0) MW. According to the monitoring methodology, a higher coordinated trade margin should therefore have been offered in the capacity calculation. However, since the German TSOs do not have the option of determining the coordinated trade margin as a function of the uncoordinated trade margin according to the monitoring methodology, but are bound to the Core methodology, the German TSOs are generally not responsible for such cases and TenneT is not responsible for them in the present case.

<u>TransnetBW control area</u>



	Share of CNE_MTU
< 31 % without IVA	0.00%
< 31 % IVA (fallback)	0.00%
< 31 % IVA (overload)	0.00%
[31 - 50 %)	1.05%
[50 - 70 %)	9.31%
>= 70 %	89.63%

Figure 19: Relative trade margin Core [TransnetBW] during the period from 09/06/2022 through 31/12/2022 (minimum value 31.0%)

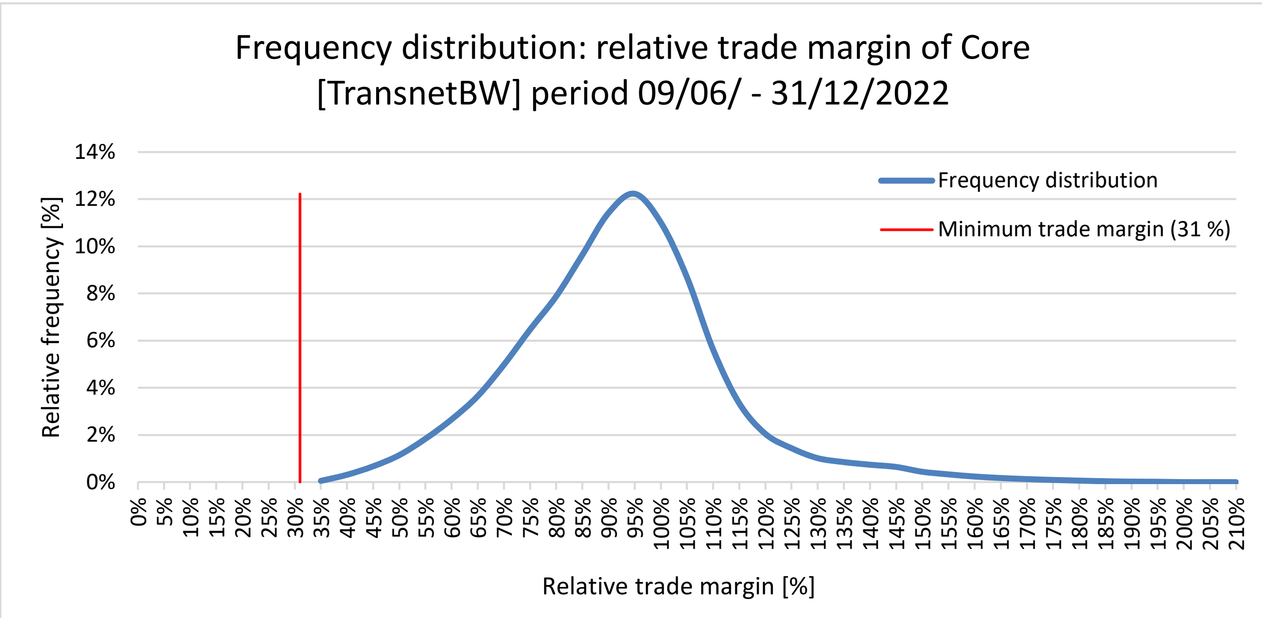


Figure 20: Frequency distribution Core [TransnetBW] during the period from 09/06/2022 through 31/12/2022 (minimum value 31.0%)

Figures 19 and 20 show the distribution of the offered relative trade margin on the CNEs of the TransnetBW control area during the period from 09/06/2022 through 31/12/2022, based on 151,765 values (one value per CNE and MTU) in a total of 4,933 MTUs. Thus, an average of 30.8 CNEs of the TransnetBW control area were considered per MTU in the graphs.

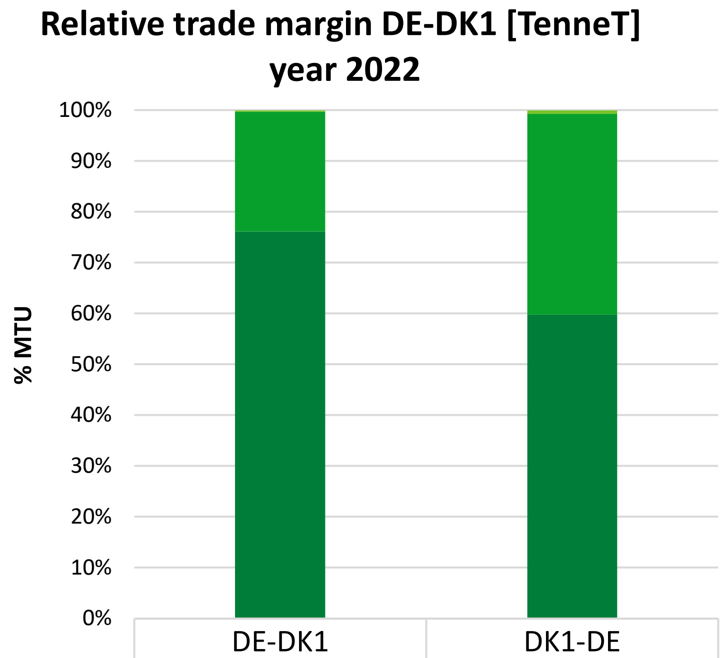
Many CNECs exhibit a high trade margin. In a given hour, a single CNEC with a lower trade margin can be sufficient to limit the market result. Providing additional capacity at these network elements for cross-zonal electricity trading therefore poses a great challenge. The currently reduced trade requirements of the linear trajectory defined by the Bidding Zone Action Plan are necessary for these particularly impacted network elements.

In summary, TransnetBW complied with the statutory requirements for cross-zonal electricity trading pursuant to Art. 15 and 16 of the EU Electricity Market Regulation at all times during the period from 09/06/2022 through 31/12/2022, meaning that the minimum capacity of the Bidding Zone Action Plan of 31.0% was fulfilled in every hour.

4.2 Hansa borders

4.2.1 NTC border Germany – Denmark 1

Figure 21 shows the distribution of the offered relative trade margin on the CNEs of the TenneT control area that determined the hourly NTC values of 2022 of the respective direction. Both directions include 8,760 values (one value per MTU). The minimum value for 2022 of 39.4% according to the linear trajectory of the action plan was met on all CNEs within the TenneT control zone. No D2CF data set was available for the first six hours of 07/11/2022 such that it is impossible to determine a trade margin. These hours account for 0.07% of the total hours and are assigned to the category "process fault”. In these hours, a backup NTC of 1,492 MW was applied for both directions, which was secured by countertrading measures. The backup NTC corresponds to the minimum capacity according to TenneT's Commitment and cannot be converted to the CNEC-based minimum capacity considered here. Figure 22 shows the frequency distribution of the relative trading margins of the CNE_MTU as a kind of density function.



	DE-DK1	DK1-DE
Process fault	0.07%	0.07%
< 39.4 %	0.00%	0.00%
[39.4 - 50 %)	0.27%	0.70%
[50 - 70 %)	23.58%	39.51%
>= 70 %	76.07%	59.73%

Figure 21: Relative trade margin DE-DK1 [TenneT] year 2022 (minimum value 39.4%)

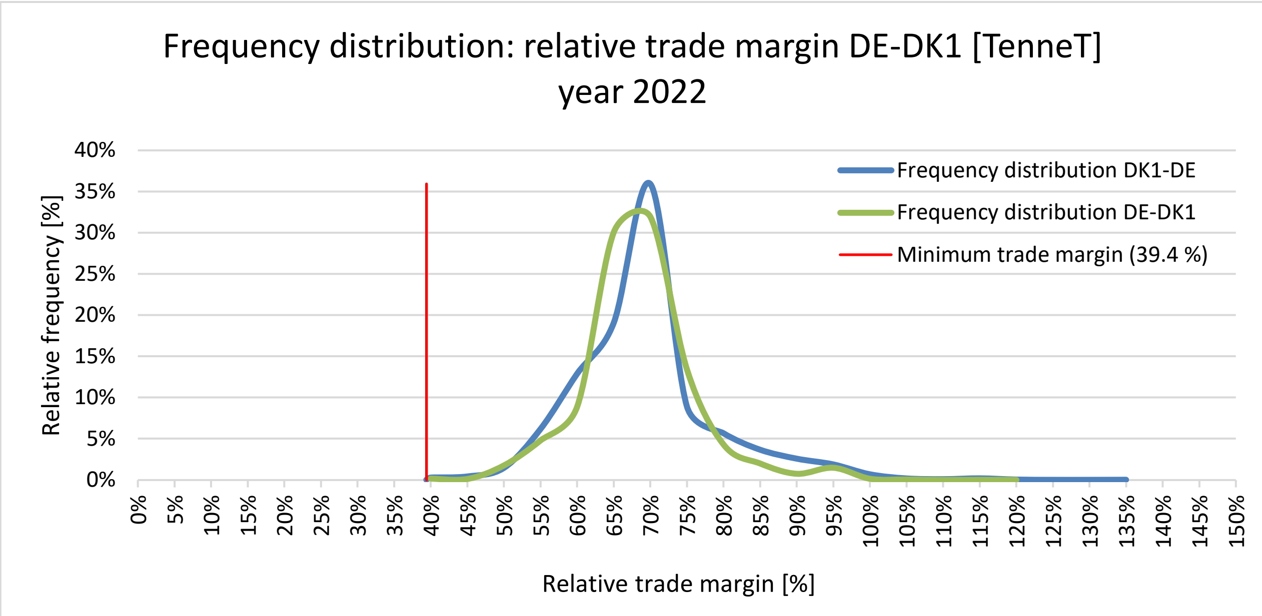
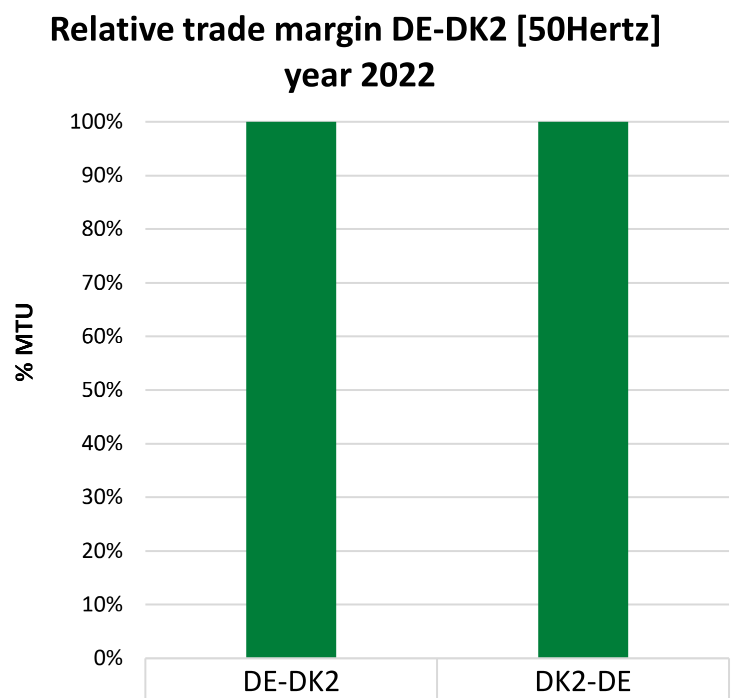


Figure 22: Frequency distribution: relative trade margin DE-DK1 [TenneT] year 2022 (minimum value 39.4%)

4.2.2 NTC border German – Denmark 2

For the border DE-DK2, the respectively applicable minimum value was complied with during every MTU of 2022. The minimum value per border and hour was 70.0% of the F_{max} of the Kontek cable plus 23.3% of the F_{max} of the Kriegers Flak CGS (after deducting the forecasted DA offshore wind power infeed)[43]. After the KF CGS went into operation, this results in a minimum value of below 70% in total for the border DE-DK2, which has to be determined on hourly basis. The following figure shows the actually offered trade margin relative to the transmission capacity at the border DE-DK2 in the year 2022[44].



	DE-DK2	DK2-DE
Process fault	0.00%	0.00%
Out of operation	0.00%	0.00%
< 70 %	0.00%	0.00%
>= 70 %	100.00%	100.00%

Figure 23: Relative trade margin DE-DK2 [50Hertz] year 2022 (minimum value <70%)[45]

Figure 23 shows that the trade margin amounted to at least 70% of the transmission capacity during all hours considered. Included are 8,760 hours in the export direction and in the import direction.

[43] See also section 3.2.2 NTC border DE-DK2 in the monitoring methodology section.
[44] For the sake of simplicity, figure 23 shows a comparison with 70% and not with the sometimes lower minimum value.
[45] The category "Process fault" means hours in which the capacity calculation was not possible, the category "Out of order" means hours in which no capacity was offered on the border.

The table below shows the number of hours in which the availability of the two interconnectors on the DE-DK2 border was restricted in 2022.[46]

Interconnector	maintenance	Partial disturbance / disturbance
Kontek cable	829	0 / 223
KF CGS[47]	648	7,347 / 0

The partial restriction on the border is essentially due to:

- Maintenance: Maintenance work is carried out annually on both interconnectors for which they are partially or completely taken out of service. For the Kontek cable, shutdowns for the replacement of the land cable and for the KF CGS shutdowns for work on cable joints have also been included in the maintenance category.
- Partial disturbance / disturbance: The Kontek cable was briefly disturbed as a result of fault trips in January and December 2022 and was therefore out of service. As a result of a temperature anomaly on a cable associated with the KF CGS, transmission capability on the system as a whole was reduced by 25 MW during most of 2022 (and by more than 25 MW at times in January). Further action will be taken in the summer of 2023 to fix the temperature anomaly.

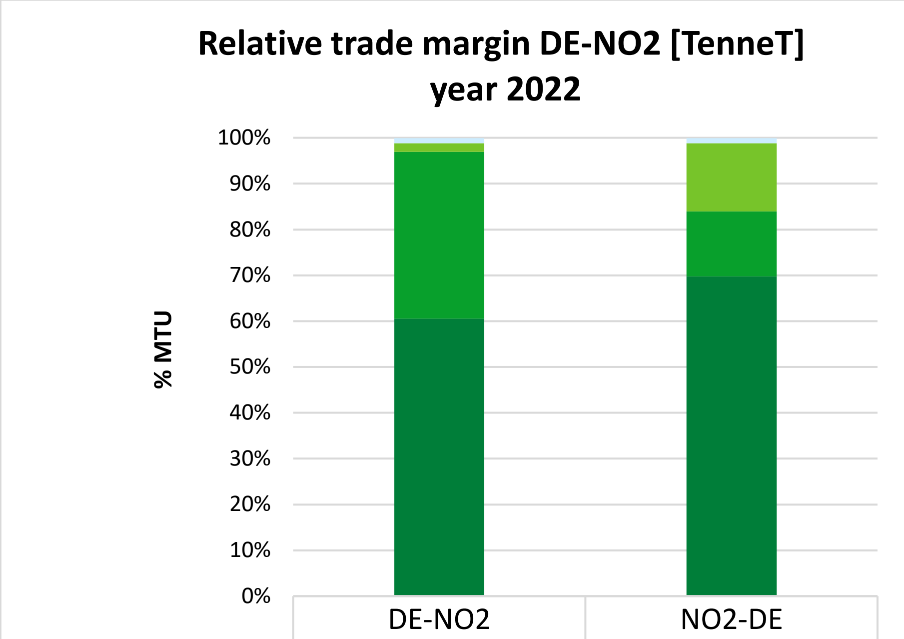
4.2.3 NTC border Germany – Norway 2

Figure 24 shows the distribution of the offered relative trade margin on the AC and DC CNECs of the TenneT control area that determined the 2022 hourly NTC values of the respective direction. Both directions include 8,760 values (one value per MTU). The minimum value for 2022 of 23.3% according to the linear trajectory of the action plan was met on all critical network elements within the TenneT control area at all MTU. The NTC of the direction DE to NO2 was determined in 2,808 hours by the NordLink cable (DC-CNEC). The NTC of the direction NO2 to DE was determined in 3,581 hours by the NordLink cable (DC-CNEC). If the NTC is determined by the DC-CNEC, NTC equals F_{max}. Therefore, the offered relative trade margin of DC-CNECs is always 100%.

No D2CF dataset was available for the first 6 hours of 07/11/2022. These hours are not included in the distribution because no relative trade margin can be determined without a network model. During these hours, backup NTC of 327 MW for the NO2 to DE direction and 337 MW for the DE to NO2 direction were applied.

[46] Hours in which there were several restrictions on an interconnector were assigned to the more capacity reducing restriction. For example, an hour in which maintenance took place and a (partial) disturbance was present at the same time was assigned to the maintenance category.

[47] The classification of restrictions has not been applied consistently. In the first half of the year there was no classification as maintenance.



	DE-NO2	NO2-DE
Process fault	0.07%	0.07%
Out of operation	1.08%	1.08%
< 23.3 %	0.00%	0.00%
[23.3 % - 50%)	1.94%	14.86%
[50%-70%)	36.37%	14.20%
>=70%	60.54%	69.78%

Figure 24: Relative trade margin DE-NO2 [TenneT] year 2022 (minimum value 23.3%)

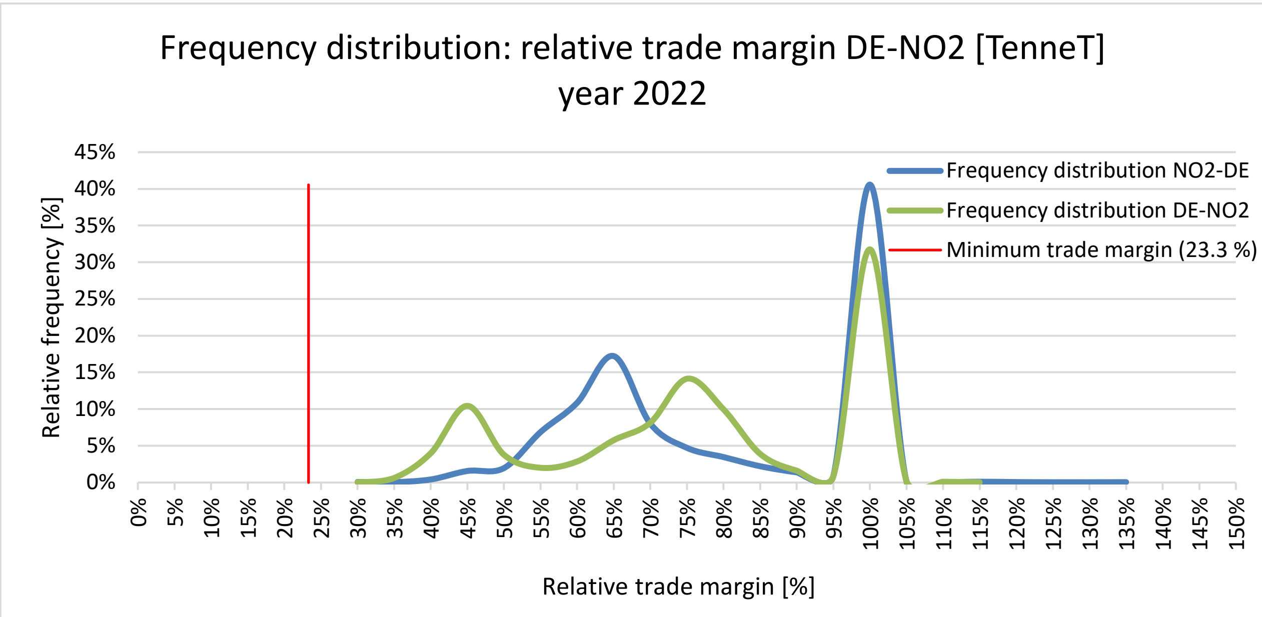


Figure 25: Frequency distribution: relative trade margin DE-NO2 [TenneT] year 2022 (minimum value 23.3%)

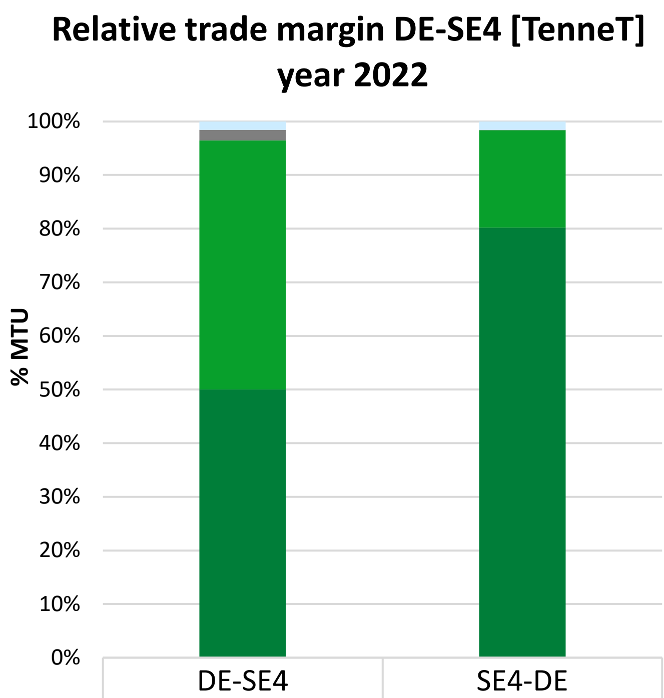
The NordLink cable was out of operation for 95 hours in 2022 due to maintenance or malfunctions. In normal operation, the F_{max} value is 1,400 MW. For 625 hours, the cable was in monopole operation with a limitation of the F_{max} value (DC CNEC) to 685 MW.[48] In 33 hours, the F_{max} value was limited to 1,000 MW at the request of the Norwegian TSO Statnett. The hours with limited F_{max} value are included in the shown distribution. The following table shows the number of hours with F_{max} restrictions by cause.[49]

Operating state	F_{max} [MW]	Number of hours with planned maintenance	Number of hours with planned repairs	Number of hours with forced outage	Total
Out of operation	0	42	18	35	**95**
Monopole operation	685	179	86	360	**625**
Limitation of direction NO2 to DE by Statnett	1,000	0	0	33	**33**
				Grand total	**753**

4.2.4 NTC border Germany – Sweden 4

The Baltic Cable, which forms the border DE-SE4, was in operation during 8,623 hours in the year 2022. In the remaining 137 hours, the cable was planned out of operation, meaning that no cross-border transmission capacity was available. Figure 26 and Figure 27 show the distribution of the offered trade margin of the DE-SE4 border in the year 2022.

[48] The NordLink cable is a bipolar high voltage DC transmission system consisting of two high voltage cables. If only one converter is available (monopole operation), only half of the transmission power minus the full transmission losses is available.
[49] Source of the restriction on request of the Statnett: https://umm.nordpoolgroup.com/#/messages/b36d8bd8-8dca-478b-98ea-a12952411567/4.



	DE-SE4	SE4-DE
Out of operation	1.56%	1.56%
< 50.9 %	2.00%	0.06%
[50.9 - 70 %)	46.43%	18.22%
>= 70 %	50.01%	80.16%

Figure 26: Relative trade margin DE-SE4 [TenneT] 2022 (minimum value 50.9%)

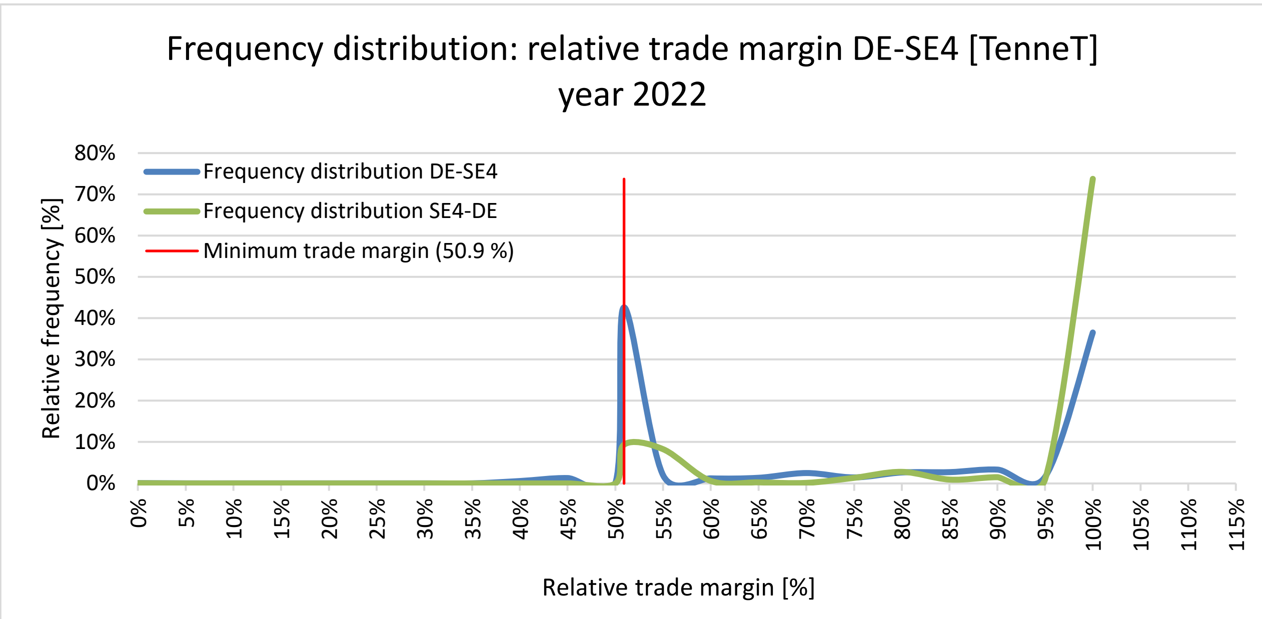


Figure 27: Frequency distribution: relative trade margin DE-SE4 [TenneT] year 2022 (minimum value 50.9%)

The minimum capacity of the border DE-SE4 of 306 MW according to the linear trajectory of the action plan, which corresponds to 50.9% of the maximum capacity of the Baltic Cable, was complied with in the south direction (SE4 to DE) for 8,618 hours (99.9% of the operating hours). In the north direction (DE to SE4), the minimum capacity was complied with for 8,448 hours (98% of the operating hours).

The minimum capacity was consistently met in the normal switching state (availability of all relevant network elements) during the year 2022 because wind turbines could be curtailed as a corrective measure to prevent the overloading of critical network elements in the connection area of the Baltic Cable.

Due to planned outage of network elements in the control area of TenneT (incl. distribution grid level), lower deviations from the minimum capacity in 175 MTU in the north direction and in 5 MTU in the south direction were necessary in accordance with Art. 16(3) of the EU Electricity Market Regulation in order to ensure system security. All lower deviations were reported to the BNetzA without delay. During 5 MTU, the transmission capacity across bidding zones was 0 MW in both directions due to switching operations of a directly connected transformer (direct coupler T411 in Siems), which cannot take place under load. Only in these 5 MTUs did market constraints occur. During the remaining 170 MTUs with lower deviations from the minimum capacity in the north direction, there were no restrictions on the market.

The lower deviations from the minimum capacity are due to the special connection situation of the Baltic Cable. The transmission capacity across bidding zones is heavily dependent on the availability of the connections between the TenneT transmission network and the subordinate distribution network of Schleswig-Holstein Netz AG (SHN). The following figure shows the network topology of the high-voltage and extra-high voltage network at the German grid connection of the Baltic Cable.

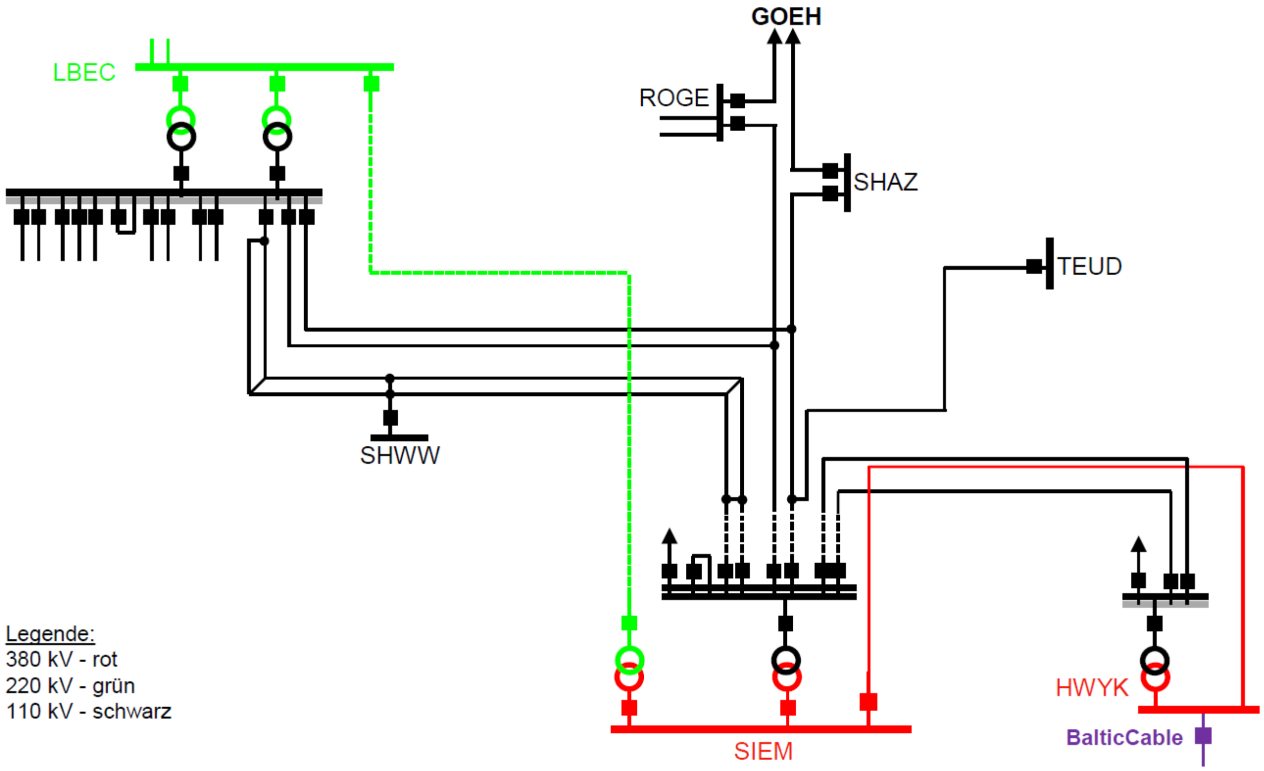


Figure 28: Network topology of the high-voltage and extra-high voltage network at the German Baltic Cable grid connection (source: SHN)

On the German side, the Baltic Cable is connected to the TenneT transmission grid at the grid connection point Lübeck-Herrenwyk (HWYK). From there, a 380 kV overhead line of TenneT leads to the Lübeck-Siems substation (SIEM). The Lübeck-Siems substation is connected to the Lübeck substation (LBEC) via a 220 kV underground cable of TenneT with a capacity of about 350 MW. The underground cable alone is not sufficient to transport the power of the Baltic Cable (600 MW on the receiving side). For the transmission of the Baltic Cable's power, the SHN distribution network must be utilised, which additionally connects the Lübeck-Herrenwyk and Lübeck-Siems substations with the Lübeck substation. At the DE-SE4 border, there is an unusual connection constellation for the Baltic Cable in that its power can only be transmitted cumulatively with the help of the transmission grid and the distribution grid.

In addition, the Lübeck substation is only connected to the rest of the TenneT transmission grid via two parallel 220 kV overhead lines to the Hamburg-Nord substation (not shown in the figure), which are also necessary for the Baltic Cable transmission. Each line has a capacity of approximately 460 MW. Only both lines together can guarantee the transport of the Baltic Cable. In the event of unavailability of relevant network elements of the transmission network or the subordinate distribution network due to necessary disconnection or outage, there may therefore be restrictions on the available transmission capacity, which may require a limitation of the cross-border capacity below the minimum capacity. This is particularly the case in the event of non-availability of the 220-KV underground cable between Siems and Lübeck, as well as non-availability of at least one of the two 220-KV lines from Lübeck to Hamburg-Nord.

Against this backdrop, TenneT has developed a corresponding capacity calculation process with SHN, which is available to the Bundesnetzagentur. This provides for a reduction in cross-border capacity per direction depending on the forecasted wind feed-in in the event of the (combined) unavailability of individual lines. The limit values for the respective shutdown scenarios are laid down in the Operational Instruction Manual of Baltic Cable.

At the times of the lower deviations, network elements of TenneT and SHN, which are essential for the provision of the minimum capacity, were not available due to maintenance, repair, or conversion work. The lower deviations from the minimum capacity at the border DE-SE4 were based on three scenarios: The unavailability of one of the two 220 kV lines Hamburg-Nord - Lübeck, the unavailability of one of the 110 kV lines Siems - Lübeck as well as the disconnection of the direct coupler T411 in Siems during switching operations.

The reason for the lower deviations is that they were necessary to ensure system security in the TenneT control area and the SHN distribution grid level. A lower deviation from the minimum capacity at the border DE-SE4 was justified for reasons of system security in accordance with Art. 16(3) of the EU Electricity Market Regulation.

LIST OF ABBREVIATIONS

AC	Alternating current
ACER	European Union Agency for the Cooperation of Energy Regulators
APG	Austrian Power Grid
BCAB	Baltic Cable AB (German TSO without control area responsibility)
BMWK	Federal Ministry for Economic Affairs and Climate Action
BNetzA	Federal Network Agency
CCR	Capacity Calculation Region
CEPS	Czech TSO
CGM	Common Grid Model
CNE	Critical Network Element
CNEC	Critical Network Element in combination with the respective Critical Contingency Combination
cNTC	Coordinated NTC method
Core FBMC	Flow-based market coupling in the Capacity Calculation Region Core
CWE	Central Western European region
CZ	Czechia
DA	Day-ahead
DAVinCy	Day-ahead Validation of Capacity
DC	Direct current
DE	Germany
DE-DK1	Border Germany – Denmark 1
DE-DK2	Border Germany – Denmark 2
DE-NO2	Border Germany – Norway 2
DE-SE4	Border Germany – Sweden 4
DFP	Default flow-based parameter
DK	Denmark
D2CF CGM	Two Day-ahead Congestion Forecast Common Grid Model
EEA	European Economic Area
EU	European Union
F_{max}	Physical capacity
F_{ref}	Reference flow
KF CGS	Kriegers Flak Combined Grid Solution
HVDC	High Voltage Direct Current
ID	Intraday
IVA	Individual Validation Adjustment
LTA	Long Term Allocation
MinRAM	Minimum Remaining Available Margin
MTU	Market Time Unit
NO	Norway
NTC	Net transfer capacity
PL	Poland
PSDF	Phase Shift Distribution Factor

PTDF	Power Transfer Distribution Factors
RAM	Remaining Available Margin
SE	Sweden
SHN	Schleswig-Holstein Netz AG (DSO in Schleswig-Holstein)
SOGL	System Operation Guideline
TSO	Transmission system operator
cTSO	Transmission system operator with control area responsibility
TTN	TenneT TSO B.V. (Dutch TSO)

LIST OF FIGURES