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Report on alternative options for distributing capacity reductions between NorNed and COBRAcable

In accordance with a request of ACM

Executive Summary

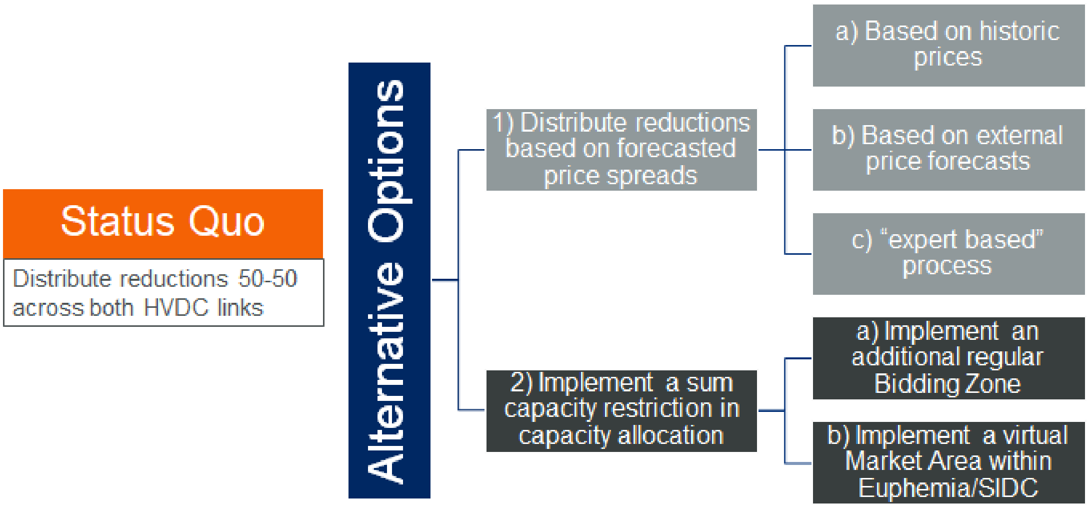
Situations in the grid can arise where, due to planned and/or unplanned outages on Dutch network elements, it is not possible to transport all possible infeed in the North of the Netherlands via internal Dutch network elements without violating operational security limits. In case of a lack of available effective remedial actions, TenneT is allowed to reduce the Net Transfer Capacity (NTC) on the bidding zone borders NL-NO2 (NorNed) and NL-DK1 (COBRAcable) to a level that respects operational security limits.

Currently, TenneT distributes such NTC reductions evenly over both bidding zone borders. For example, when 400 MW of imports have to be reduced in the North of the Netherlands, the capacity on both links will be reduced with 200 MW. This is a non-discriminatory approach, but does not necessarily lead to the best outcome from social welfare perspective. ACM requested TenneT to investigate alternative options which would take such social welfare perspective also into account.

TenneT has investigated what alternative options are available in such situations to distribute a required NTC reduction before the day-ahead market coupling across the bidding zone borders NL-NO2 and NL-DK1. TenneT has identified two alternative options:

1. Distribute reductions based on forecasted price spreads;
2. Implement a sum capacity restriction in capacity allocation.

Both these main alternative options can be broken down in several implementation options:



The first option concentrates on finding ways to put the necessary NTC reductions firstly/mostly on the bidding zone border with the expected lowest price spread. This because welfare is impacted the least when reductions are applied on the bidding zone border with the lowest price spread. The sub options mostly differ in how the necessary price forecast is established.

The second option is about the application of allocation constraint during the capacity allocation stage based on which the total simultaneous import or export of both interconnectors together is limited to the extent necessary to respect operational security limits. The general idea is that using an allocation constraint in the capacity allocation stage is a more fundamental solution to minimise welfare effects, because the day-ahead and intraday market coupling algorithms can then determine the 'welfare optimal' ratio for the reductions based on the actual buy and sell orders and allocate the available capacity to the bidding zone border(s) where it creates most welfare. The identified sub-options differ in whether they make use of a regular bidding zone, or apply a virtual market area 'behind the scenes' in the market coupling algorithms.

All options carry upsides and downsides, and have some limitations and potential issues/uncertainties. In general, the implementation of a sum capacity restriction in capacity allocation is the welfare optimal solution, but carries more potential issues and uncertainties. Also, it requires significantly more implementation effort than implementing a process where reductions are distributed based on price forecasts, and in contrast to distributing reductions based on price forecasts the implementation of a sum capacity restriction also requires several changes to the common IT-systems of the TSOs and NEMOs.

After the realisation of the ongoing project Noord-West 380 kV, the need to apply NTC reductions on the HVDC interconnectors is expected to significantly decrease per 2023. Any alternative solution to the status quo approach, would therefore mainly be applied in the period 2022-2023. Given that distributing reductions based on price forecasts can be implemented on much shorter notice, it seems to be the more obvious solution to remedy negative welfare effects of the status quo approach. However, it is not yet fully clear whether this option qualifies as a non-discriminatory approach and/or what conditions would need to be fulfilled to regard it as a non-discriminatory approach.

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1. Introduction

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.

In 2020, TenneT has at times reduced the NTC capacity on HVDC bidding zone borders during significant and longer duration outage situations on critical network elements as, otherwise, operational security limits would be violated[1]. The reductions for NorNed and COBRAcable were for the vast majority of the time related to the fact that throughout 2020 there have been several planned and unplanned outages in the 380 kV grid of North of the Netherlands (Eemshaven area).

Currently, TenneT distributes such NTC reductions evenly over both bidding zone borders. For example, when 400 MW of imports have to be reduced in the North of the Netherlands, the capacity on both links will be reduced with 200 MW.

Within the public consultation on the NL MACZT monitoring report 2020, Statkraft has provided a response (zienswijze)[2] in which they bring forward that the equal distribution of reductions leads to a decrease of social welfare compared to alternative distributions. Their main arguments are that:

- The price spread between NL and NO2 was a magnitude larger than between NL and DK1. Therefore, for economic reasons it would have been better to first reduce the NTC between NL and DK1, before reducing the NTC between NL and NO2.
- There were several Market Time Units (MTUs) with export from NL to Denmark via COBRAcable. For those MTUs, the capacity on NorNed would not have to be reduced to 300 MW to respect the operational security limit of maximum simultaneous import of 600 MW.

In a response to the opinion of Statkraft, TenneT acknowledged that the applied even distribution of reductions amongst both bidding zone borders does not necessarily lead to the best outcome from social welfare perspective, but that TenneT does so on the basis that it needs to apply a non-discriminatory approach to both bidding zone borders. Nevertheless, the detrimental effect on social welfare was already sufficient grounds for TenneT to start investigating whether there are alternative options to distribute capacity reductions across NorNed and COBRAcable - when necessary for operational security – which would take social welfare aspects into account while at the same time respecting the non-discrimination principle.

As follow-up on the observations from the MACZT monitoring report 2020 and the consultation, ACM requested TenneT to finish this investigation and to deliver a report to ACM.[3] This report presents the results of this investigation.

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[1] For more information, see the NL MACZT monitoring report 2020.
[2] https://www.acm.nl/nl/publicaties/zienswijze-statkraft-over-beoordelingsverslag-tennet-actieplan
[3] https://www.acm.nl/sites/default/files/documents/brief-aan-tennet-beoordelingsverslag-en-zienswijze-statkraft.pdf

2. Scope of this investigation

In general, when one or more critical network elements are in outage, TenneT aims to respect the obligations on minimum capacity to be made available for cross-zonal trade 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, TenneT is allowed to reduce capacity available for cross-zonal trade to a level that respects operational security limits. For a more elaborate description of the operational security process, we refer to section 4.3 of the NL MACZT monitoring report 2020.

This investigation focuses on the specific situation where, due to planned and/or unplanned outages on Dutch network elements, it is not possible to transport all possible infeed in the North of the Netherlands (including AC & DC imports, conventional generation and off-shore and onshore wind) via internal Dutch network elements. Both the COBRAcable and NorNed interconnector are connected to the Dutch grid in the North of the Netherlands, and, therefore, generally face the same limitations. In principle, even when one or several critical network elements are in outage, TenneT shall aim to respect the requirement to make at minimum an amount of 70% available for cross-zonal trade. However, in case of a lack of available effective costly and non-costly remedial actions, TenneT might need to reduce the day-ahead NTC capacity on NL-NO2 (NorNed) and/or NL-DK1 (COBRAcable) to a level below 70% that respects operational security limits.[4]

This investigation should identify what options are available in such situations to distribute a required NTC reduction before the day-ahead market coupling across the bidding zone borders NL-NO2 and NL-DK1. Potential improvements to the process to determine the required amount of reduction (on both interconnectors together) are out of scope for this investigation.

The request of ACM requires TenneT to study alternatives for the time period until the introduction of Advanced Hybrid Coupling. However, as set out in section 5.3, TenneT concluded that Advanced Hybrid Coupling is actually not a valid option for this purpose and had to be discarded. Also, it was concluded that currently ongoing grid investments are expected to significantly reduce the need for NTC reductions on the HVDC interconnectors (see section 3.3). Therefore, the scope for alternative measures has been brought back to their applicability for the **period 2022-2023**.

The application of cross-border redispatching and countertrading is considered out of scope for this report. Firstly, because this is considered a measure to reduce the level of required reductions which would thus be applied in the step where it is determined whether and how much NTC reduction would be required. Secondly, coordinated redispatching and countertrading will be implemented as part of the operational security coordination methodology and the coordinated redispatching and countertrading methodology of CCR Hansa in accordance with article 76 of the SOGL regulation and article 35 of the CACM Regulation, respectively. Therefore, this is already foreseen to be implemented and does not require additional investigation.

[4] For a more elaborate description of situations which have occurred in 2020 and have led to a reduction of NTC capacity on NorNed and COBRAcable, we refer to section 6.3 of the NL MACZT monitoring report 2020.

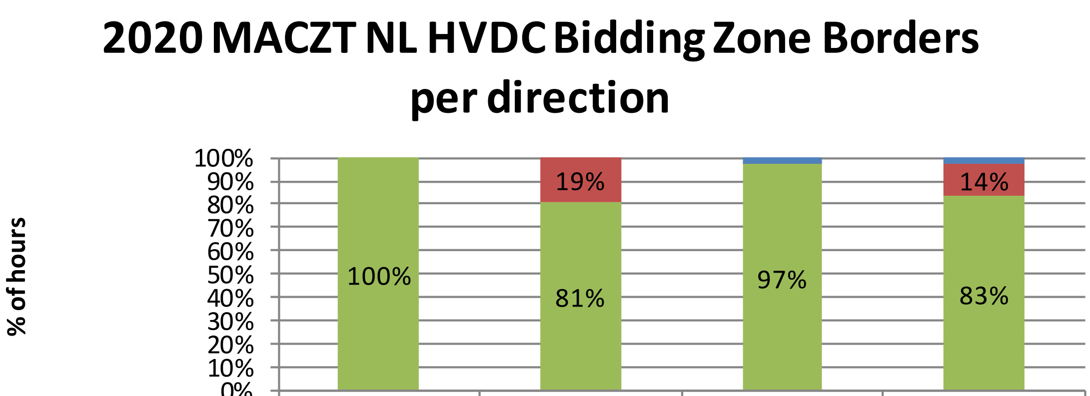
TenneT TSO B.V.

3. Reflection on the expected future needs for NTC Reductions on Cobra & NorNed during outages

This section summarises the NTC reductions which have happened in 2020 which triggered this report, the reductions applied so far in 2021 (Jan-September), and an outlook on the need for future reductions in relation to currently ongoing grid investments.

3.1 Reductions in 2020

In the NL MACZT monitoring report 2020, TenneT reported on the amount and frequency of reductions applied on the NL-DK1 and NL-NO2 bidding zone border. Not all reductions on these bidding zone borders were triggered by TenneT. The figure below shows that for 19% of MTUs for DK1->NL and 14% of MTUs for NO2->NL, the MACZT was below the minimum MACZT due to a reduction by TenneT.



	NL-->DK1	DK1–>NL	NL-->NO2	NO2-->NL
Reduction by Statnett/Energinet	0%	0%	3%	2%
Reduction by TenneT	0%	19%	0%	14%
MACZT >=70%	100%	81%	97%	83%

Figure 1: Percentage of the time when the relative MACZT is above 70% on the NL HVDC borders, per direction, for the full year 2020. Source: NL MACZT monitoring report 2020

The majority of the reductions was caused by a significant unplanned outage of one and a half months on Meeden-Zwolle, based on which the maximum production capacity on 380 kV in the Eemshaven area had to be reduced to ensure operational security limits. A further explanation of the reasons behind the reductions is included in section 6.3 of the NL MACZT monitoring report.

3.2 NTC Reductions so far in 2021

In the three figures below, the NTC reductions for both interconnectors for the period Q1-Q3 2021 have been provided. In these figures, it can be seen that there were very few reductions on COBRAcable and some more on the NorNed cable. As indicated in Figure 4, the reductions on the NorNed cable were mostly triggered by Statnett or were due to an outage of the interconnector itself. Only for 209 MTUs (3.1% of the time), TenneT applied simultaneous reductions on both bidding zone borders because of limitations in the Dutch grid. Also, no reductions below a MACZT of 70% (corresponds to 490 MW) have been applied by TenneT, the reductions below a MACZT of 70% in the figures below, were applied by Energinet/Statnett.

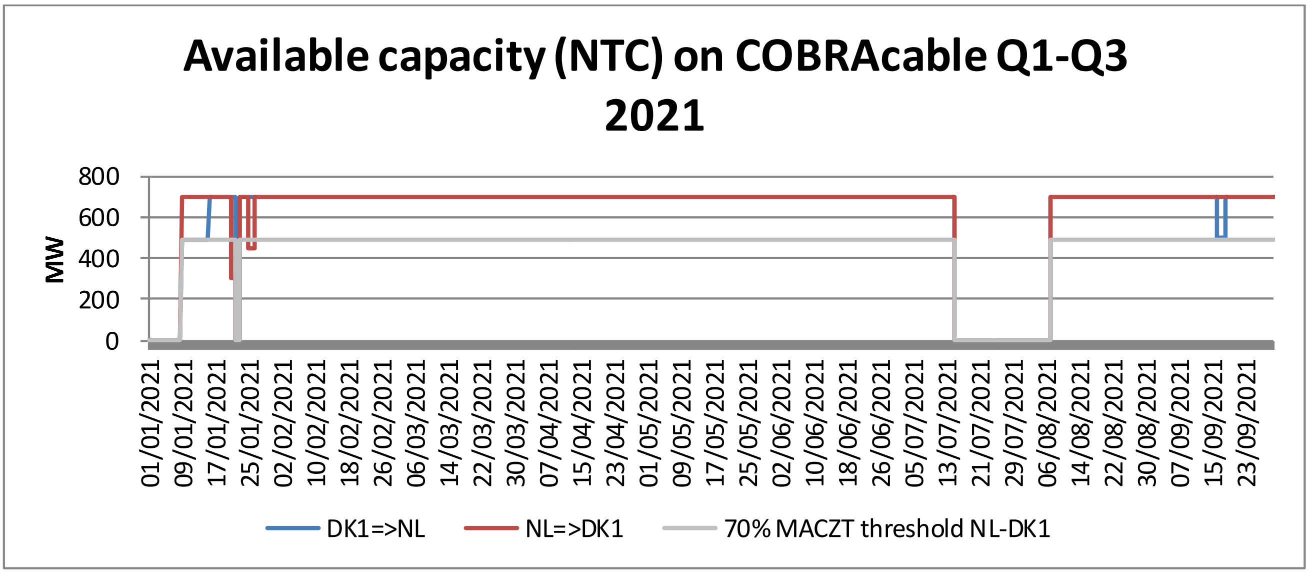


Figure 2: Available capacity (NTC) on the NL-DK1 bidding zone border, period Q1-Q3 2021

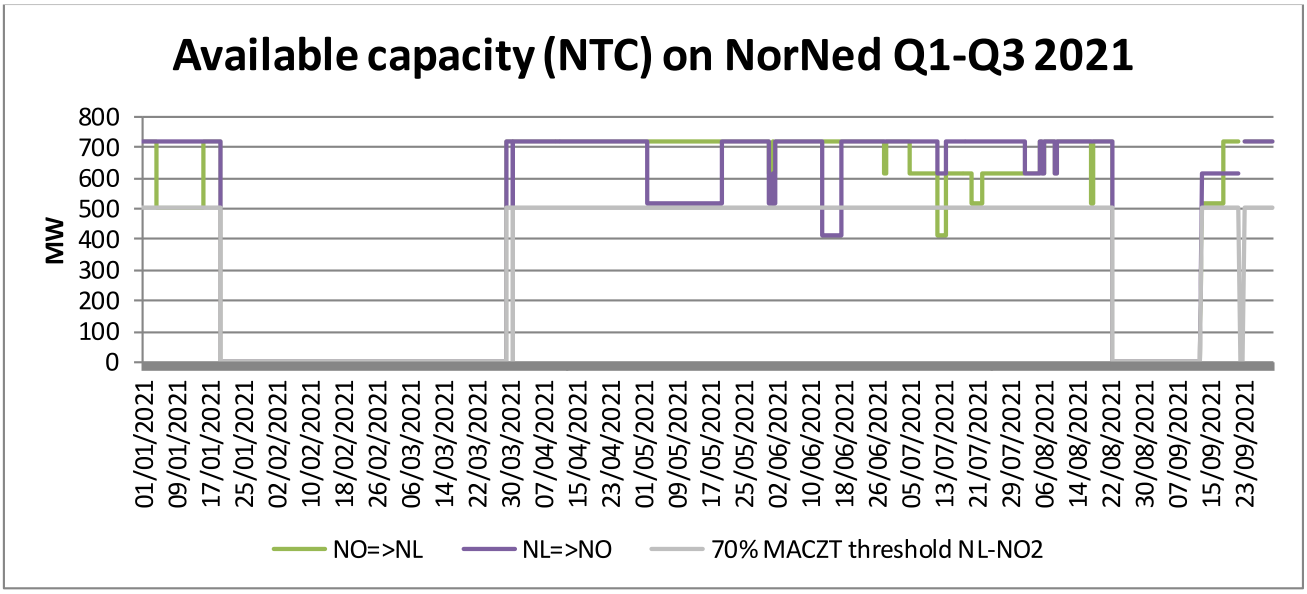
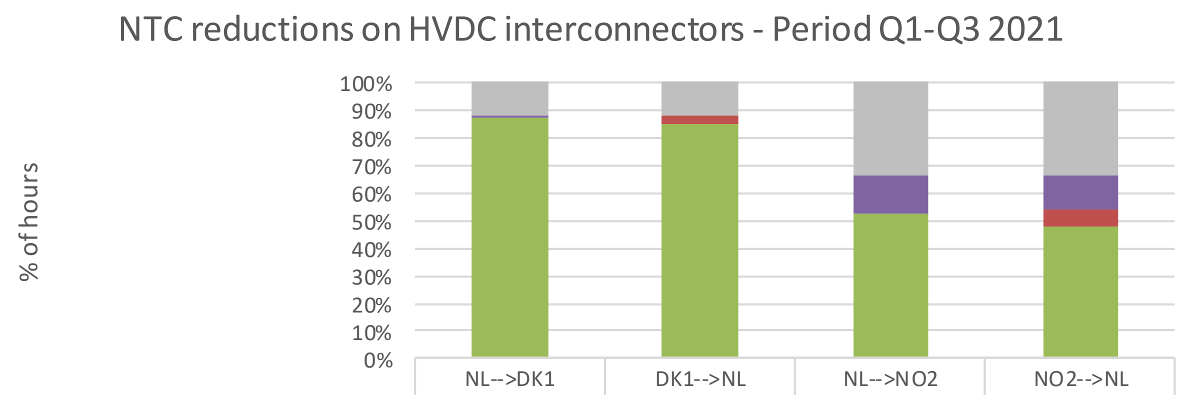


Figure 3: Available capacity (NTC) on the NL-NO2 bidding zone border, period Q1-Q3 2021



	NL-->DK1	DK1-->NL	NL-->NO2	NO2-->NL
NTC reduction because of interconnector outage	779	779	2175	2175
NTC reduction by Statnett/Energinet	50	0	938	826
NTC reduction by TenneT	0	209	0	401
No NTC reduction	5722	5563	3414	3125

Figure 4: NTC reductions on NL-DK1 and NL-NO2 bidding zone border per causer, period Q1-Q3 2021

3.3 Reductions expected from 2022 onwards

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, as well as what measures will be taken to comply with this linear trajectory. The major driver for increasing capacity available for cross-zonal trade is doing grid investments. Relevant grid investments are detailed in the aforementioned investment.

Future grid investments will also alleviate the need for NTC reductions in the future. The project 'Noord-West 380 kV, fase 1' will relieve the existing bottlenecks for transporting generation and import from the Eemshaven area to other parts of the Netherlands. Within this project 4 circuits of 2635 MVA between the substation Eemshaven Oudeschip and substation Vierverlaten will be realised. These circuits and the transformers in substation Vierverlaten can then be used to transport more electricity from the Eemshaven area into the 220 kV grid.

The project is already in realisation phase, and is expected to be operational per 2023[6]. An overview of the project is given in Figure 5.

[5] Action plan of the Netherlands, Implementation of Articles 14, 15 & 16 of Regulation (EU) 2019/943. The Hague, December 2019, Ministry of Economic Affairs and Climate Policy of the Netherlands. Link

[6] Ontwerpinvesteringsplan Net op land 2022-2031, Consultatiedocument 1 november 2021. Link

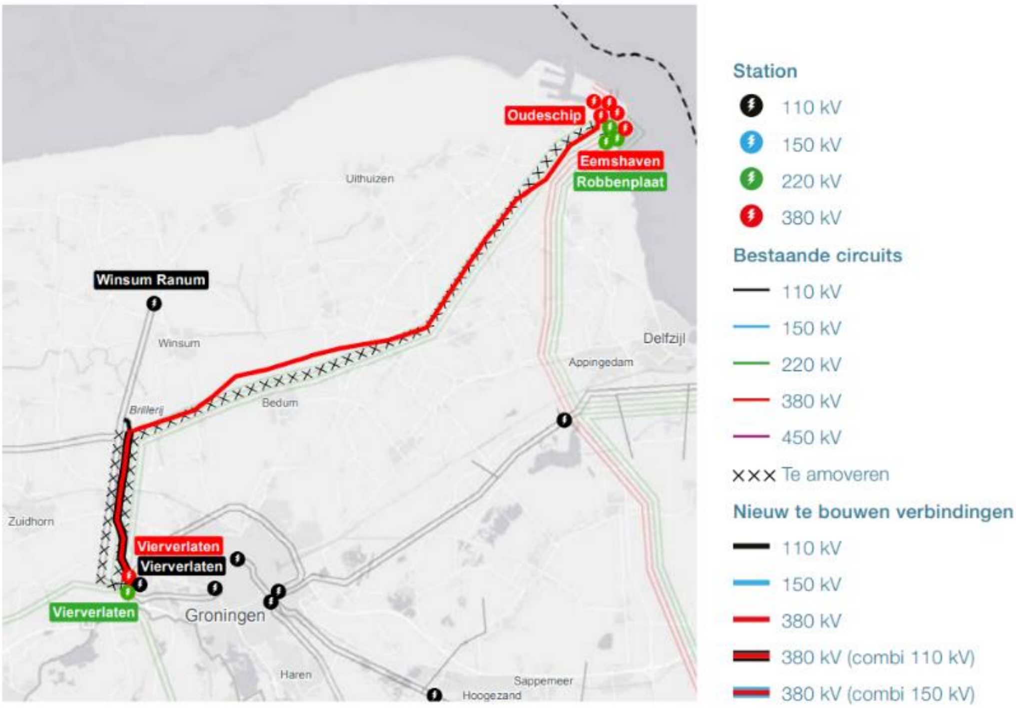


Figure 5: Scope of project Noord-West 380 kV, Source: Ontwerpinvesteringsplan Net op land 2022-2031 [6]

3.4 Overall conclusions on the expected future needs for reductions

Compared to 2020, in 2021 already significantly less reductions took place, both in frequency and magnitude. In the period Q1-Q3 2021, during only 209 MTUs a parallel reduction on COBRAcable and NorNed took place. In addition, no reductions below a MACZT of 70% (corresponds to 490 MW) have been applied by TenneT. Also, it is generally expected that after the realisation of the project Noord-West 380 kV, the need to apply NTC reductions on the HVDC interconnectors will significantly decrease.

Together, this leads to the conclusion that any alternative option for capacity reduction will most likely only be applied for a limited number of MTUs for only a limited period of time (2022-2023).

4. Basic principles/conditions to which the options should comply

If for reasons of operational security NTC reductions are to be applied on the bidding zone borders NL-NO2 (NorNed) and NL-DK1 (COBRAcable), the distribution of the reductions across these borders should comply with the following principles/conditions:

- Non-discrimination: both bidding zone borders should be treated on an equal footing;
- Comply with obligatory minimum capacity margins available for cross-zonal trade (MACZT) of 70%
- Not reduce social welfare more than necessary.

Also, the alternative option should meet the following criteria:

- The effort required for the implementation is reasonable in comparison to the infrequent occurrence of NTC reductions. Given that NTC reductions are not happening on a structural basis and only in particular circumstances, and that per 2023 the need for NTC reductions will decrease due to grid investments , a costly and/or resource-consuming implementation does not seem justified.
- The alternative option is not error prone.
- The alternative option is understandable and transparent.
- There is broad acceptance with stakeholders for this alternative solution.

5. Alternative options to distribute capacity reductions between NorNed and COBRAcable

TenneT has identified two main alternative options for the distribution of capacity reductions between NorNed and COBRAcable:

1. Distribute reductions based on forecasted price spreads;
2. Implement a sum capacity restriction in capacity allocation.

Both these main alternative options can be broken down in several implementation options. Figure 6 gives an overview of the identified main and implementation options.

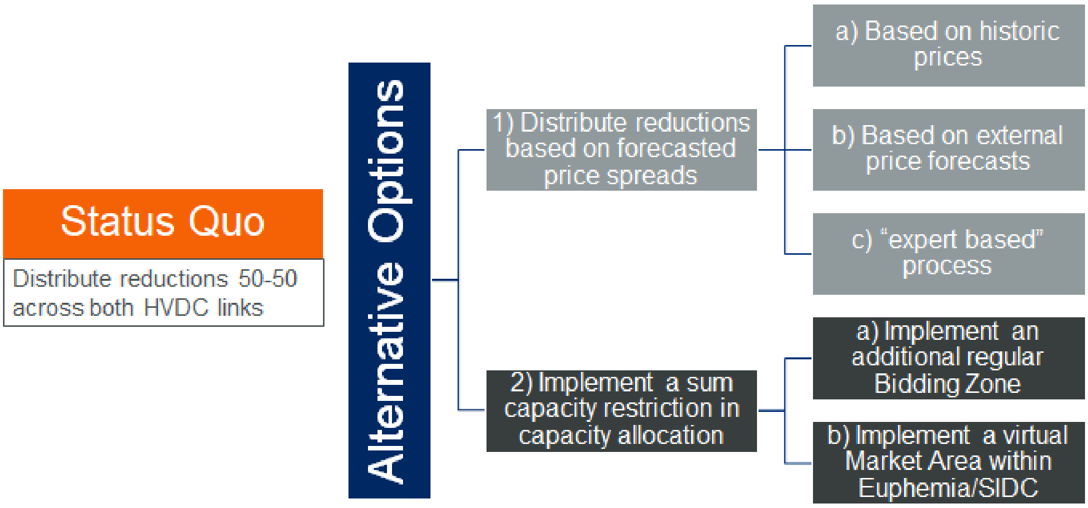


Figure 6: Overview of alternative options for distributing capacity reductions between NorNed and COBRAcable

Next to these two options, another option was evaluated: the use of virtual hubs, which are to be introduced in the future by Advanced Hybrid Coupling in the Core and Hansa capacity calculation region (CCR). The previous understanding of both TenneT and ACM was that this would provide an alternative option for distributing capacity reductions between NorNed and COBRAcable, which is why an interim period until the go-live of Advanced Hybrid Coupling was specified in ACM's request for this assignment. However, during the execution of this assignment it was concluded that this was actually not a valid option for the purpose of distributing capacity reductions and had to be discarded. More information on this, is included in section 5.3.

In the following sections these options are briefly described. For each option a general explanation and an overview of the most important upsides and downsides is given. A more detailed explanation of the implementation of the options including identified potential issues and uncertainties is included in section 6. A final evaluation summarising the upsides, downsides, potential issues/uncertainties and the implementation effort of each option is then included in section 7.

5.1 Distribute NTC reductions based on forecasted price spreads

One of the alternatives could be to distribute NTC reductions based on forecasted price spreads to determine what ratio for the reduction will lead to the least social welfare effects.

Generally, the welfare is impacted the least when reductions are applied on the bidding zone border with the lowest price spread. Based on forecasted day-ahead price spreads between the different bidding zones, the necessary NTC reductions can then firstly/mostly be placed on the bidding zone border with the expected lowest price spread as this would impact social welfare the least.

In principle there are several possibilities for how a forecast of the price spreads could be established:

a) A **process**, where the forecast is **based on historical data** of BZB price spreads (e.g. the average price spread on this price forecast);
b) **Procuring price forecasts** for NL, DK1 and NO2 from an external service provider, and basing the reduction on this price forecast; or
c) A more **'expert based' process**, where a forecast is based not only historical data, but also based on other information such as (un)expected outages of power plants, gird elements, weather expectation etc.

The time required to implement this option depends on the implementation chosen. In case of option c), it is expected that it will take time to develop and test the process to identify and optimise the various parameters to obtain a reliable price forecast. In case of option b), implementation may go relatively quickly as this only requires to transform price forecasts into a ratio. Implementation time of option a) will be somewhere in between the two other options.

<u>Upsides and downsides</u>

The major upsides of this option are

1. It seems a fairly straightforward way to minimize detrimental impact of reductions on social welfare
2. It can be implemented by TenneT individually, without a need for adjustment to common systems with other TSOs or the NEMOs.
3. Depending on the implementation chosen, it might be relatively easy to implement it.

However, there are also some specific downsides and risks to this approach:

1. Forecast errors could lead to situations that social welfare is impacted even more compared to the status quo situation of applying 50-50 reductions.
2. It is unclear whether this approach complies with the principle of non-discrimination
3. There are certain limitations in the amount of 'freedom' to allocate reductions if the MACZT target of 70% is to be respected for both borders (see section 6.1.4).

5.2 Implement a sum capacity restriction in capacity allocation bidding zone borders

An alternative to reducing capacity per interconnector – as is currently done when necessary to respect operational security limits - is to apply an allocation constraint during the capacity allocation stage based on which the total simultaneous import or export of both interconnectors together is limited to the extent necessary to respect operational security limits.

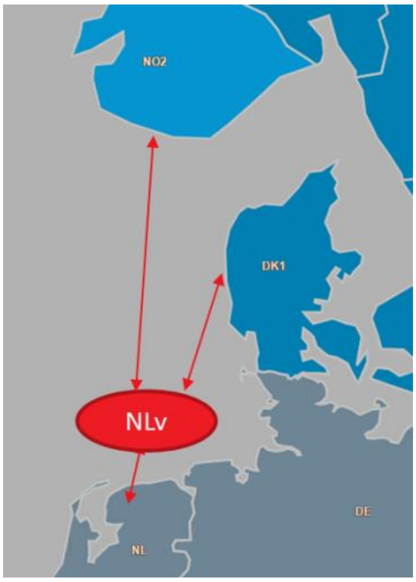
The general idea is that using an allocation constraint in the capacity allocation stage is a more fundamental solution to minimise welfare effects. This is so because during the allocation stage, the day-ahead and intraday market coupling algorithms can determine the 'welfare optimal' ratio for the reductions based on the actual buy and sell orders. The market coupling algorithms will then allocate the available sum capacity to the bidding zone border(s) where it creates most welfare.

Two options have been identified on how a sum capacity restriction could be implemented during capacity allocation:

a) Implement an additional 'regular' Bidding Zone
b) Implement a Virtual Market Area in SDAC/SIDC

For the purpose of applying a sum restriction, both solutions would lead to the same result. However, the major difference between these two options is that:

a) A Bidding Zone would have an actual net position with a price. A virtual market area would not have a net position nor a price, and would simply be linked to an existing Bidding Zone.
b) A Bidding Zone would be visible in all systems and publications (e.g. EE transparency platform) while a virtual market area would be implemented more 'behind the scenes' in the market coupling algorithms.



For the sake of convenience, hereafter both the additional 'regular' Bidding Zone and Virtual Market Area implementation options will be referred to as 'hub'.

<u>Explanation of the solution</u>

In both solutions, a new hub (NLv) would be placed 'in between' the Dutch Bidding Zone (NL) and the interconnectors NorNed and COBRAcable, and the price of this bidding zone would be set equal to the price of the bidding zone NL.

This would lead to the following new bidding zone borders:

- NL-NLv (new)
- NLv-NO2[7] (replacing NL-NO2)
- NLv-DK1 (replacing NL-DK1)

[7] Statnett is working on the implementation of a virtual market area 'NO2A' to be implemented on the DC interconnectors connected to bidding zone NO2 per mid-November. For sake of simplicity, this note still refers to NO2 as the bidding zone to which the NorNed interconnector connects.

Now in situations where reductions are required, TenneT would no longer place these reductions on the interconnectors directly, but on the border connecting the bidding zone NL with the new hub. The capacity between the bidding zone NL and the new hub would then be set at the level of the maximum possible infeed or outflow on both interconnectors simultaneously. An example of a situation with reductions compared to the capacity in a regular situation is given in Table 1.

Table 1: Example of NTC capacities with a new hub for regular situations without reductions compared to a situation where a sum capacity restriction would be applied.

Border	Regular situation	Situation with a sum capacity restriction
NLv-NO2[8]	723 MW	723 MW**Error! Bookmark not defined.**
NLv-DK1	700 MW	700 MW
NL-NLv	≥1423 MW (i.e. NLv-NO2 + NLv-DK1)	The level that can at maximum be imported/ exported via the interconnectors. (e.g. 1000 MW)

An additional upside of applying a sum restriction compared to applying NTC reductions on the interconnectors themselves, is that these allow for a market coupling outcome where one of the interconnectors is on full import to NL, while the other is on full export from NL. In this case the net infeed/outflow to NL is zero – and thus stays below the sum restriction – while still using the interconnectors to their full extent.

Statnett is already working on the implementation of a virtual market area ‘NO2A’. This area is to be implemented on the DC interconnectors, including NorNed, connected to bidding zone NO2. This area would fulfil a comparable function to the zone NLv, but Statnett announced that the purpose is rather to apply ramping restrictions on all DC links together, instead of applying a sum restriction.

In order to implement a bidding zone or a Virtual Market Area several changes in configuration need to happen on internal IT systems of TenneT (and potentially Statnett and Energinet), as well as several common IT-systems of the TSOs and NEMOs such as for CCR Core, CCR Hansa, SDAC and SIDC.

<u>Upsides and downsides</u>

This option carries several upsides:

1. It takes social welfare aspects fully into account and is not error prone.
2. It allows for imports on one bidding zone border in combination with exports on the other bidding zone border, allowing more possibilities for the market coupling to optimise social welfare.
3. The interconnectors are treated on an equal footing and therefore this option complies with the principle of non-discrimination. They both face the same sum restriction on NL-NLv

[8] Because of implicit loss handling, on the 700 MW NorNed cable for the day-ahead and intraday market a NTC of 723 MW is offered based on a loss factor of 3.2%. If allocated, the ‘excess’ of 23 MW is used to compensate for the losses across the cable.

However, the approach also carries some downsides:

1. The implementation will not be straightforward and is expected to require considerable time and effort. This because the implementation will affect not only TenneT internal systems and processes, but also requires changes to common IT systems of the TSOs and NEMOs such as for CCR Core, CCR Hansa, SDAC and SIDC. The implementation, therefore, cannot be done by TenneT individually but will have to be coordinated with other TSOs and the NEMOs.
2. There might be some unintended consequences on congestion income distribution (see section 6.4.3)

5.3 Discarded option: Wait for the future introduction of Advanced Hybrid Coupling

Another option that was considered by TenneT was to continue the current practice to distribute reductions equally to both bidding zone borders, where each gets half of the reduction, until the implementation of virtual hubs for Advanced Hybrid Coupling (AHC). It was believed that these virtual hubs could be used in a similar way as the introduction of a virtual bidding zone. However after further evaluation it is now understood that this would not be the case and that AHC would not allow for an improved distribution of reductions for NorNed and COBRAcable.

For the sake of completeness, the theory is retained so as to provide an explanation why Advanced Hybrid Coupling has been discarded as solution.

<u>Explanation</u>

Hybrid coupling refers to the combined use of Flow-Based (FB) and Available Transmission Capacity (ATC) constraints in one single allocation mechanism, and is found in the shapes of “Standard” and “Advanced”. Currently, on NorNed and COBRAcable "standard Hybrid Coupling" is applied, but the target as set by the Hansa and Core DA CCM is to in the future introduce the so called Advanced Hybrid Coupling for these borders.

Advanced Hybrid Coupling (AHC) facilitates competition for the use of the scarce capacities of critical network elements with contingency (CNEC) that shall be made available for the cross-CCR exchanges and the intra-CCR exchanges in the day-ahead market coupling. The AHC ensures that no priority access to the scarce CNEC capacity is given to any relevant exchanges. Besides providing a non-discriminatory access to the scarce capacity, the expectation is that Flow-Based DA MC will benefit from the implementation of AHC in socio-economic welfare terms as well.

It is foreseen that in order to implement Advanced Hybrid Coupling, virtual hubs will be introduced, in a comparable way as that virtual hubs have been introduced in CWE FB DA CC for the inclusion of the HVDC ALEGrO interconnector between Belgium and Germany. The virtual hubs then allow to model the flows across the HVDC cables with Flow-Based parameters.

It was believed that these virtual hubs would allow for the same approach as described within the previous option, where a sum restriction can be applied on the capacity between NL-NLv to accommodate for necessary capacity reductions. However, because of the following reasons it was concluded that this is not possible:

- With AHC the HVDC borders would not be grouped to a single virtual hub, but each HVDC border would get its own virtual hub. Therefore sum reductions would not be possible.
- The virtual hubs as used for Advanced Hybrid Coupling are only used within a CCR

Because of these limitations, TenneT eventually concluded that Advanced Hybrid Coupling is not a solution which enables an alternative distribution of reductions on both bidding zone borders.

6. Implementation of the options

In this section, a more detailed evaluation of the implementation of each of the options is given. Also, potential issues and uncertainties for each option are included in this section.

6.1 Option 1: Distribute NTC reductions based on forecasted price spreads

This approach would require the development of a methodology to set a ratio for the NTC distribution between Cobra and NorNed depending on the expected price spread and the level of certainty of the predictions. For the day-ahead market, such predictions have to be made before D-1 9.30/10h to be able to take the adjusted capacity into account in the day-ahead market coupling. In case NTC reductions on NorNed & Cobra are applied during the intraday timeframe, the same ratio as established on D-1 could be used or an alternative ratio could be determined on D-1 between closure of the day-ahead market and the publication of the available cross-zonal capacity for the continuous intraday market / future cross-border intraday auctions.

During the week-ahead grid security assessment, a ratio would be determined for how the reductions, if any, would be distributed over both interconnectors. The output to operation would then be a reduction of X MW on NorNed and Y MW on COBRAcable (as it is now). Therefore, implementation should be a standalone tool, which would have limited impact on operations and does not require changes to internal IT systems, or common systems with NEMOs or other TSOs.

6.1.1 Option 1(a) based on historic prices

To implement a price forecast based on historical prices a script would be needed, for example in Excel, which makes use of historical data and translates this into a ratio. The input of market data to update the script would likely need to be done manually.

It is expected that some testing and calibration is required to determine what period of data is representative for the ‘near future’ and minimises forecast errors.

6.1.2 Option 1(b) based on price forecasts

For this option, It is assumed a service provider is able to provide price forecasts for the NL, NO2 and DK1 bidding zones, or price forecasts on the bidding zone borders NL-NO2 and NL-DK1. This data would become available to TenneT without creating a direct interface to the TenneT internal systems (e.g. via an. external website and/or email, etc).

This data then still needs to be processed into a ratio for reductions across both bidding zone borders. TenneT would need to develop this process, where based on a flow diagram or script in excel the external price forecasts are transformed into such a ratio. Manual efforts in operation would be to login to the site of the external service provider to look at price forecasts there and manual inputting these to the flow diagram/script in order to get to a ratio for the distribution.

6.1.3 Option 1(c) Expert based

Implementation would require a combination of making use of historic data (option 1(a)) with other qualitative data to forecast what BZB is expected to have the highest price spread. A script would need to be manually updated with Market data and qualitative data would need to be gathered and assessed as to whether it would give rise to adjust the outcome of the script.

6.2 Potential issues and uncertainties on option 1

For option 1, two potential issues and uncertainties have been identified.

6.2.1 Compliance with principle of non-discrimination

As set out in the basic principles of section 4, the alternative solutions should comply with the principle of non-discrimination meaning that both bidding zone borders should be treated on an equal footing.

The status quo of distributing reductions 50-50 to both interconnectors, is considered a non-discriminatory approach. To TenneT, it is not fully clear on whether distributing reductions on the basis of price forecasts can also be regarded as a non-discriminatory approach. Most likely, this depends very much to what extent the process behind determining the ratio to distribute the reductions is objective, reproducible and based purely on given input data, or whether manual efforts and individual personal estimates are involved behind making the price forecasts and the resulting distribution ratio. From this perspective, option 1(a) is most likely to be regarded as non-discriminatory as this is purely based on publicly available historic prices, followed by option 1(b) and option 1(c) as least likely.

TenneT would welcome guidance from ACM on whether distributing NTC reductions on the basis of forecasted price spreads would be regarded as a non-discriminatory approach and/or what conditions would need to be fulfilled to regard it as a non-discriminatory approach.

6.2.2 Limitations related to obligations on making at minimum 70% capacity available for cross zonal trade

In accordance with the Electricity Regulation article 16(8) TenneT needs to make at least 70% of the transmission capacity of NorNed and COBRAcable available for cross-zonal trade, while respecting operational security limits. This means that in principle, reductions to values below 70% of the nominal capacity of the interconnectors have to be avoided, unless these are required to respect operational security limits.

This obligation brings certain limitations in the amount of 'freedom' to distribute NTC reductions if the MACZT target of 70% is to be respected for both borders. In practice, when the 700 MW interconnectors are fully available respecting the 70% target means that the NTC on NL-DK1 and NL-NO2 cannot be reduced to values lower than 490 MW (i.e. 70% * 700 MW)[9]. This means that if the 70% minimum is to be respected, a maximum reduction of 210 MW (700-490 MW) on the bidding zone border can take place.

[9] For the sake of simplicity, we ignore the fact that because of implicit loss handling on the NorNed interconnector, in practice the NTC on NL-NO2 is raised with 3.2% to 723 MW take into account the losses on the interconnector.

Error! Reference source not found. summarises the limitations incurred by the 70% MACZT obligation.

Table 2: Summary of limitations on how NTC reductions can be distributed on NL-NO2 and NL-DK1 if the 70% MACZT target is to be respected, if reductions are applied on the bidding zone borders directly.

Amount of reduction	Limitations if reductions are applied on NL-NO2 and NL-DK1 directly based on forecasted price spreads
1-210 MW	No limitations. Reductions can be distributed to both BZBs without impacting MACZT compliance. Therefore, in principle full freedom to determine the ratio of NTC reductions across both BZBs.
211-420 MW	Limitations apply. One BZB can at maximum be reduced with 210 MW (i.e. the 70% MACZT level), the remaining part of the reduction would then have to be assigned to the other BZB. The maximum amount of reduction which still complies with 70% target for both interconnectors, being 420 MW, would de facto be distributed 50-50 across both BZBs just as in the status quo.
421-910 MW	Limitations apply. In this range, it is not possible to respect the 70% MACZT target for both interconnectors. However, by limiting the reduction on one of the BZBs to, at maximum 210 MW, the 70% MACZT obligation for this BZB could still be respected. Therefore, in this range the outcome will be that the BZB with the highest forecasted price spread would be reduced with 210 MW, and the remaining part of the reduction will be applied on the other bidding zone border.
>910MW	No limitations. For such amount of reductions, for none of the BZBs the 70% MACZT target can be respected. Therefore, in this case the 70% MACZT target does not hinder the possibility to determine the ratio of NTC reductions across both BZBs.

This table makes it clear that for certain amounts of reduction, the reductions can be distributed to both BZBs in a way which enables to stay above 70% on at least one of the borders. However, this might conflict with a potential outcome of price spread forecasts that from welfare perspective it would be better to assign NTC reductions solely to one of the bidding zone borders.[10] Therefore, the 70% MACZT target will hinder the potential effectiveness of the welfare optimization based on price spread forecasts.

These limitations do not apply for the implementation where reductions would be applied on the basis of a sum capacity restriction on a border NL-NLv between the bidding zone NL and a new hub NLv (option 2). For this implementation, the general understanding is that border NL-NLv should get a minimum NTC of 980 MW (70% * (700 + 700)) to respect the 70% MACZT target. Reductions of more than 420 MW would be considered as not respecting the 70% MACZT target for the border NL-NLv.

[10] Example: Suppose the simultaneous inflow of both interconnectors has to be limited from 1400 MW to 1000 MW, thus meaning a reduction of 400 MW on both interconnectors together. If this reduction would be applied fully to a single interconnector (with the lowest expected price spread) that interconnector would not comply with the 70% target (700-400)/700 = 43%). If instead the reduction would be applied as 210 MW on one interconnector and 190 MW on the other, the interconnectors would reach MACZT levels of 70% ((700-210)/700) and 73% ((700-190)/700) respectively, which would comply. From MACZT compliance point of view, the latter case would have to be selected.

6.3 Option 2: Implement a sum capacity restriction in capacity allocation bidding zone borders

In section 5.2, two possibilities were introduced how a sum capacity restriction could be implemented during capacity allocation:

a. Implement an additional ‘regular’ bidding zone;
b. Implement a Virtual Market Area in SDAC/SIDC.

When these options are implemented, the impact on the daily processes is fairly minimum. The only thing that operators will need to do is to enter the total available capacity for the virtual bidding zone as part of the current bilateral capacity coordination processes and future CCR Hansa processes.. However, in order to implement these options, significant changes need to happen.

In the below sections we briefly touch upon the main implementation elements of both solutions.

6.3.1 Option 2(a) – Implement an additional regular bidding zone

For this option, a new bidding zone NLv would have to be configured in between the bidding zone NL and the bidding zones NO2[7] and DK1.

In order to implement a bidding zone several changes in configuration need to happen on internal IT systems of TSOs, as well as common IT-systems of the TSOs and NEMOs. Given that bidding zones are included into almost every system of TSOs and NEMOs, a lot of systems will be impacted by this change including at least systems SDAC, SIDC, CCR Hansa and CCR Core.

For all these systems, there are strict change processes with extensive testing (to minimise risks on issues and decoupling) and also a full pipeline of upcoming changes which likely qualify as having a higher priority. Here, TenneT strongly depends on the willingness and cooperation of the TSOs and NEMOs to implement an additional bidding zone.

On top of that, there are also other aspects and systems to be taken into account, such as changes to the ENTSO-E transparency platform in order to make it possible to transparently report on the capacity to / from the new bidding zone.

All in all, the implementation of a regular bidding zone is expected to require a considerable effort for many parties and probably does not fit the timeline as set in the scope of this report.

6.3.2 Option 2(b) – Implement a virtual market area

Just as for the implementation of a regular bidding zone, several changes in configuration need to happen on internal IT systems of TSOs, as well as common IT-systems of the TSOs and NEMOs. However, in general it is expected that these changes are significantly less than for the implementation of a regular bidding zone. Most likely the changes would be limited to the internal systems of TenneT, Statnett and Energinet, to the ENTSO-Transparency platform and to the market coupling systems of SDAC and SIDC, but do not require (significant) changes to systems of CCR Core and CCR Hansa. Still, we expect that TSOs and NEMOs are not willing to change things in advance of the go-live of day-ahead and intraday capacity calculation in CCR Hansa currently estimated for end of 2022.

SDAC and SIDC already contain the possibility to configure virtual market areas just as will be used for the upcoming virtual market area NO2a. However, at this point in time it is not yet possible in SIDC to connect to virtual market areas directly together. This has been identified as a change to be made to the SIDC systems, and is expected to go live per Q2/Q3 2022.

6.4 Potential issues and uncertainties on option 2

While performing the more in-depth assessment of how these options could be implemented, also some potential issues and uncertainties have been identified.

6.4.1 Conflict with regulatory provisions governing bidding zone reconfigurations

Regarding option 2a, implementing an additional bidding zone, it is unclear from a regulatory perspective whether TenneT is actually allowed to implement an additional bidding zone, without performing a bidding zone review. In principal, the electricity regulation requires to study alternative bidding zone configurations to determine whether there is a structural congestion and whether that is effectively mitigated by creating a different bidding zone configuration. Based on the results to date, the congestions leading to the applications of reductions are not structural but are related to planned and unplanned outages (see section 3 and section 6.3 of the NL MACZT monitoring report). Therefore, these congestions do not qualify as structural congestions and as such are no legal basis to go forward with adjusting the bidding zone configuration and without executing a bidding zone review.

Also, it is questionable whether TenneT could go forward with adjusting the bidding zone configuration without a decision of the Dutch State and potentially other neighbouring Member States, in particular Denmark and Norway since it directly affects their bidding zone borders. This because the competence to decide on bidding zone configuration lies with Member States, and not with TSOs.

Both elements create major uncertainty on whether implementing a plain bidding zone is the best way to address these reductions. Therefore, TenneT has some significant concerns on whether from regulatory perspective the implementation of an additional bidding zone is actually a valid option. In any case, it does not fit to the time frame in scope of this study (2022-2023).

6.4.2 Potential conflicts with limitations on allocation constraints as included in CCR Hansa and CCR Core

The application of allocation constraints is severely limited by the Capacity Calculation Methodologies of CCR Hansa and CCR Core, which do not contain clear provisions based on which sum restriction could be applied. Therefore, it is unclear whether TenneT is actually allowed to apply allocation constraints for this purpose or whether first justifications have to be provided and be approved by the relevant NRAs or ACER before such allocation constraints can be taken in operation. Potentially, the capacity calculation methodologies would have to be adjusted before TenneT is allowed to apply such allocation constraints. In case of the latter, this would seriously impact the timeline for implementing this solution.

6.4.3 Potential effects on congestion income distribution

The introduction of a new border NL-NLv might potentially impact the congestion income distribution amongst TenneT, Statnett and Energinet.

In case of price divergence between NL and NO2 and/or DK1 during the application of sum restrictions, the market coupling algorithm will most likely establish that the border NL-NLv has been the limiting element.

- In case of a the application of virtual market area, the price in NLv will be linked to the price in NL. This would mean that although the border NL-NLv has become limiting, no congestion income is awarded to this border because there is no price spread across this border. In this case, the congestion income is awarded ‘as normal’ to the borders NLv-NO2 and NLv-DK1 and distributed between TenneT, Statnett and Energinet.
- In case of a separate bidding zone however, the price in NLv can differ from the price in NL. In such situations, the price the price of NLv should in principle converge towards the price in NO2[11] or DK1 as either NorNed or COBRAcable is then not fully used and therefore not congested. As result some congestion income would then be attributed to the border NL-NLv, which would then in principle be collected by TenneT only.

6.4.4 Potential conflict with go-live of CCR Hansa

As mentioned before there are strict change processes for TSO and NEMO systems with extensive testing procedures (to minimise risks on issues and decoupling). Also, all these systems face a full pipeline of upcoming changes where TSOs and NEMOs determine what change gets highest priority.

When it comes to adjustment of IT systems, in particular we expect that TSOs and NEMOs are not willing to implement a bidding zone or virtual market area in advance of the go-live of day-ahead and intraday capacity calculation in CCR Hansa (currently estimated for end of 2022), as this could endanger the go-live. Therefore, solution 2a and 2b can probably not be implemented before 2023.

The implementation of option 1, to distribute NTC reductions based on forecasted price spreads, would not be in conflict with a go-live of CCR Hansa

[11] Because of implicit losses handling on NorNed, likely never full price convergence with the NO2 price will occur.

7. Evaluation of the options

The two options have been evaluated against the basic principles and conditions as listed in section 4. A summary of the evaluation can be found in the tables below.

7.1 Summary of Option 1

	a) historic prices	b) price forecasts	c) expert based
Upsides	• No changes required to SDAC/SIDC or TSO (IT) systems required. Implementable via separate tool/process outside operational environment		
	• Straightforward approach; historical data available	• Takes also actual and near future situations impacting electricity prices into account • Likely less error prone than using only historic prices	• Likely better than just using historical prices, but probably not as good as external price forecasts (if available)
Down Sides	• Might be error prone	• No service provider identified yet that could provide such price forecasts •	• More manual effort, without certainty that this significantly improves the quality of the price spread forecasts (in particular if over the year different persons will be making the forecasts.)
Potential issues / uncertainties	• There are limitations in the amount of 'freedom' to distribute NTC reductions across both bidding zone borders if the 70% MACZT target of 70% is to be respected insofar possible		
	• Would this be sufficient reliable / sufficient error prone?	• Unclear whether such price forecast are available at the time when reductions are determined (week-ahead), and at what cost • Doubtful that this complies with non-discrimination criteria (if forecast not publicly available)	• Doubtful that this complies with non-discrimination criteria

Implementation Effort	• Establish method to process historical price spreads into a ratio for the NTC distribution • Requires some calibration to determine what period of data is representative for the 'near future' and minimises forecast errors	• Establish a method to process the price forecasts into a ratio for the NTC distribution	• Establish a method to process the price forecasts into a ratio for the NTC distribution • In comparison more implementation effort required than for the other options.

7.2 Evaluation of option 2

	a) Regular Bidding Zone	b) Virtual Market Area
Upsides	• Welfare optimal allocation of available capacity • No need for TenneT to make predictions, and no risks of detrimental effects because of erroneous predictions. • Interconnectors (NorNed and COBRAcable) are treated on an equal footing and therefore this option complies with the principle of non-discrimination.	
	• Fully transparent how sum restrictions are applied	• Less intrusive and impactful than a separate bidding zone, working more 'behind the scenes' of the market coupling algorithm
Down Sides	• A Bidding zone border NL-NLv would not reflect the place of congestion in the grid which would be the cause for restricted capacity	• Perhaps less transparent than a regular bidding zone • Not yet possible in SIDC to connect virtual market area NLv directly to virtual market area NO2a
Potential issues / uncertainties	• The application of allocation constraints is severely limited by the capacity calculation methodologies of the CORE and Hansa CCRs, unclear whether they allow allocation constraints for this purpose and what additional reporting efforts will be required once implemented • Potential unintended consequences on congestion income distribution	
	• Is it allowed to implement a new bidding zone without a BZ review? • It is questionable whether TenneT could adjust the bidding zone configuration without an explicit decision of the Dutch State and potentially other neighbouring Member States (including Norway and Denmark) • It is conflicting with the principle that bidding zone borders are defined by structural congestions, as the congestions causing sum restrictions are not structural (see section 3)	

Implementation Effort	• Requires adjustment of CCR definition, which is a lengthy legal process • Potentially requires execution of a BZ Review process • Significant implementation effort because of impact on a lot of TSO/NEMO systems: CCR Core, CCR Hansa, SDAC, SIDC	• Less implementation effort than a regular bidding zone, but still changes required to CCR Hansa, SDAC and SIDC. • Implementation not expected to be possible before 2023 because of estimated Hansa go-live

Annex 1: List of acronyms

Abbreviation	Definition
ACM	the Dutch national regulatory Authority for Consumers and Markets
AHC	Advanced Hybrid Coupling
ATC	Available Transmission Capacity
BZ	Bidding Zone
BZB	Bidding Zone Border
CCR	Capacity Calculation Region
CNE	Critical Network Element
CNEC	Critical Network Element with contingency
DK1	The Bidding Zone DK1 in Denmark
HVDC	High-Voltage Direct Current
MACZT	Margin Available for Cross-Zonal Trade
MTU	Market Time Unit. In this report, 1 hour given that the MTU for the day-ahead market in 2020 was 1 hour.
NEMO	Nominated Electricity Market Operator
NL	(the Bidding Zone of) The Netherlands
NLv	A new hub, either as bidding zone or virtual market area, in the Netherlands, to be placed in between the Dutch Bidding Zone (NL) and the interconnectors NorNed and COBRAcable
NO2	The Bidding Zone NO2 in Norway
NTC	Net Transfer Capacity
SIDC	Single IntraDay Market Coupling
Qx	Quarter of the year, with x denoting whether it is the first (Jan-March), second (April-June), third (July-September) or fourth (October-Decmeber) quarter of the year
SDAC	Single Day-Ahead Market Coupling
TSO	Transmission System Operator