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Congestion management research

Zeeland

Foreword

This report contains the findings of the congestion management study carried out for the 150 kV constituent grid in Zeeland, including the 380/150 kV interconnection at Borssele and the 380 kV line from Borssele to Rilland. The study was conducted according to the requirements for a congestion management study as stipulated in Article 9.5 paragraph 5 of the Electricity Grid Code. This article specifies that "congestion management shall be implemented if the study shows that:

- the grid operator(s) concerned deem(s) it technically possible in terms of the grid(s) and;
- the grid operator(s) concerned deem(s) it possible in terms of operational management and;
- the period of expected structural congestion is longer than 1 year and shorter than 4 years, and;
- there are enough potential participants in the area in question to implement congestion management."

We shall elaborate on these aspects in the following chapters.

This congestion management study was conducted according to the prevailing Electricity Grid Code. In early 2017, the *Overlegtafel Energievoorziening aan Energie Nederland (*Dutch Energy Supply Round Table) asked Energie Nederland and Netbeheer Nederland to prepare a code amendment proposal that would extend the suitability of the rules for congestion management to distribution grids and better tailor them to the present context of transmission scarcity, caused mainly by the advance of sustainable generation of electricity. The proposed amendment will also give more concrete form to the testing of the concept "reasonably" in Article 24(2) of the 1998 Electricity Act; after all, there is a limit to the extent to which scarce transmission capacity can be (re)distributed using congestion management. In anticipation of the amendment being adopted, this report sets the absolute limit of the possibilities of market-based congestion management at 120% of the technical transmission capacity, taking into account the applicable grid design criteria and operational safety limits in a grid or grid section.

In late 2019, the Authority for Consumers & Markets (ACM) shared an informal report entitled "Implementation of congestion management reports", reflecting the current expectations regarding congestion management and the implementation of the associated reports in order to provide transparency to the industry. This report from the ACM has been included as a guideline.

Contents

1. Introduction

As stated in the preliminary announcement of 24 July 2020, TenneT expects structural transmission constraints on production in Zeeland. The reason for this is the connection of Offshore Wind (1400 MW) to the 380 kV Borssele substation. These wind farms have been fully operational since Q4 2020. The anticipated congestion will be a result of the demand for transmission capacity being greater than the available transmission capacity. In the congestion area mentioned, the expected simultaneous demand for transmission capacity is predicted to be 3500 MW. The total available transmission capacity is approx. 2500 MW. This production capacity includes the regional grid operator's predicted growth. Production in the congestion area of Zeeland is distributed over the 380 kV grid, 150 kV grid and the lower voltage grids. In the coming period, there will be congestion at the following locations in the grid, Figure 1-1.

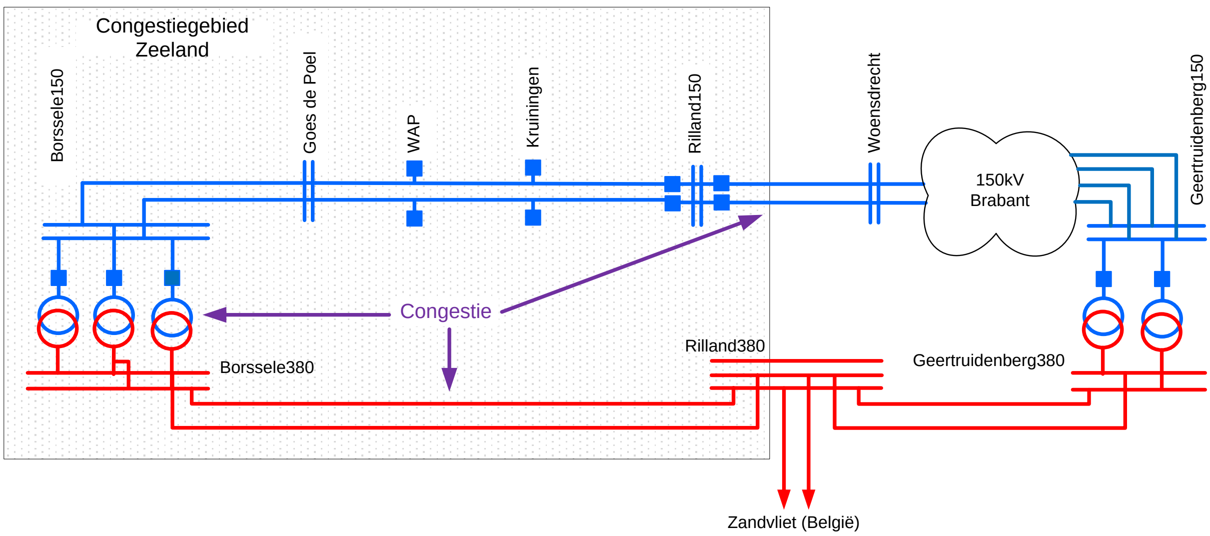

Figure 1-1 Announced congestion area of Zeeland

2. Transmission capacity analysis

2.1 Transmission capacity currently available

The 150 kV grids in Zeeland and North Brabant are operated together. In addition, Zeeland's 150 kV grid is connected to the 380 kV grid in Borssele and North Brabant's 380 kV in Geertruidenberg and Eindhoven. Owing to the inadequate short-circuit resistance of the Borssele 150-kV substation, only two of the three 380/150 kV transformers can be deployed there simultaneously.

The available transmission capacity is shown in Table 2-1, which lists the grid links limiting the section of the grid referred to in the introduction. The available capacity takes into account the legally binding safety margins and seasonal limits.

Table 2-1 Available transmission capacity

Grid link (lines, transformers etc.)	Available capacity, summer value (MVA)	Available capacity, winter value (MVA)
380 kV Borssele – Rilland	2x 1645*	2x 2040*
380 kV Borssele transformers	2x 500	2x 500
150 kV Rilland-Woensdrecht	2x 312	2x 343

*Dynamic Line Rating is used on this line, which means, depending on the weather conditions, that a higher transmission capacity is available than the one stated.

2.2 Development of relevant measures

Table 2-2 lists ongoing projects and planned measures to increase available transmission capacity.

Table 2-2 Planned measures to increase available transmission capacity

Network link to be upgraded (lines, transformers, etc.)	Putting in operation	Planned available capacity, summer value [MVA]	Planned available capacity, winter value [MVA]
3rd Transformer Borssele, parallel	Q3/Q4 2021	3x 500	3x 500
2 Rilland transformers	Q3 2022	2x 500	2x 500
380 kV line between Borssele and Rilland (South West-West)	Q2 2023	2x 2635	2x 2635

2.3 Current and expected load on the relevant grid links

2020 situation with interconnected 150 kV line between Zeeland and Brabant

In the 2020 grid situation, only two of the three transformers in Borssele can be used simultaneously due to a short-circuit problem in the Borssele 150 kV substation.
The short-circuit problem will be resolved in Q3/Q4 2021, after which we will also be able to use the 3rd transformer simultaneously. Until then, we need to take account of a closed 150 kV interconnection between

Zeeland and Brabant.

This leads to overloads of around 40% on the 150 kV interconnection between Zeeland and North Brabant. Figure 2-1 shows overloads on the 150 kV interconnection. In this situation, the transformers in Borssele and the 380-kV line from Borssele to Rilland are not overloaded.

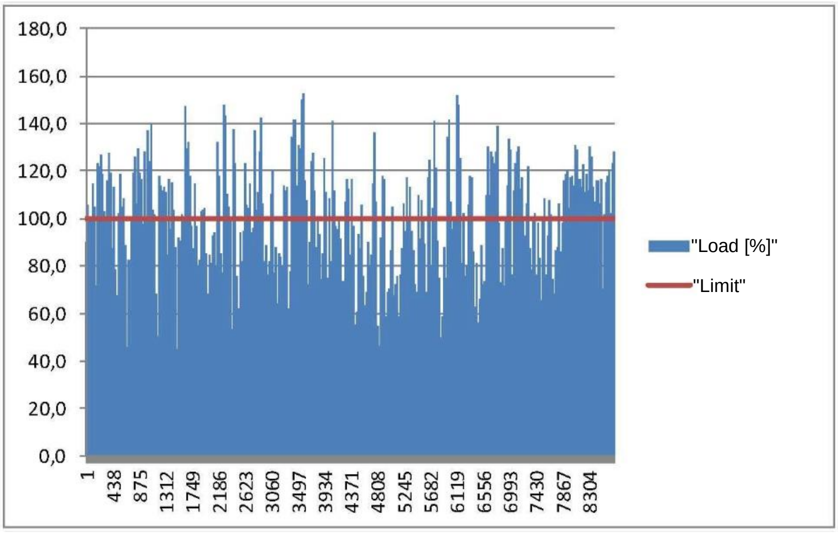

Figure 2-1 Relative load on Rilland150–Woensdrecht with closed 150 kV interconnection (market analysis for 2020)

In order to eliminate the overload, production must be regulated downwards in the 150 kV grid. As a result of the meshed network structure, up to three times more production capacity in the 150 kV grid needs to be adjusted downwards than the extent of the overload. This is caused by the fact that some of the power generation connected to the 380 kV grid finds its way over the 150 kV grid. This means that, in the event of a 40% overload, there will need to be a downward regulation of 375 MW production in the 150 kV grid and/or the downstream grids.

The situation with closed 150 kV interconnection will result in the following congestion in 2020 and total congestion on an annual basis, Table 2-3.

Table 2-3 Congestion in MWh/year with closed 150 kV interconnection

	Redispatch based on Zeeland / Brabant being interconnected (factor 3)
Volume [MWh]	
Redispatch summer	124,574
Redispatch winter	61,023
Redispatch per year	185,597

Situation from Q3 2021 onwards with opened 150 kV line between Zeeland and Brabant
From late 2021 onwards, it will be possible to deploy 3 transformers simultaneously and open the 150 kV interconnection. Consequently, the total surplus of production in the 150 kV grid in Zeeland will be transmitted to the 380 kV grid via Borssele. The opened 150 kV interconnection will create a radial grid structure and with it a 1-to-1 ratio between the required overload reduction and the production that has to be adjusted downwards.

With 3 coupling transformers in Borssele in operation and an opened 150 kV interconnection, congestion will occur on the 380 kV Borssele-Rilland connection, as shown in Figure 2-2.

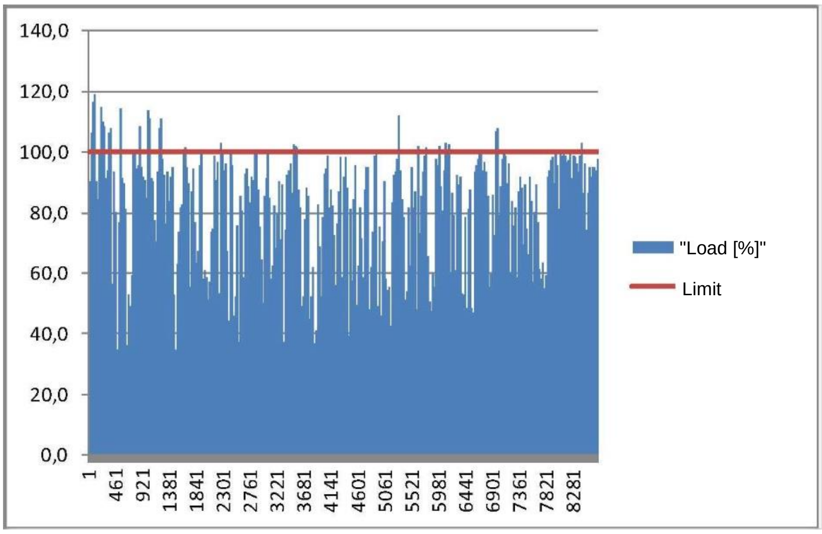

Figure 2-2 Relative load on Borssele-Rilland380 with opened 150 kV Zeeland-Brabant interconnection (market analysis for 2020)

The annual volume of congestion is much lower than in the case where the interconnection is closed, see Table 2-4.

Table 2-4 Congestion Borssele-Rilland380 in MWh per year with opened 150 kV interconnection (market analysis for 2020)

	Redispatch (factor 1 for 380 kV) [MWh]
Volume [MWh]	
Redispatch summer	2,437
Redispatch winter	10,956
Redispatch per year	13,393

This congestion can be resolved by using downward regulation of production, in which case all production in Zeeland contributes 1-to-1 to resolving the congestion, regardless of the voltage level to which it is connected. In the case of the highest overrun percentage, the transmission of 475 MW of production must be restricted regardless of the grid section into which the production is connected.

Situation in Q3 2021 – Q3 2022 without 380/150 kV transformers in Rilland

If the grid situation remains unchanged, congestion will increase as a result of the growth in renewable power generation in Zeeland, mainly in the Enduris grids. Not only on the 380 kV line, but also on the transformers in Borssele. Based on the market analysis for 2025, the following overloads will occur on the line and the transformers respectively, Figure 2-3 and Figure 2-4.

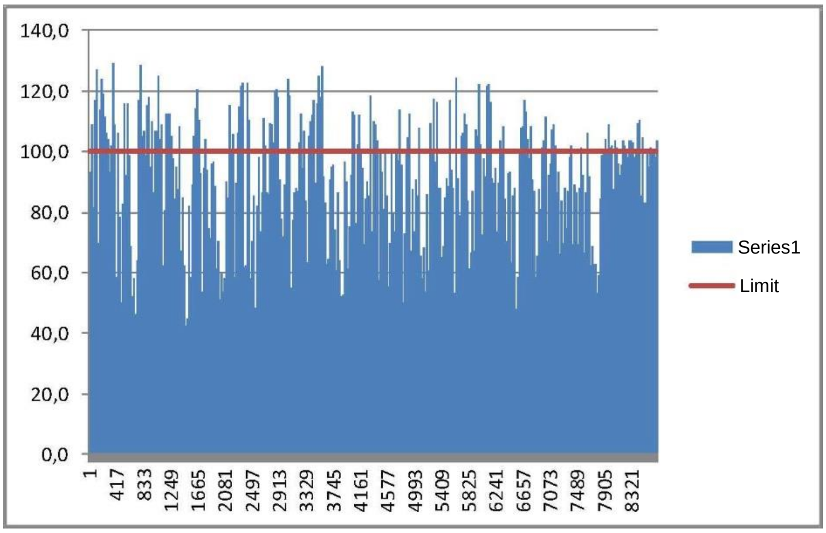

Figure 2-3 Relative load on Borssele-Rilland380 with opened 150 kV Zeeland-Brabant interconnection (market analysis for 2025)

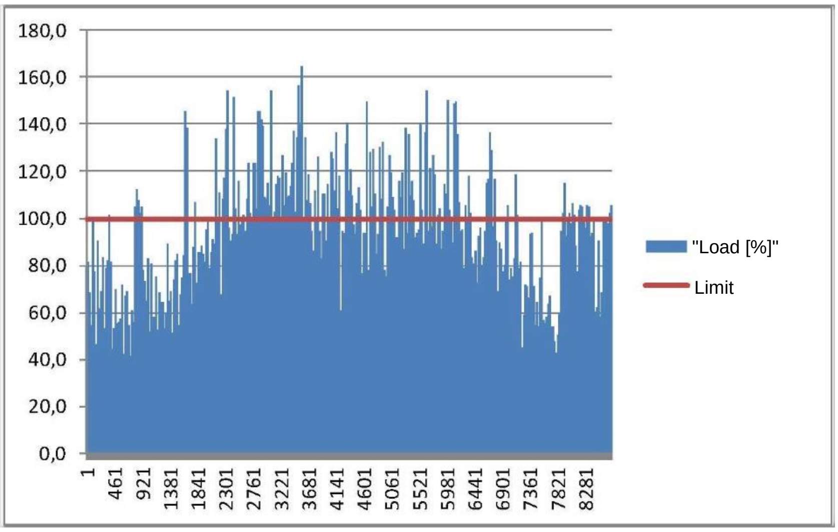

Figure 2-4 Relative load on Borssele transformers with opened 150 kV interconnection (market analysis for 2025)

Table 2-5 shows the corresponding annual congestion. This is calculated by taking the highest congestion in MW at the hours when congestion simultaneously occurs on the Borssele-Rilland connection or the transformers at Borssele.

Table 2-5 Congestion on 380 kV line or on transformers when 150 kV interconnection is opened (market analysis for 2025)

	Redispatch (factor 1 for 380 kV) [MWh]
Volume [MWh]	
Redispatch summer	118,082
Redispatch winter	45,020
Redispatch per year	163,102

Situation in Q3 2022 – Q2 2023 with 380/150 kV transformers in Rilland

Congestion of the above extent will be avoided by the installation of two 380/150 kV transformers in Rilland, scheduled for Q3 2022. Additionally, a second grid opening will be made in the 150 kV Goes de Poel substation and a grid configuration as shown in Figure 2-5 will be created.

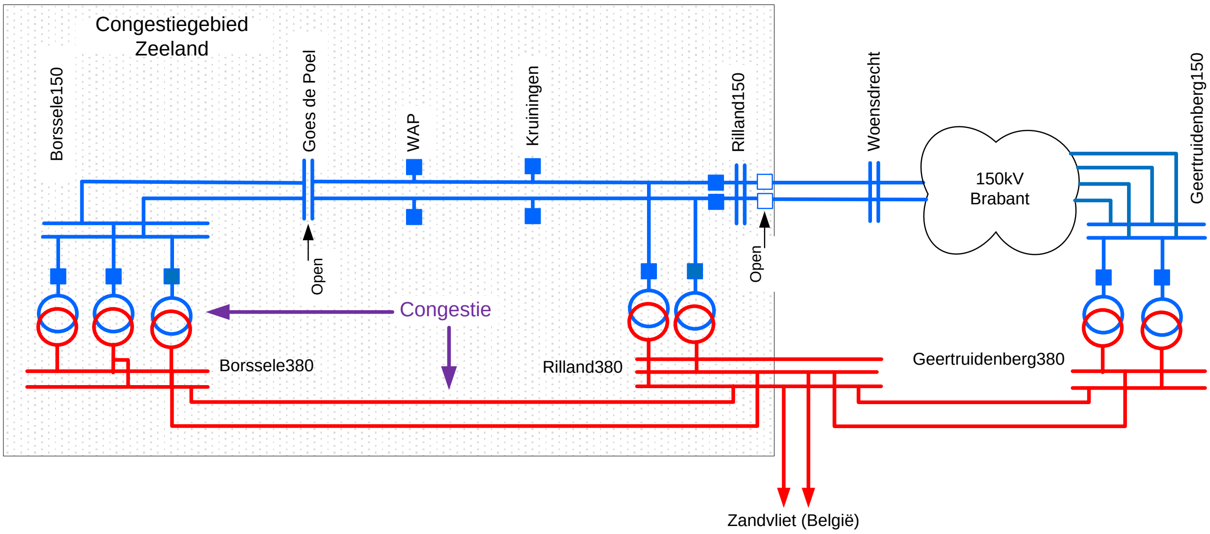

Figure 2-5 Planned grid configuration in Zeeland in Q3 2022 with a separate 'Rilland' constituent grid.

This will reduce the overload on the transformers in Borssele and the 380 kV line. Figure 2-6 and Figure 2-7 show the relative loads from the market analysis for 2025, assuming the installation of the two transformers in Rilland.

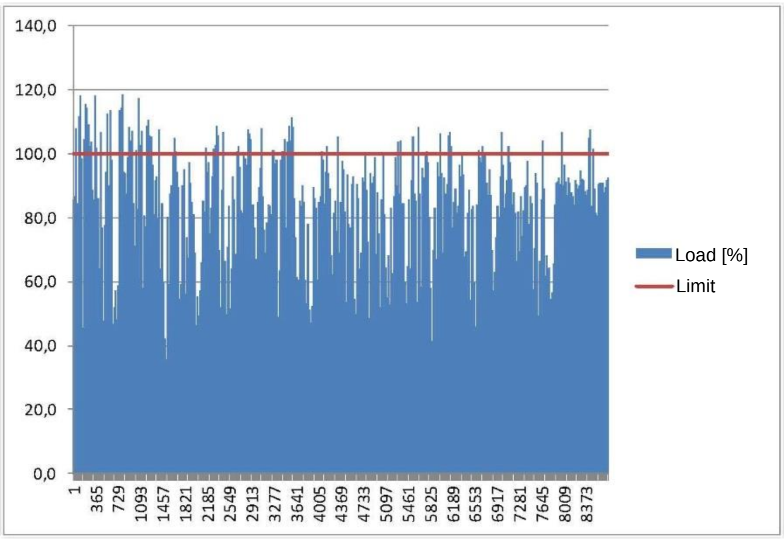

Figure 2-6 Relative load on Borssele-Rilland380 with a Rilland constituent grid (market analysis for 2025)

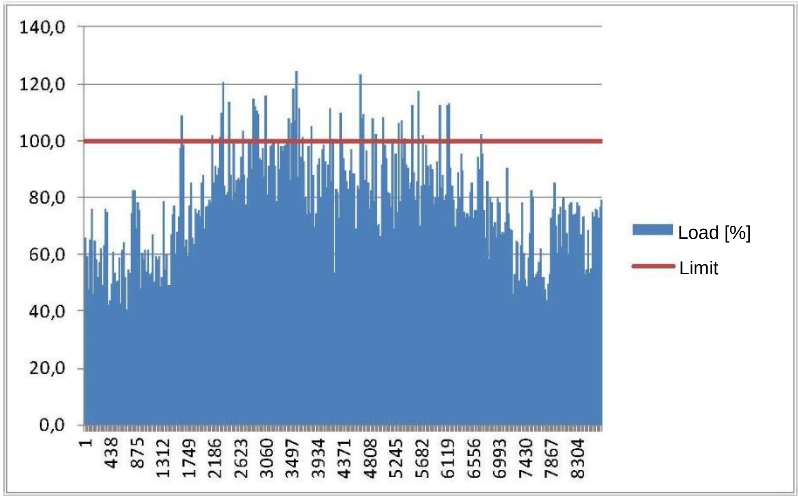

Figure 2-7 Relative load on Borssele transformers with a Rilland constituent grid (market analysis for 2025)

Solving congestion on the 380 kV line will require 475 MW of production capacity, which may be found at random in Zeeland. Solving the congestion on the transformers will require 200 MW of production capacity, which may be found in the 150 kV grid or downstream grids. The above figures apply to the market analysis for 2025. Assuming interpolation, the figures for the years 2021 to Q2 2023 will be lower. This is because the level of congestion is particularly linked to the amount of solar and wind power capacity set up for those years, see Figure 2-8.

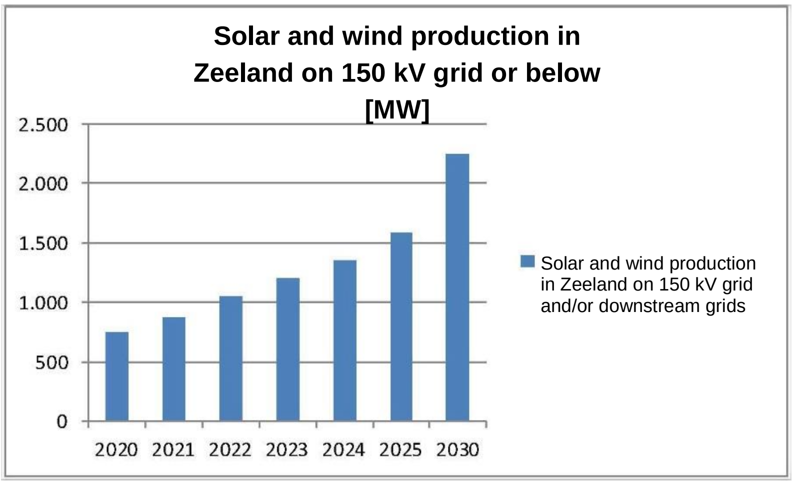

Figure 2-8 Projected solar and wind production at 150 kV and below included in the calculations

Table 2-6 shows that the overload for 2025 will result in annual congestion, where the largest overrun in MW is included for hours with simultaneous congestion on the 380 kV link and the transformers at Borssele.

Table 2-6 Congestion on 380 kV line (left) and on transformers (right) (market analysis for 2025)

	Redispatch factor 1
Volume [MWh]	
Redispatch summer	12,514
Redispatch winter	24,363
Redispatch per year	36,878

Table 2-7 shows the congestion for the different stages of infrastructure development.

Table 2-7 Congestion per year for various grid configurations and production over time

Grid situation	Redispatch GWh/year (summer/winter/total)	Underlying market scenario
Present grid situation with closed 150 kV line between Zeeland and Brabant	125 / 61 / 186	2020
Situation in Q3 2021 with opened 150 kV line between Zeeland and Brabant without 380/150 kV transformers in Rilland	2 / 11 / 13 118 / 45 / 163	2020 2025
Situation in Q3 2022 – Q2 2023 with 380/150 kV Rilland transformers	13 / 24 / 37	2025

2.4 Duration of structural congestion

After the installation of two 380/150 kV transformers in Rilland and the completion of the new 380 kV Borssele-Rilland connection (South West-West) in Q2 2023, the congestion will be resolved. To prevent further congestion, the number of 380/150 kV transformers in Borssele needs to be increased to accommodate the growth in renewable power generation in the 150 kV grid and below. For this reason, installation of a 4th transformer is planned in Q4 2024.

2.5 Supplementary requirements from the Grid Code

Besides preventing the n-1 safe transmission capacity from being exceeded, the Grid Code requires that short-circuit capacity must not be exceeded and voltage quality must be achieved. Both aspects are briefly explained below.

2.5.1 Short-circuit capacity

A check for a possible overrun of the short-circuit capacity will be conducted in accordance with Grid Code Article 9.4 section 2.a. The test will be carried out for the most likely (standard) scenario of the Investment Plan. The calculations show that the short-circuit resistance at the 150 kV Borssele substation is exceeded for the year 2020 and beyond. This will be resolved with an operational measure, which will result in only 2 of the 3 transformers in Borssele being used simultaneously. This situation will be structurally resolved in Q3/Q4 2021. Following this, no short-circuit problems are expected until 2025.

2.5.2 Voltage quality

There are no specific issues connected with voltage quality.

2.6 Conclusions

The results we have presented of the congestion calculations can be influenced by several factors. The most significant factor is the extent to which conventional power generation in Zeeland is deployed in practice, in accordance with the assumptions used in the market analysis. Another significant factor is how simultaneous high power generation from solar and wind will ultimately coincide with consumption in Zeeland relative to the scenarios used based on the market analysis.
Furthermore, the calculations do not take into account work on the grid (including scheduled outages for the installation of the new 380 kV line) and failures (unscheduled outages). Both can raise the extent of congestion.

Before the new 380 kV Borssele-Rilland connection is put into service in Q2 2023, a number of measures will be introduced to help reduce congestion. The measures are:

- Resolving the short-circuit problem in Borssele, which will allow three transformers to be used simultaneously, and opening the 150 kV interconnection between Zeeland and North Brabant.
- Installing two additional 380/150 kV transformers in Rilland, reducing overloads on the transformers in Borssele and on the Borssele-Rilland line.

Congestion on the 380-kV Borssele-Rilland line will be permanently resolved by the new 380-kV line. Growth in renewable power generation on the 150 kV grid will necessitate a 4th 380/150 kV transformer in Borssele. This is planned for Q4 2024.

Congestion management cannot be used with a closed 150 kV coupling, because there is no clear relationship between the problem and the production that needs to be reduced. However, this is possible with an open 150 kV interconnection because there is a 1-to-1 relationship between the overload and its cause.

The required amount of downward regulation power and the area in which it has to be found are shown inTable 2-8.

Table 2-8 Required downward regulation power

Grid configuration	Required downward regulation power [MW]	Where to apply downward regulation to production
150 kV interconnection closed	375*)	150 kV grid Zeeland and/or below grids
150 kV interconnection open, without transformers in Rilland	475*)	380 kV grid, 150 kV grid and/or below grids
150 kV interconnection open, with transformers in Rilland	475*)	200 MW in the 150 kV grid in Zeeland excluding the 'Rilland' constituent area, the remaining 275 MW in the 380 kV grid, 150 kV grid and/or lower grids, except the Rilland constituent area.

*) these values are based in the highest relative overrun multiplied by the effectiveness factor for downward regulation.

The results and conclusions of the congestion study are based on known data at the time of the study. New developments, such as connection and transmission requests from new production or the upgrading of existing production, may give rise to a new congestion study.

3. Market analysis

This chapter provides insight into the possibilities of using congestion management in the area surrounding the grid section. In this area, an inventory has been made of the potential participants that are expected to be able to contribute to congestion management within this congestion area. The analysis focuses on connected parties on the 150kV and 380kV grid, on the basis of the technical criteria relating to operational management.

3.1 Preconditions

To ensure an efficiently operating market-based solution with redispatch bids, there must be enough potential congestion management participants. This is tested against the following criteria.

1. **Satisfactory number of participants**
   There are at least three potential participants that are operationally capable of contributing to congestion management. The potential participants must be independent parties. For this reason, when identifying various potential participants the owner and balance responsible parties (BRP) of the connections are taken into consideration.

2. **Satisfactory redispatch power**
   The expected available redispatch power of the potential participants, excluding the largest potential participant, is more than the required redispatch power.

To estimate with sufficient certainty whether connected parties can contribute to congestion management, the identification of potential participants must take into account at least the following:

- Operational preconditions for participation of connections; and
- The distinction between those parties that are obliged to submit bids (which includes renewable) and those that have no obligation (process linked or those with high public interest).

3.2 Analysis

The analysis of the expected available redispatch power from potential participants takes into account the expected availability of controllable power while the transmission problem is ongoing. In addition, the relationship between production (party causing the problem) and the problem is not always 1 to 1, as was also explained in Chapter 2. The effectiveness of redispatch is the relationship between the reduction in MW at the point of congestion and an MW of downward adjusted production power. In the grid situation where the 150 kV Borssele-Woensdrecht line is closed, redispatch represents 33% of the effective contribution to resolving the problem on the 150 kV line for all connected parties in the 150 kV grid. In such a case, the contribution made by connected parties in the 380 kV grid is negligible and therefore ineffective. When the 150 kV Borssele-Borssele line is opened, the redispatch of all connected parties is 100% effective in resolving problems.

1. **Satisfactory number of participants**
   For 2021, physical congestion is expected to occur in the congestion area in 1265 hours. For 1224 of these hours there are fewer than three potential participants connected to the TenneT grid. For 2022, physical congestion is expected in 470 hours, and on 308 of these hours fewer than three potential participants are connected to the TenneT grid. This is structurally fewer than the minimum of three potential participants. Therefore, there are not enough potential participants connected to the TenneT grid to ensure an efficiently operating market-based solution with redispatch bids when applying congestion management especially in 2021 and 2022.
   For 2023, physical congestion is expected in 235 hours, and no physical congestion is expected in 2024. In each of these hours, there are three or more potential participants. This is more than the minimum of three potential participants. The number of potential participants is therefore enough for the use of congestion management in 2023 and 2024.

2. **Satisfactory redispatch power**
   In the congestion area, insufficient redispatch power is planned in 919 hours for 2021, excluding the largest potential participant. For 2022, insufficient power for redispatch is planned in 217 hours, excluding the largest potential participant. Therefore, there is not enough volume of available redispatch power from potential participants connected to the TenneT grid to ensure an efficiently operating market-based solution with redispatch bids when using congestion management, especially in 2021 and 2022.
   In the congestion area, insufficient redispatch power is planned in all hours for 2023 and 2024, excluding the largest potential participant. The available volume of redispatch power is therefore satisfactory for the use of congestion management in 2023 and in 2024.

3.3 Cost analysis

The projected costs for resolving physical congestion in the grid section for the 2021-2024 period are:

- 2021 – €21 million
- 2022 – €9 million
- 2023 – €4 million
- 2024 – *no costs planned*

This is based on the projected physical congestion volume according to the market scenario used, typical redispatch bid costs, and the effectiveness of the redispatch on resolving physical congestion. The actual costs involved in resolving the physical congestion are subject to a high level of uncertainty. Several factors could substantially alter the actual costs; among other things, this depends on the accuracy of congestion forecasts, market conditions, and changes in supply and demand in the grid section.

3.4 Conclusions

Based on the abovementioned criteria, the congestion area for 2021 and 2022 does not contain enough participants or enough volume of available power to guarantee an efficiently operating market-based solution with redispatch bidding when using congestion management. However, this is mainly the case up until the end of Q3 2021, partly because of the limited effectiveness of redispatch as long as the 150 kV Borssele-Woensdrecht line is closed. After that, the required redispatch power decreases. The occurrence of the expected physical congestion, however, doesn't depends on the use of congestion management. Should congestion management not be used, then the physical congestion would also be resolved with redispatch as part of the regular process for resolving transmission problems. The market criteria are therefore not a necessary precondition for the assessment as to whether congestion management can be used in the grid section.

Based on the aforementioned criteria, for 2023 and 2024 the congestion area contains enough participants and enough volume of available power to resolve the expected congestion. We have concluded that based on market analysis, congestion management will be possible for 2023 and 2024.

4. Analysis of operational possibilities

During congestion management, the grid operator remains responsible for the safety of the grid and the connected parties. In order to ensure this, the grid operator must have adequate measures in place and the technical means to forecast, monitor and, where necessary, direct flows in the grid.

This paragraph sets out a description of the adequate measures and an estimate of the technical means necessary to make the use of congestion management possible. If relevant, the time required to implement these means is also indicated.

4.1 Measures available for congestion management

The measures available for congestion management involve the use of redispatch by calling for available bids for the upward and downward regulation of production units and/or demand facilities and other measures including temporary topological changes in the grid.

Redispatch

In addition to the analysis in paragraph 3 concerning there being enough available participants to enable congestion management to be implemented in the congestion area, we examined two other conditions that will have to be met before redispatch can be implemented.

Satisfactory power for the redispatch counteraction.
In addition to calling for the required downward regulation in the congestion area, sufficient upward regulation power must also be available outside the congestion area so that a full redispatch action can be performed in order to not cause a power imbalance. For the congestion area of Zeeland under consideration, we expect that there will be enough power available outside the congestion management area to handle the redispatch counteraction.

Interaction with other grid components
If we examine the interaction with other parts of the grid where congestion management does not apply, the choice of the congestion area will result in a workable process, provided the congestion area can be considered to be what is known as a pocket. This is a defined piece of infrastructure from which transmission exchange with the rest of the grid takes place across a single point. In a pocket of this type, there is a 1-to-1 relationship between the downward regulation of power in the congested area and the reduction of congestion on the overloaded connections.

In the present grid situation, both the 380 kV and the 150 kV high voltage grids between Zeeland and Brabant are interconnected. Consequently, the grid structure is a meshed structure rather than a pocket. In this type of grid structure, the load on these grids and the measures that need to be taken depend largely on the situation in the 150-kV grid in Brabant and the remaining part of the 380-kV grid in Zeeland and Brabant. Only when the 150 kV grids between Zeeland and Brabant are operated separately, will the condition for a pocket be met and consequently the condition that will allow congestion management to be used.

In order to implement congestion management in this area, the following measure must be taken:

- The 150 kV grids in Zeeland and North Brabant must be operated separately. This requires making the 380/150 kV substation in Borssele suitable for simultaneous operation of three 380/150 kV transformers. This measure is scheduled to take place during 2021.

TenneT deems the implementation of this measure possible as part of introducing congestion management.

4.2 Technical means for forecasting, monitoring and controlling

To ensure the safety of the grid, during operational preparation TenneT must be able to adequately predict the times at which measures will have to be deployed during the day of implementation. Next, during the day of implementation, it must be possible to monitor whether the work has resulted in the grid's safe operation so that if grid safety is compromised, it will be possible to intervene using controls.
Finally, the administration of congestion management with the market parties concerned must be possible with respect to the cost settlement of resources deployed for redispatch, energy programme changes and the settlement of any congestion imbalance detected.

4.2.1 Operational processes preparation (forecasting) and settlement

In the context of using congestion management, it must be possible to carry out preparation and settlement processes.

Connected parties on the TenneT grid
During operational preparation, the expected demand for transmission in the congestion area can be sufficiently predicted on the basis of available forecasts and T-prognoses from market parties and regional grid operators connected to the 150 kV and 380 kV grids in Zeeland.

For the purpose of congestion management, the performance of the dispatched bids must be validated by comparing the measured values of actual power inputs from these units with the T-prognoses submitted. Discrepancies relative to submitted T-prognoses will be settled against what is known as the congestion imbalance price.
The required T-prognoses and measured values of actual power inputs from connections on the 150 kV and 380 kV grids in Zeeland will be available so the congestion imbalance can be settled.

Connected parties on the Enduris grid
The T-prognoses and measurements of connected parties on the downstream distribution grid belonging to Enduris are not available to TenneT for the purposes of preparation and settlement processes.

If connected parties on the downstream distribution grid belonging to Enduris in the congestion area need to be involved, the following measures must be implemented:

- Exchange of T-prognoses and changes of T-prognoses between TenneT and connected parties in the Enduris grid via Enduris; the lead time for this measure has not been looked into.

In the context of using congestion management, TenneT regards implementation of this measure as possible under certain conditions, depending on the lead time.

4.2.2 Surveillance and operation of assets/monitoring and control

In the context of using congestion management, it must be possible to perform real-time monitoring and control of assets.

TenneT transmission lines and connected parties on the TenneT grid
During operational management, it is possible to remotely monitor the load on TenneT's lines using the available real-time measured values and to use the Energy Management System (EMS) to control it.
In addition, during operational management, it is possible for TenneT to monitor the power inputs and/or outputs of units belonging to connected market parties on TenneT's grid on the basis of available real-time measured values and to use an EMS to regulate these units upwards or downwards or switch them.

Connected parties on the Enduris grid
During operational management, it is not possible for TenneT to monitor the power inputs and/or outputs of units belonging to connected market parties on the grid belonging to regional grid operator Enduris on the basis of available real-time measured values nor for TenneT to have these units regulated upwards or downwards or switched off.

If connected parties on the downstream distribution grid belonging to Enduris in the congestion area need to be involved, the following measures must be implemented:

- Real-time data exchange between connected parties on the Enduris grid and TenneT via Enduris. The lead time for this measure has not been looked into.
- Measures to allow TenneT to use an EMS to perform upward or downward regulation of units on the downstream distribution grid belonging to Enduris. The lead time for this measure has not been looked into.

In the context of using congestion management, TenneT regards implementation of this measure as possible under certain conditions, depending on the lead time.

4.3 Conclusion on operational possibilities

Based on the analysis of operational possibilities, the following measure must be taken in order to implement congestion management in this area:

- The 150 kV grids in Zeeland and North Brabant must be operated separately. This requires making the 380/150 kV substation in Borssele suitable for simultaneous operation of three 380/150 kV transformers. This measure is scheduled to take place during 2021.

If the above measure is implemented, from an operational perspective congestion management can be used for the grid operated by TenneT and the connected parties on that grid.

With regard to the connected parties on the downstream distribution grid belonging to Enduris, the operational preconditions are not met. If it is necessary to involve connected parties on the downstream distribution grid belonging to Enduris in the congestion area, various measures need to be implemented, which would have to result in the possibility of Enduris and TenneT exchanging T-prognoses and real-time data with one another, and of allowing upward or downward regulation of units connected to the Enduris grid from TenneT's EMS. These measures are necessary to enable operational processes linked to forecasting, monitoring and control.

5. Conclusions

Based on the study set out in the chapters above, the conclusions for each section can be summed up as follows:

Capacity section:
Based on the market scenarios used, the outcome of the Capacity Study is that technically speaking, the use of congestion management should be possible from around the end of 2021 or early 2022, after the grid investments in the 380 kV Borssele substation have been implemented, which is a precondition for being able to open the 150 kV interconnection between Brabant and Zeeland.

Comments:

- *deviations from the deployment of, in particular, conventional production resources in practice, as opposed to the market scenarios used, may lead to different and especially higher loads on the grid, including the associated congestion as reported in this study;*
- *use of congestion management will require the planned grid investments in the Borssele and Rilland substations and the new 380 kV connection between them to be completed on schedule. This is relevant given the substantial growth in new wind and solar power plants expected during this period. A delay in the completion of grid investments will lead to a sharp increase in congestion in Zeeland compared to the congestion as it is reported in this study;*
- *this analysis does not take account of maintenance situations in the grid that are necessary for the completion of the investment projects. During these periods, we anticipate a substantial reduction in the available transmission capacity. The corresponding impact is not included in this study.*

Market analysis:
Based on the results of the Capacity section, the technical operational criteria and the inventory of connected parties on the 150 kV and 380 kV grids, the outcome of the Market Analysis is that in 2021 and 2022, an efficiently operating market-based solution with redispatch bids cannot be sufficiently guaranteed. However, this is mainly the case up until the end of Q3 2021. The occurrence of the expected physical congestion, however, doesn't independent of the implementation of congestion management. Should congestion management not be used, then the physical congestion would also be resolved with redispatch as part of the regular process for resolving transmission problems. The market criteria are therefore not a necessary precondition for the assessment as to whether congestion management can be used in the grid section.

However, the outcome of the Market Analysis is that there are sufficient guarantees that we can expect an efficiently operating market-based solution with redispatch bidding to be in place for 2023 and 2024.

Comment:

- *deviations from the deployment of, in particular, conventional production resources in practice, as opposed to the market scenarios used, may lead to a different result from the assessment of the* *available market for congestion management as reported in this study, in many cases putting pressure on a favourable assessment as to whether there are enough potential participants.*

<u>Operations:</u>
Based on the feasibility of the processes from an operational perspective, we can conclude that congestion management is possible with the parties connected to TenneT's 150 kV /380 kV grid as soon as the 150 kV interconnection between Brabant and Zeeland is open and the operation of the grid in Zeeland is run as a pocket.

Comment:

- *if connections with the Enduris grid need to be involved, then additional measures must be introduced so that TenneT can predict, monitor and control them.*

Final conclusion:

<u>Applicability of congestion management</u>

Based on the partial conclusions reached in the three sections of the study, the final conclusion is that using congestion management in Zeeland in compliance with the Grid Code will be possible from late 2021/early 2022 as soon as the operation of the grid in Zeeland is run as a pocket.

Strict application of the criteria for the market analysis adversely affects the adoption of congestion management until 2023, but does not carry enough weight in an overall assessment.

The regular process for resolving transmission problems will be used until such a time as congestion management is used. Optimal use will be made of the resources available in the Zeeland and Brabant grids to resolve these transmission problems , including the available resources of parties connected to the Enduris grid.