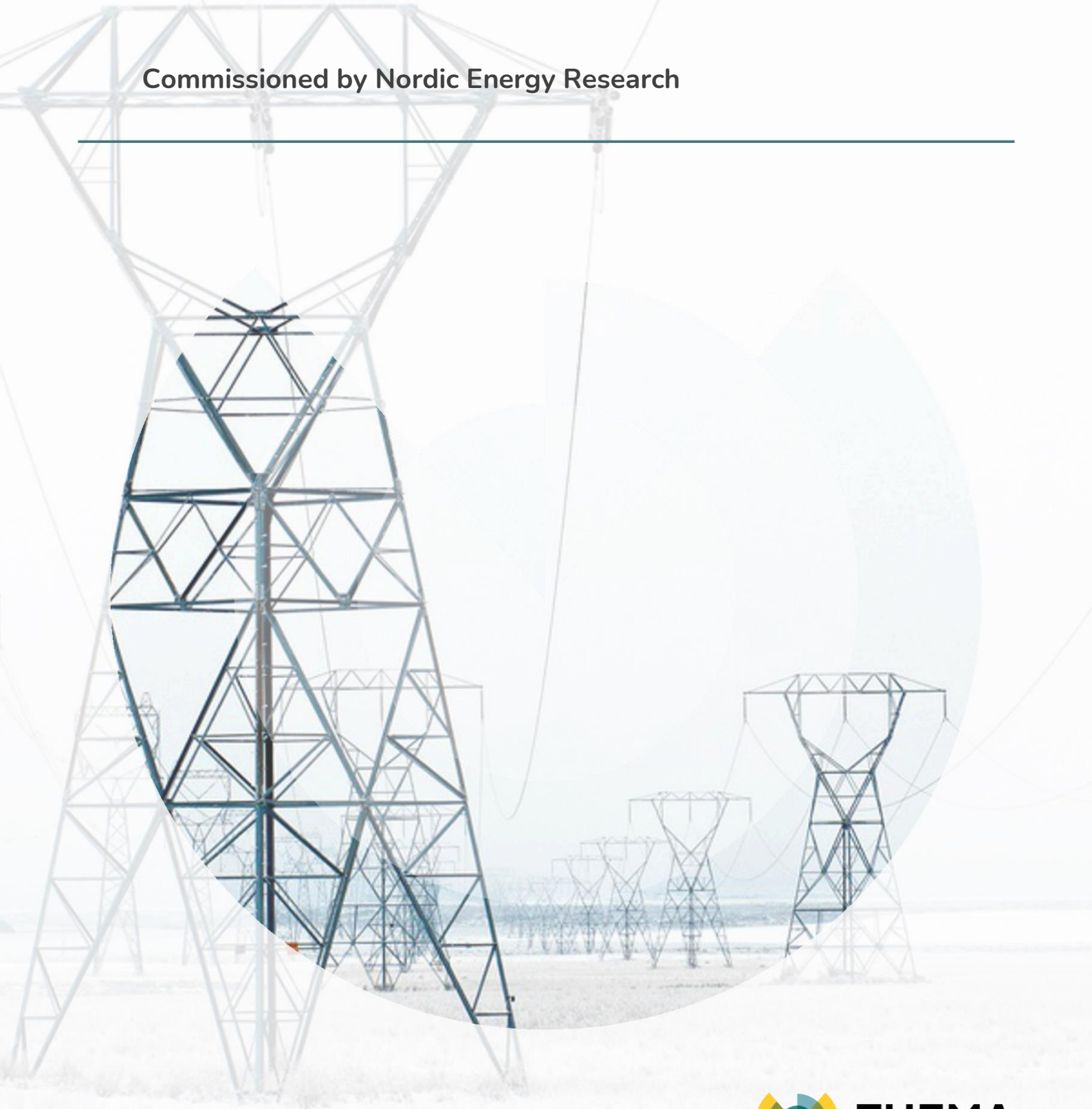
A comparison of different ways to implement the 70 percent rule

Commissioned by Nordic Energy Research



THEMA
CONSULTING GROUP

Publication date
09.09.2022

About the project

Project number:	NER-22-01
Project title:	A comparison of different ways to implement the 70 percent rule
Client:	Nordic Energy Research

About the report

Report title:	A comparison of different ways to implement the 70 percent rule
Report number:	2022-18
ISBN-number:	978-82-8368-116-1
Availability:	Confidential

Project description

This report explores current and potential future interpretations of the so-called 70 percent rule establishing minimum levels of electricity transmission capacity to be made available for cross-border trade. It describes the rules' current application and highlights differences in national approaches to assessing compliance that imply effective differences in the target level among Member States. It also explores areas of active regulatory debate related to the rule's application to the intraday market timeframe and the treatment of third-country flows. We conclude that amendments to the regulation should seek to distinguish between physical and so-called virtual capacity so that the regulatory regime can target incentives on the expansion of physical capacity and foreclose a perpetual reliance on the use of virtual capacity.

Project team

Team leader

Julian Hentschel
Julian.Hentschel@thema.no
+47 47 46 70 26

Contributors (alphabetically)

Stephany Paredes
Mina Bergerøy Ryssdal
David Attlmayr
Lukas Feldhaus
Anders Lund Eriksrud

About THEMA Consulting Group

Mail address: Øvre Vollgate 6
Visiting address: Nedre Vollgate 9
0158 Oslo, Norway
Organisation number: NO 895 144 932
www.thema.no

THEMA Consulting Group is a Norwegian consulting firm focused on Nordic and European energy issues, and specialising in market analysis, market design and business strategy.

Preface

The Nordic countries established one of the first regional integrated electricity markets in the world. This Nordic model has influenced power market integration in Europe and was the foundation for the European internal electricity market.

Regulatory processes happened simultaneously to the practical process of market integration. One of the regulatory cornerstones of the integrated day-ahead and intraday markets is Commission Regulation (EU) 2015/1222 establishing a guideline on Capacity Allocation and Congestion Management, also called CACM.

The situation changed with the revised Electricity Markets Regulation 2019/943 as part of the Clean Energy Package among other factors, causing the need for a revision of CACM. ACER published their CACM revision proposal in December 2021.

One of the major changes is the 70% rule that appears in Article 16 (8) in Regulation 2019/943, requiring that 70% of the grid capacity should be made available to trading on the internal electricity markets. Understood by the TSOs and the markets to apply to the day-ahead and implemented only in the day-ahead, ACER's proposal extends the implementation of the rule explicitly to the intraday markets.

Nordic Energy Research commissioned THEMA to analyze different ways to interpret the 70% rule, whether extending the application to intraday or describing other different interpretations observed in EU countries. The purpose of this study is to give technical background knowledge to the Nordic Electricity Market Group for them to advise Nordic ministries in this revision process. As such the study purely represents the consultant's observations and conclusions.

Klaus Skytte

CEO

Nordic Energy Research

CONTENTS

EXECUTIVE SUMMARY

System Operators are required to make as much transmission capacity as possible available to the power market for the trading of power between bidding zones. They are assumed to comply with this requirement if at least 70 percent of the capacity of critical transmission network infrastructure is made available. The remaining 30 percent can, for example, be used for transferring power within a zone, handling loop flows and/or providing an operational safety margin.

The legislation establishing the 70 percent rule provides little detail on how compliance should be assessed. ACER has subsequently published detailed methodological guidance and conducts monitoring. However, enforcement is primarily the responsibility of National Regulatory Authorities and there remain potentially important differences in national monitoring practices. Consequently, the German NRA may conclude, based on their methodology, that the German TSOs are compliant even when ACER's monitoring implies that they are not. We discuss three national variations from ACER's methodology in this report:

- The German NRA employs an alternative methodology to calculate the capacity being made available for flows on non-coordinated borders,
- The French NRA opts not to enforce the rule for market times units and borders where there is full price convergence, and
- The Polish NRA opts not to account for the impact of 'allocation constraints' on potential cross-zonal trade volumes.

Distinct from variations in the methodology used to monitor compliance, the current compliance framework also fails to distinguish between capacity that is physically made available for cross-zonal trade and so-called 'virtual' capacity. Virtual capacity is provided to the day-ahead market but cannot be supported by the physical system. Consequently, cross-zonal trade relying on virtual capacity triggers a need for remedial actions, such as countertrade or redispatch, to effectively reverse the trade and obtain a technically feasible solution.

The provision of virtual capacity pushes market prices towards levels consistent with the availability of trade capacity between bidding zones. Proponents of the use of virtual capacity highlight that it can support price stability and ensure that current prices reflect future conditions—assuming the use of virtual capacity is temporary. However, 'correcting' day-ahead prices in this way implies distorting short-term price signals, thereby reducing dispatch efficiency and adding to system security risks.

The current system's failure to distinguish between physical and virtual capacity implies that both are incentivised equally. Most worryingly, it leaves open the possibility of using virtual capacity in perpetuity.

This fundamental deficiency in the target and monitoring framework is fostering disagreement about whether the 70 percent rule should be applied to the intraday market. If the rule were stringently applied in the intraday timeframe, this could prevent remedial actions from being conducted intraday, making both remedial actions and, by extension, the use of virtual capacity more difficult. Although making virtual compliance more difficult could indirectly address the failure to distinguish between physical and virtual compliance, if poorly implemented, it could exacerbate the problems of the current system—requiring some System Operators to rely on virtual capacity but at greater costs in terms of the inefficiency of dispatch and the risks posed to system security.

In effect, the current debate on whether the 70 percent rule should be applied intraday is a proxy for a wider debate on the extent to which Member States must undertake the network investments and bidding zone reforms needed to physically increase cross-zonal trade capacity. To avoid this debate inadvertently resulting in legislation that perversely encourages System Operators to misrepresent secure cross-zonal transmission capacities and then undertake costly remedial actions, efforts should be made to

distinguish more clearly between physical and virtual compliance. If necessary, the target framework itself should be adjusted to better target actions likely to foster physical increases in cross-zonal capacity.

1 OBJECTIVE AND SCOPE OF THE REPORT

This report, conducted on behalf of Nordic Energy Research, examines the current and potential future implementation of the so-called 70 percent rule establishing minimum levels of electricity transmission capacity to be made available for cross-border trade.

Specifically, the report:

- Describes the 70 percent rule and its current application,
- Identifies key differences in how the rule is interpreted,
- Sets out the arguments for and against alternative interpretations,
- Illustrates the rule's effect on the power market and power system using power market simulations, and
- Where differences exist, proposes some key points to think about when trying to identify solutions that support the secure and efficient operation of the power system.

The remainder of the report is structured as follows:

- Section 2 briefly explains the 70 percent rule and explains some of the history and rationale underpinning its inclusion in current European electricity market regulation
- Section 3 provides a useful summary of how compliance with the rule is assessed and explains the system of derogations included in the relevant legislation
- Section 4 sets out the key differences in how the rule is interpreted and the arguments underpinning alternative interpretations, and
- Section 5 shares the result of modelling designed to illustrate the rule's potential impacts.

2 THE RATIONALE AND HISTORY BEHIND THE 70 PERCENT RULE

2.1 What is the 70 percent rule?

Put simply, the '70 percent rule' is a requirement in European power market regulation that all transmission system operators (TSOs) must make 70 percent of the capacity of transmission system infrastructure critical for electricity flows across bidding zones available for trade. This rule is codified in EU Electricity Regulation (EU) 2019/943. In practice, it means that the capacities provided by TSOs to market exchanges for use by market participants exceed minimum threshold values.

Formally, the regulation espouses the principle that TSOs should provide as much transmission capacity as possible to the market. The 70 percent threshold reflects the point at which it is presumed that this principle is met.

Subsequent methodological guidance produced by ACER has provided more detail on what is implied by the rule. Central to this guidance is the concept of the Margin Available for Cross-Zonal Trade (MACZT) and it is this margin that must be equal to or greater than the 70 percent threshold.

The associated legislation brought the 70 percent rule into force from January 1st, 2020. However, it also established transitional mechanisms designed to allow Member States to reach compliance over time. Specifically, if EU Member States could evidence structural congestion within their bidding zones and provide an Action Plan setting out how they would achieve compliance by the extended deadline, the deadline for realising the 70 percent threshold could be extended until December 31st, 2025. Such extensions have been granted to Germany, Poland and the Netherlands, among others.[1] 'Structural congestion' here denotes congestion that is expected to persist for years. After 2025, all States must abide by the 70 percent rule even if doing so forces them to use subsequent redispatch and countertrading measures to ensure a technically feasible dispatch solution. We provide more details on the derogations and exceptions granted in section 3.2.

The relevant National Regulatory Authorities, as well as ACER, supervise and control the implementation of both the 70 percent rule and the Action Plans. If an Action Plan is unsuccessful, the affected Member State must consider whether to change the bidding zone´s design, substantiate their decision and deliver it in written form to ACER and the EU Commission. If affected neighbouring Member States do not agree with the Member State's decision, the EU Commission and ACER will decide on the bidding zone´s design.

The scope to redraw bidding zone borders is a key enforcement tool for the 70 percent rule, as a redesign can alter what is defined as cross-zonal trade capacity. The EU Electricity Regulation mandates that bidding zone design should reflect structural congestion, with zonal borders reflecting congestion between network areas. A change in bidding zone design has the potential to abruptly change electricity prices in the affected areas as participants are exposed to the inability of the network to facilitate trade between them. Since such price changes may be politically undesirable, Member States have an incentive to abide by the 70 percent rule and avoid a redesign of bidding zones, especially one that is not within their direct control.

[1] ACER, "Action Plans: Overview and Main Characteristics."

2.2 Why the 70 percent rule exists

European electricity market regulation is ultimately intended to ensure that there is a common internal market for power across the EEA. In practice, this implies that consumers and generators have non-discriminatory access to the power market irrespective of their national jurisdiction. One practical challenge is therefore ensuring that all market participants have non-discriminatory access to the network infrastructure that underpins trade in electricity.

Before the implementation of the fourth energy package in 2019, the relevant legislation sought to ensure non-discriminatory access by including the principle that TSOs should make the maximum possible capacity of those network elements affecting cross-border flows available to the market. ACER oversaw the monitoring and the implementation of this principle. However, enforcement was challenging since the concept of 'maximum possible capacity' was formulated so ambiguously as to be subject to a wide variety of interpretations.

In its monitoring role, ACER concluded that TSOs offered only minor shares of the available capacity up to the market for use in cross-zonal trade. It suspected that the volumes of capacity being made available were being limited to manage congestion within bidding zones, with the implication that out-of-zone market participants faced potentially undue discrimination when accessing network capacity relative to in-zone market participants.[2]

The creation of the 70 percent rule was a reaction therefore to:

- the desire to prevent out-of-zone market participants from facing discriminatory access to the available grid infrastructure and
- the need to establish an enforceable rule that would motivate a change in TSO, NRA and Member State behaviour.

The use of an explicit quantitative minimum for cross-zonal capacity availability was intended to give regulators a clear-cut benchmark against which to hold TSOs to account. However, as discussed in further detail in later sections, the legislation itself did not completely resolve differences in interpretation.

2.3 Current regulatory developments

At the request of the European Commission, ACER prepared a recommendation on reasoned amendments to the Capacity Allocation and Congestion Mechanism (CACM) Regulation last year. Although formally distinct from the legislation containing the 70 percent rule, CACM governs much of the detailed processes involved in the coordinated calculation of the capacities available for cross-zonal trade. As such, these regulations are closely interrelated and, indeed, the electricity market regulations make explicit reference to CACM.

The revisions proposed by ACER include text that effectively integrates compliance with the 70 percent rule into the procedures define in CACM. As such, it has become increasingly important to consider the 70 percent rule's interpretation and effects. We discuss the proposed changes and their impact in further detail in section 4.1.

[2] ACER, "ACER Report on the Result of Monitoring the Margin Available for Cross-Zonal Electricity Trade in the EU in the First Semester of 2020."

3 CURRENT MONITORING, DEROGATIONS AND EXCEPTIONS

3.1 A simplified description of ACER's monitoring approach

ACER conducts standardised monitoring of the Margin Available for Cross Zonal Trade (MACZT) on transmission assets. In 2019, ACER published a Recommendation detailing the methodology for monitoring the MACZT.[3] The methodology aims to ensure a harmonised approach to monitoring performance in relation to the 70 percent rule. The Recommendation was complemented by a follow-up methodological paper (v1 in Oct 2019, v2 in Dec 2020)[4] that further describes the steps used to estimate the MACZT, including a description of the simplifications and caveats needed to generate results in the face of limited data or model availability. In April 2022, ACER published a note on a common approach to monitoring the MACZT.[5] The 'practical note' presents a common approach to monitoring and reporting on MACZT results and is meant to be used consistently in the relevant reports from ACER, the NRAs and TSOs. The following description of ACER's monitoring approach is based on these papers.

ACER creates reports on the results of its MACZT monitoring. Two monitoring reports were produced in 2020 and, since then, the report is published annually. For 2020, ACER also published a separate Nordic report due to late data submission.

Overall, ACER's Recommendation on the monitoring methodology states that the achievement of the MACZT target relies on two tests (subject to derogations and action plans). "First, MACZT should reach at least 70 percent for all monitored critical network elements (CNECs) in all coordination areas during all capacity calculation market time units. Second, the impact of allocation constraints on the CNECs' MACZT target should be monitored."[6]

Coordination areas

Capacity calculations according to the CACM Regulation are conducted within specific coordination areas. A coordination area describes the sets of bidding-zone borders within which capacity calculation is fully coordinated. The capacity calculation undertaken within a coordination area must nevertheless consider the impact that bidding-zone borders outside the coordination area have on the physical flows on the critical network elements used within the coordination area.

Approaches to capacity calculation

The capacity calculation method in a coordination area can be based on either a flow-based (FB) or the net transfer capacity (NTC) approach.

Flow-based capacity calculation works by defining the system limits relevant to specific transmission assets, so-called critical network elements (CNEs). For each CNE, a MW limit is identified as representing the maximum flow that can be supported by the relevant component(s). Power transfer distribution factors (PTDFs) are also defined that establish a linear relationship between

[3] ACER, "Recommendation 01/2019."
[4] ACER, "Estimating the Margin Available for Cross-Zonal Trade Pursuant to ACER Recommendation 01/2019 in Light of Article 16(8) of Regulation (EU) 2019/943 (Version 2)."
[5] ACER, "Practical Note: Monitoring the Margin of Capacity Available for Cross-Zonal Trade."
[6] ACER, "Recommendation 01/2019," 18.

zone-to-zone trade in power and the corresponding MW flow induced across each CNE. Thus, the PTDF might state that for each 1 MW traded from Zone A to Zone B, a 0.5 MW flow is induced on a specific CNE. These two pieces of information, the MW limits on each CNE and the PTDFs, define the 'security domain', i.e. the set of cross-zonal trades that can be supported by the physical network.

With a net transfer capacity (NTC) approach, the market limits are instead defined directly as the maximum number of MWs that can be traded in each direction between each pair of directly connected zones. Thus, net flows from Zone A to Zone B might be limited to 1 000 MW and net flows from Zone B to Zone A might be limited to 500 MW.

More information on the physical properties and constraints of the power grid is provided by the flow-based approach and this greater detail allows for better grid utilisation and therefore higher welfare. For this reason, flow-based is the preferred capacity calculation method.

Relevant CNECs to be monitored

MACZT, and therefore compliance with the 70 percent rule, is monitored at the level of individual critical network elements. The actual process uses information on so-called critical network elements with contingency (CNECs). Each CNEC defines not only a relevant set of physical assets by also the operational situation of the network (or 'contingency'). Example contingencies are normal or N-1 etc.

Where flow-based capacity calculation is used, the capacity made available to the market is already defined at the level of CNEs and so all CNEs are monitored.

Where the capacity available to the market is defined as an NTC value, this value is not explicitly linked to CNEs. In practice, as discussed below, the NTC is therefore converted into a CNE-level equivalent. The process used to do this implies that the CNE-equivalent will tend to understate the effective capacity available on all but the limiting CNECs, i.e. those CNECs that impose a binding constraint on trade. For this reason, the monitoring regime under an NTC approach looks only at the limiting CNECs.

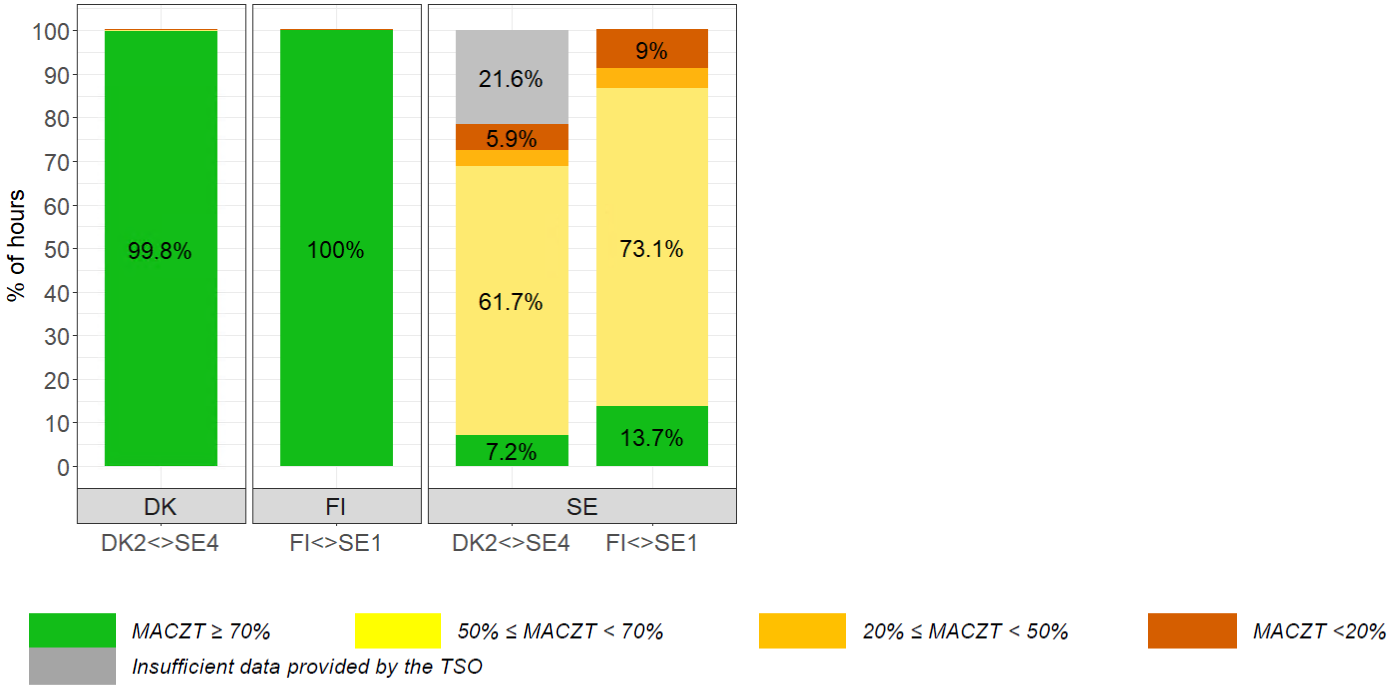
Establishing the percentage share defined in the target

Assessing compliance with the 70 percent rule clearly entails the need to estimate a corresponding percentage. The relevant percentage is the ratio of the Margin Available for Cross-Zonal Trade (MACZT) (defined in MW) and F_{max} (also defined in MW). The calculation of the MACZT is explained in further detail below. F_{max} is a concept defined in the CACM Regulation and is set to equal the maximum feasible flow on a specific Critical Network Element (CNE). This ratio produces the percentage of the maximum flows on a network element that have been made available for cross-zonal trade. This percentage can then be compared to a threshold level, i.e. 70 percent or a level defined in a national action plan.

Note that since different margins can be made available for different Market Time Units in different market timeframes (e.g. day-ahead and intraday), there is in principle a distinct percentage for every CNEC in each Market Time Unit and each market timeframe. Consequently, performance against the target is often reported in the percentage of Market Time Units in which all CNECs in the day-ahead market had a ratio above some threshold value (e.g. 70 percent). The figure below is an extract from ACER's monitoring of the Nordic countries and is typical of the structure of monitoring results. As an example of how these results can be interpreted, looking at the DK2–SE4 border and considering the day-ahead market, we observe that the limiting CNEC in Sweden had a Margin

Available for Cross-Zonal Trade that was less than 70 percent but greater than or equal to 50% of the CNEC's maximum feasible flow capacity in 61.7% of hours. This is shown by the yellow element of the third column from the left.

Figure 1 Percentage of the time when the minimum 70 percent target was reached, per country and coordination area, in the Nordic region, considering third countries – 2020 (% of hours)



Source: ACER, "Results of Monitoring the Margin Available for Cross-Zonal Electricity Trade (MACZT) on the Nordic Alternate Current Borders in 2020."

Calculating the Margin Available for Cross-Zonal Trade (MACZT)

Estimating the MACZT for each CNEC and comparing it to the 70 percent threshold involves computing the potential flows induced by cross-zonal trade. The MACZT is calculated as the sum of two parts: the margin from the coordinated capacity calculation (MCCC) and the margin from the non-coordinated capacity calculation (MNCC). The MCCC reflects the capacity available for trade between bidding zones within a capacity calculation region whereas the MNCC reflects the flows induced by trade on borders with areas outside the capacity calculation region.

In flow-based coordination areas, the MCCC is equal to the capacity made available to the market for trade on each CNEC—formally known as the Remaining Available Margin (RAM)—adjusted for already allocated and nominated capacities[7]. In NTC coordination areas, the MCCC for each limiting CNEC is based on an estimation of RAM equivalents. These equivalents are calculated by identifying the maximum flow that might occur on the CNEC consistent with the NTC limits. Specifically, the NTC values are converted into CNE-level flow values through the use of PTDFs (which define the relationship between zonal exchanges and CNE-level flows). Effectively the method identifies the set of cross-zonal exchanges compliant with the NTC limits that induces the

[7] I.e. cross-zonal capacities which have already been allocated and nominated in previous timeframes.

maximum flow on the limiting CNECs. These flow values are then considered to equal the margin from the coordinated capacity calculation (MCCC).

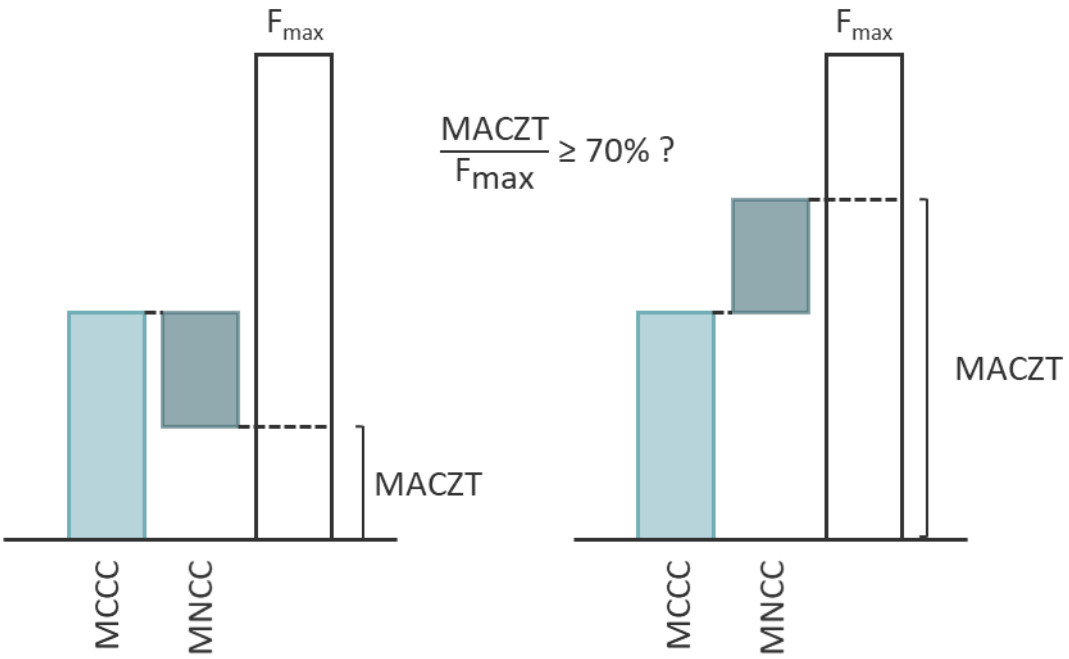
Note again that, even under an NTC framework, monitoring is conducted at the level of individual CNECs and not individual borders. As such, there is no threshold NTC value for a border that is equivalent to the 70 percent level.

MNCC defines the flow induced by cross-zonal exchanges on bidding-zone borders outside the coordination area. For both NTC and flow-based coordination areas, the MNCC is estimated by combining a forecast of cross/zonal exchanges outside the coordinated region with PTDFs. Again, this allows the estimation of the implied flow on each CNEC. Importantly, and unlike the process used to estimate RAM equivalents of the MCCC described above, these estimated flows can be positive or negative, potentially resulting in a positive or negative MNCC. A negative MNCC implies that the flows induced by expected trade outside the coordinated region are likely to oppose and potentially offset the trade flows within the region, effectively freeing up capacity on the network element.

The sum of the MCCC and the MNCC equals the MACZT ($MACZT = MCCC + MNCC$).

The key relationships underpinning the monitoring framework are represented visually in Figure 2 below.

Figure 2 Illustration of the monitoring framework's key elements for cases with a negative and positive MNCC



Both AC and DC bidding-zone borders are monitored. For bidding-zone borders with HVDC interconnectors, the MACZT on the interconnector is assumed to be equal to the hourly NTC provided by TSOs and this is directly compared to the hourly F_{max}. This is because flows on HVDC interconnectors can be directly controlled by the relevant TSOs and it is, therefore, unnecessary to estimate the induced effect of flows from energy market trade.

The provision of data by TSOs is critical to the monitoring of the 70 percent rule. Practice varies as to whether TSOs compute and provide the MCCC and MNCC values directly to ACER or else provide the inputs necessary for their calculation, e.g. PTDFs, a list of

CNECs and a grid model. In some cases, ACER may opt to calculate values distinct from those supplied by TSOs and NRAs.[8] This is notably the case where ACER has reservations about the approach being used to generate the MCCC and MNCC values provided.

Allocation constraints

The description of the monitoring approach above covers the monitoring of the capacities explicitly provided to the market for cross-zonal trade. However, ACER's monitoring framework also assesses the implications of any allocation constraints imposed by TSOs.

Allocation constraints can take various forms and the approach used to assess a constraint's impact on compliance with the 70 percent rule may differ depending on the nature of the constraint. Two common forms of constraint include so-called 'external constraints'—which limit the maximum import into and/or exports from a specific bidding zone—and 'technical profiles'—which limit the joint allocation of a set of NTC capacities on defined, oriented bidding-zone borders. The latter operate like a joint NTC limit across two or more borders.

ACER's methodology implies that the Margin Available for Cross-Zonal Trade should be calculated both including and excluding the effects of allocation constraints to help assess these constraints' impact on the relevant margin. It also states that "all types of allocation constraints should be studied, including the allocation constraints needed for operation security or implemented for technical efficiency."

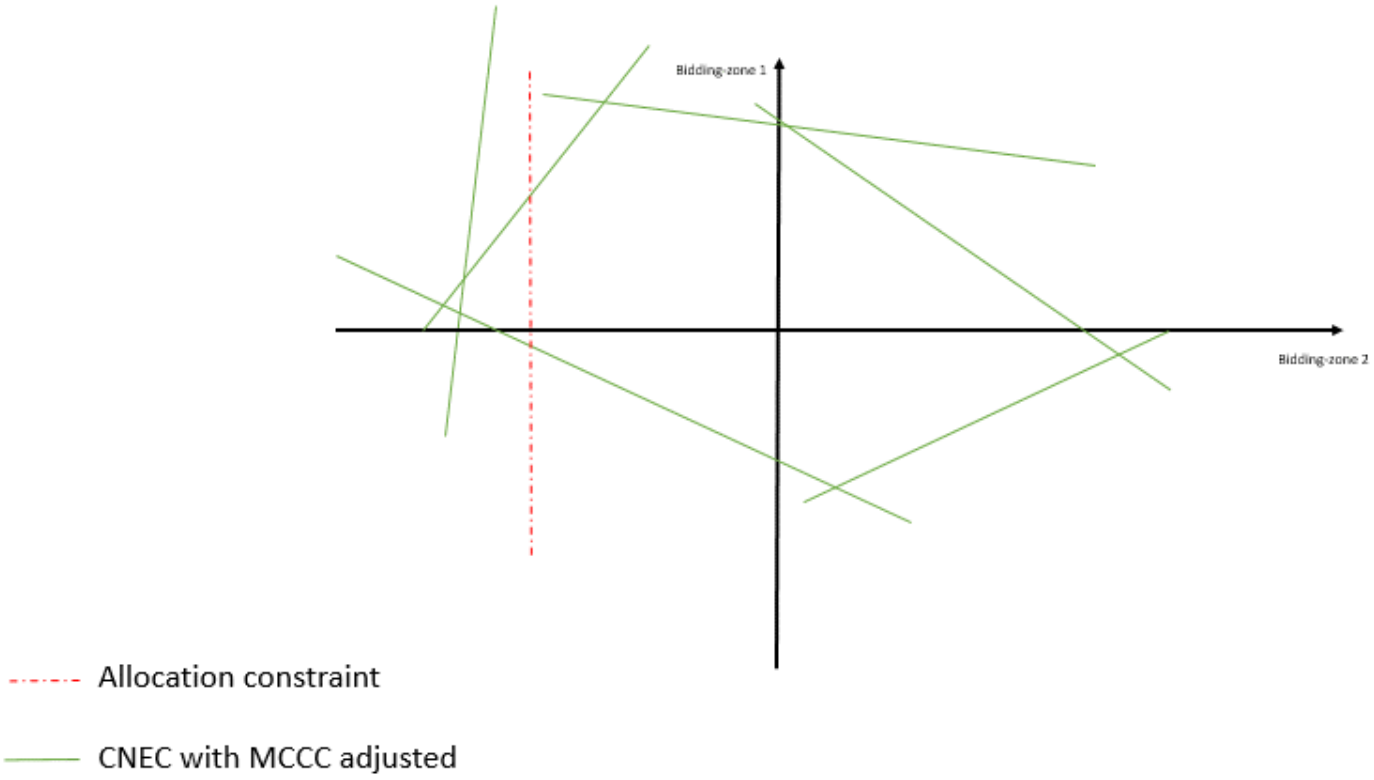
For external constraints, the approach to monitoring is as follows. ACER begins by defining the minimally compliant security domain, i.e. the smallest set of RAMs that just hit the 70 percent level (or interim target level where relevant). To do this, ACER calculates, for each CNE, the MCCC that just satisfies the equation:

$$MCCC_{adjusted} = MACZT_{target} - MNCC$$

The minimally compliant RAMs defined by this process, together with the PTDFs, define a minimally compliant security domain, shown in Figure 3 below as the area enclosed by the green lines. Each of the green lines reflects the minimally compliant limits of a specific CNE.

[8] ACER, "Estimating the Margin Available for Cross-Zonal Trade Pursuant to ACER Recommendation 01/2019 in Light of Article 16(8) of Regulation (EU) 2019/943 (Version 2)."

Figure 3 Illustration of the approach used to assess the impact of external constraints



The external allocation constraint can also be defined in this space and is then tested mathematically to see whether it is redundant, i.e. whether it would rule out part of the minimally compliant security domain. If, as shown above, the allocation constraint would make the potential domain smaller, then the allocation constraint would be deemed inconsistent with achieving the target margin. If the allocation constraint is redundant, then it is consistent with the relevant target margin.

For 'technical profiles' the approach is slightly different. Such constraints take the form of a limit on multiple oriented borders, for example, the sum of flows A→B and A→C cannot exceed 100 MW. To assess compliance, ACER assumes a specific set of NTCs that are compliant with the constraint. Specifically, it assumes "that the complete capacity of the technical profile is allocated on the border with the highest price spread (for the considered timeframe and CC MTU)".[9] So, assuming the price spread between zone A and B was the greatest and that the maximum NTC on the A→B border was otherwise equal to or greater than 100 MW, ACER would assume an A→B NTC of 100 MW and an A→C NTC of 0 MW (i.e. a specific set of NTCs consistent with the allocation constraint).

This specific set of NTCs is then used with the NTCs on other borders to calculate CNE-level flow values as described earlier on page 9. These implied flows can then be used to assess the total implied Margin Available for Cross-Zonal Trade and, in turn, the constraint's consistency with the target.

[9] ACER, "Recommendation 01/2019," 21.

Nordic challenges

In the Nordic region, the network models to support flow-based capacity calculation are still under development and the NTCs provided to the market may not be calculated with reference to explicit limiting CNECs. This difference in working methods has made it difficult for Nordic TSOs to provide the input data needed to support the monitoring framework described above. In the case of Sweden, the level of detail that can be provided to ACER on the network's assets may also be limited by regulation designed to secure information on critical network infrastructure.

When the Nordic TSOs implement flow-based coupling, the explicit use of RAMs, PTDFs and CNECs within the market process should significantly simplify the monitoring process.

3.2 Derogations and exceptions

The regulation defining the 70 percent rule defines two different mechanisms to defer or limit a TSO's obligations: derogations and Action Plans. We describe both below.

3.2.1 (Short-term) derogations

Short-term derogations from the 70 percent rule are defined in (EU) 2019/943, Art 16(9). If a TSO can prove that allocating 70 percent of cross-zonal capacity to the free market endangers operational security, the National Regulatory Authority may grant a short-term derogation. This derogation must be agreed upon by the other affected National Regulatory Authorities (NRAs) from bordering bidding zones and may not exceed two years. If not all NRAs agree to grant a derogation, the decision on whether to grant the derogation is passed to ACER. If a derogation is granted, the TSO in question must develop a plan to overcome the energy security challenges arising from the 70 percent rule. The derogation ends when either the planned solution is implemented, or when the time limit elapses.

3.2.2 Action Plans

In addition to the short-term derogations described above, and as mentioned previously, the regulation on the 70 percent rule also includes the possibility of a derogation lasting until the end of 2025 if the relevant TSO can evidence structural congestion within a bidding zone. The granting of a longer-term derogation is conditional on the TSO publishing an Action Plan setting out how it will meet a linearly increasing MACZT target that reaches the 70 percent level by January 1st, 2026. The draft Action Plan must be approved by the relevant NRA. Furthermore, a longer-term derogation can only be granted if all other NRAs from within the same capacity calculation region agree. If they do not, the decision on whether to grant a longer-term derogation passes to ACER.

The NRA and ACER supervise the implementation of the approved Action Plan and, in particular, performance relative to the increasing MACZT target. If the Action Plan is unsuccessful, the relevant Member State must consider whether to change the affected bidding zone´s design and deliver a reasoned decision in written form to ACER and the EU Commission. All Member States within the same capacity calculation region must agree on the Member State's decided course of action. If the proposal is not unanimously agreed on, the decision on the appropriate bidding zone design passes to the EU Commission and ACER.

The derogation framework implies that all Member States must implement the 70 percent rule from January 1st, 2026, even if compliance requires expensive countertrading and re-dispatch measures.

Approved and anticipated Action Plans are listed below in Table 1. The table also shows the applicable start values for the increasing MACZT target. These starting positions are calculated either from the average MACZT over the last three years where data is available (e.g., 2016-2018), or as the average of the last available year (e.g., 2018), whichever is larger. Newly built lines after the start of the derogation period usually start with a zero percent MACZT target. In all cases, the target increases linearly to reach 70 percent from 2026.

Table 1 Approved and anticipated Action Plans

	Start year	***Initial MACZT per zone***
Austria	2021	18.4%
Germany	2020	CWE & Alegro: 11.5%
		DE-PL & DE-CZ: 11.5%
		DE-DK1: 23.9%
		DE-SE4: 41.4%
Netherlands	2020	CWE region: min: 20%, max: 70%, mean: 26%, median: 20%
		NL-GB: 70%
		NL-DK1: 70%
		NL-NO2: 70%
Poland	2020	PL-CZ, PL-DE, PL-SK: min: 0%, max: 29%
		PL-LT: 70%
		PL-SE4: 40% (SE4-PL: 70%)
Romania	2021	RO-HU: 33%
		RO-BG: 25%
Croatia	Planned: 2022	TBD
Hungary	TBD	Likely around 25%

Source: ACER, "Action Plans: Overview and Main Characteristics."

4 KEY AREAS OF INTERPRETATION

4.1 An overview of the key areas of interpretation

Although considerable progress has been made in developing a standardised approach for interpreting and assessing compliance with the 70 percent rule, there remain several outstanding differences in the rule's interpretation. This results in inconsistency in actors' understanding of the actions required to ensure compliance, as well as seemingly conflicting assessments of past compliance.

In this section, we set out the most important of these differences and the rationale underpinning different interpretations. These interpretations cover different elements of the regulatory framework, including possible changes to the CACM Regulation and the details of the methodology used to calculate the Margin Available for Cross-Zonal Trade.

Specifically, we consider:

- Intraday implementation – Should the 70 percent rule apply to capacity provided in the intraday timeframe and, if so, how should compliance be measured?
- Third-country flows – How and under what circumstances are flows from trade with third countries to be counted towards compliance with the 70 percent threshold?
- Calculation of the MNCC (Germany) – How should the margin made available for trade across borders outside of the coordinated capacity calculation be calculated?
- Relevant market time units (France) – In which Market Time Units should compliance with the 70 percent rule be enforced?
- Monitoring of allocation constraints (Poland) – Should the 70 percent rule cover the impact of allocation constraints or should it be limited to the simple capacity values provided by TSOs to the market?

In selecting which issues to include above, we have sought to capture all active areas of policy debate as well as differences that may lead to inconsistency in the rule's enforcement among Member States. In general, we have sought to focus on those areas likely to be most relevant to future policy discussions on how the 70 percent rule should be interpreted.

The sections below discuss each of these differences in interpretation in turn.

4.2 Intraday implementation

Probably the most substantive of the differences of interpretation noted above is whether the 70 percent rule should apply to cross-zonal capacity provided in the intraday timeframe and, if so, how compliance should be measured.

Article 16(8) of Regulation (EU) 2019/943, which establishes the 70 percent rule, does not explicitly state the relevant market timeframes. However, it does refer to the need to account for contingencies consistent with the CACM Regulation and, as we return to below, these pieces of regulation are often read in conjunction.

ACER's guidance

ACER's methodological guidance on the implementation of the 70 percent rule has consistently made clear that ACER considers both the intraday and day-ahead market timeframes relevant to an assessment of compliance with Article 16(8). Its stated

reasoning for this is that Article 16(8) should be seen in conjunction with the CACM Regulation and that CACM's scope is the day-ahead and intraday markets. However, ACER's initial guidance on the monitoring framework placed much of the focus on day-ahead monitoring, since this was the timeframe in which coordinated capacity calculation was most developed. Section 4.3 of the ACER's 2019 Guidance states:

> "MACZT should in general be monitored for the day-ahead capacity calculation timeframe. When coordinated capacity calculation is implemented for the intraday timeframe and in some cases (deemed justified by regulatory authorities) where TSOs are unable to reach the MACZT target in the day-ahead timeframe, the intraday timeframe may also be taken into account in the monitoring of the MACZT target. TSOs should as much as possible avoid delaying the offering of high MACZT after the day-ahead timeframe, in order to avoid adversely affecting the internal electricity market (see Annex III for details). In order to define justified cases and whether additional capacity was effectively provided in the intraday timeframe, this Recommendation may need to be updated once intraday coordinated capacity calculation is implemented."

In other words, the 70 percent rule should be applied day-ahead but credit towards meeting the objective may also be gained by releasing capacity intraday. Consistent with this, section 5.2.1 of ACER's original methodology includes formulas to enable monitoring of compliance intraday for flow-based systems.

ACER's monitoring framework does not explicitly cover the issue of virtual capacity—i.e. offering capacity day-ahead and then conducting countertrade intraday to reduce resultant cross-border flows. This practice is used by some TSOs to comply with cross-zonal capacity targets. For example, day-ahead cross-zonal capacities on the Danish-German border must comply with minimum levels agreed bilaterally by the respective National Regulatory Authorities. In practice, these capacities are offered to the day-ahead market but cross-zonal flows are limited through redispatch conducted using manual reserves. In the future, flows may be reduced through countertrade conducted directly within the intraday market under proposals currently being developed by Energinet.

ACER is aware of the need for greater clarity on the proposed treatment of intraday, however. Its most recent monitoring report explicitly foresees a future revision of its guidance to address this point:

> "In 2020 and 2021, the monitoring of the minimum 70% target focused on the day-ahead timeframe. The intraday timeframe was not yet monitored, because intraday coordinated capacity calculation methodologies were not yet implemented. For example, in the Core region, intraday coordinated capacity calculation is expected to be implemented in June 2023. To ensure a harmonised monitoring of the MACZT in the intraday timeframe ACER intends to update its Recommendation No 01/2019. The upcoming amendment of the Capacity Allocation and Congestion Management (CACM) Regulation will also provide further clarity on the fulfilment of the minimum 70% target for the intraday timeframe."[10]

[10] ACER, "Report on the Result of Monitoring the Margin Available for Cross-Zonal Electricity Trade in the EU in 2021," para. 21.

Proposed revisions to CACM

Discussion about how the 70 percent rule ought to be interpreted within the intraday timeframe has been re-ignited by ACER's recent recommendations on revisions to the CACM Regulation. The focus of this debate relates to the wording of Articles 26(3) and 32(8) in the revised text. Abridged versions of these articles are reproduced below.

> **Article 26(3)**
>
> "The capacity calculation methodology shall transpose the requirements regarding the minimum level of available capacity for cross-zonal trade pursuant to Article 16(8) of Regulation 2019/943, without prejudice to the action plans pursuant to Article 15 of Regulation 2019/943 or the derogations granted by the regulatory authorities pursuant to Article 16(9) of Regulation 2019/943."
>
> **Article 32(8)**
>
> "Each RCC, for each capacity calculation region applying the flow-based approach, and for each critical network element (with contingencies), shall:
>
> [...]
>
> (g) increase the available margins from point (f) such that sum of the adjusted available margin and the flows from point (e)ii, (e)iii and if applicable (e)iv is at least equal to the minimum capacity target pursuant to Article 26.3."

Put simply, the text implies that the 70 percent rule should be transposed directly into capacity calculation methodologies, accounting for any relevant derogations. Furthermore, when Regional Coordination Centres conduct flow-based capacity calculations, they must ensure that the margins made available comply with the 70 percent rule.

ENTSO-E believes that this wording implies the direct enforcement of the 70 percent rule within the intraday capacity calculation process, with the implication that any necessary remedial actions must therefore be conducted in operational timescales. They argue that restricting remedial actions to operational timescales imposes a risk to security of supply, since it may not be feasible to activate sufficient redispatch within the limited time available. Even if achievable, they note that the change in practice would likely add to the costs of remedial actions due to the limited availability and higher cost of fast-acting reserves.[11]

ACER's formal reasoning, which accompanies its proposed amendments, also explicitly addresses the question of how the 70 percent rule ought to be applied intraday. The relevant text is reproduced below.

> "The first problem is the application of Article 16(8) of Electricity Regulation to the intraday timeframe. This article does not specify in which timeframe the minimum capacity requirements need to be respected. While ACER, all TSOs and all regulatory authorities agree that they should apply to the day-ahead timeframe, their application to intraday timeframe is disputed by some TSOs and regulatory authorities. The reason for such dispute is that in many regions, TSOs can achieve these targets only with an extensive application of remedial actions. Offering minimum capacities in the day-ahead is not problematic, because TSOs have sufficient time after the closure of

[11] Entso-E, "CACM 2.0 Amendment Advocacy Report."

the day ahead market to apply remedial actions. However, the same is not true for the intraday timeframe, which closes one hour before delivery and if all minimum capacities are utilised, TSOs do not have sufficient time to apply the necessary remedial actions.

For the above reasons, some TSOs and regulatory authorities argue that minimum capacity requirements should not apply for the intraday timeframe as they cannot be met in regions which rely on remedial actions to achieve these targets. Some regulatory authorities argue the opposite that minimum capacity requirements should apply to the intraday timeframe as well, since the application of redispatching to tackle structural congestion problems should only be a transitional solution. They also expressed concerns that without minimum capacity targets in the intraday timeframe there would very often be zero intraday capacities in the whole region and this would effectively stop the cross-border intraday trading and prevent efficient integration of renewables to the internal market for electricity.

Given the above, ACER invites the Commission to look into this problem and proposes a solution that would address the underlying concerns, i.e. to provide a transitional period in which intraday capacity targets could be relaxed in order for each Member State to finish its action plans and in order to stop relying on redispatching to achieve minimum capacity targets."[12]

Practical implications of applying the 70 percent rule intraday

Although the proposed revisions to CACM do indeed tend to incorporate the 70 percent rule directly into the capacity calculation process, it is less obvious what intraday compliance implies in practice. As noted above, ACER's original 2019 methodology document already includes formulas for the calculation of the MACZT in the intraday timeframe. These intraday formulas explicitly provide credit for 'Already Allocated Capacities'. The methodology also explicitly notes that, when considering intraday timeframes, 'Already Allocated Capacities' include "capacity allocation in the previous timeframes (including long-term, DA, and previous ID timeframes)".[13] One reasonable interpretation of the detailed methodological guidance is, therefore, that intraday capacities will be assessed to be compliant provided that sufficient capacity was allocated at an earlier point in time. If true, this might imply that compliance day-ahead effectively carries over into all subsequent market timeframes, such that TSOs can provide virtual capacity day-ahead, conduct countertrade intraday and nevertheless comply with the 70 percent rule in all market timeframes.

In informal discussions with ACER staff, we set out our interpretation that, when monitoring compliance with the 70 percent rule in the intraday timeframe, capacity offered to the market day-ahead would effectively count towards the 70 percent target in all subsequent timeframes under the current methodology. We also noted that if the 70 percent rule is met day-ahead, it would therefore necessarily be met in all subsequent market timeframes even if this was achieved using virtual capacity and subsequent countertrade.

[12] ACER, "Recommendation 02/2021: Annex 4 – Reasoning to Proposed Amendments to the CACM Regulation," sec. 11.2.
[13] ACER, "Recommendation 01/2019," sec. 5.2.1.

ACER commented that:

- All capacity offered day-ahead and then allocated in the day-ahead market coupling would be accounted for within the 70 percent in the intraday timeframe. On top of that, the total capacity offered at the intraday level should independently comply with the 70% percent target. The fact that ACER's Recommendation 01/2019 on MACZT does not fully address this need is due to the fact that there were no coordinated intraday capacity calculations at the time. ACER envisages an update of the Recommendation after their implementation[14].
- Regarding the use of virtual capacity, ACER highlighted that a persistent reliance on virtual capacity and remedial actions was unlikely to be efficient relative to the use of network investment or bidding zone redesign and should not be considered as a long-term solution.

Overall, therefore, the practical significance of applying the 70 percent rule intraday is far from clear and may be smaller than envisioned by ENTSO-E if compliance day-ahead is effectively carried forward into subsequent market timeframes. However, given the significantly different requirements placed on TSOs by different intraday monitoring frameworks, the interpretation cannot be left ambiguous. In particular, it must be made clear whether the practice of offering virtual capacity day ahead will count towards compliance intraday if intraday compliance is made necessary by the revised CACM text.

Summarising the key arguments

The main argument against imposing the 70 percent rule in the intraday market timeframe is a belief that it will force remedial actions to take place after intraday gate closure. Whether or not this is the case is unclear. It is likely to depend on:

1. How intraday compliance is assessed—in particular, whether day-ahead compliance effectively carries over—and
2. Whether remedial actions are conducted outside the market.

As noted above, if capacity allocated day-ahead is carried forward to assessments of compliance intraday, then it will still be possible to use intraday countertrade as a means of hitting the 70 percent target, limiting the need for remedial actions in operational timescales.

Similarly, to the extent that TSOs can conduct remedial actions out of the market—for example by using a regulatory right to redispatch generators or through access to dedicated flexibility resources, such as Germany's network reserve—remedial actions will continue to be possible ahead of intraday gate closure. Indeed, one of the unintended consequences of applying the 70 percent rule to the intraday market may be to encourage TSOs to find ways of conducting congestion management outside of the market.

If, however, applying the 70 percent rule to the intraday market does force necessary remedial actions to be deferred until after intraday gate closure, it may imply the flowing negative consequences:

- Increased security of supply risk (assuming that SOs do not incur additional costs to offset this risk—see below),
- Welfare losses (assuming that SOs are forced to use less efficient, fast-acting redispatch solutions or else incur other costs to ensure security of supply)

[14] ACER, sec. 4.3.

- Higher financial costs for remedial actions and commensurately higher redistributive effects between network tariff payers and flexibility providers, and
- Given the risk to security of supply, potentially persistent (tolerated) non-compliance on the part of NRAs.

That said, and precisely because it makes remedial actions hard, applying the 70 percent rule to the intraday market may help to discourage the persistent use of remedial actions to address structural congestion. The persistent[15] use of virtual capacity and remedial actions conducted out-of-market undermines the effective functioning of the market by giving the day-ahead market inaccurate information about the capacity to be made available for cross-zonal flows. This has several negative consequences, including:

- Distorted price signals across the day-ahead and intraday markets due to the market's failure to fully anticipate remedial actions,
- Distorted day-ahead price signals between zones as some flows are supported by virtual capacity,
- A likely loss of welfare (assuming remedial actions result in a less efficient dispatch solution than a well-informed market),
- A financial cost to grid users associated with remedial actions and the potentially undesirable redistributive effects of financing such actions, and
- Arguably, discrimination between market actors based on different actors' ability to partake in remedial actions and the terms under which these actors are compensated.

There is therefore a case in favour of requiring the 70 percent rule to be met intraday as a means of foreclosing the persistent use of remedial actions to manage structural congestion.

Considerations relevant to finding a solution

The arguments for and against the application of the 70 percent rule to the intraday market timeframe are not in direct opposition and, in theory at least, it should therefore be possible to develop a regulatory framework that supports each of the following implicit objectives set out above.

- Aligning the market model and network capabilities (such that market outcomes are efficient and the persistent use of remedial actions is unnecessary),
- Avoiding constraints on remedial actions that might jeopardise security of supply, and
- Ensuring that remedial actions are as efficient and non-discriminatory as possible

To achieve these objectives, we (THEMA) believe that the policy solution will need to include the following elements:

- A monitoring framework that makes clear where compliance with the 70 percent rule is achieved using 'virtual capacity',
- A target and monitoring methodology that does not encourage the persistent use of virtual capacity, and

[15] The temporary use of virtual capacity can be used to help ensure that current prices are reflective of typical or expected cross-zonal capacity availability, thereby supporting price stability and arguably helping to ensure investment signals that reflect long-term capacity goals. However, this comes at the expense of efficient near-term price signals. It is also debatable to what extent these 'adjusted' prices support more efficient investment decisions, since significant power sector investments will often be made based on long-term projections as opposed to current prices. The former will often independently assess cross-zonal capacity availability.

- Mechanisms to support Member States' compliance without the need to rely on virtual capacity (e.g. by instead realising grid reinforcements or effecting bidding zone redesign)[16]

In practical terms, it will be important that the revised drafting of the CACM Regulation does not result in compliance with the 70 percent rule taking precedence over system security analysis in determining the availability of cross-zonal capacity. While enforcing compliance via the capacity calculation process might discourage the persistent use of remedial actions by making them more difficult, this approach would seem to impose an unnecessary risk to system security. It may also impose unachievable goals on TSOs that had expected to be able to make use of remedial actions to meet the targets established in their action plans.

A better approach is likely to be to address the persistent use of remedial actions explicitly within the target framework and to set targets that rule out this practice within feasible timeframes.

A good starting point would be to extend the current monitoring framework so that a TSO's reliance on virtual capacity, i.e. the persistent use of remedial actions, is clear. For example, two different measures of the Margin Available for Cross-Zonal Trade could be defined, one including and one excluding the contribution from virtual capacity. In practice, the current day-ahead measure already includes any virtual capacity offered day-ahead. Another equivalent measure could calculate the margin at the point of intraday gate closure and net out any countertrade volumes or, alternatively, look at effective trade in the actual delivery period by netting out all remedial actions. Comparing performance using these different measures will make clear to what extent remedial actions are being relied upon to increase the day-ahead measure.

The creation of a performance measure that excludes the contribution of the persistent use of remedial measures makes possible the creation of a target that can only be met by taking action to add to the structural availability of cross-zonal trade capacity—the assumed policy intention of the 70 percent rule. Importantly, this measure and its associated target do not encourage or reward the persistent use of remedial measures.

Pragmatically, we do not believe it is realistic to preserve the existing 70 percent target and legislative deadlines while also choosing to link the target to this new and more stringent measure of the Margin Available for Cross-Zonal Trade. However, a comparable regime with a percentage target and clear enforcement deadlines could be established. Provided the target is feasible, it should encourage TSOs to make the network investment and bidding zone changes necessary to realise structural increases in the availability of cross-zonal trade capacity while also avoiding incentives encouraging the persistent use of remedial actions.

The existing target and timelines could be explicitly linked to the measure of the Margin Available for Cross-Zonal Trade that allows for the persistent use of remedial actions. This would recognise formally what is, in reality, current practice. It would also ensure that there is no weakening of the existing commitments to day-ahead-market participants and ensure stability in the regulatory framework.

[16] Some relevant mechanisms to support enduring increases in cross-zonal capacity already exist. For example, bidding zone redesign is foreseen in the existing legislation and support for infrastructure investment is provided through the designation of Projects of Common Interest and through the funds available via the Connecting Europe Facility. The 70 percent rule needs to be seen in conjunction with such support measures to ensure that actors have both the incentive and support needed to make lasting improvements to the availability of cross-zonal capacity.

This approach would thereby both:

- Preserve the paramount importance of system security in the capacity calculation process and,
- Obligate TSOs to make the fundamental changes needed to increase the structural availability of cross-zonal trade capacity.

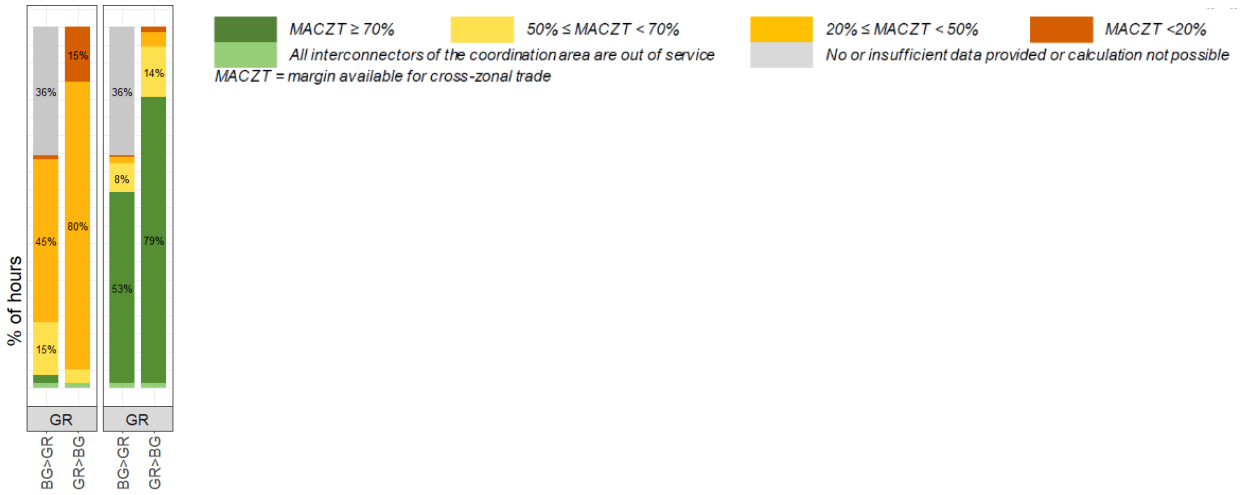
4.3 Third-country flows

In practice, TSO transmission assets support cross-border flows with third countries that are not parties to European energy legislation. The treatment of such flows is, therefore, an important complicating factor when agreeing on the target and monitoring framework.

It is worth noting that there are at least two distinct policy debates currently taking place concerning third-country flows. The first concerns the treatment of third countries within the capacity calculation process. Put simply, coordinated capacity calculation processes need to take account of potential flows on borders with third countries. Some actors are concerned that the processes currently in use discriminate unfairly between third-country and internal borders. This is most obviously the case if third-country borders are effectively granted capacity first, ahead of an internally coordinated capacity allocation process. A second, separate issue concerns the treatment of third-country flows when assessing compliance with the 70 percent rule. In this section, we focus on the latter of these two issues, namely how to incorporate third-country flows into the 70-percent-rule monitoring regime.

ACER's monitoring framework therefore calculates and reports on the Margin Available for Cross-Zonal Trade both including and excluding these third-country flows. In some cases, assessed performance against the target can vary dramatically depending on the treatment of these flows. See, for example, the assessed performance of Greece below.

Figure 4 Percentage of the time when the minimum 70% target was reached for Greece excluding (LHS) and including (RHS) third-country flows – 2021 (% of hours)



Notes: For 36% of the hours in the direction BG>GR, the Greek TSO declared that the CNEC was the interconnector between Greece and Turkey. Turkey is not modelled in the Continental Europe grid model; therefore, ACER could not calculate the MACZT on these CNECs.

Source: ACER, "Report on the Result of Monitoring the Margin Available for Cross-Zonal Electricity Trade in the EU in 2021."

ACER's guidance

According to section 4.1 of ACER's 2019 methodology paper, this dual approach reflects guidance provided to ACER by the services of the European Commission's Directorate-General for Energy in a letter of 16 July 2019. The Commission's guidance is paraphrased in the methodology document as follows:

> "consideration of third (i.e. non EU member) country flows in capacity calculation and MACZT should be possible on the condition that an agreement has been concluded by all TSOs of a CCR with the TSO of the third country, approved by the respective regulatory authorities. The agreement should be fully in line with EU capacity calculation principles and rules, and should cover at least:
>
> (i) consideration of internal third country constraints for intra-EU capacity calculation,
> (ii) consideration of EU internal constraints for capacity calculation on the border with third country [sic], and
> (iii) cost-sharing of remedial actions.
>
> Until such an agreement has been concluded, two different MACZT values should be computed to estimate the impact of third country flows: one including flows induced by exchanges with third countries, and the other excluding them."

Proposed revisions to CACM

Again, the debate on the appropriate treatment of these flows has been re-ignited by ACER's recent recommendations on revisions to the CACM Regulation. In particular, ENTSO-E's advocacy report on the CACM revisions expresses concern that "ACER's recommendation is conducive to exclude flows resulting from exchanges with 3rd countries from the calculation of the 70% requirement". It also claims that the "exclusion of 3rd countries from the provisions of CACM could inflate the 70% requirement leading to impossible requirements to offer 90-100-110% of capacity of the grid to market exchanges."[17]

Here, it is important to note that the link between the proposed revisions to the CACM text and the treatment of third-country flows within the 70 percent rule monitoring regime is far from explicit.

The actual changes to the legislative text include the removal of explicit derogations to the standard deadlines for the introduction of a flow-based capacity calculation methodology designed to account for the exact timing of single day-ahead coupling with Switzerland (Article 20 of the current CACM text).

In addition, Article 32.9 of the revised text, which sets out the process for the regional calculation of cross-zonal capacity, notes in the section designed to ensure that calculated capacities are consistent with the 70 percent rule that third-country flows should be accounted for only "if applicable". The relevant text is reproduced for reference below.

> **Article 32(9)**

[17] Entso-E, "CACM 2.0 Amendment Advocacy Report," 14.

(e) iii. "calculate flows resulting from cross-zonal exchanges outside the capacity calculation region between the Union and third countries as well as between the third countries as assumed in the common grid model;

(f) for all critical network elements with contingencies calculate the available margin which shall be equal to the flows from point (e)i and increase it such that the sum of this margin and the flows from point (e)ii and **if applicable** (e)iii is at least equal to the minimum capacity target pursuant to Article 26.3;" [bold added]

ACER's formal reasoning provides some insight into the reason for these changes and, again, the relevant text is reproduced below:

> "The second problem is the question whether the physical flows arising from cross-zonal exchanges with third countries count as being part of the margin available for cross-zonal trade pursuant to Article 16(8) of the Electricity Regulation. In particular, there are very different arrangements for capacity calculation and allocation with third countries in place. Sometimes, capacity calculation with third countries is coordinated at wider regional level, whereas at other times it is not. Similarly, in capacity allocation some trade with third countries is based on capacity allocation with similar access rules as within the EU, whereas some other trade is based on long-term bilateral contracts without third party access. Some NRAs argue by implication of Article 16(8) subparagraph 2 of the Electricity Regulation that third country flows are to be taken into account in the margin available, as they differ from reliability margin, loop flows, and internal flows. Given the wide variety of the arrangements with third countries, ACER asks the Commission to clarify how the physical flows arising from cross-zonal exchanges with third countries should be taken into account in the margin available for cross-zonal trade pursuant to Article 16(8) of the Electricity Regulation."[18]

Summarising the key arguments

Cross-zonal trade with third countries also imposes demands on TSOs' transmission networks. If these flows are excluded outright from the assessment of compliance with the 70 percent target, it makes the effective target harder to achieve for those TSOs for which third-country cross-zonal trade is relevant.

Neither the current monitoring regime nor the proposed text excludes third-country flows outright. Rather, the current monitoring framework produces results both including and excluding these flows where an agreement has not been reached among all the affected parties.

The outright exclusion of third-country flows from the assessment framework would be undesirable in practice since it would imply that either:

- the affected National Regulatory Authorities simply tolerate non-compliance because the framework unjustly penalises them,
- the affected Member States seek to achieve what is, in effect, a more stringent target, potentially incurring costs in excess of any benefits, or

[18] ACER, "Recommendation 02/2021: Annex 4 – Reasoning to Proposed Amendments to the CACM Regulation," para. 112.

- the affected Member States seek to restrict power market trade between themselves and third countries, likely to the detriment of both.

The ostensible reason for the proposed changes to CACM is not to exclude third-country flows from the assessment of the 70 percent rule but rather to avoid the development of the European market being held up by delays in negotiating arrangements with third countries. Therefore, any efforts to account for third-country flows must be structured to ensure they do not become a source of delay or otherwise skew incentives when undertaking negotiations with third countries on power market integration.

Considerations relevant to finding a solution

Again, the arguments raised by various parties about the treatment of third-country flows are not directly opposed. In theory, therefore, it should be possible to develop a regulatory framework that achieves the objectives of:

- taking due account of the network capacity used for cross-zonal trade with third countries in assessing compliance with the 70 percent rule, and
- ensuring that negotiations with third countries do not become a source of delay for European power market integration.

One pragmatic solution to the currently somewhat ambiguous treatment of third-country flows would be to establish a default approach for their inclusion in the monitoring arrangements absent specific agreement. This default approach would do away with the unhelpful practice of excluding third-country flows entirely from some results but would also be independent of the need to reach a specific agreement either within a Capacity Calculation Region or with a third country.

These default arrangements could be based on a principle of equivalent treatment of third-country and EU flows or include an explicit preference for internal EU flows by underweighting the capacity assumed to be used by third-country flows.

Importantly, the creation of these default arrangements need not foreclose flexibility in the treatment of specific borders since these default arrangements can and should be supplanted by specific agreements where such agreements are made. Here, the legislation would ideally specify the conditions under which the default arrangements may be supplanted by a specific agreement. One possibility would be to simply formalise the conditions provided to ACER by the European Commission and discussed in the section on ACER's guidance on p.23. In this case, the default treatment of third-country flows would apply to the monitoring of the 70 percent target except where alternative arrangements are agreed upon by all TSOs within the affected CCR, the TSO of the third country and the respective regulatory authorities.

Overall, this approach should ensure that the 70 percent target always gives due consideration to the impact of third-country flows without becoming hostage to agreements between the specific stakeholders involved. It should also allow the framework to reflect the specifics of the arrangements made on individual borders subject to the mutual agreement of the relevant stakeholders.

4.4 Calculation of the MNCC (Germany)

As described in section 3.1, the Margin Available for Cross-Zonal Trade consists of two components:

1. the MCCC—which accounts for flows within the coordinated capacity calculation—and
2. the MNCC—which accounts for flows across borders outside the relevant coordinated capacity calculation.

The German National Regulatory Authority has opted to estimate the MNCC in a way that differs from ACER and the other NRAs, as described further below. Their chosen approach has the potential to increase the assessed MNCC and therefore increase the assessed Margin Available for Cross-Zonal Trade.

Nature of the difference in the approach

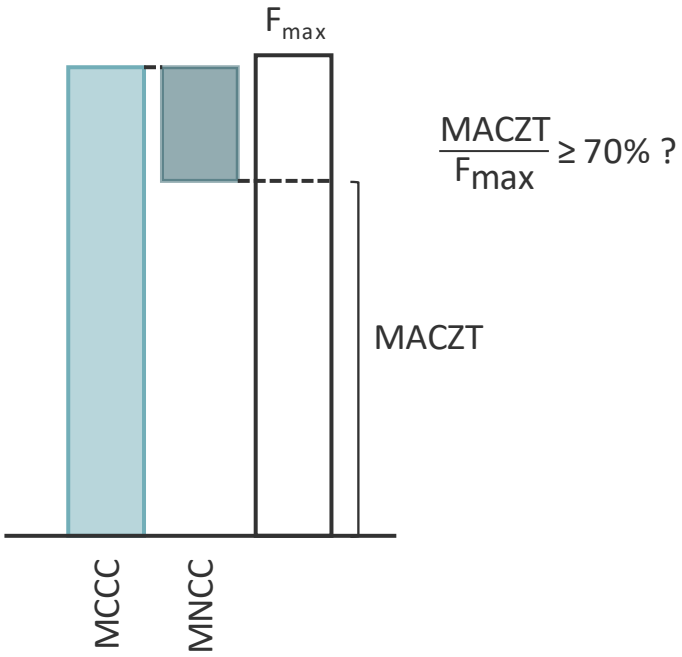
The recently published Practical Note on monitoring the Margin Available for Cross-Zonal Trade[19], produced jointly by ACER and the NRAs, both sets out a common approach for monitoring and notes exceptions in the approaches taken by national regulators. Under the common approach, the estimation of MNCC involves estimating the relevant flows on CNEs based on forecast exchanges across those borders not included in the coordinated capacity calculation. In contrast, Germany's national monitoring framework estimates MNCC using the Net Transfer Capacity (in both directions) made available on the relevant borders. This difference in the approach used has at least two implications for the assessment of compliance against the 70 percent rule.

First, and perhaps most obviously, the estimated-flow and NTC values may be different. For example, if the NTC value is high but this trade capacity is not expected to be used, then this will result in a correspondingly low MNCC when assessed under the common approach but a high MNCC when assessed using the German approach. Since expected flows will typically be lower than NTC values, the assessed MACZT will tend to be higher under the German approach, making compliance relative to the target threshold (e.g. 70 percent) easier to achieve.

Second, the common approach is designed to allow for the netting of flows—something that is not possible when using the German approach. Put simply, when a specific flow is anticipated on a given border, this induces flows in a specific direction on each CNEC. Trade flows on other borders can potentially offset these flows by inducing flows in the opposite direction. The common methodology, which is based on a specific set of forecast flows, accounts for these offsetting effects. For a TSO to meet the 70 percent target under the common methodology, it must release capacity sufficient to account for any helpful offsetting flows expected on borders outside the coordinated capacity calculation. In terms of the actual calculations, the common methodology can result in a negative MNCC, implying a need to make more capacity available via coordinated capacity calculation (the MCCC) to reach the target. This relationship is illustrated below in Figure 5.

[19] ACER, "Practical Note: Monitoring the Margin of Capacity Available for Cross-Zonal Trade."

Figure 5 Example of the effect of a negative MNCC



In contrast, the German approach cannot result in a negative MNCC. Effectively, when considering the impact of flows on non-coordinated borders, these flows are always expected to be in the direction that competes for capacity on the CNEC. Consequently, there are never any 'helpful' flows and the effective MNCC is always strictly non-negative. This tends to increase the assessed Margin Available for Cross-Zonal-Trade and, again, will tend to make assessed compliance with the 70 percent rule better.

Impact on assessed compliance with the 70 percent rule

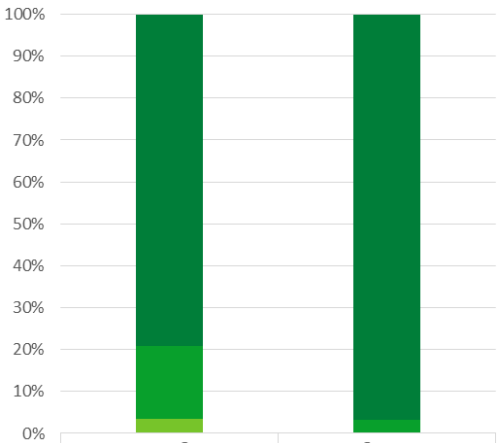
To our knowledge, no analysis has been performed on the magnitude of any difference in assessed compliance. Anecdotally, past reports produced by ACER and the German NRA come to markedly different conclusions on performance relative to targets.

For example, if we contrast assessed performance during the second half of 2020 on the border between Germany and the Czech Republic and Poland, the German NRA concludes that action plan targets were met, whereas ACER's monitoring suggests that they were not.

Figure 6 below shows the assessment of the German TSOs for the year 2020 for the action plan target of 11.5%. If there was any doubt about the conclusion of the analysis, the summary section of the associated report helpfully makes clear that "The minimum values for cross-zonal electricity trading at the borders Germany – Denmark 1, Germany – Denmark 2, Germany – Norway 2 and Germany – Poland/Czech Republic were fulfilled at all times during 2020 by the responsible transmission system operators 50Hertz and TenneT."[20]

[20] German TSOs, "Report of the German Transmission System Operators on Available Cross-Zonal Capacity for the Year 2020 Pursuant to Article 15(4) Internal Market for Electricity Regulation (EU) 2019/943," 3.

Figure 6 Percentage of limiting CNECs with different MACZT levels on the DE-PL&CZ border for 2020 as assessed by the German TSOs

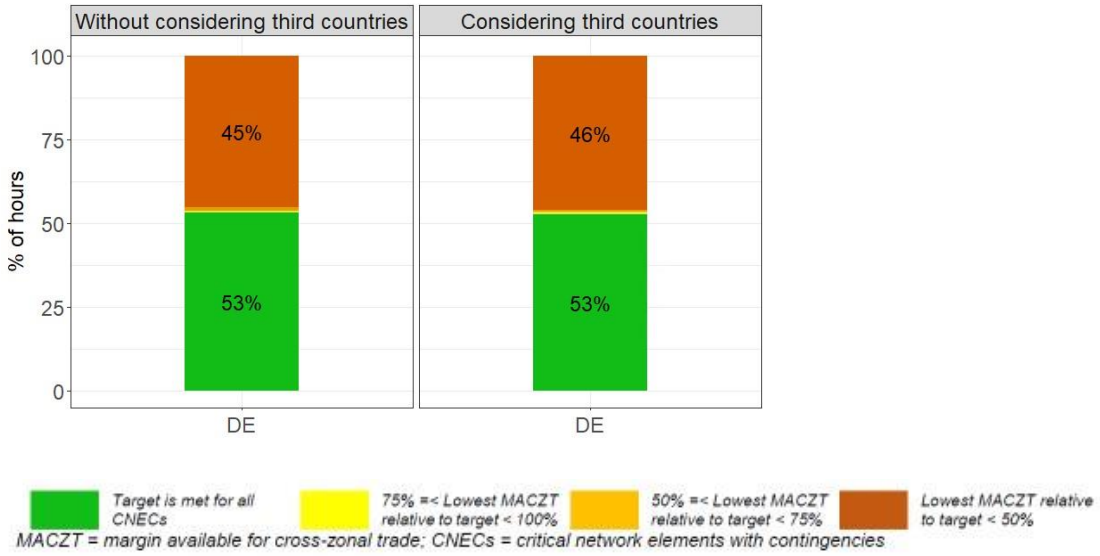


	DE-PL&CZ	PL&CZ-DE
>= 70 %	79.24%	96.88%
[50 - 70 %)	17.33%	2.96%
[11,5 - 50 %)	3.43%	0.16%
< 11,5 %	0.00%	0.00%

Source: German TSOs, "Report of the German Transmission System Operators on Available Cross-Zonal Capacity for the Year 2020 Pursuant to Article 15(4) Internal Market for Electricity Regulation (EU) 2019/943," fig. 1.

Contrast this with ACER's monitoring of the same border for the second half of 2020, as illustrated in Figure 7 below. This figure suggests that the action plan target was not met in almost half of all hours—a conclusion very hard to square with the analysis by the German TSOs.

Figure 7 Percentage of hours with different minimum MACZTs on the DE-PL&CZ border for the second half of 2020 as assessed by ACER



Note: The figure considers the impact of the technical profile of Germany (German borders with the Czech Republic and Poland).
Source: ACER, "Report on the Result of Monitoring the Margin Available for Cross-Zonal Electricity Trade in the EU in the Second Semester of 2020," fig. 32.

The exact impact of differences in the calculation of the MNCC cannot be determined with certainty as there are multiple methodological differences at work. For example, whereas the German TSOs split the column shares by the share of CNECs, ACER divides the column by the share of hours. However, this difference does not materially affect the threshold for compliance in the way that differences in the MNCC calculation do.

In our discussions with the German NRA, they made clear:

- that differences in the monitoring approach could impact the associated results, and
- that they believed the differences related to the calculation of the MNCC were likely to be more important than other differences in approach between the German TSOs and ACER.

Summarising the key arguments

In our discussions with them, the German NRA put forward three main arguments for why they have chosen their approach to the calculation of the MNCC. These are:

1. Consistency with the approach used to establish the action plan targets,
2. Security of supply considerations, and
3. Consistency with the procedures approved for capacity calculation.

The first argument is simply that the starting point for the linear trajectory of targets under Germany's action plan was calculated based on the German approach to calculating the MNCC. Therefore, when monitoring compliance against these targets (as in the figures above), they need to adopt a consistent approach.

The second argument is that the common methodology fails to ensure that TSOs take due account of security of supply considerations when determining the amount of capacity that should be made available to the market. Simply put, the forecast flows used when estimating the impact of trade on non-coordinated borders may be wrong and TSOs should not be encouraged to release capacity that they may be unable to supply if actual flows are not as forecast. Instead, according to this argument, TSOs should only release capacities that can be provided under the least-favourable case consistent with the capacities made available on non-coordinated borders.

Finally, the German NRA considers their approach to calculating the MNCC to be consistent with the actual operating procedures for capacity calculation.

It is worth noting that the need to be consistent with the methodology used to establish the action plan trajectory only implies the need for a time-limited difference in the monitoring approach. In contrast, the other arguments suggest the need to maintain different monitoring methodologies in perpetuity.

ACER considers that its approach to calculating the MNCC is more in keeping with the applicable European legislation. Specifically, they note that:

1. The legislation establishing the 70 percent rule makes explicit reference to the need to account for the netting effects described above, and
2. Reliability margins are both explicitly intended to account for forecast uncertainty and explicitly excluded from the estimation of the relevant margin available for cross-zonal trade.

On the first of these points, while the legislation does not make detailed reference to the calculation used to assess the Margin Available for Cross-Zonal Trade, Article 16(11) of Regulation (EU) 2019/943 does state:

> **Article 16(11)**
>
> "As far as technically possible, transmission system operators shall net the capacity requirements of any power flows in opposite directions over the congested interconnection line in order to use that line to its maximum capacity. Having full regard to network security, transactions that relieve the congestion shall not be refused."

ACER believes that the German approach to calculating the MNCC, by failing to account for power flows in opposing directions over network assets, is not in keeping with the intention of the original legislation. However, the German NRA does not believe this text applies to the 70 percent rule, defined in Article 16(8).

ACER also pointed out that in the Core capacity calculation, TSOs, in line with the regulation, net the forecasted flows. Consequently, not netting them when monitoring the MACZT is not consistent with the processes in place.

On the second, there is clearly no denying that forecasted flows on the non-coordinated borders may be wrong. However, in other discussions related to sources of error in the capacity calculation process, ACER has pointed to the fact that such errors are foreseen by the legislation and ought to be included within the 30 percent margin allowed by the legislation.

Specifically, Regulation (EU) 2019/943 states that:

> **Article 16(8)**
>
> "The total amount of 30 % can be used for the **reliability margins**, loop flows and internal flows on each critical network element." [bold added]

Furthermore, the Core capacity calculation methodology explicitly notes the need to account for uncertainty about the level of external trade in estimating the Flow Reliability Margin.

Again, the implication is that the security of supply argument is anticipated by the legislation and cannot be used to justify Germany's approach to the calculation of the MNCC.

Regardless of which approach to the calculation of the MNCC is correct, inconsistency in the approach across Member States is inherently undesirable. In theory at least, these differences can alter the effective target implied by the 70 percent rule such that different Member States are effectively facing different targets. Possible changes in the methodology over time also leave open the possibility of moving the goal posts by changing the effective threshold for compliance.

Considerations relevant to finding a solution

Ultimately, the 70 percent threshold is inherently somewhat arbitrary and so it is hard to say that any specific level is 'right' for every Member State. However, a principle of fairness suggests that the effective target should be the same for all Member States, especially in the long term. This, as well as a desire to avoid intractable debates as to whether compliance was achieved, implies the need for consistency in the methodology used to assess performance.

From a practical point of view, given that Germany's position on the netting of flows appears to be an outlier, it would seem to be easiest to simply formalise the so-called 'common' approach outlined by ACER as the intended approach for assessing compliance, at least concerning assessments relative to the final 70 percent target.

For assessment relative to Germany's action plan, there is good reason to ensure consistency in the approach between target-setting and monitoring. Ideally, the analysis used to set the trajectory could be redone to establish the targets relevant under the 'common' methodology. Although this may imply some slipping on the target in the next few years, this is infinitely preferable to the perpetual existence of inconsistent methods for assessing compliance with the rule.

The need to maintain security of supply is critical. However, variations in the method for calculating the MNCC within the monitoring framework are a needlessly indirect and ineffective means of achieving this objective. Instead, efforts to help ensure security of supply should focus on:

- ensuring security of supply's primacy in the revised CACM regulation,
- ensuring that the coordination and monitoring framework provides TSOs with ample, timely access to remedial actions, and
- setting an overall target and timeline for the '70' percent rule consistent with the secure operation of the system.

4.5 Relevant market time units (France)

Another area in which national regulatory practice differs from the 'common' methodology concerns the timeframes over which compliance is enforced. Under the common methodology, the 70 percent rule applies in all Market Time Units, e.g. in every hour of every day. When the system moves to 15-minute Market Time Units, the rule will be applied to each of these units.

The French National Regulatory Authority monitors all time units "but considers that the target must be met only on the market time units when there is no price convergence".[21]

Summarising the key arguments

The rationale for the French NRA's approach is alluded to in a published position paper.[22] Here, they point out that achieving the 70 percent target implies a cost to TSOs, notably in terms of the costs of undertaking remedial actions. They also point out the need to apply the regulation pragmatically, such that the 70 percent threshold is guaranteed "at the times necessary to maximise cross-border trade" but has "in mind the efficiency of any new expenditure".

Implicitly, the argument underlying France's decision not to enforce the rule during periods of price convergence is that increasing trade capacity during such periods will not add to social welfare. To understand why, it is worth remembering that the benefits realised from increases in cross-zonal trade capacity result from an ability to substitute high-cost power in one zone with cheaper power from a bordering zone. The difference in price between the zones reflects the size of the associated welfare gain. By extension, when prices are the same between zones, substituting power from one zone with power from the other zone does not

[21] ACER, "Practical Note: Monitoring the Margin of Capacity Available for Cross-Zonal Trade," table 1.
[22] Commission de régulation de l'énergie, "European Green Deal: Contribution of the Commission de Régulation de l'énergie,"Position Paper No. 9.

result in any direct reduction in costs and therefore produces no welfare gain. From the French NRA's perspective, forcing TSOs to comply with the 70 percent rule when prices have already converged entails potentially forcing them to incur costs, e.g. the costs of remedial action, for no welfare benefit. This cannot be efficient.

There are two counterarguments to excluding some Market Time Units as implied by the approach.

The first is that price convergence is only established after System Operators allocate capacity. Consequently, System Operators cannot know with certainty whether a Market Time Unit is exempted in advance. Arguably, providing an ex-post exemption to some Market Time Units may encourage System Operators to estimate which time units will be exempted and to limit remedial actions accordingly to reduce costs. If they incorrectly anticipate price convergence, cross-zonal trade will end up being restricted in prices in which prices do not converge and this will impose a welfare cost, albeit one that will be captured under the ex-post monitoring framework.

The second argument is that, even in periods in which prices converge, limits to cross-zonal trade capacity may still imply unwarranted discrimination between network users in different bidding zones. Specifically, the restriction of trade capacity between zones favours the matching of bids and offers within a zone even though, from a market-price perspective, out-of-zone bids and offers are equally attractive.

Considerations relevant to finding a solution

In this case, it may be that there is a genuine conflict between the objectives of supporting economic efficiency and the strict legal enforcement of non-discrimination within the internal market. Ultimately, whether it is more efficient to support cross-zonal trade with remedial action or allow within-zone trade, possibly itself requiring congestion management, will depend on the specifics of the case.

The 70 percent rule itself takes no explicit account of the costs and benefits associated with expanding cross-zonal capacity on any individual border. As a result, it is entirely possible that enforcing compliance on some borders implies a net social cost. Opting not to enforce compliance during those Market Time Units with price convergence appears to be a pragmatic approach to allow NRAs to better reflect the implied costs and benefits of action without significantly complicating the monitoring regime.

Overall, therefore, formalising the exclusion of Market Time Units with price convergence is likely to support greater efficiency in the management of the system, especially where compliance is achieved using remedial actions.

As noted in section 4.4, and notwithstanding the conclusion above, it is also important that monitoring is consistent across NRAs. Amendments to the legislation underpinning the 70 percent rule should ideally, therefore, stipulate the applicable Market Time Units in such a way that inconsistent implementation is no longer possible.

4.6 Monitoring of allocation constraints (Poland)

As noted in section 3.1 above, the monitoring framework accounts not just for the transfer capacities and available margins that form the key input into market-based capacity allocation. It also accounts for the implications of any additional allocation constraints imposed by TSOs. The legislation underpinning the 70 percent rule is not explicit as to whether or how such constraints are to be accounted for when assessing compliance against the 70 percent target.

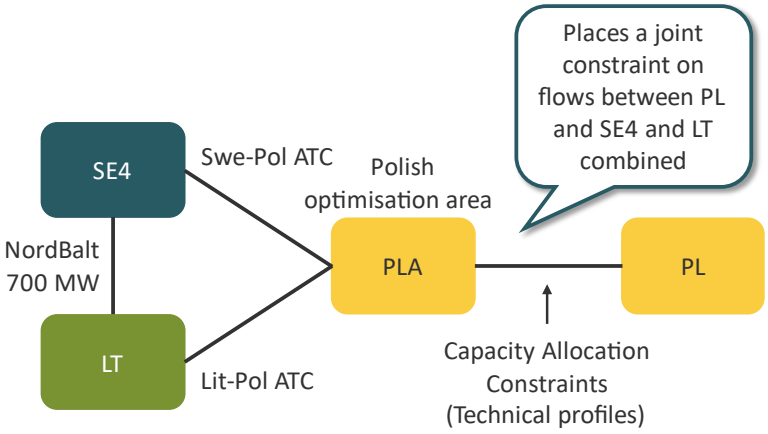
The 'common' methodology implies that the Margin Available for Cross-Zonal Trade should be calculated both including and excluding the effect of allocation constraints to help assess these constraints' impact on the relevant margin. However, according to ACER and NRAs' note on the 'common' methodology, "The Polish NRA does not consider allocation constraints relevant for the monitoring of the MACZT and therefore it will not analyse their impact of [sic] on the MACZT".[23]

An example of how allocation constraints are used in practice

To understand the arguments for and against including allocation constraints in the monitoring framework, it is useful to understand how such constraints operate in practice in Poland. A useful example is the so-called Polish optimisation area, or PLA, depicted in Figure 8 below. The Polish optimisation area is an allocation constraint implemented as a virtual bidding area positioned between Poland and the Swe-Pol and Lit-Pol HDVC cables. These cables connect Poland to Sweden and Lithuania respectively.

The area allows the Polish TSO to place a joint constraint limiting how much power can be imported or exported from Poland via these cables as a set. In practice, this arrangement allows transfers between Poland and the connected countries to be constrained without inadvertently constraining trade flows between SE4 and Lithuania via the Polish optimisation area.

Figure 8 Functioning of the Polish optimisation area



Summarising the key arguments

The argument in favour of accounting for such constraints within the monitoring regime is that they can have a significant impact on "the volume of interconnection capacity to be made available to market participants". At the extreme, the joint constraint above could be used to completely block all trade between Poland and both Sweden and Lithuania without any apparent limits to the capacities made available on any individual border. In this extreme example and when ignoring allocation constraints, the 70 percent rule would be complied with even though the effective margin for cross-zonal trade is zero. Given this link, ACER argues that the impact of allocation constraints needs to form part of a meaningful assessment of compliance against the 70 percent target.

[23] ACER, "Practical Note: Monitoring the Margin of Capacity Available for Cross-Zonal Trade," table 1.

The argument for the exclusion of allocation constraints is less clear to us. However, it is worth pointing out that ACER's methodology does include some exemptions for allocation constraints. Specifically, it distinguishes between two different sets of allocation constraints defined under CACM's Article 23.

> **Article 23(3)**
>
> "If TSOs apply allocation constraints, they can only be determined using:
>
> (a) constraints that are needed to maintain the transmission system within operational security limits and that cannot be transformed efficiently into maximum flows on critical network elements; or
> (b) constraints intended to increase the economic surplus for single day-ahead or intraday coupling."

Whereas those allocation constraints falling under point (a) are subject to monitoring, "The impact of allocation constraints introduced pursuant to Article 23(3)(b) of the CACM Regulation on MACZT should not be monitored."[24]

Certainly, the Polish optimisation area does play a useful role in ensuring that trade between Sweden and Lithuania is not compromised by Poland's desire to limit net imports or exports. In doing so, the allocation constraint supports a higher economic surplus than if the same security of supply objectives were achieved by directly restricting the Net Transfer Capacities available on the cables. However, the constraint itself would probably not fall under the exemption outlined by ACER given that its fundamental purpose is supporting operational security limits within Poland.

Considerations relevant to finding a solution

Given that allocation constraints can have a potentially large impact on the effective Margin Available for Cross-Zonal Trade, it seems appropriate that the monitoring framework should account for them. This should ideally be made explicit in the relevant legislation. Certainly, a blanket exemption for such constraints would leave a large and easily exploitable hole in the monitoring regime.

As noted above, the monitoring regime already includes some exemptions for the assessment of allocation constraints and there is scope to make these exemptions both clearer and more flexible by linking them to a requirement for agreement between all the affected TSOs and NRAs. In particular, the wording of CACM Article 23(3)b defines this type of constraint by its intent, which is hard to verify and open to abuse. In contrast, a requirement that all affected TSOs and NRAs agree on the need to exempt an allocation constraint gives considerable flexibility as to the rationale for the constraint, but it is easily verifiable and hard to abuse by any individual Member State.

[24] Footnote 36, p.19

5 ANALYSIS OF THE RULE'S IMPACT

5.1 Scope of the analysis

In this section, we describe some modelling simulations designed to help illustrate the 70 percent rule's influence on the power market and the need for remedial actions. It is important to emphasize that modelling alone cannot fully explore the costs and benefits of alternative interpretations of the rule because there is no model available that can suitably account for all the operational considerations that must be made by TSOs. Consequently, if we observe that TSOs restrict cross-zonal trade in the absence of the rule, we cannot judge whether doing so is efficient, i.e. whether this is the least-cost means of achieving an operational objective. We can simply show that valuable trade was forgone in the process.

Given this important limitation, the purpose of the modelling is to provide a high-level illustration of the rule's potential impact in the Nordics. It cannot and does not provide a full view of the costs and benefits of either the rule itself or of the different interpretations set out in the previous section.

The model analysis covers the year 2027, at which point, according to the legislative deadlines, the rule should be fully implemented. We examine one scenario designed to reflect the rule being implemented and one scenario designed to reflect a world in which the rule is not in effect. The rule's actual impact can be expected to vary over time and with future market developments. Consequently, the specific results provided should be understood as a snapshot that is subject to variation. Given this, the discussion below emphasises the general dynamics illustrated by the modelling since these can be expected to be both more robust to different outcomes and more enduring over time.

5.2 Modelling approach

The model analysis was done using the power market model *TheMA*. A more detailed description of the model can be found in the annex. The analysis was carried out in three steps:

1. Grid model analysis was used to determine the NTC values applied in the scenario in which the 70 percent rule does not apply
2. Market model simulations were performed with and without the 70 percent rule, and
3. Implied remedial action volumes and costs were calculated based on results from the market model simulations

Each of these steps is explained in further detail below.

Grid model analysis

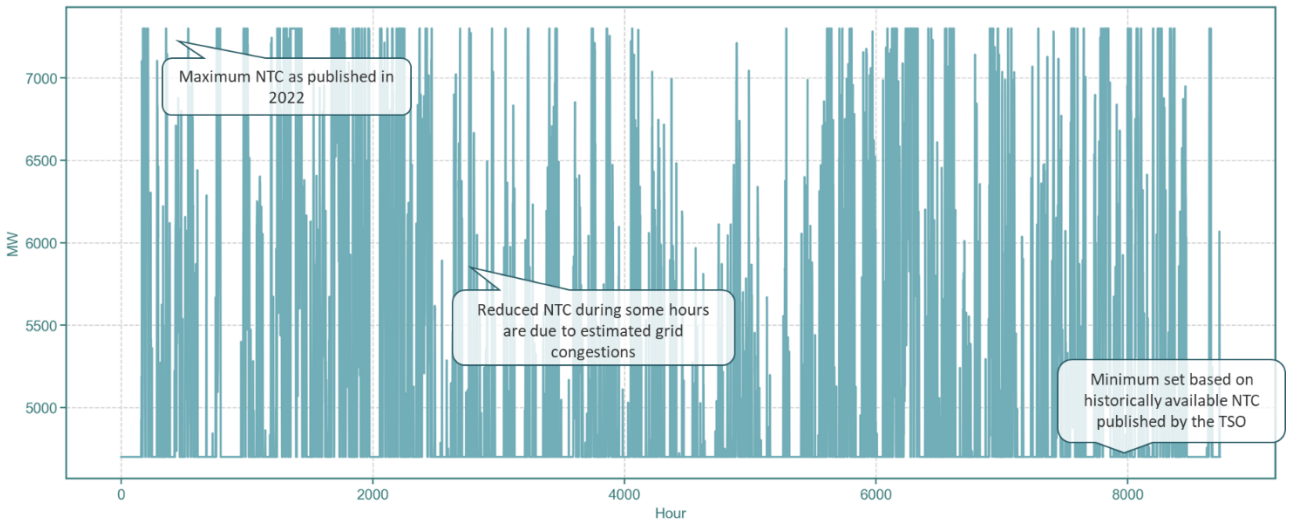
The grid model analysis was done in a nodal DC OPF model. The purpose of the analysis was to define the NTC values that would be provided to the market absent the 70 percent rule (see below). As grid data for Norway and Sweden is not publicly available, the grid dataset was based on publicly available sources, such as the grid map from ENTSO-E. The grid model, therefore, provides a simplified representation of the Nordic synchronous grid where, for instance, voltage stability constraints are not taken into account.

Market model analysis

The market model was run with an NTC coupling approach. The main reason for this choice was the limited availability of grid data and the fact that, even in a flow-based setup, we would not be able to represent many of the real-world operational constraints facing TSOs (e.g. voltage stability and quality constraints). Due to the lack of detailed grid data, we assumed that the current max NTC values reported to market operators reflect the capacities that must be made available under the 70 percent rule. That is, in the model simulation for the 70 percent rule, all NTC values were set to the max NTC reported as of 2022.

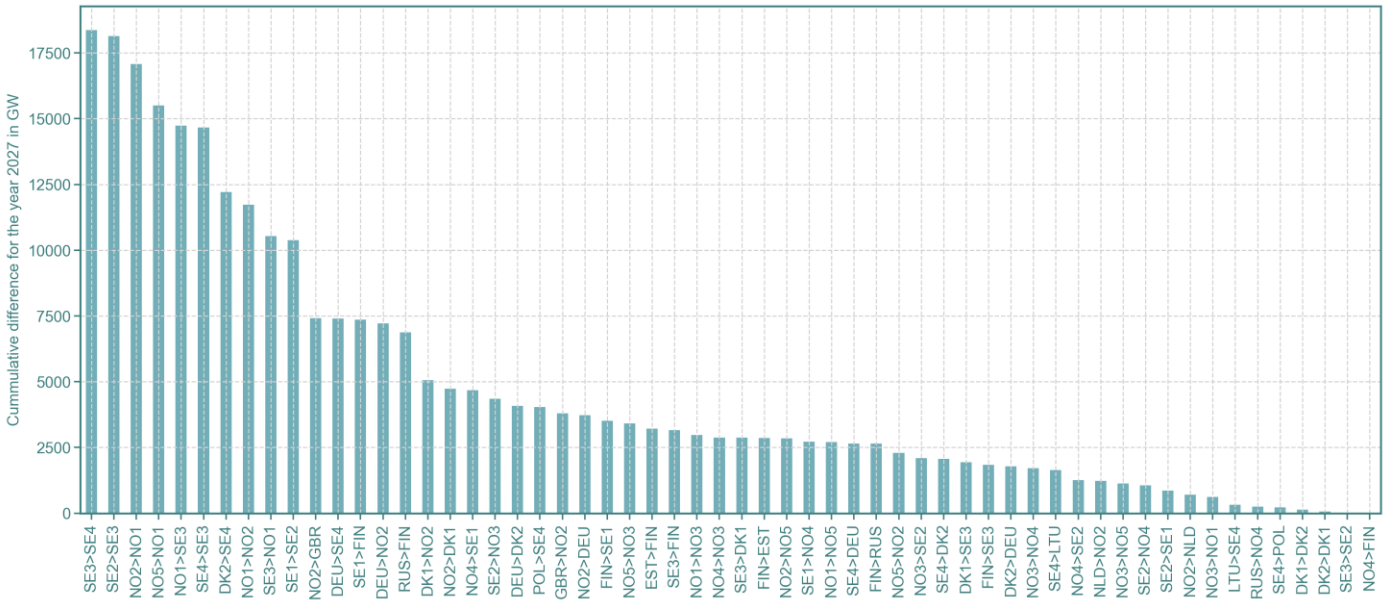
In the simulations where the 70 percent rule did not apply, the NTC values were reduced to reflect the cross-border flows from the grid model. A floor value was also imposed on each border based on historical observations of NTC values. An illustration of the NTC values made available for SE2-SE3 ("Snitt 2") for each hour of the year under the scenario without the 70 percent rule is shown in Figure 9. As you can see, in many hours these capacities fall well below the max value, which we have assumed to be the level consistent with the 70 percent rule.

Figure 9 Example of how NTC constraints are determined in the scenario without the 70 percent rule



To illustrate the implied differences in available capacity between the scenarios, we show the cumulative differences in available NTC by border in Figure 10.

Figure 10 Cumulative difference in the NTCs made available with and without the 70 percent rule by border



As can be seen, the rule's impact varies significantly from border to border, with some borders being minimally affected whereas others experience significant absolute changes in available capacity. Our simplified attempt to implement the rule implies that the biggest practical effect of the 70 percent rule is to significantly expand flows from bidding zones in northern Norway and Sweden, which are marked by the availability of relatively low-cost onshore wind, to centres of power demand in Continental Europe. Without the 70 percent rule, these flows are effectively blocked by congestion within the grid model. Although these are by no means the only borders affected by the rule, the expansion of these flows is the most notable direct impact of the rule within the Nordics.

Remedial action calculations

We have estimated the volume of remedial actions implied by the implementation of the 70 percent rule as being equal to the difference in zonal net positions (generation minus demand) for each hour when comparing the market models with and without the 70 percent rule. For instance, if the scenario without the 70 percent rule showed higher generation than the scenario with the 70 percent rule in a given zone and hour, we interpret this as a need for upregulation in that zone when the 70 percent rule is applied.

In practice, this implies that remedial actions are used to fully restore the zonal balances implied by the grid model. This approach potentially overestimates the total need for remedial actions, as some of the implied changes may be motivated by dispatch efficiency rather than operational security. Some adjustments, described in section 5.3.1, have been made to strip out the most conspicuous examples where changes appear to reflect dispatch optimisation rather than system security. However, the modelling approach does not allow a clear distinction to be made between the two.

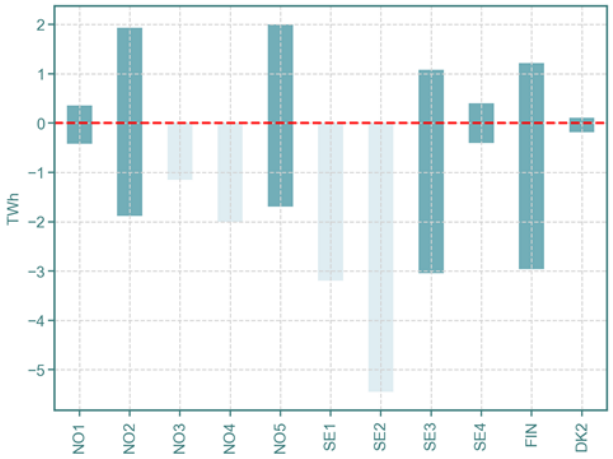
We have also sought to provide an indicative cost for the volume of remedial actions calculated above. The cost estimate is based on the use of supply curves constructed to reflect the generation flexibility available in the relevant zone and is described in further detail in section 5.3.2 below.

5.3 Results

5.3.1 Volume of remedial actions

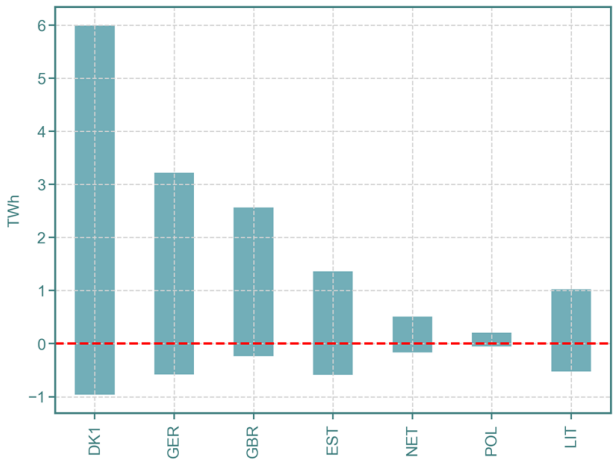
As discussed above, we use the difference in zonal generation/demand balances between scenarios with and without the 70 percent rule as a basis for understanding the potential need for remedial actions. The differences observed for each zone within the Nordic synchronous area are shown in Figure 11. The volumes above the horizontal axis reflect a need for increased generation, whereas the areas below the axis reflect a need for reduced generation. Figure 12 shows the equivalent information for other zones, however, while the total volume of regulation in these other zones is reasonable, the zonal allocation is unreliable because the zones have not been modelled in detail.

Figure 11 Regulation volumes within the Nordic synchronous area



Note: NO3, NO4, SE1 and SE2 are assumed to need no up-regulation of hydro

Figure 12 Regulation volumes outside the Nordic synchronous are



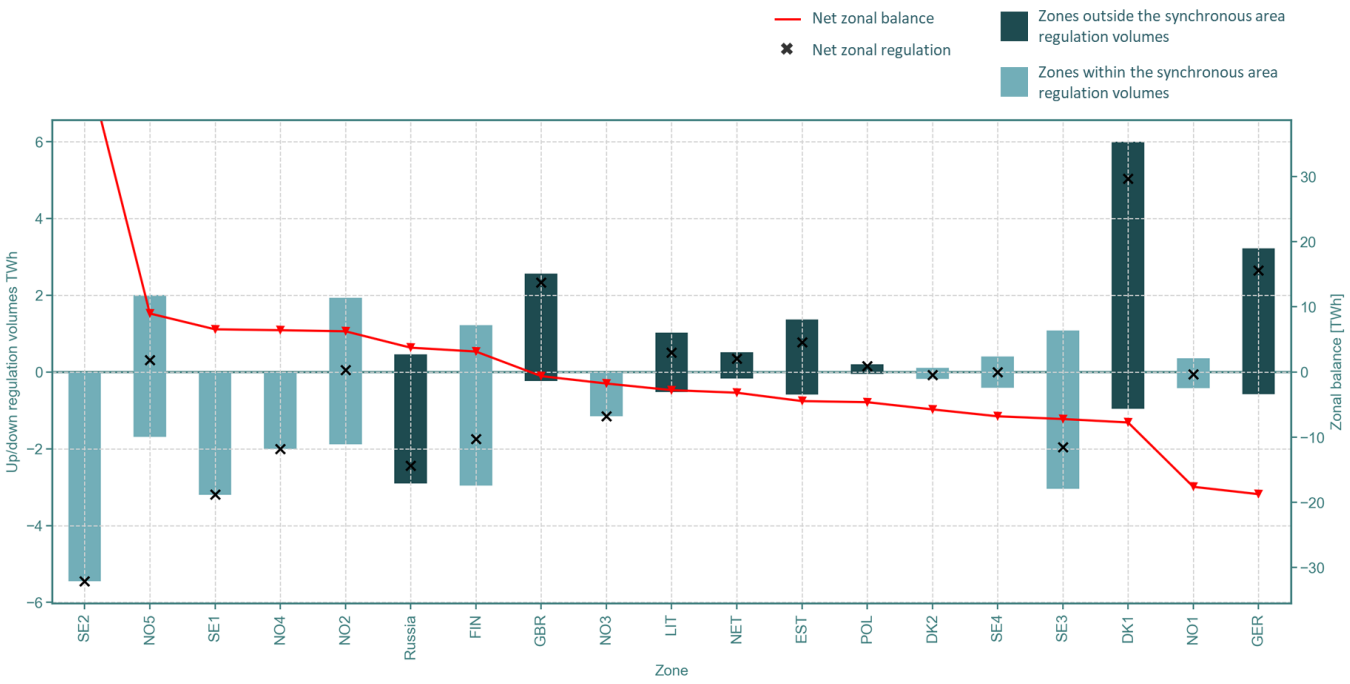
Note: Although the total volume of regulation shown above is reasonable, the zonal allocation is unreliable because these zones have not been modelled in detail.

The figures suggest a general need for up-regulation in net load zones, notably in Continental Europe. Conversely, areas with a generation surplus, predominately in the North, experience a need for down-regulation.

Note that some of the differences in hourly zonal balances observed in the two scenarios are the result of differences in hydro reservoir management that are unlikely to be driven by the need for remedial actions. We have removed the most obvious examples of this from the numbers by stripping out increases in hydro generation from NO3, NO4, SE1 and SE2. Put simply, up-regulation is unlikely to be necessary in such zones given the fact that low-cost generation capacity significantly outstrips within-zone demand.

Figure 13 shows the same information on the need for up- and down-regulation against each zone's overall generation/demand balance (shown in red). In general, we would expect to see zones with large generation surpluses, like SE2, to have a disproportionately high need for down-regulation. Similarly, we would expect zones with a negative generation/demand balance to have a disproportionately high need for up-regulation. Although these expectations are partially borne out in the data, the actual patterns observed are more complicated. SE4, for example, has relatively symmetric needs for up- and down-regulation despite having significantly more consumption than generation. Given that SE4 is located between surplus and deficit zones, it may be that it acts as more of a transfer zone for the trade flows enabled by the 70 percent rule. Consequently, even though flows through SE4 are affected by the need for remedial actions, the ultimate need for changes in generation is felt in other zones.

Figure 13 Relationship between the need for up/down-regulation (left axis) and zonal balances (right axis)

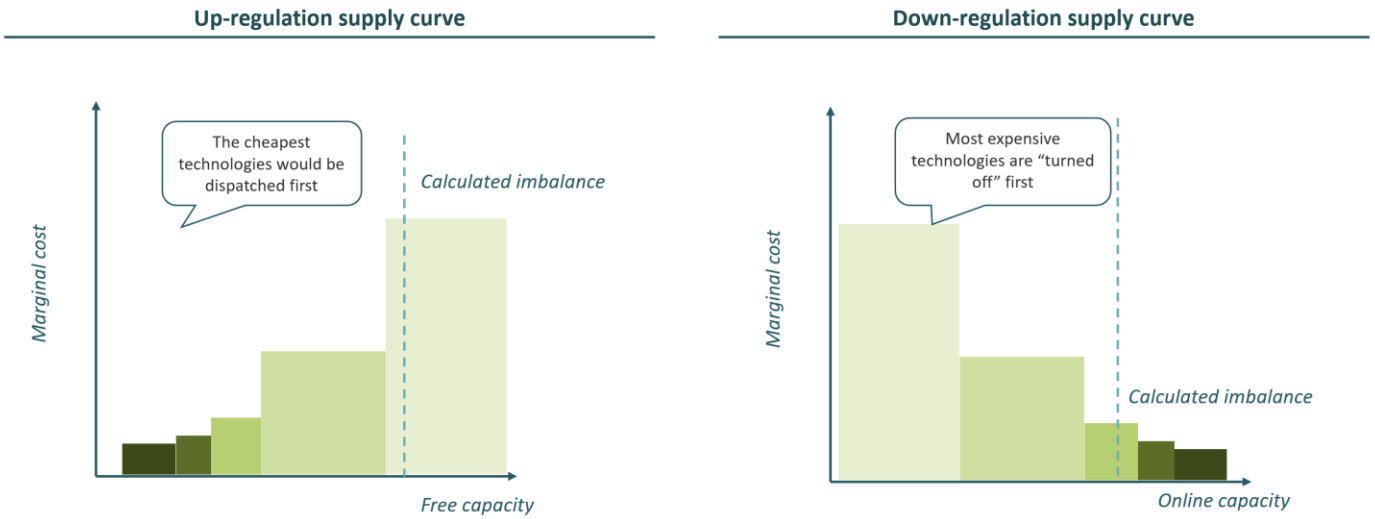


Note: Although the total volume of regulation shown for zones outside the Nordic synchronous area is reasonable, the allocation among these zones is unreliable because these zones have not been modelled in detail.

5.3.2 Potential cost

Remedial actions impose a cost that will depend on how much flexibility there is in the system. To examine the approximate scale of the costs involved, we construct supply curves for every hour and each zone. The volumes of up- and down-regulation available reflect the actual dispatch solution in the relevant hour such that, for example, hours with high wind generation enable greater down-regulation of wind. The costs of regulation reflect the marginal costs of the relevant generation technology. Figure 14 illustrates the resultant structure of these supply curves.

Figure 14 Illustration: Supply curves for countertrade costs calculation

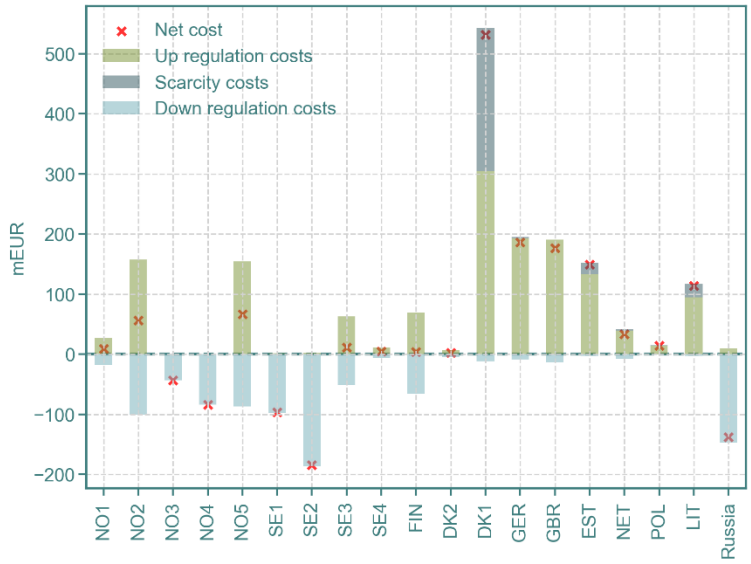


During the hours in need of up-regulation, the cheapest technologies available are dispatched first and the costs are calculated on a pay-as-bid basis. In other words, the cost estimate reflects the area under the stepped curve shown. For up-regulation, we assume that the most expensive technologies are shut down first. In this case, the 'costs' of down-regulation are negative and equal to the avoided costs of generation. This approach to cost estimation produces an estimate that approximates the economic costs of countertrade since it excludes both the possibility of strategic bidding on the part of flexibility providers as well as the paying of prices in excess of a bidder's marginal costs. The actual financial costs of countertrade and redispatch may be higher.

Applying this logic to the required volumes of up- or down-regulation in each zone, we obtain the total costs for all remedial actions, as shown in Figure 15. Note that all of the cost impacts are attributed to the zone with the original need for up- or down-regulation. The element labelled 'scarcity costs' corresponds to hours where the need for up- or down-regulation exceeds the estimated potential flexibility within the zone. During these hours, we assume that flexibility is provided at an assumed scarcity price of 100 EUR/MWh. In reality, this flexibility might potentially be sourced from other zones where excess transmission capacity is available or through demand-side response. However, the simplified modelling approach used here does not allow us to transfer the need for remedial action to other zones.

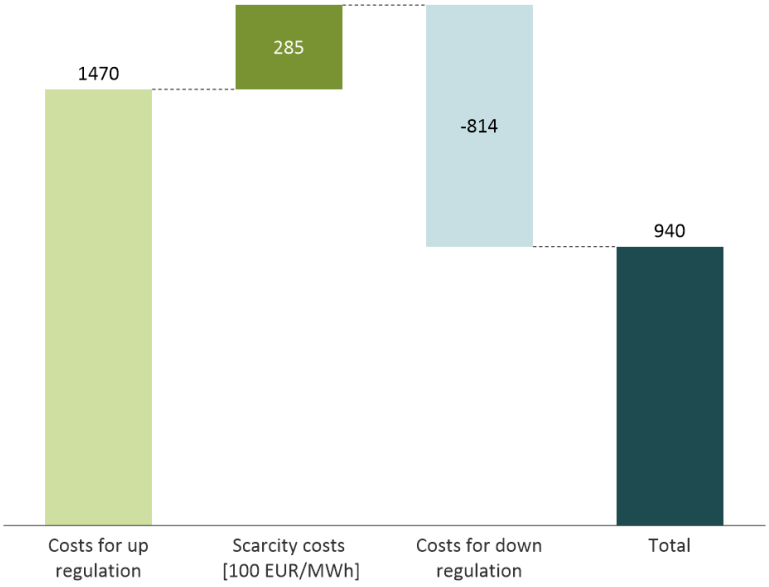
As mentioned in Section 5.3.1, the zonal attributions for zones outside of the Nordic synchronous area are unreliable as these zones have not been modelled in detail. However, these numbers feed into the estimation of the overall costs of remedial actions, some of which are undertaken outside the Nordic synchronous area.

Figure 15 Annual costs of remedial actions per component in each zone



When aggregating the total costs for the entire region, we end up with three different components: the costs of up-regulation, the costs attributable to our assumed scarcity prices and the savings (avoided costs) due to down-regulation. For 2027 and under these assumptions, the total cost of all remedial actions implied by the implementation of the 70 percent rule on the Nordic borders comes out at just under one billion euros. This covers the costs of 22 TWh of countertrade, i.e. 22 TWh of up-regulation and 22 TWh of down-regulation (See Figure 15). This implies an average cost of about 21 EUR/MWh for a unit of up or down-regulation.

Figure 16 The implied cost of remedial actions in million EUR for 2027



To put these numbers in context, Denmark's total electricity consumption amounted to about 35 TWh in 2021 after losses.[25] As such, the scale of remedial actions is very large. Germany's total costs for all grid congestion management activities amounted to about 1.4bn EUR in 2020 of which 355m EUR were the costs of countertrade and redispatch.[26] The average costs for countertrade and redispatch in 2020 were about 21 EUR/MWh, nearly identical to our modelled estimate.[27]

It is important to note that these costs are measured relative to a starting position in which virtual capacity is assumed to be available. Consequently, even if these remedial actions were perfectly efficient and produced an ultimate dispatch solution that was fully efficient, our results would still show an economic cost associated with remedial actions. In this case, this cost would fully reflect the economic 'cost' of the virtual capacity being unavailable. For example, if virtual trade capacity allows us to substitute a costly generator with a cheaper one, at least in the market solution, remedial actions are seen to reverse this benefit, resulting in a cost.

The calculated cost of remedial actions in the analysis, therefore, reflects both the potential gross benefits, excluding costs, of achieving the 70% rule without the need for remedial actions and a conservative estimate of the financial costs of the remedial actions needed to achieve the target when relying on the use of virtual capacity. The estimate is conservative because it reflects pay-as-bid costs combined with cost-reflective bidding behaviour. In reality, providers of flexibility may well receive payments that exceed their pure costs.

Given that the degree of flexibility available to System Operators is a potentially important driver of these costs, we have also conducted some sensitivity analysis related to the flexibility assumptions. For illustration purposes, we have estimated the use of the fallback 'scarcity price' under different assumptions about the flexibility available from different technologies. These assumptions are set out in Table 2. The percentages show the share of technically available capacity, based on the market dispatch solution, that we assume the System Operator can make use of when organising remedial actions. Please note that where non-dispatchable technologies are listed as available for up-regulation, we do not mean that they can produce more than what is physically possible but rather that any voluntary curtailment can be reversed.[28]

[25] Energistyrelsen, "Electricity Monthly Statistics."
[26] This covered 16.561 TWh of countertrade and redispatch, seemingly with both up and down regulation contributing to the total. The equivalent figure from our modelling would therefore be around 44 TWh.
[27] Bundesnetzagentur, "Monitoringbericht 2021," table 56.
[28] Hydro RoR (Run of river) has been modelled as must-run and therefore only down-regulation is relevant in this case.

Table 2 Available regulation volumes as a percentage of available capacity per scenario

Generation technology	Base Case (Full availability)		Case 1 (Selected technologies)		Case 2 (Selected and restricted technologies)	
Gas	100%	100%	100%	100%	50%	50%
Bio	100%	100%	0%	0%	0%	0%
Hydro Res	100%	100%	100%	100%	50%	50%
Wind	100%	100%	100%	100%	50%	50%
Nuclear	100%	100%	0%	0%	0%	0%
Coal	100%	100%	0%	0%	0%	0%
Lignite	100%	100%	0%	0%	0%	0%
Oil	100%	100%	100%	100%	50%	50%
CHP	100%	100%	0%	0%	0%	0%
Peat	100%	100%	0%	0%	0%	0%
Hydro RoR	0%	100%	0%	100%	0%	50%
Solar	100%	100%	100%	100%	50%	50%

As is to be expected, reducing available flexibility within the different zones makes it harder to find sufficient flexibility. For each case described above, the shortfall—or scarcity volumes—implied in each zone is shown in Figure 17. Here we observe that SE3 appears to be particularly at risk of remedial action volumes outstripping the local supply of generation flexibility.

The magnitude of the shortfalls highlights the importance of system flexibility when implementing the 70% rule using virtual capacity. It is important to note that some of these scarcity volumes could potentially be mitigated through demand response measures, such as load shifting. Due to the challenges of modelling demand response at specific grid nodes, we do not model demand flexibility for these scenarios and therefore the shortfall volumes presented in this chapter can be interpreted as an upper bound for each zone.

Figure 17 Increased scarcity volumes per scenario. On the left: Results for case 1. On the right: Results for case 2

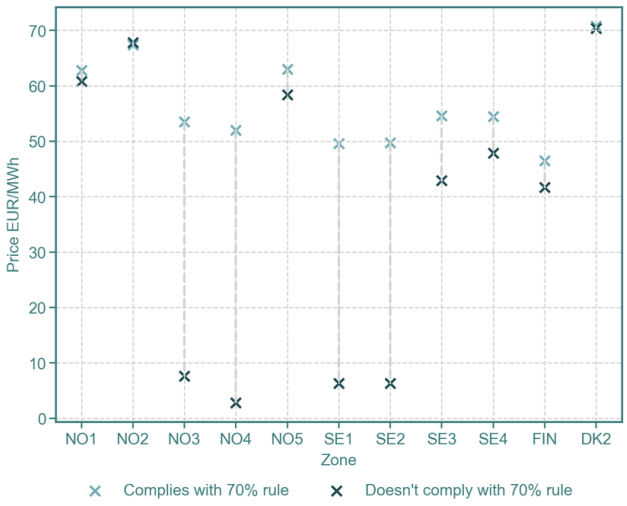
5.3.3 Price impacts

The 70 percent rule increases the cross-zonal capacity available to the market, allowing for larger exchanges of power between net generation and net consumption zones. This results in greater price convergence between net generation and net consumption zones under the 70 percent rule, with generation zones receiving higher prices and consumption zones lower prices.

As discussed in more detail in section 5.4, structural increases in cross-zonal capacity have the potential to increase social welfare. However, if this price convergence is supported by the provision of virtual capacity, it may distort price signals and incentives, ultimately reducing welfare. For example, higher prices in net generation zones that cannot usefully export their power may weaken the incentives to consume power within such zones or, equivalently, result in excessive incentives to increase generation. In both cases, poor incentives can encourage inefficient, welfare-costly behaviour.

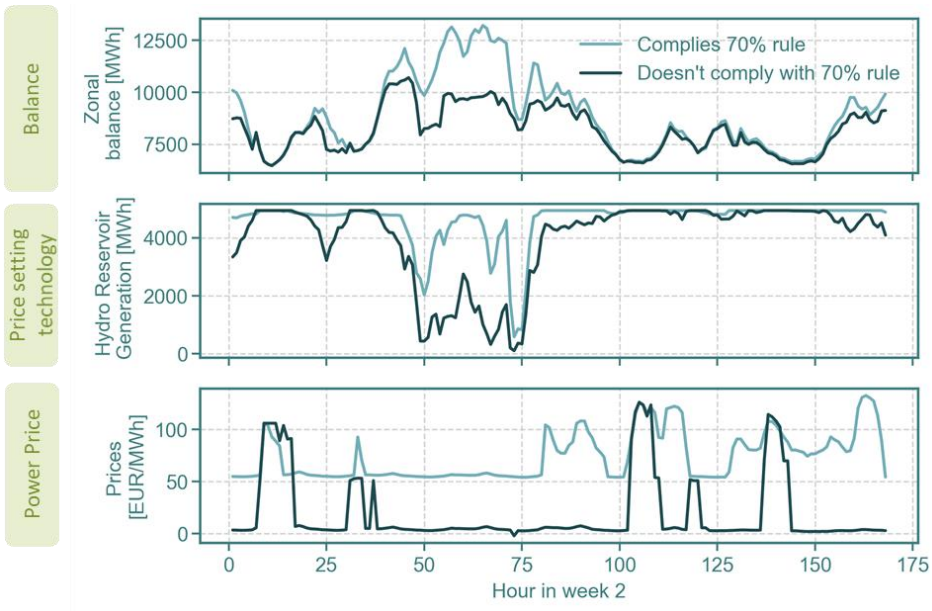
In terms of the price effects observed in the modelling, the restriction of available transmission capacity in the scenario without the 70 percent rule means that zones with large power surpluses, such as northern Norway and northern Sweden, have prices that significantly decouple from those in more southerly zones. Prices in these zones are very sensitive to changes in the zonal power balance and available export capacity. This was clearly shown by the experiences of 2020, where power prices were less than 10 EUR/MWh in Norway and less than 15 EUR/MWh in northern Sweden due to the large power surplus and limited export capacity in these regions. Since prices on the Continent are typically higher than those in the Nordics, higher transmission capacities under the scenario with the 70 percent rule tend to increase effective export capacity and pull up prices in the Nordics, as seen in Figure 18.

Figure 18 Change in average zonal prices with and without the 70 percent rule



To illustrate the mechanisms responsible for the marked decoupling of prices in the northernmost zones, it is useful to take a closer look at the hourly structure of prices in SE2, as shown in Figure 19. Absent the 70 percent rule, cross-zonal transmission capacity is restricted, effectively reducing the potential for generators in these zones to export power. We see the effects of this export restriction as a decline in output from hydro generators in the week shown and in the net generation position of the zone overall. In contrast, when export capacity is available under the scenario with the 70 percent rule, power can be exported at prices reflective of the willingness-to-pay in neighbouring zones and this supports prices of around 50 EUR/MWh during the middle of the day. Absent this export capacity, generation is effectively trapped in SE2 and prices frequently fall to the much lower levels needed to encourage some hydro generation.

Figure 19 Hourly structure for a selected week in SE2



5.3.4 Value of cross-zonal capacity

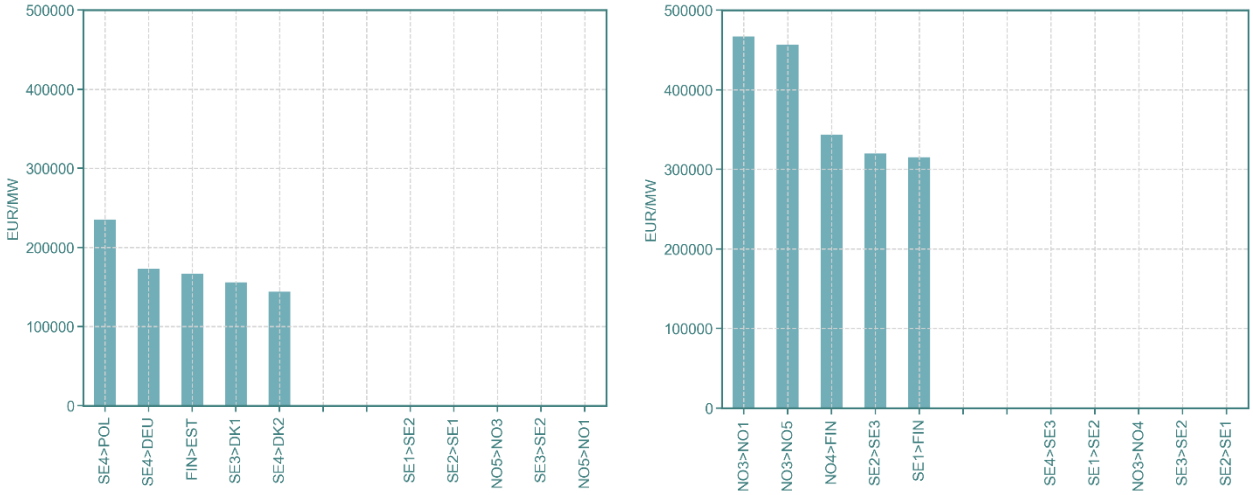
Implicit in the creation of the 70 percent rule is the idea that restrictions to cross-zonal capacity below the 70 percent threshold impose a welfare cost that is greater than the costs of investment and system management activity needed to support higher cross-zonal trade. In short, the rule assumes that forcing trade capacity up to a certain level is net beneficial. We cannot reliably estimate the investment and network management costs needed to expand trade capacity and so cannot directly assess the validity of this underlying assumption. However, we can say something about the benefits that changes to cross-zonal capacity would bring on each border, thereby making clear the benefits, if not the costs, of increasing trade capacity.

The size of these benefits depends on how much trade is already occurring and the extent to which prices in the connected zones have already partially converged. In general, adding trade capacity will be subject to diminishing returns, with initial additions from a small starting base being more valuable than subsequent additions when prices between the zones have already started to converge.

Figure 20 shows the welfare benefit associated with adding a marginal unit of capacity to specific borders in 2027. The borders shown are those with the lowest and the highest marginal values and give a sense of both the magnitude of the benefits and how they can change. The chart on the left shows the results assuming the 70 percent rule is implemented. In this case, the abundance of power available in northern Sweden and Norway can reach SE4 thanks to the cross-zonal capacities made available to the market. As such, the most valuable capacity additions involve strengthening connections between southern Sweden (SE4) and the Continent. The numbers involved suggest that an additional MW of transfer capacity between SE4 and Germany would provide welfare benefits, ignoring the costs of the infrastructure, of about 170,000 EUR/MW in that year. In contrast, the chart on the right shows the results assuming the 70 percent rule is not implemented. In this case, the most valuable capacity additions involve borders, notably within Norway and Sweden, that can help relieve the effective export constraint facing low-cost generation in northern Norway and Sweden. The value of these additions is notably larger than those in the scenario in which the 70 percent rule is enforced, and in which greater price convergence has already been achieved. Strengthening the North-South flows out of NO3

implies annual benefits before costs of around 460,000 EUR/MW. The implications of these differences, notably on incentives to invest in cross-zonal capacity, are considered in further detail in section 5.4.

Figure 20 Value of additional cross-zonal capacity. On the left: results with the 70 percent rule. On the right: results without the 70% rule.



Note: The '>' symbol indicates the direction of the flows.

5.4 Conclusions

In seeking to analyse the impacts of the 70 percent rule, it is apparent that its influence extends far beyond the direct effect on trade and the need for remedial actions. In this section, we look at the results as a whole and what they imply for both the 70 percent rule's overall impact and the appropriate focus of policy development.

5.4.1 The need for and costs of remedial action

The structure of the modelling approach assumes that the 70 percent rule is complied with in all hours and, where necessary that this is achieved using remedial actions, either in the form of countertrade or redispatch. We cannot accurately determine what cross-zonal capacities are formally required by the 70 percent rule due to the lack of available grid data and the fact that the rule is defined at the level of individual network elements. Our assumptions imply that there is a significant mismatch between what the grid will be capable of in 2027 and the capacities that must be made available for trade under the rule. As noted above, the modelling implies the need for something like 22 TWh of both up and down-regulation each year just to comply with the rule across the Nordics' borders.

If the mismatch between feasible operation and the requirements of the rule is as large as assumed and compliance is to be achieved using virtual capacity and remedial actions, we are going to see correspondingly large financial flows linked to these remedial actions. Having such large financial flows occur outside of the power market is unlikely to be desirable. In particular, it will weaken the importance of the price signals provided by the market, as described below, and may result in elements of the system's dispatch behaviour being increasingly determined outside the market and its associated regulatory framework. Extensive reliance on remedial actions would also end up creating large transfers between network tariff payers and flexibility providers.

5.4.2 The impact on prices

Increases in trade capacity resulting from the 70 percent rule can significantly alter trade volumes and prices. Provided that these increased trade volumes are realised, i.e. that expanded market trade reflects structural improvements in the system's ability to transfer power between regions, the resultant changes in prices will be indicative of the welfare benefits realised through such trade. Perhaps most obviously, price convergence between zones implies that net generation zones receive higher prices, increasing generation revenues, while net consumption zones receive lower prices, lowering consumption costs. However, if the 'increase' in market trade achieved by the rule is entirely virtual, then this increase reflects a growing discrepancy between market outcomes and physical reality that is liable to undermine efficiency and add to economic costs.

To see this, imagine that the 70 percent rule's only effect was to encourage offers of virtual capacity by TSOs, capacity which is then withdrawn through countertrade. Let us also imagine, rather generously, that the countertrade used to restore system security is perfectly efficient. What will happen to prices when there is extensive use of virtual capacity to achieve compliance.

As discussed above in section 5.3.3, adding cross-zonal capacity to the market will tend to affect prices. However, this modelling result implicitly assumes that the market believes that more cross-zonal capacity is available. If cross-zonal capacities are routinely withdrawn through intraday countertrade and this practice becomes a systematic part of the market, market actors should realise that the actual capacity available between zones is not what is being reported to the day-ahead market. Market actors should instead anticipate countertrade and its effect on prices. Eventually, the post-countertrade prices may themselves be reflected in the bids and offers made day-ahead. Taken to the extreme, the day-ahead market might effectively ignore 'virtual' capacity entirely, with prices being identical irrespective of whether virtual capacity is made available. To the extent this is true, and the market comes to anticipate the virtual nature of the capacity, the modelled price impacts of additional cross-zonal capacity may be exaggerated.[29]

That said, it is very unlikely that market participants will be fully capable of filtering out the impact of virtual capacity and countertrade on prices. There will always be some degree of uncertainty that prevents day-ahead prices from fully reflecting the market solution absent virtual capacity. Consequently, additional virtual capacity will influence market prices and pull day-ahead prices out of alignment with the real-world capabilities of the power system.

[29] There are parallels here to so-called inc-dec gaming, in which spot market actors alter their bids and offers to reflect the anticipated energy price in a subsequent redispatch market. We should expect structural countertrade resulting from the 70 percent rule to give rise to the same anticipatory bidding behaviour. There is, however, a potentially important difference in that inc-dec gaming relies on differences in the geographic structure of the spot and redispatch markets, which are the result of congestion in the physical grid. As a result, market actors within a single spot market bidding zone face potentially different bidding incentives and these differing incentives tend to systematically exacerbate congestion within the bidding zone. In the context of the 70 percent rule, if countertrade is conducted in a market with the same zonal definition as the day-ahead market, market actors within each bidding zone all face the same bidding incentives. As a result, their anticipatory bidding behaviour should not be expected to systematically exacerbate congestion problems. On the contrary, their bidding behaviour can be seen as playing a useful market function in terms of signalling a more realistic expectation of equilibrium prices after virtual capacity has been removed from the market via countertrade.

5.4.3 The efficiency of price signals

This distortion of prices resulting from offers of virtual capacity has the potential to harm efficiency. In section 5.3.3, we saw how zones with net generation in the northernmost Nordics could potentially achieve prices that were significantly above the marginal value of generation. This occurred due to a belief that more power could be exported from these zones than the grid model suggested was feasible. This inefficient price signal has the potential to motivate a range of inefficient behaviours, such as insufficient power consumption, excessive generation and poor investment decisions.

The extent to which inefficient decisions are triggered by these distorted day-ahead market prices will depend on how important these prices are in motivating actual behaviour. If decisions to invest in additional generation capacity in saturated bidding zones are taken based on an analysis of future market prices that makes transparent the sensitivity of prices to available cross-zonal export capacity and the impact of the 70 percent rule, then the actual impact on generation investment may be smaller than implied by the large, modelled difference in average prices in one year. However, these price effects still clearly have the potential to motivate inefficient decisions and thereby reduce welfare. In this case, these inefficiency costs are not the costs of implementing the 70 percent rule itself but rather the costs of inadvertently creating a systematic mismatch between the capacity reported as available to the market and the physical limitations of the system.

Distorted prices will also change the price spreads between zones and thereby the apparent value of additional cross-zonal transmission capacity. As shown in Figure 20 above, the welfare impact of marginal capacity increases on various cross-zonal borders changes significantly depending on whether or not the 70 percent rule is implemented. These changes reflect the potential impact on the marginal congestion incomes available on different borders and how the 70 percent rule tenders to narrow price spreads and therefore the marginal income available from investment in cross-zonal capacity. However, similar to the discussion above on the basis for investment decisions in generation capacity, the scope for these price changes to result in inefficient investment decisions in cross-zonal capacity will depend on the analytical basis on which these decisions are made. If the relevant investments are driven by investment on the part of TSOs, then these TSOs will presumably understand that the true value of investments in physical transmission capacity between zones will be to substitute the use of virtual capacity (supported by the cost of remedial actions) with structural capacity. Provided that the relevant TSOs are responsible for bearing the costs of the remedial actions that can be forgone following the investment, then the value associated with forgoing these costs may well be an appropriate incentive to invest in cross-zonal capacity even in the absence of a conspicuous price spread.

5.4.4 The critical distinction between structural and virtual increases in trade capacity

The above discussion highlights again the critical distinction between structural and virtual additions to cross-zonal capacity. Whereas structural increases in trade capacity can support more efficient dispatch and therefore increased welfare, compliance that is based on the persistent use of remedial actions is, at best, going to incur countertrade and remedial costs that offset the welfare gains of ‘virtual’ trade. At worst, the use of virtual capacity will induce suboptimal dispatch, increase security of supply risks and trigger a range of inefficient market behaviour based on distorted price signals. This implies a need to make the distinction between structural and virtual increases in trade capacity more prominent in the legislative framework surrounding the 70 percent rule.

ANNEX 1: Modelling Framework

The analysis in this project was conducted using the TheMA power market model, including its grid module. The model is a deterministic partial economic equilibrium model. It matches supply and demand on an hourly basis, with the price determined by the marginal costs of the marginal generator (or the marginal willingness-to-pay of the marginal consumer). There is no strategic behaviour or market power assumed in the model. The model is licensed to several European utilities, electricity consumers, authorities and financial institutions. The grid module is implemented as a nodal DC OPF model, which simulates the physical flows in the transmission grid. The DC OPF approach neglects active power losses and only active power flows are simulated. There are, for example, no voltage stability constraints represented in the model.

To find the intersection between supply and demand, the model uses linear programming techniques, since the matching of demand and supply can be formulated as a mathematical welfare maximisation problem under a set of constraints. The model itself is implemented in GAMS (General Algebraic Modelling System) and is run with the commercial solver CPLEX.

The model accounts for start-up and ramping costs, as well as other intertemporal restrictions relevant to generation costs. The approach for modelling start-up costs and part-load efficiencies is based on Weber, C. (2004): “Uncertainties in the electric power industry: methods and models for decision support”. The model has full sequential hourly time resolution. It incorporates detailed hydropower modelling, based on implicit water values, and includes the simulation of reservoirs, hourly plant availability and inflows, and minimum discharge/generation restrictions, etc. Variable renewable generation, like wind and solar, is modelled using historically observed hourly volatility.

The geographical scope of the model used in this analysis covers the Nordic synchronous grid. That is, all Nordic zones except DK1 are represented endogenously in the model. All connected zones (including DK1) are represented with an exogenously given price series, with trade to the Nordic zones limited by NTC values. Cross-zonal flows are optimised (based on the price spread), assuming implicit NTC coupling between all bidding zones.

In this study, all assumptions for electricity demand, generation capacities, fuel prices, etc are based on the Best Guess scenario from THEMA’s power market outlook as of February 2022.

REFERENCE LIST

ACER. “ACER Report on the Result of Monitoring the Margin Available for Cross-Zonal Electricity Trade in the EU in the First Semester of 2020,” 2020. https://www.acer.europa.eu/Official_documents/Acts_of_the_Agency/Publication/MACZT report - S1 2020.pdf.

———. “Action Plans: Overview and Main Characteristics,” 2022. https://documents.acer.europa.eu/Official_documents/Acts_of_the_Agency/Publications Annexes/ACER Report on the result of monitoring the MACZT Generic/ACER Report on the result of monitoring the MACZT Derogations.pdf.

———. “Estimating the Margin Available for Cross-Zonal Trade Pursuant to ACER Recommendation 01/2019 in Light of Article 16(8) of Regulation (EU) 2019/943 (Version 2),” 2020. https://documents.acer.europa.eu/en/Electricity/Market monitoring/Documents/20201209 Methodological paper MACZT_final.pdf.

———. “Practical Note: Monitoring the Margin of Capacity Available for Cross-Zonal Trade,” April 12, 2022. https://extranet.acer.europa.eu/official_documents/acts_of_the_agency/publication/acer and nras practical note maczt.pdf.

———. “Recommendation 01/2019,” August 8, 2019. https://www.acer.europa.eu/Official_documents/Acts_of_the_Agency/Recommendations/ACER Recommendation 01-2019.pdf.

———. “Recommendation 02/2021: Annex 4 – Reasoning to Proposed Amendments to the CACM Regulation,” 2021. https://acer.europa.eu/Official_documents/Acts_of_the_Agency/Recommendations Annexes/ACER Recommendation 02-2021 on CACM/ACER Recommendation 02-2021 on CACM - Annex 4 - CACM Reasoning.pdf.

———. “Report on the Result of Monitoring the Margin Available for Cross-Zonal Electricity Trade in the EU in 2021.” Ljubljana, June 10, 2022. https://www.acer.europa.eu/sites/default/files/documents/Publications/ACER MACZT Report 2021.pdf.

Bundesnetzagentur. “Monitoringbericht 2021,” 2022. https://www.bundesnetzagentur.de/SharedDocs/Mediathek/Monitoringberichte/Monitoringbericht_Energie2021.pdf?__blob=publicationFile&v=6.

Commission de régulation de l’énergie. “European Green Deal: Contribution of the Commission de Régulation de l’énergie,” 2020. https://www.cre.fr/en/media/File/autres/fiche-europe-1.

Energistyrelsen. “Electricity Monthly Statistics.” Accessed June 30, 2022. https://ens.dk/en/our-services/statistics-data-key-figures-and-energy-maps/annual-and-monthly-statistics.

Entso-E. “CACM 2.0 Amendment Advocacy Report,” February 2021. https://eepublicdownloads.azureedge.net/clean-documents/Network codes documents/NC CACM/2022/February_NC-ENTSOE_CACM_Amendment_advocacy_report_TSOs_only_part_light_version.pdf.

German TSOs. “Report of the German Transmission System Operators on Available Cross-Zonal Capacity for the Year 2020 Pursuant to Article 15(4) Internal Market for Electricity Regulation (EU) 2019/943.” Berlin, Dortmund, Bayreuth, Stuttgart, Malmö, 2021. https://www.netztransparenz.de/portals/1/Compliance_bericht_EN.pdf.

Disclaimer

Unless stated otherwise, the findings, analysis and recommendations in this report are based on publicly available information and commercial reports. Certain statements in this report may be statements of future expectations and other forward-looking statements that are based on THEMA Consulting Group AS (THEMA) its current view, modelling and assumptions and involve known and unknown risks and uncertainties that could cause actual results, performance or events to differ materially from those expressed or implied in such statements. THEMA does not accept any liability for any omission or misstatement arising from public information or information provided by the Client. Every action undertaken on the basis of this report is made at own risk. The Client retains the right to use the information in this report in its operations, in accordance with the terms and conditions set out in terms of engagement or contract related to this report. THEMA assumes no responsibility for any losses suffered by the Client or any third party as a result of this report, or any draft report, distributed, reproduced or otherwise used in violation of the provisions of our involvement with the Client. THEMA expressly disclaims any liability whatsoever to any third party. THEMA makes no representation or warranty (express or implied) to any third party in relation to this report. Any release of this report to the public shall not constitute any permission, waiver or consent from THEMA for any third party to rely on this document.

About THEMA

THEMA Consulting Group is a Norwegian consulting firm focused on Nordic and European energy issues, and specializing in market analysis, market design and business strategy.

THEMA Consulting Group

Øvre Vollgate 6

0158 Oslo, Norway

www.thema.no

Berlin office

Albrechtstrasse 22

10117 Berlin, Germany