# Explanatory Note of the “Methodology for a coordinated capacity calculation in accordance with Article 37 of Commission Regulation (EU) 2017/2195 of 23 November 2017 establishing a guideline on electricity balancing within GRIT CCR”

Consultation document

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Disclaimer: This explanatory document is submitted by the TSOs of the Greece-Italy region for information and clarification purposes only accompanying the TSOs’ proposal for a “Methodology for a coordinated capacity calculation in accordance with Article 37 of Commission Regulation (EU) 2017/2195 of 23 November 2017 establishing a guideline on electricity balancing within GRIT CCR”.

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# 1. Introduction

This technical document sets out the main principles for the "Methodology for a coordinated capacity calculation in accordance with Article 37 of Commission Regulation (EU) 2017/2195 of 23 November 2017 establishing a guideline on electricity balancing within GRIT CCR".

The participating TSOs for this calculation are Terna (IT) and IPTO (GR).

The border between Greece and the connecting Italian Bidding Zone (Italy "SUD") and all the borders between internal Italian Bidding Zones are considered.

# 2. Coordinated NTC calculation methodology

## 2.1. Inputs

In order to allow the Coordinated Capacity Calculator to perform the relevant CCC processes, each TSO for the GRIT region shall provide the following relevant input data:

- Base Case – Individual Grid Models
- Generation Load Shift Keys
- List of contingencies
- List of available Remedial Actions
- Operational security limits

In this chapter details about the previous data are described.

### 2.1.1. List of contingencies

A Critical Network Element (CNE) is a network element either within a bidding zone or between bidding zones monitored during the CCC process. The CNEC (Critical Network Element and Contingencies) is a CNE limiting the amount of power that can be exchanged, potentially associated to a contingency. They are determined according to the procedure described in Annex 1 of the Methodology for a coordinated capacity calculation in accordance with Article 37 of Commission Regulation (EU) 2017/2195 of 23 November 2017 establishing a guideline on electricity balancing within GRIT CCR, considering the list of contingencies defined by each GRIT TSO for its own network, according to article 33 of the Regulation (EU) 2017/1485.

Hence, the CNECs are defined by:

- A CNE: a line or a transformer that is significantly impacted by cross-border exchanges
- An "operational situation": base case (N regime) or contingency cases (N-1, N-2).

A contingency is defined as the trip of one single or several network elements that cannot be predicted in advance. A scheduled outage is not a contingency. Contingencies situation could result from the combined loss of several elements.

### 2.1.2. Operational security limits

#### Maximum permanent and temporary current on a Critical Branch

The permanent current/power limit (PATL) means the maximum loading that can be sustained for an unlimited duration without risk to the equipment.

The temporary current/power limit (TATL) means the maximum loading that can be sustained for a limited duration without risk to the equipment (e.g. 120% of permanent physical limit can be accepted during 20 minutes).

An additional temporary current/power limit (FSATL) maybe defined by TERNA and /or ADMIE if needed if automatic remedial actions are available in order to solve this specific congestion.

Each individual TSO is responsible for deciding which values (permanent or temporary limit and duration of each overload) should be used.

As thermal limits and protection settings can vary in function of weather conditions, different values are calculated and set for the different seasons within a year. These values can be also adapted by the concerned TSO if a specific weather condition is forecasted to highly deviate from the seasonal values.

#### Maximum/minimum voltage value/drop on a node of the network

If the voltage on a node is significantly impacted by cross-border exchanges, the voltage on this element shall be monitored in the CCC process.

Each TSO shall specify the voltage limits for each element of its transmission system and/or the maximum acceptable deviation between the initial (N-state) and the final (after contingency) values.

### 2.1.3. Reliability Margin (RM)

According to Article 22 of the CACM Regulation, a methodology to determine the reliability margin is developed and the results are elaborated in order to define the transmission reliability margin (TRM) values.

The methodology for the CCC is based on forecast models of the transmission system. The outcomes are subject to inaccuracies and uncertainties. The aim of the TRM is to cover these inaccuracies and uncertainties induced by those forecast errors.

Considering the technical details of the GRIT border that is an HVDC link, the TRM is considered equal to 0.

Regarding the Italian internal borders, the TRM value on each border is set to 0MW since:

- The Italian TSO manages the power system using an Optimal Power Flow (OPF) function in real-time able to cope with potential cross-border congestions;
- An assessment of the deviations between scheduled and realized flows (described here below) demonstrates that no reliability margins are needed on these borders.

In particular, a probability distribution of the deviations between the expected power flows at the time of the capacity calculation and realized power flows in real time is calculated.

The "unintended" deviation of flows on a section i-j between internal market zones (i and j) cannot be measured by the simple difference between expected power flows and realized power flows:

$$\Delta_h^{i \to j} = Realized\_flows_h^{i \to j} - Expected\_flows_h^{i \to j} \qquad \text{Equation 1}$$

because part of this deviation is induced on a voluntary basis by Terna when optimizing system management in the OPF algorithm adopted in the Ancillary Services Market (named MSD, i.e. on the eligible power plants) and considering the impact of all the market sessions and existing balancing platforms. For this reason, it useful to decompose flow deviations in two terms:

$$\boldsymbol{\Delta_h^{i \to j} = \Delta Intended_h^{i \to j} + \Delta Unintended_h^{i \to j}} \qquad \text{Equation 2}$$

Where:

ΔIntended = deviation caused by real-time resource activation requested by Terna;

ΔUnintended = deviation caused by differences between actual generation/consumption and the schedules (as modified also according to Terna's real-time activation). This amount can be computed, for each hour, using imbalance quantities netted at zonal level and summing-up all the values for the Bidding Zones below the border under assessment.

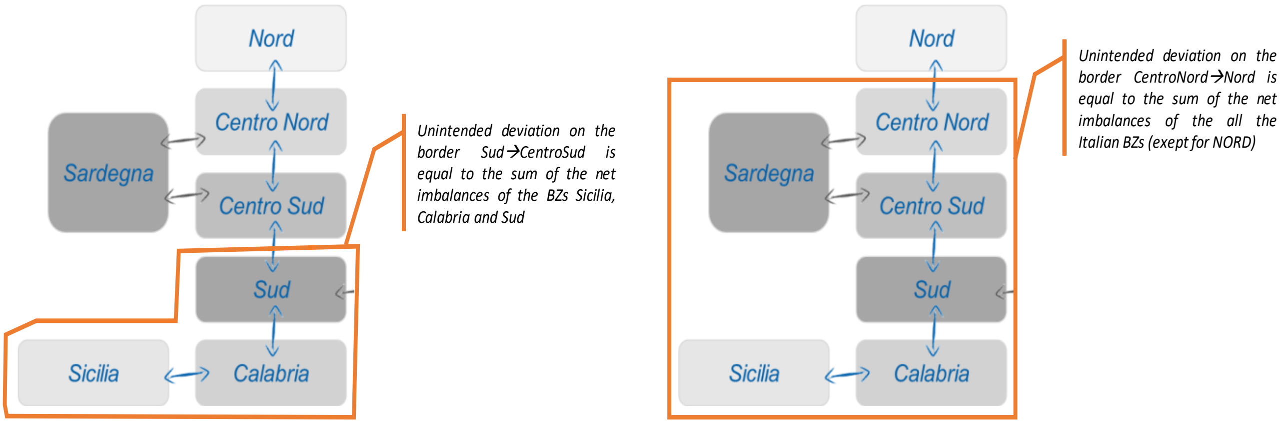



**Figure 1. Unintended deviations**

An assessment based on historical data of $\boldsymbol{\Delta Unintended_h^{i \to j}}$ considering January 2021 – November 2022 data has been performed considering, for each relevant border[1], highly loaded hours[2]. The results (table 1) confirm that, on average, the deviation is negligible (even negative), confirming the choice of a 0 MW TRM value, in line with Day Ahead and Intraday Capacity Calculation Methodology of the GRIT CCR.

| Percentili | CALASICI | SICICALA | CALASUD | SUDCALA | SUDCSUD | CNORNORD | NORDCNOR |
|---|---|---|---|---|---|---|---|
| 0.25 | -105.29 | -171.1 | -147.028 | -81.862 | -304.3435 | -332.451 | -260.3175 |
| 0.5 | -22.98 | -65.222 | -37.518 | 9.047 | -0.332 | -14.444 | -33.254 |
| 0.75 | 71.523 | 49.7015 | 118.558 | 123.952 | 263.0185 | 358.439 | 165.634 |

**Table 1**

According to article 6(1) of the GRIT CCM, GRIT TSOs do not apply any reliability margin, adopting NTC values equal to the computed TTC values, without the application of costly curative remedial actions. Italian TSO shall reassess TRM values in accordance with the methodology at least once every 36 months.

[1] HVDC borders are not assessed since their flows are fully controllable. CNOR-CSUD border is excluded since affected by Sardinian HVDCs setting decisions from Terna.

[2] Hours where the Day Ahead Market schedule resulted to be higher than 90% of the related NTC value.

### 2.1.4. Base Case - Individual Grid Model (BC-IGM)

#### 2.1.4.1. BC-IGM preparation

Basis for the Individual Grid Model (IGM), adopted in the CCC process, is a past snapshot (SN) of the grid, assumed to be representative of the expected conditions for the market time unit under assessment.

The selected SN will be updated in order to correctly represent the market time unit (obtaining the so called “Base Case – Individual Grid Model”) in terms of:

- Grid topology: outages of grid elements is adapted according to the approved outages plans;
- Load conditions: most recently updated load forecast is implemented;
- Conventional generation sheet, the last available market results are adopted;
- Renewable generation infeed: the best available forecasts are adopted;
- Net positions and initial cross-border exchanges, accordingly to the approach described in the following paragraph.

The BC-IGMs prepared by the GRIT TSOs will then be merged into a Common Grid Models according to Article 28(5) of CACM Regulation. The resulting Common Grid Models will be adopted in the capacity calculation process.

TSOs shall provide relevant grid models to be used in the capacity calculation process of the GRIT region in order to ensure an accurate representation of the of the GRIT CCR. These grid models shall include at least a detailed representation of the 380kV-220-150 kV grid and, where considered relevant by the concerned TSO, the 150kV grid.

Pending the finalization of the European Common Grid Model for the day-ahead and intraday capacity calculation timeframe in accordance with Article 17 of the CACM Regulation, TSOs shall provide relevant grid models to be used in the capacity calculation process of the GRIT region in order to ensure an accurate representation of the of the GRIT CCR. These grid models shall include at least a detailed representation of the 380kV-220kV grid and, where considered relevant by the concerned TSO, the 150kV grid.

#### 2.1.4.2. Coordination of the net positions and initial cross-border exchanges

The net position of each bidding zone of the GRIT region and the cross-border exchanges on each border are defined according to the latest available market results.

### 2.1.5. Generation Load Shift Key (GLSK)

#### 2.1.5.1. GLSK files

GLSKs are needed to transform any change in the balance of one bidding zone into a change of injections in the nodes of that bidding zone. GLSKs are elaborated on the basis of the best forecast information about the generating units and loads.

GLSK file is defined for each:

- control area: GSLK is computed for each relevant network node in the same control area;

- and time interval: GLSK is dedicated to individual market time unit in order to model differences between different system conditions.

In order to avoid newly formed unrealistic congestions caused by the process of generation shift, TSOs should be able to define both generation shift key (GSK) and load shift key (LSK):

- Generation shift: GSK constitute a list specifying those generators that shall contribute to the shift.
- Load shift: LSK constitute a list specifying those load that shall contribute to the shift in order to consider the contribution of generators connected to lower voltage levels (implicitly contained in the load figures of the nodes connected to the 150, 220 and 400 kV grid).

If GSK and LSK are defined, a participation factor is also given:

- G(a) Participation factor for generation nodes
- L(a) Participation factor for load nodes

The sum of G(a) and L(a) for each area has to be to 1 (i.e. 100%).

Hence, for a given control area and a market time unit, a GLSK file contains for each node of the relevant grid:

- Node identification code;
- Available upward margin;
- Available downward margin;
- Merit order rank.

How to distribute the shift among different generators and loads connected to the same node is then defined according to the participation factors.

#### 2.1.5.2. Merit order list for the Italian bidding zones

This kind of shift methodology can be considered for the Italian bidding zones.

The main reason for this choice is due to the fact that the Italian grid has a high level of RES generation installed in general and close to the GRIT link in particular. Those generators as well as the conventional generation are geographically located in different areas, then for different generation profiles we get different power flows in the grid elements and consequently different stress areas in the systems with potential impact in the NTC calculations. Examples:

- If the wind production is high the marginal production could be reduced.
- If the winter is wet the opportunity-cost of hydro power-plants could be lower than the short-run-marginal-cost of thermal power-plants, and vice-versa for dry seasons.
- Depending on the primary sources' prices, the market behaviour will be different and affect the location of the production.

#### 2.1.5.3. Proportional to the remaining capacity available on generation for the Greek bidding zone

This kind of shift methodology can be considered for the Greek bidding zone.

GRIT TSOs shall make ex-post analysis of GSKs (including the testing period) and if considered necessary request to change them

### 2.1.6. Remedial Action (RA)

This topic is detailed in the Annex 1.

## 2.2. Capacity calculation approach

Coherently with the "Capacity calculation methodology for the day-ahead and intraday market timeframe for Greece-Italy CCR in accordance with Articles 20 and 21 of Commission Regulation (EU) 2015/1222 of 24 July 2015 establishing a guideline on capacity allocation and congestion management" ("DA/ID CCM" hereafter) and due to the specificities of the GRIT CCR, GRIT TSOs will use coordinated NTC approach to determine the cross-border capacities for each border of the GRIT CCR. This choice is mainly driven by the network structure of the GRIT Region, which is mainly "non-meshed".

The "Greece-Italy Balancing Timeframe Capacity Calculation Methodology Proposal" requires the introduction of two TTC calculation processes:

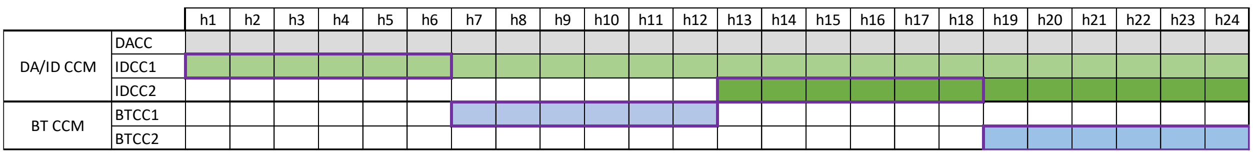
a. the BT CCC process 1 starts on D-1 and ends on D.

b. the BT CCC process 2 is executed entirely in day D.

The Total Transfer Capacity (TTC) at each border of GRIT region shall be assessed in both border direction:

- Using Alternate Current (AC) load-flow algorithm in order to assess (n-1) network security of the relevant CNECs, taking also into consideration the beneficial effects of coordinated remedial actions;
- Based on:
  - updated intraday CGMs for BT CCC process 1 or the relevant grid models for the market time unit;
  - updated intraday CGMs for BT CCC process 2 or the relevant grid models for the market time unit.
- Applying modification of cross border-zonal exchanges according to GLSK files. The corresponding method is detailed in the next paragraph.

The aim of these processes is to increase the TTC computation frequency, in such a way that TTC values for MTUs having the higher lead time between the end of the last Intraday Capacity Calculation Process relevant for these MTUs and the start of the given MTU are updated by additional Capacity Calculation Processes based on updated input data (see the Figure below).



In addition, a TTC update process is foreseen: after each Intraday Gate Closure, which is expected every 15 minutes, TSOs shall monitor any relevant deviation occurred on the assumptions adopted in the latest Capacity Calculation Process affecting this MTU, and possibly the following MTUs, and a new TTC calculation process is triggered in case those deviations are deemed to significantly impact the use of the capacity in the upcoming balancing processes.

A TTC calculation process carried out after each IDGC for the relevant MTU implies a time window of less than 30 minutes to perform the full calculation process on all the borders and directions of the GRIT CCR. This short timeframe does not allow the implementation of a detailed TTC calculation procedure (including the related checks for validation) as prescribed in the "DA/ID CCM".

For this reason, strong simplifications would have been implemented for executing the capacity calculation process in such a short timeframe, endangering the possibility to have:

- a detailed model of voltage and reactive power constrains: solutions adopted in other CCRs are mainly based on a linearized approach based on precomputed zonal PTDFs coefficients and a predefined list of CNECs and related RAM values, which is significantly different from the extensive AC security assessment approach adopted in the "DA/ID CCM" for the GRIT CCR.
- A detailed representation of special protection schemes implemented on the borders of the GRIT CCR, which are crucial to maximize TTC values released to the market.
- An automatic identification of the CNEC list based on objective criteria and algorithms (as described in Annex 1): CNECs should be predefined in order to precompute the related PTDFs.
- A detailed optimization of Remedial Actions, including topological measures and their validation.

In addition, only few minutes would be available for the TSO in order to validate cross zonal capacities on 16 border/directions.

In view of this, the proposed structure allows to:

- Maximize the coherency with the "DA/ID CCM" in terms of input data, TTC calculation procedures (see Annex 1) and expected results.
- Avoid any strong simplification (eg. DC vs AC loadflow approach, Remedial Action optimization, …) necessary to cope with shorter timelines for the TTC calculation process.
- Ensure updated TTC values: a higher frequency in the occurrence of the TTC calculation process is not expected to improve the quality of the results, considering that significant simplifications would have been required to cope with stricter timelines.
- Update TTC values after any IDGT in case relevant changes occurred in the power system.

In order to confirm the validity of the current assessment, a cost benefit analysis will be carried out by TSOs of the GRIT CCR after six months from the implementation of this methodology, comparing potential benefits and risks deriving from a TTC calculation process carried out after each IDGC for the relevant MTU. This cost benefit analysis shall be sent to the regulatory authorities of GRIT CCR no later than 10 months after the implementation of this methodology.

The CBA should contain at least:

- Analysis on historical data of the TTC available after the IDGCT and of the frequency of cross-zonal congestions;
- Analysis of the additional TTC made available by the ID capacity calculation with respect to the

previous calculation;

- Assessment of the potential increase of TTCs achievable with a more frequent calculation;
- Assessment of the computational burden and resources needed for the alternative calculation, with respect to the benefits provided by the additional TTC.

In case CBA results point out the proposed approach does not profitable, TSOs shall amend the methodology accordingly.

# 3. Coordinated NTC calculation process

## 3.1. Creation of a common grid model (CGM)

### 3.1.1. Individual Grid Model (IGM)

All TSOs develop scenarios for each market time unit and establish the IGM. This means that GRIT TSOs will create:

- hourly IGMs referred to period h7-h12 for each delivery day (D) in D-1. These models shall be used in the BT CCC process for the creation of the Common Grid Models;
- hourly IGMs referred to period h19-h24 for each delivery day (D) in D. These models shall be used in the ID CCC process 1 for the creation of the D Common Grid Models.

These IGMs shall include all the relevant data described in paragraph 2.1.4.

The detailed structure of the model, as well as the content is described in the Common Grid Model Methodology (CGMM), which is common for entire ENTSO-E area.

### 3.1.2. IGM replacement for CGM creation

If a TSO cannot ensure that its IGM for a given market time unit is available by the deadline, or if the IGM is rejected due to poor or invalid data quality and cannot be replaced with data of sufficient quality by the deadline, the merging agent will apply all methodological & process steps for IGM replacement as defined in the CGMM (Common Grid Model Methodology).

### 3.1.3. Common Grid models

GRIT TSOs shall provide the GRIT Coordinated Capacity Calculator with an IGM for each relevant market time unit.

The individual TSOs' IGMs are merged to obtain a CGM according to the CGMM. The process of CGM creation comprises the following services:

- Check the consistency of the IGMs (quality monitoring);
- Merge IGMs and create a CGM per relevant market time unit;
- Make the resulting CGM available to all TSOs.

The merging process is standardized across Europe as described in European Merging Function (EMF) requirements. As a part of this process the Coordinated Capacity Calculator checks the quality of the data and requests, if necessary, the triggering of backup (substitution) procedures (see below).

Merging process can be performed using common Entso-e tools and methods (if available).

GRIT CGM represents the part of the GRIT transmission system relevant for the CCC process.

## 3.2. Quality check

The Coordinate Capacity Calculator gives feedback to the TSOs of GRIT Region about the correctness of their input files used for CCC process. This check concerns the following input files:

- IGMs provided by TSO of GRIT Region
- GLSK provided by TSO of GRIT region
- CGM (merged of IGM files)

The quality has to be done for each file provided by TSOs of GRIT region and for the merged CGM file. The optimal solution in an automatized process is where the uploading TSO of GRIT region gets feedback when files are uploaded to a common system and the quality check starts immediately.

Quality checks can be performed using common Entso-e tools and methods (if available).

## 3.1. Regional calculation of cross-zonal capacity

### 3.1.1. The TTC calculation

This process is detailed in Annex 1.

In this context, two main indicators are computed in order to limit the set of relevant CNECs for each border:

- The indicator $\Delta^{k}$ expresses the impact (MW/MW) of a change in the cross-zonal exchange (at the given border) on the flow on the given CNEC: applying a threshold on this indicator allows to filter out CNECs which congestions cannot efficiently be managed with a reduction of the cross-zonal capacity;
- The indicator $\varphi^{k}$ expresses the percentage of the CNEC transmission capacity occupied by flows related to cross-zonal scheduled exchanges. This indicator shall be higher than 70% in order to be compliant with article 14.6 of Regulation (EU) 2019/943.

### 3.1.2. The final validation

Once the coordinated capacity calculator has calculated the TTC, it provides the concerned TSOs with these values. Each TSO then has the opportunity to validate the TTC value calculated centrally or can reduce the value in case the centralized calculation could not see a particular constraint. Such constraints cannot be monitored by the BT CCC process or other centralized processes.

The TSO requesting a capacity reduction is required to provide a reason for this reduction, its location, and the amount of MW to be reduced in accordance with article 26.5 of CACM regulation.

Where the two TSOs of a bidding zone border request a capacity reduction on their common border, the coordinated capacity calculator will select the minimum value provided by the TSOs. The reason associated to this value will be the one considered in all report required by relevant legislation.

For each border, direction and time unit, the final available capacity for markets will be defined as the difference between the computed NTC value and the already scheduled/allocated flow in the previous market timeframes. If this difference is negative, no capacity will be made available to the market.

## 3.2. Backup & Fallback processes

### 3.2.1. Backups and replacement process

For all inputs related to the capacity calculation, standard backup communication process has been defined among GRIT TSOs and the coordinated capacity calculator. Where inputs are not available for one of the parties at the expected time, back up procedures are applied until a critical deadline is reached, in order to get the associated inputs and carry on with the original process.

Where a critical deadline is reached and the inputs could not be provided to the concerned party on time, then fallbacks are applied, meaning that GRIT TSOs and the coordinated capacity calculator could use other inputs to perform their tasks.

As an example, inputs from the day before since network situations are usually stable from one day to another and could be re-used in order to complete the CCC process.

### 3.2.2. Fallback NTC values

If the GRIT TSOs and the coordinated capacity calculator could not complete a BT CCC process within the agreed time for calculation, the last coordinated cross border capacity calculated in previous CC processes is then used as an input for validation.

The coordinated capacity calculator uses this Capacity as an input of the validation process. The TSOs have then the opportunity to adjust these values following the rules of this process.

# 4. Timescale for the CCM implementation

- **December 2022**: Submission of the amended methodology for approval
- **June 2023:** Approval of the amended methodology by the GRIT NRAs
- **January 2025**: Start of the Capacity Calculation test period
- **March 2025:** Go-Live of the Capacity Calculation process.