# Explanatory Note of the Coordinated NTC methodology for 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 common DA-ID capacity calculation methodology in accordance with Article 21 of the Regulation 2015/1222 of 24 July 2015 establishing a Guideline on Capacity Allocation and Congestion Management.

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# 1. Introduction

This technical document sets out the main principles for the Coordinated Capacity Calculation (CCC) methodology for the day-ahead (DA) and intraday market (ID) timeframes applied in the Greece-Italy area (GRIT). It contains a description of both the methodology and the calculation process in compliance with the Capacity Allocation and Congestion Management guideline (hereafter CACM).

The participating TSOs for this calculation are Terna (IT) and ADMIE (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 GRIT Capacity Calculation Methodology, 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 inputs are created two days before the delivery day with the best available forecast. Therefore, 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) can not be measured by the simple difference between expected power flows (in this case understood as transits under the day ahead energy market - MGP) and realized power flows:

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

because part of this deviation is induced on a voluntary bases 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):

$$\boldsymbol{\Delta_h^{i\rightarrow j} = \Delta ABI_h^{i\rightarrow j} + \Delta NAB_h^{i\rightarrow j} + \Delta FRNP_h^{i\rightarrow j} - \Delta LOAD_h^{i\rightarrow j}} \qquad \text{Equation 2}$$

where

ΔABI = deviation on MSD eligible production unit

ΔNAB = deviation on not MSD eligible production unit

ΔFRNP = deviation on renewable production unit, such as solar photovoltaic and wind source

ΔLOAD = deviation on load forecast

For this reason it is possible to define also:

$$\Delta NAB_h^{i\rightarrow j} + \Delta FRNP_h^{i\rightarrow j} - \Delta LOAD_h^{i\rightarrow j} = \Delta_h^{i\rightarrow j} - \Delta ABI_h^{i\rightarrow j} \qquad \text{Equation 3}$$

where

$\Delta NAB_h^{i\rightarrow j} + \Delta FRNP_h^{i\rightarrow j} - \Delta LOAD_h^{i\rightarrow j}$ is the “unintended” deviation term, and

$\Delta ABI_h^{i\rightarrow j}$ is the “intended” deviation term.

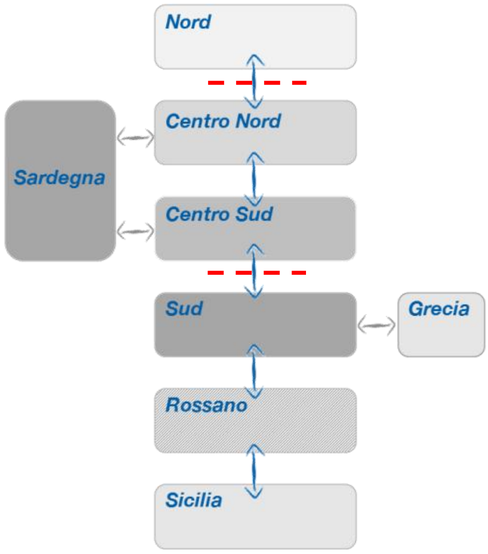
According to Equation 3

$$\Delta \mathrm{unintended}_h^{i\rightarrow j} = \Delta_h^{i\rightarrow j} - \Delta \mathrm{ABI}_h^{i\rightarrow j} \qquad \text{Equation 4}$$

This analysis is based on market time unit historical data of $\Delta_h^{i\rightarrow j}$ and $\Delta ABI_h^{i\rightarrow j}$, considering most recent yearly data.

The application of the methodology to the Italian border case leads to the conclusion that the TRM values shall be equal to zero on the internal sections as the statistical analysis shows that the “unintended” deviation term, evaluated in the event that the flow exceeds the *Expected_flows*, has a negative average value and therefore the application of a non-zero TRM has no mathematical significance.

The results of the most critical sections (for greater number of unintentional factors included in the areas below) are shown:




| | SUD→CSUD | CNOR→NORD | NORD → CNOR |
|---|---|---|---|
| **median** | -600 | -1100 | -1600 |
| | | | |
| **standard deviation** | 600 | 1000 | 1100 |
| | | | |
| **TRM (σ)** | **0** | **-100** | **-500** |
| **Expected Flow (min value)** | 3900 | 1200 | 2700 |
| **Expected Flow (max value)** | 9999 | 9999 | 9999 |
| **% samples** | 11% | 18% | 18% |

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.

### 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:
    - for the D-1 CCC process, the best available forecast is adopted,
    - for the ID CCC processes, 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.

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-220-150 kV 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*

##### Day-Ahead timeframe

Forecasting of the net positions two days preceding the delivery day in GRIT CCR is based on a common process established in ENTSO-E: the Common Grid Model Alignment (CGMA). This centrally operated process ensures the grid balance of the models used for the CCC across Europe. The process is described in the Common Grid Model Alignment Methodology (CGMAM), which was approved by all TSOs in ENTSO-E.

Main concept of the CGMAM is presented in Figure 1 below:

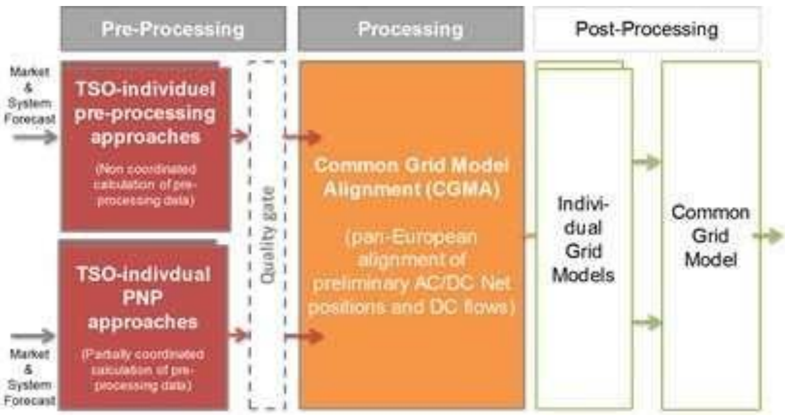



Figure 1: Main concept of the CGMAM

The CGMAM input data are created in the pre-processing phase, which shall be based on the best available forecast of the market behavior and Renewable Energy Source (RES) generation.

Pre-Processing Data (PPD) of CGMA are based on either an individually or regionally coordinated forecast. Basically, the coordinated approach shall yield a better indicator about the final net position than an individual forecast. Therefore, TSOs in GRIT CCR agreed to prepare the PPD in a coordinated way.

The main concept of the coordinated approach intends to use statistical data as well as linear relationships between forecasted NP and input variables. The data shall represent the market characteristic and the grid conditions in the given time horizon. The coefficients of the linear model will be tuned by archive data.

The result of the process is the “Balanced Net Position” (BNP) for each control area and for each market time unit.

TSOs of the GRIT region initially provide the best available forecast of TSOs on the DC link, afterwards will adopt the balanced flow on the DC link as the result of the CGMA process and finally adjust their IGM models by making use of the balanced flow on the DC link.

- The exchange program on the borders between internal Italian Bidding Zones are defined according to the best available forecast and respecting the NTC values computed within the long term timeframes.

#### Intra-Day timeframe

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 take into account 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

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"

During the DA and the ID CCC processes, 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:

- merged day ahead CGMs (D2CF merged models) for DA CCC process or the relevant grid models for the market time unit;
- merged intraday CGMs for ID CCC process 1 or the relevant grid models for the market time unit;
- merged intraday CGMs (IDCF merged models) for ID 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.

# 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 for each delivery day (D) in D-2. These models shall be used in the DA CCC process for the creation of the D-2 Common Grid Models;
- hourly IGMs for each delivery day (D) in D-1. These models shall be used in the ID CCC process 1 for the creation of the D-1 Common Grid Models.
- IGMs for each remaining delivery hour of the delivery day (D) in D. These models shall be used in the ID CCC process 2 for the creation of the ID 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 a 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 a 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).

## 3.3. Regional calculation of cross-zonal capacity

### 3.3.1. The capacity calculation process

For each relevant market time unit, the DA and the ID CCC processes designed in the GRIT CCR are respectively represented in figure 2 and in figure 3.

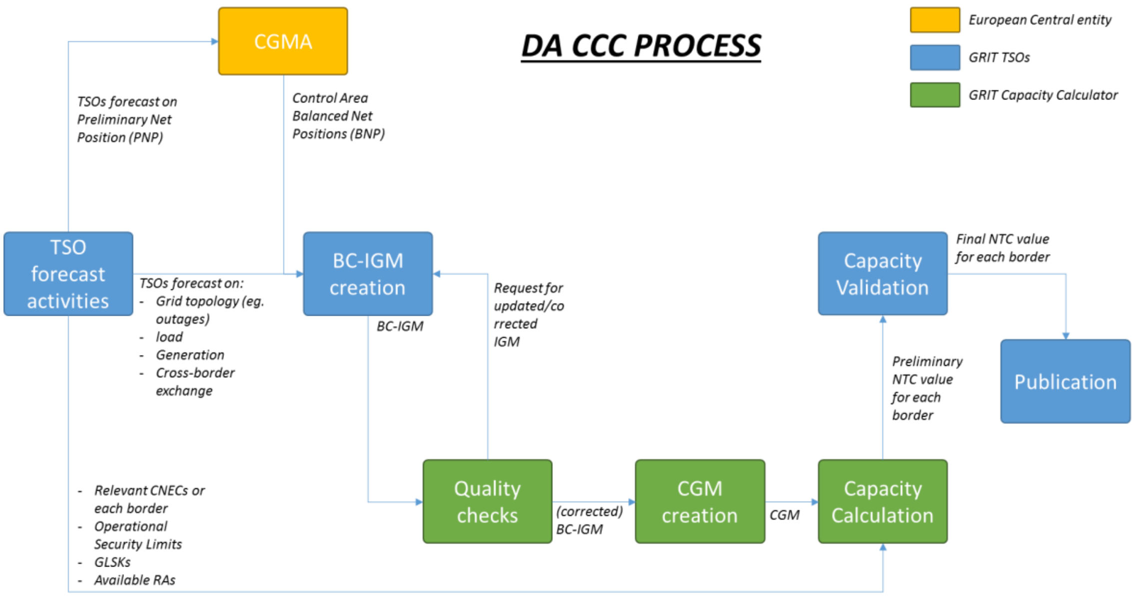



Figure 2: DA CCC process

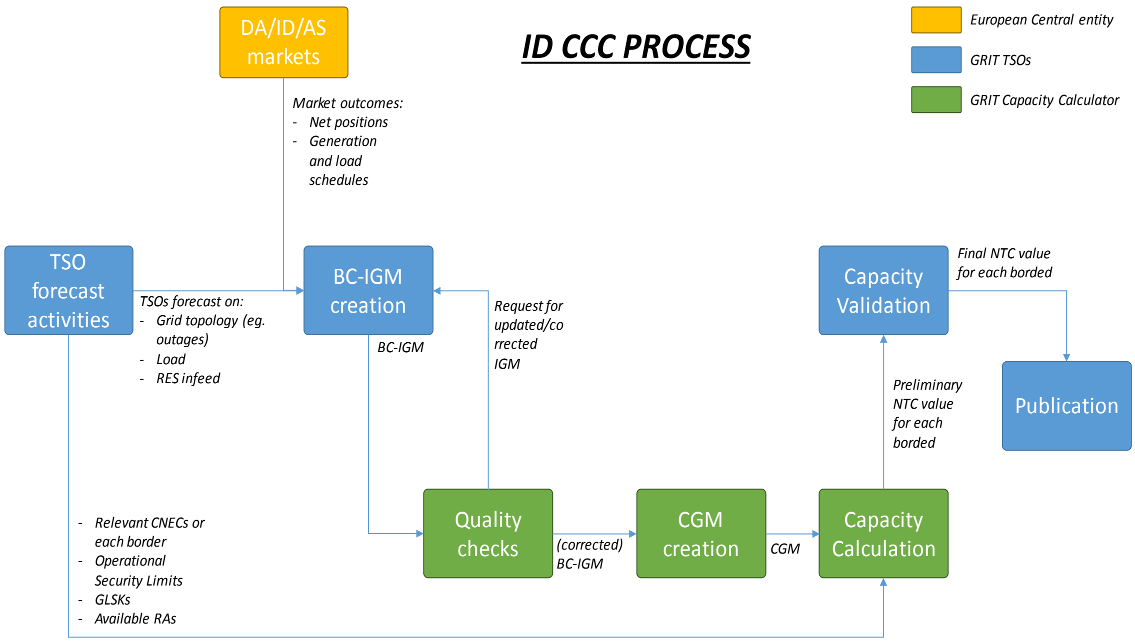



Figure 3: ID CCC process

### 3.3.2. The TTC calculation

This process is detailed in Annex 1.

### 3.3.3. 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 DA/ID CCC process or other centralized processes. Those constraints could be, but not limited to unplanned outages that occur after the deadline to update the inputs.

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 taken into account 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.

## 3.4. Backup & Fallback processes

### 3.4.1. Backups and replacement process

For all inputs related to the capacity calculation, standard backup communication process have 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.

### 3.4.2. Fallback NTC values

If the GRIT TSOs and the coordinated capacity calculator could not complete a CCC process within the agreed time for calculation, the last coordinated cross border capacity calculated within the long term timeframe (long term NTC values considering the last outages information as agreed by the involved TSOs) 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

Article 9(9) of the CACM Regulation requires that:

"*The proposal for terms and conditions or methodologies shall include a proposed timescale for their implementation and a description of their expected impact on the objectives of this Regulation.*"

The deadline for implementing a harmonized CCM within a Capacity Calculation Region is defined in article 21(4):

"*All TSOs in each capacity calculation region shall, as far as possible, use harmonized capacity calculation inputs. By 31 December 2020, all regions shall use a harmonized capacity calculation methodology which shall in particular provide for a harmonized capacity calculation methodology for the flow-based and for the coordinated net transmission capacity approach*."

The following section provides the description of the planned implementation timeline for the GRIT capacity calculation methodology.

## 4.1. Prerequisites

When the new Capacity Calculation (CC) goes live, the calculation will be performed by the coordinated capacity calculator based on input provided by the TSOs, and finally validated by the TSOs. Two crucial elements in this process are the Common Grid Model (CGM) and the Industrialized Capacity Calculation Tool.

The CGM is being developed by a coordinated project of all EU TSOs, and the industrialized capacity calculation tool is being developed by the coordinated capacity calculator. Both shall be implemented before the "go-live" of the CCM.

## 4.2. Timeline for implementation of the CCM

- **June 2020**: Submission of the amended methodology for approval
- **December 2020:** Approval of the amended methodology by the GRIT NRAs
- **January 2021**: Start of the Capacity Calculation for the day-ahead market timeframe parallel run
- **July 2021:** Go-Live criteria of the Capacity Calculation for the day-ahead market timeframe
- **July 2022**: Start of Intraday Capacity Calculation process performed in D-1 parallel run
- **January 2023**: Go-Live criteria of the Intraday Capacity Calculation process performed in D-1
- **February 2021**: Start of Intraday Capacity Calculation process performed in D parallel run
- **July 2021**: Go-Live criteria of the Intraday Capacity Calculation process performed in D