**Explanatory note DA ATC CC for Italy North CCR**

For Public Consultation

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# Introduction

This technical document sets out the main principles for the coordinated capacity calculation methodology for the day-ahead market timeframe applied in Italy North region. 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), RTE (FR), Swissgrid (CH), APG (AT) and ELES (SI), following borders are considered Italy – France, Italy – Switzerland, Italy – Austria, and Italy – Slovenia.

# DA Capacity Calculation Approach

This document describes coordinated NTC approach to determine the cross-border capacities for each border of the Italy North (IN) CCR. The NTC of each border are calculated in two scenarios, one with Italy importing from all the borders of the Region at the same time and one with Italy exporting to all the borders of the Region at the same time. The full description of the process is present in the following chapters.

# Italy’s import direction

## Capacity calculation input

### Transmission Reliability Margin (TRM)

#### General principles

Two concepts are to be taken into account when assessing the TRM value:

1. Unintended load-frequency regulation deviations;
2. Uncertainties in TTC computation;

The TRM shall be calculated every year for the next year Until the TRM will not be calculated according to this methodology, the TRM value is equal to 500 MW.

**Unintended load-frequency regulation deviations**

These can be estimated through statistical analysis of past data (previously rejecting extraneous values introduced by large deviations caused by system wide contingencies), using the estimated variance of last year’s deviation time series. The assumption that the result is independent of the volume of programmed exchanges seems to be reasonable enough (these deviations are rather dependent of the ‘quality’ of the spinning reserve in each control area).

Conceptually, at least, the main problem is that TRM is associated to a ‘border’ and regulation deviations margin is computed over a ‘border’ or over the whole control area i.e.: it applies as if it was associated to the TTC limiting condition (as if the deviations flow only through the network element which sets the limit for TTC). One TRM value is calculated for all the IN borders together.

**Uncertainties in TTC computation**

These account for physical model inaccuracies and uncertainties, i.e.: TTC figures are based on a given scenario, so uncertainties about the accuracy of the foreseen scenario translate into uncertainties about TTC[[1]](#footnote-2). It has to be pointed out that in some cases these uncertainties diminish gradually when getting closer to the operating horizon whilst in some others – namely in day ahead market type organisations - these only reduce at a given time in the day ahead and once the previously computed TTC values have been published and served as the basis to manage congestion. More extensive exchanges of information between TSO’s should, in some cases, enhance the TTC estimates reducing then the magnitude of this term contribution to TRM.

To assess the magnitude of the uncertainty margin which takes into account this source of uncertainty, one approach might be to compute twice the TTC: the TTC based on the best forecast of the scenario for the day ‘D’ and the TTC based on the day ahead ‘firm’ scenario. The statistical analysis of these differences would then be used to quantify this uncertainty.

#### TRM figure computation

Lets note Ur, and Us the considered margins for the regulation deviations and the scenario uncertainty. If Ur and Us are statistical estimates both can be expressed in terms of their respective pdf variance estimates: σ2r and σ2s. Then Ur = K × σr and Us = K × σs; K being a choice depending on the probability threshold (for the actual flows not exceeding published TTC value) being considered. The value that will be used is K=3.

To combine these sources of uncertainty into a TRM value, the following rule is applied:

* To assume that these uncertainties are random and normally distributed (probability combination):

TRM = √(U2r + U2s)

### Operational security limits, contingencies and allocation constraints

Operational security limits, contingencies and allocation constraints in capacity calculation on Italy North are provided daily by all TSOs of the Italy North region in form of the critical outage list, list of critical network elements and additional allocation constraints.

**The critical Outage (CO**) list describes the contingencies to be assessed during capacity calculation. A contingency can be a trip of a line, a cable or a transformer or a set of the aforementioned contingencies. This list, called “reference outages”, contain all Italian interconnectors as well as internal lines of 5 TSOs which are affected with Italian import and is predefined and agreed among the 5 participating TSOs; however, the list can be updated as soon as it is required and agreed among the participating TSOs.

**Critical network element (CNE)** is a network element either within a bidding zone or between bidding zones taken into account in the capacity calculation process, limiting the amount of power that can be exchanged. Each participating TSO is required provide a list of critical network elements (CNEs) of its own control area based on operational experience as well as its operational security limits. A critical network element can be an interconnector, an internal line or a transformer. The operational security limits used in the common capacity calculation are the same as those used in operational security analysis. CNEs are independently and individually associated with relevant outages. Additionally, for each CNE for each outage, zero or more remedial actions that relieve the CNE is/are defined. As selection of monitored elements might have an impact on the total calculated capacity, it is defined that CNE can only be an element that is consistent with the real time security rules and at the same time its loading is significantly impacted by the Italian import.

For that, at the beginning of the process, TSOs have to create an initial list of CNEs for each calculated timestamps. There will be a so-called “selection” of CNEs, based on sensitivity of exchange, in order to avoid that pre-congested grid elements whose the loading is almost not influenced by cross borders exchanges could limit the exchanges at the Italian Northern Border. For the moment, this methodology is not yet implemented, but under testing phase, with a sensitivity equal to 5%. At the end of this experimentation phase the TSOs will have the possibility to reassess the sensitivity threshold. TSOs have the possibility to add a specific CNE if it is sensitive in particular situation but would not be detected by the pre-processing with an ex-post justification.

In case there is any CNE whose power flow is influenced by cross-zonal power exchanges in different Capacity Calculation Region, before including it in the Capacity Calculation process, the TSOs have to define rules for sharing the power flow capability of the CNE among the different Capacity Calculation Regions in order to accommodate this flow.

**Allocation constraints** are typically used to take into account additional security constraints that cannot be expressed with CO/CNE combinations. In Italian Nord, such constraints are related to Special Period and currently only used by Italian TSO to limit the maximum value of Italian import for the whole Northern Italian Interconnection. It reflects Italian operational constraints related to the control of voltage profiles and dynamic stability of Italian system, especially in presence of low consumption. These two kinds of constraints are needed to maintain the transmission system within secure operations but cannot be transformed efficiently into maximum flows on critical network elements. Furthermore, they require additional data and more complex calculations, which shall be adapted to cover specific and different cases, and cannot be described into standard and automatic procedures.

When the additional constraint is applied, the TTC will be no higher than the value TTCmax, at the end of the calculation.

Low demand can lead to Security issues:

* High voltage values on the transmission grid;
* Low system inertia;
* Dynamic instability.

The size of the additional constraint depends on the minimum number of power plants needed on the grid for supplying those dispatching services necessaries to cope with dynamic instability and avoid violation of voltage limits.

The additional constraints are quantified basing on particular scenarios, that characterize the Italian power system, in conditions of extremely low demand. These scenarios are peculiar of some periods of the year which can be summarized as follows:

* Bank holidays common to other Countries (i.e. Christmas, Easter, May 1st );
* Bank holidays related to National Feasts (i.e. April 25th , June 2nd , etc.);
* Summer period.

With reference to Summer, the most critical days are typically the ones where the industrial load is not relevant for the National consumption (weekends) or when the temperatures are still not very high and the air conditioning absorption is limited.

The low-consumption periods have become more and more relevant since 2008, also in relation to the economic and industrial crisis. The import from neighbouring Countries is limited in these periods in order to create a sufficient room for the conventional power plants that guarantee the security of the Italian system.

In order to determine the value of maximum import sustainable in secure conditions, the process can be described as follows:

1. Identification of the critical periods

Basing on the feasts’ occurrence on the calendar and depending on the day of the week, the low-consumption period is identified. The day of the week is quite relevant indeed, since, to give an example, Christmas can occur on Sunday, and the impact is not relevant in this case, or can occur on Wednesday, and in this case the bank holiday is made of several days.

1. Identification of the typical system conditions

Once the potential low consumption periods are identified, the typical system conditions, mainly in terms of consumption are analyzed. The analysis takes into account the historical data referred to similar situation, considering that the information of the preceding year is not necessarily the most significant because the feasts occurrence can be subject to variation. For example, in 2015 Christmas was on Friday while the following year, being bissextile, Christmas occurred on Sunday.

1. Information refreshment

The historical data are updated according to the most recent information and the forecasted trend. Among other elements, the refreshment involves the consumption forecast and the level of water in the reservoirs of the hydro power plants.

1. Scenarios building

On the base of the historical data, properly updated, typical scenarios are built by means of a simulation tool.

1. Security check

The power system security is assessed for the above mentioned scenarios aiming at verifying:

* + The system stability in terms of voltage profile;
	+ The system security in terms of minimum inertia.

Moreover, it is necessary to take into account that in case of permanent fault on a network element, it is necessary to guarantee a minimum margin in terms of tertiary reserve in order to re-modulate the power flows in case of need in order to guarantee system security.

1. Definition of the maximum import

The NTC is the output of the above described process and is limited by the technical minimums of the conventional plants that are considered in operation in order to guarantee the power system security and controllability.

1. Import profiling

The maximum import is profiled for the different hours of the day according to the variations of the demand curve. The import for the low-consumption is shaped in order to take into account the different conditions in the hours of the day.

1. Management of low-consumption periods

The NTC is shaped at yearly and monthly level, on the base of the most accurate forecasts. Before the D-2 calculation process starts, the NTC value assessed at yearly level is reconsidered according to the new data and information. In case of significant variations, the value is reconsidered and, in case this happens, usually an additional NTC is released to the daily market. The additional constraint is forwarded to the RSC as input for the capacity calculation process.

All the data above is included in a so called “individual CRAC” file of each TSO. Prior to calculation, individual CRAC files of all TSOs are merged.

### Generation and Load Shift Keys (GLSK)

Generation and Load shift keys are needed to transform any change in the balance of control area into a change of injections in the nodes of that control area. In order to avoid newly formed unrealistic congestions caused by the process of generation shift, TSOs define both generation shift key (GSK) and load shift key (LSK), where GSKs constitute a list specifying those generators that shall contribute to the shift and LSKs 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 220 and 400 kV grid). Each TSO can decide how to represent its best generation shift. Several methods are supported by the process:

• **Proportional**: the shift is done in proportion of the active power, either of the load or of the generation, connected in the grid model for nodes judged relevant by the TSO (usually all);

• **Participation factors**: each node selected by the TSO has a explicitly specified participation (percentage) to the generation shift;

• **Reserve**: shift is done proportionally to the remaining available capacity of each generation unit (remaining available capacity being the difference between current active power and min or max active power of generation units);

• **Merit order**: the generation shift is done in a sequence of generation units representing their economic merit order of activation.

Generation shift keys in Italy North region are determined by each TSO individually on the basis of the latest available information about the generating units and loads.

### Remedial Actions

Remedial action refers to any measure applied in due time by a TSO in order to fulfil the n-1 security principle of the transmission power system regarding power flows and voltage constraints. Capacity calculation in Italiy North region uses two types of remedial action:

• Preventive Remedial Actions (PRAs) are those launched to anticipate a need that may occur, due to the lack of certainty to cope efficiently and in due time with the resulting constraints once they have occurred.

• Curative Remedial Actions (CRAs) are those needed to cope with and to relieve rapidly constraints with an implementation delay of time for full effectiveness compatible with the Temporary Admissible Transmission Loading. They are implemented after the occurrence of the contingencies.

Preventive and curative actions in Italy North region may be declared as shared or declared to be used only locally by TSO.

Remedial actions are defined by each TSO of the region daily as a part of individual CRAC file. Each remedial action has a pre-agreed name so other TSOs can refer to it. The remedial actions are used by CC if they have a positive impact on capacity of import of Italy. New preventive remedial actions can be added by a TSO in its daily CRAC file and some others can be removed depending on the forecasted situation.

Each TSO within the Italy North Region shall coordinate with the other TSOs of the Region regarding the use of remedial actions to be taken into account in capacity calculation and their actual application in real time operation.

Each TSO shall ensure that remedial actions are taken into account in capacity calculation under the condition that the available remedial actions remaining after calculation, taken together with the reliability margin referred to in Article 5, are sufficient to ensure operational security.

The use, during the real time, of remedial actions defined during capacity calculation process will be described in the implementation of security analysis according to the SO GL Article 75 and 76.

### Creation of Common Grid Model

Common grid model (CGM) used for capacity calculation represents expected state of ENTSO-E interconnected grid for selected timeframe. CGM is obtained with merging of individual grid models (IGMs) provided by the TSOs.

All TSOs of the region are obliged to provide D-2 IGMs for selected timestamps (currently 12 timestamps per day) prior to the calculation. The D-2 IGMs (known also as D2CF) have to contain the following information:

* Best estimation for:
	+ the planned grid outages;
	+ the outages of generating units and the expected output power of the running generating units;
	+ the forecasted load pattern;
	+ the forecasted RES generation.
* Have the balance compliant with a reference day balance on the Day ahead reference Website (Vulcanus).

For TSOs outside Italy North region, D2CFs are typically not available; therefore, their DACF files are used instead.

Once all IGMs are available, merging entity starts the process of merging them into CGM. If non-participating TSO’s inputs are missing, predefined back-up procedure is applied replacing missing IGMs with the most appropriate alternative ones. If any D2CF by TSO of the region is missing, merging process is interrupted immediately, as replacing regional IGM with older one topology can have a significant influence on power flow distribution and as consequence on performed security analysis results.

The merging process itself is split into the following sub-processes:

* Data pre-treatment (each participating IGM is checked for compliancy with the rules, check of convergence and balance);
* Building of control blocks corresponding to the Day ahead reference Website data;
* Balance adjustment on control blocks or TSOs;
* Merging of the ENTSOE wide data set;
* Final balance adjustment of the ENTSOE data set.

The result of merging process is a common grid model used for capacity calculation in the Italy North region.

##  Capacity Calculation Methodology

Each Coordinating Capacity Calculator performs, for each timestamp, a capacity assessment to calculate the TTCtotal by combining the inputs and applying the capacity calculation methodology as detailed in the next chapters.

### General principles

The Total Transfer Capacity (TTCtotal) for the whole northern Italian border is assessed using the following principles:

* using Alternate Current (AC) load-flow algorithm, considering reactive power capability limits of generators;
* based on merged D-2 and DACF grid models;
* the modification of exchanges is realized according to GSKs and Splitting FactorBorder (which take into account the impact of planned outages near a specific border, assessed through NTC reductions);
* the maximum current for the network security of Critical Network Elements is respected (taking into account effects of remedial actions used);
* being not higher than the additional constraint (corresponding to low consumption periods);
* aiming at maximizing the TTCtotal by respecting the above mentioned constraints, especially by combining efficiently the given Remedial Actions.

### Principles to perform the Generation Shift

* For any modification of total import on the northern Italian border, the modification of balance shall be shared among TSOs according to splitting factors.
* Exchanges through some particular lines are kept constant and equal to predetermined values given by the TSOs. Are considered as particular lines the followings:
	+ - Lines not represented in the grid model, whose flows are conventionally considered as fixed;
		- Those of the Merchant lines which are operated at a fixed flow during real time for operational reasons.
* When during the calculation a GSK is exhausted (cannot provide additional shift), then a load redistribution is allowed to continue the calculation (based on the load of the related country).
* For all types of GSK except MERIT ORDER, in case, some generating nodes are reaching their maximum or the minimum limitations, this node is set to Pmax or Pmin. The rest of the power to be shifted in the CGM should be distributed to the others nodes being contained in the GSK files, without taking into account the node which is at the saturation.

The mathematical formulation is the following one, where:

* ***Exchange*** represents commercial exchanges. Therefore they include all exchanges to be transmitted through the grid, either TSO-owned or merchant lines;
* ***ExchangeTSO*** represents the part of exchanges that will be transmitted through TSO-owned grid (as opposed to merchant lines);
* ***ExchangeML*** represents the part of exchanges that will be transmitted through merchant lines;
* ***Border*** index stands for one of the four north Italy borders: **CH**-**IT**, **FR**-**IT**, **AT**-**IT**, and **SI-IT**;
* ***ref*** indexrefers to quantities from the reference day, implemented in the merged ***CGM.***

For each border we have by definition the identity:

***ExchangeBorder = ExchangeTSO Border + ExchangeMLBorder***

During TTC calculation, only ***ExchangeTSO*** shall vary, for each border, according to ***Reduced Splitting Factors***.

***ExchangeTSOBorder = Reduced Splitting FactorBorder . ExchangeTSONorth Italy***

***ΔExchange****Border* ***= ΔExchangeTSO****Border****= ExchangeTSOBorder – ExchangeTSOref****Border*

***ΔBalance****TSO* ***= ∑TSO BordersΔExchange****Border*

Variations are applied on the merged CGM for which exchanges values are given by the reference day values. **Exchanges through ML are assumed equal to their daily Fixed Flow provided as input data.**

***ExchangeTSOrefBorder = ExchangerefBorder - ∑Border Fixed FlowML***

**Summary**

This may be summarized as:

***ΔBalance****TSO* ***= ∑TSO Borders Reduced Splitting FactorBorder . ExchangeTSONorth Italy - ExchangeTSOref****Border*

***ΔBalanceTSO*** shall be implemented from the initial merged CGM, according to GSK handling rules, for each participating TSO. Generation shift handling is described below.

For each country, this translates into:

***ΔBalance FR = Reduced Splitting FactorFR>IT . ExchangeTSONorth Italy - ExchangeTSOref****FR>IT*

***ΔBalance CH = Reduced Splitting FactorCH >IT . ExchangeTSONorth Italy - ExchangeTSOref CH*** *>IT*

***ΔBalance AT = Reduced Splitting FactorAT >IT . ExchangeTSONorth Italy - ExchangeTSOref AT*** *>IT*

***ΔBalance SI = Reduced Splitting FactorSI>IT . ExchangeTSONorth Italy - ExchangeTSOref SI****>IT*

***ΔBalance IT= -ΔBalance FR-IT - ΔBalance CH-IT - ΔBalance AT-IT - ΔBalance SI-IT***

### Dichotomy approach

The Capacity calculation step can be described as a calculation by dichotomy.

The coordinated capacity calculator will define a starting capacity level and check if this level of exchange allows the transmission system to be operated within its operational security limits.

If the level is secure, it will then test a higher value of TTC. Otherwise the coordinated capacity calculator will then test a TTC value in between the secure and unsecure TTC values until it reaches the last secure TTC. The dichotomy is set with a 50 MW step in order to optimize the capacity offered to the market while reducing the computation time.

**

### Handling of Remedial Actions

The scheme below summarizes the conditions to be fulfilled with this combination of remedial actions to state that all security constraints are respected. Each rounded square represents a different network state.

On N state, preventive remedial actions are implemented and Imax of “basecase” branches are monitored.

On N-1 states, outages are applied and *Imax\_AfterOutage* are monitored. They represent transient admissible current on the monitored branches. Transient current can exceed permanent admissible current provided that available SPS and curative remedial actions are sufficient to keep permanent current not greater than permanent admissible current.

On SPS states, outage and SPS are applied, Imax\_AfterSPS are monitored. They represent transient admissible current on the monitored branches after SPS. Transient current can exceed permanent admissible current provided that available curative remedial actions are sufficient to keep permanent current not greater than permanent admissible.

This step is useless if:

* If no SPS: Imax\_AfterSPS = Imax\_AfterOutage

On After Curativestates, outage, SPS and curative remedial actions are implemented and Imax\_AfterCRA are monitored. They represent permanent admissible current on the monitored branches.

If an outage or a remedial action leads to an unbalance situation due to a modification of generation or load pattern, this unbalance has to be compensated inside the concerned country, by using the GSK of this one.

**Initial case**

**N situation**

**N-1 situation *1***

**N-1 situation *n***

**SPS situation *n***

*Apply outage* *O1*

*Apply outage* *On*

*Apply SPS1 for* *O1*

*Apply SPSn for* *On*

…

…

…

…

*Apply PRA*

**I < Imax for all branches to be monitored on base case**

**For each N-1 situation i:**

I < Imax\_AfterOutage for all branches to be monitored after outage Oi

**For each SPS situation i (if defined):**

I < Imax\_AfterSPS for all branches to be monitored after outage Oi and SPS

**Security checks**

**System states**

**SPS situation *1***

**After Curative situation *n***

**After Curative situation *1***

**For each after curative situation i:**

I ≤ *Imax\_AfterCRA* for all branches to be monitored after outage Oi, SPS and curative remedial actions, with respect to the swiss grid (**➃)**

*Apply CRAn for* *On*

*Apply CRA1 for* *O1*

…

…

### Extrapolation algorithm

This chapter describes how the TTC is calculated for those timestamps for which no direct calculation is performed during the transitory period in which only few timestamps will be taken into account as references for the whole day.

For each hour H, be Href the reference hour for TTC calculation (i.e. if 10:30 is the only studied timestamp for the period 07:00-23:00, Href=10:30 for all the hours h in the interval 07:00-23:00). The TTC value for hour H is calculated according to the following table depending on the “type” of hours H and Href:



Where:

* Type “No LC” means that the hour is in a normal period, without Low Consumption NTC;
* Type “LC” means that the hour is in a Low Consumption period;
* Type “Ramp” means that the hour is in a ramp period (e.g. connecting Low Consumption NTC to Normal NTC);
* TTCHref is the Selected TTCTTC selection Total North, the selected TTC of the reference hour Href as described in the HLBP;
* TTCP,Hi is the scheduled TTC (the TTC defined in the programming stage taking into account all the reductions for planned maintenances and low consumption period) of the generic hour Hi which has Href as reference hour;
* ΔTTCP,H-Href = TTCP,H - TTCP,Href;
* ACH is the Additional Constraint defined for hour H.

### Results

For each Coordinating Capacity Calculator and each timestamp, the set of results is:

* The initial (merged) grid model and the final (merged) grid model corresponding to the final state of the network for a maximum secured northern Italian import. In this final state, all preventive (“pre-fault”) Remedial Actions are implemented;
* Concatenated GSKs, a concatenated CRAC files containing Critical Network Elements, Critical Outages, and Remedial Actions and additional constraint (maximum value of TTCtotal);
* TTCtotal;
* Limiting elements of TTCtotal (Critical Network Elements and Critical Outages). In case the calculation stops to an import level equal to the additional constraint, there is no limiting element (the reason of limiting TTCtotal is the additional constraint itself), otherwise limiting elements always exist;
* results of security analysis with preventive and curative Remedial Actions.

## Methodology for TTC Selection

The transition from the practices based on daily NTC to the one based on the outcome of the D-2 calculation process requires attention in terms of security, costs and transparency.

The final compatibility of the outcomes of D-2 calculations with the abovementioned requirements has to be assessed progressively on the base of the experience, by comparing and analyzing daily values with values from the D-2 process.

A limiting band is considered necessary until the real operation proves that forecast evaluations are sustainable. To prove the sustainability this band has to be broaden gradually till the full stabilization of the D-2 process. The band is limited by two values, the Upper Total Transfer Capacity (UTTC) and Lower Total Transfer Capacity (LTTC).

### Definition of the basic parameters

With the aforementioned rationale the selection criteria is described in the following.

Definitions:

|  |  |
| --- | --- |
| **i** | is the index of the observation period |
| **j** | is the index of the generic TTC value resulting from the calculations of the Coordinated Capacity Calculator |
| **h** | is the hour of the day to which the timestamps refer. (e.g. at present h=**p** means peak hours h=**o** means off peak hours). |
| **Ti**  | is the ith observation period, being T0 the last 3 months of the same season. |
| **TTCj,h** | is the TTC value resulting from the calculations of the Coordinated Capacity Calculator referring to hour h. |
| **RTTCh** | Is the yearly TTC value reduced to take into account maintenances and low consumption periods |
| **UTTCi,h**  | is the upper limit of the TTC for the period Ti and hour h. TTCi,h greater than this upper limit are considered not credible reasons of violation could be wrong input data or serious bugs in the process of Coordinated Capacity Calculator. |
| **LTTCi,h**  | is the lower limit of the TTC for the period Ti and hour h. Below this limit the results are considered not credible for the same reasons above.  |
| **Iss i,h**  | is the significant set of statistical samples of **TTCj,h** showing consistency of results of the Coordinated Capacity Calculator in a given period of observation Ti. Issi,h does not includes cases:* where:
	+ days are affected by additional constraints (e.g. low consumption days)
	+ data are affected by errors in individual grid models
* Coordinated Capacity Calculators fail the calculation process
* one Coordinated Capacity Calculator is below LTTC and the other over the UTTC in case of two Coordinated Capacity Calculators perform the TTC Calculation,
* referring to days when the real time emergency procedures have been applied (for upper limits only) [[2]](#footnote-3) and the Italia import has been reduced for security reasons.
 |
| **Issi,h+** | is the subset of **Issi,h** including the samples **greater than UTTC** only |
| **δhi+** | is the mean value of the samples resulting from Max (0; **Issi,h+** - **RTTCh**) in a given observation period Ti respectively for  |
| **δhi-** | is the mean value of the samples resulting from Max (0; **RTTCh** - **Issi,h-** ) in a given observation period Ti

|  |  |
| --- | --- |
| **UTTCi,h** | **= RTTCh + δhi+** |
|  |  |
| **LTTCi,h**  | **= RTTCh - δhi-** |

 |

The above mentioned set of parameters will be processed for each additional timestamp adopted in the future in the capacity calculation process.

### Selection procedure

Figure 1 depicts the criterion with the following comments.



Figure 1

* In case of two Coordinated Capacity Calculators provide valid results, if the couple of TTCj,h lies inside the plausibility band UTTC – LTTC, then the selected value has to be the lowestbetween the two outcomes.
* In case of two Coordinated Capacity Calculators provide valid results, if the couple of TTCj,h lies outside the band and both on the same side, selected value will be the closest band limit. In this case the a priori diagnosis is that something went wrong with input data. More careful validation is required.
* In case of two Coordinated Capacity Calculators provide valid results, with one outcome is over the upper limit and the other is under the lower limit, the selected value will be shifted at the center of the band. In this case the a priori diagnosis is that something went wrong with the calculations but both results have 50% of probability to be correct. Also in this case the validation has to be intensified and operators are allowed to propose increases of the validated TTC.
* In case of outcomes delivered by just one Coordinated Capacity Calculator, the comparison is skipped and according to the confidence on the process the values inside the band are supposed valid.

### Initial calculation (winter Period)

Please note that the daily TTC in days w/o lines out of services (i.e. the annual TTC) has been taken into account. This because the daily values are variable and it would be necessary to have a maximum for each possible topology.

This is considered acceptable because the final goal is to find plausible values.

In addition to that:

* UTTC values have been calculated including days w/o maintenance and including in the Iss+ the values above the yearly TTC
* LTTC values including all the rest of the days.

Please note that some refinements are expected to be necessary in the future for the following reasons:

1. The number of samples turned out to be limited from the statistical point of view
2. A reason why there are differences against annual values deserve to be further analysed. In particular with regard to:
	1. The influence of Remedial Actions
	2. The influence of monitored elements
3. Define set of parameters with and without planned outages.

#### Peak Hour Values [MW]

PEAK summer and winter

* UTTC = daily + 600 MW
* LTTC = daily – 500 MW

#### Off peak values [MW]

OFF PEAK summer

* UTTC = daily + 600 MW
* LTTC = daily - 500 MW

OFF PEAK winter

* UTTC = daily + 500 MW
* LTTC = daily - 500 MW

### Band broadening

The band ***i+1*** is calculated at the end of each season (summer/winter).

Before calculating the band ***i+1***, an observation period must be completed and some parameters must be respected in order to ensure that the data used for the calculation guarantee a sufficient degree of representativeness (i.e. if the calculated NTCs have almost never been fully used by markets it’s not possible to state the calculations were reliable enough). For that, the following condition must be respected:

* **NH**≥240[[3]](#footnote-4) and **ND**≥20 : as soon as an observation period with the application of the band ***i*** is completed, they are evaluated:
	1. the number of hours (**NH**) for which **UTTCi-1, h < Sh < UTTCi, h** and no import curtailment has been applied and no ATC reduction has been needed. **Sh** is the total schedule of Italy.
	2. the number of days (**ND**) during which at least in one hour **UTTCi-1, h < Sh < UTTCi, h** and no import curtailment has been applied and no ATC reduction has been needed. **Sh** is the total schedule of Italy.

In case of the conditions above are not met, the observation period is considered as not yet completed and the new band ***i+1*** is not calculated. The “observation period” will continue until both conditions are met and at this time the new band ***i+1*** will be calculated.

Then, the application of the new band ***i+1*** can be done only if the following additional conditions are met:

* The security of the grid is guaranteed with the former band ***i*** after an in-depth analysis of available remedial actions. The following security criteria must be full-filed:
1. Remedial actions available during Capacity Calculation were also available during operational phases (DACF, IDCF, Real Time).
* Any security problem, which may have led to import curtailments or ATC reductions, has been properly investigated and its causes identified;
* Solutions have been defined and implemented for the identified causes.

If the security criteria are not yet fulfilled, the TSOs can adjust the values for the new band ***i+1***.

### Band Fall back

The band fall back will be managed as follows:

* As soon as two import curtailments (not due to increases in the IDCC process) or two ATC reductions (ATC reduction will be taken into account until the IDCC V2 process will be in place) took place within a rolling time window of seven days, the current UTTC of the band ***i*** is restricted to the UTTC of former band ***i-1*** (LTTC is not changed). After 2 weeks without any import curtailment, the band ***i-1*** is enlarged again with the value of the band ***i*.**

In case during an observation period of a band fall back the same conditions for band fall back are reached an additional fall back to the UTTC of the former band is triggered (from band ***i-k*** to band ***i-k-1***).

After 2 weeks without any import curtailment, the band ***i-k*** is enlarged again with the value of the band ***i*.**

### Control of the LTTC

Once the criteria for band broadening or fall back are met, the update of both the limits of the band (LTTC and UTTC) is triggered. On the other hand those criteria are mainly designed to check that the band guarantees against unsecure NTC values due to the upper limit and there is no specific criterion to prevent from having unrealistic or unsecure “low” NTC values (LTTC could be too low or too high). For this reason, for the time being, the Fall Back to former values of the LTTC will be triggered by experts based on the experience and on the analyses of the results.

In case the LTTC value will prove to be systematically not appropriate, new ad-hoc criteria will be defined in order to calculate and adjust it.

The update process is described in Figure 2.



Figure 2

## Methodology for the validation of cross-zonal capacity

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.

Those constraints could be, but not limited to, dynamic behavior of the grid, unplanned outage that occurs after the deadline to update the inputs.

The TSO requesting a capacity reduction is required to provide a reason for this reduction, its location (all borders on only one border) and the amount of MW to be reduced in accordance with article 26.5 of CACM regulation.

Where several TSOs of a bidding zone border request a capacity reduction on their common border, TERNA 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.

## Methodology of bilateral splitting among borders

This part of the document describes the algorithm for the NTC calculation and its splitting. It also describes how the NTC is calculated for those timestamps for which no direct calculation is performed.

The final NTC values for each hour and each border are calculated following the steps described below:



Figure 1: NTC Calculation diagram

**Preliminary NTC calculation**

For each hour h, the Preliminary NTC is calculated from the result of TTC Selection, extrapolation included, and Validation on the total Northern Italian Border.

**NTCh = TTCh - TRM**

**Preliminary Split**

The preliminary NTC is split between the borders taking into account the merchant lines on the North Italian Border and the splitting factors. The Splitting factors are calculated according to the NTC values defined in the programming stage by the programming departments of the TSOs taking into account the NTC yearly values and the planned maintenances, which affect the security of the Italian import.

**Bilateral Validation**

For each hour, the preliminary NTC values are subject to the Bilateral Validation. If a TSO sends a lower bilateral NTC value than the previously calculated (red flag), this value is taken into account for the Final NTC calculation. Then all bilateral NTC values in the respective hour are summed and the NTC profile throughout the 24 hours is smoothed, in order to avoid large variations between one hour and the next, as described below.

**NTC profile smoothing**

Large variations of NTC between one hour and the next may endanger the grid security during real time operations. For this reason, in line with the long and mid-term NTC planning, the NTC profile throughout the 24 hours has to be checked and possibly smoothed in order to respect the limits of maximum NTC increase or decrease in one hour defined by TERNA.

NTC values of the 24 hours (whether they are calculated or extrapolated from reference timestamps), coming from the Bilateral Validation process, are subject to the following iterative process:

1. Detect all hours h for which:

* NTCh+1 > NTCh + Max\_NTC\_Stepupward
* or NTCh-1 > NTCh + Max\_NTC\_Stepdownward

2. Start analyzing from the hour H, within those ones detected at point 1, with the minimum NTC

3. Step forward as long as NTCh+1 > NTCh + Max\_NTC\_Stepupward:

* Set NTCh+1 = NTCh + Max\_NTC\_Stepupward
* Step foreward (h=h+1)

4. Step backward as long as NTCh-1 > NTCh + Max\_NTC\_Stepdownward

* Set NTCh-1 = NTCh + Max\_NTC\_Stepdownward
* Step backward (h=h-1)

5. Go back to step 1 (until no NTC value has to be changed)

The results of the Smoothing process are the **NTCFinal** of each hour. The **TTCFinal** of each hour are calculated as:

**TTCFinal,h = NTCFinal,h + TRM**

**Final NTC splitting**

The NTC after smoothing (NTC Final) is split between the borders taking into account the merchant lines on the North Italian Border and the splitting factors. The splitting factors take into account the possible Bilateral Red Flags and the NTC values defined in the programming stage by the programming departments of the TSOs taking into account the NTC yearly values and the planned maintenances which affect the security of the Italian import.

## Fall back procedure

At the beginning and during every D-2 process the availability of all necessary files are constantly checked. For files that are missing or do not respect the formatting rules, a manual or automatic replacement is performed. Manual communication is done via Phone and via E-Mail. Manual data exchange is done via the ECP or E-Mail. Any new file update should be communicated to Coordinated Capacity Calculator in due time. In case Coordinated Capacity Calculator receive a new file within the given timeframe, the calculation should be restarted. If a necessary file is not received in time and no replacement is possible or the calculation dose not succeed, the process is ended and reported as failed. In case of process failure, the commercial department will use the reduced yearly NTC.

# Italy’s Export direction

## Methodology

Taking into account the historical market data for the Italy North CCR, the IN TSOs do not expect to perform daily capacity calculation in export direction for the moment because the full export is still expected to be the unlikely market direction and the optimization of the capacity in this direction is supposed to be applied rarely. Nevertheless the export capacity for each border is reassessed every year, and this value is used for the daily allocation.

The behaviour of the market is monitored by the TSOs of Italy North CCR. In case the number of cases in which Italy exports will significantly increase, the TSOs of Italy North CCR will propose a methodology to handle the capacity in such different scenarios.

1. The uncertainties which directly affect the TTC computed value possibly refer to a reduced part of the physical model, in other words, TTC is significantly sensitive to a possibly small subset of the whole physical model. [↑](#footnote-ref-2)
2. For lower limits days when the real time emergency procedures were applied have to be included and the TTC = TTC- reduction amount due to real time emergency procedures [↑](#footnote-ref-3)
3. This means the band has been used at least in 240 hours, which roughly correspond to 10 full days. [↑](#footnote-ref-4)