ACER
Agency for the Cooperation of Energy Regulators

SEE Capacity Calculation Methodology

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Introduction – Electricity market design

- Bidding-zone is the largest geographical area within which market participants are able to exchange energy without capacity allocation
- Within a bidding-zone, wholesale prices are uniform
- From the perspective of market participants who wish to buy or sell electricity within the bidding zone, there are no grid constraints ('copper plate model')

To ensure efficient market functioning:

- structural congestions should be located at bidding zone borders
- capacities for cross-border trade should be limited only by the physical capacity of interconnector lines…
- taking into account operational security limits and contingencies

Introduction – Capacity calculation

Why do we need capacity calculation?

To ensure electricity trading and exchanges do not create physical congestions.

Bidding-zones should be designed such that:

- trading inside zones is not limited and doesn't create congestions
- congestions between zones are prevented by setting limits/capacities for trading between zones

What exactly is capacity calculation?

Ex-ante limitations on trading between zones to prevent congestions created by trading

- ensure operational security of the network

Capacity calculation requires coordination between TSOs at regional level:

- direct trading between Poland and France may create congestion on DE-NL border

Introduction – Capacity calculation

In flow-based, maximum flows of network elements constrain combinations of imports and exports

<u>Flow-based capacity calculation:</u>

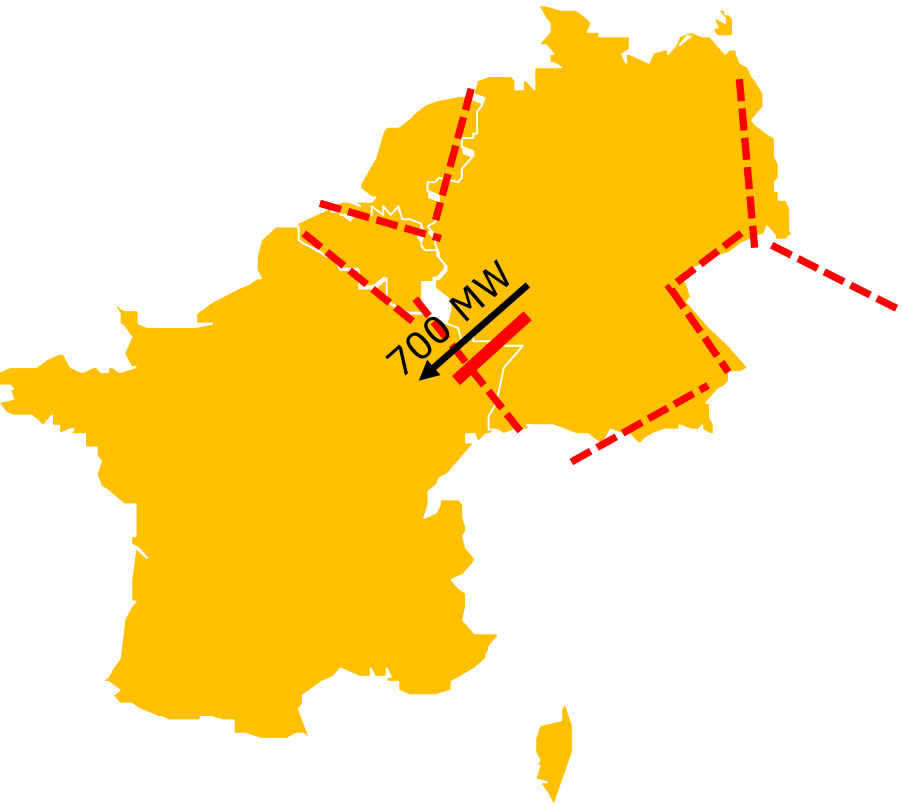
Maximises the economic value of matched bids and offers for imports and exports

such that:

$$NP\_DE * PTDF\_FR + NP\_PL * PTDF\_FR + NP\_FR * PTDF\_FR + NP\_AT * PTDF\_AT \leq 1000\ MW$$

Introduction – Capacity calculation

In NTC (SEE approach) , maximum exchanges on the borders implicitly constrain combinations of imports and exports



Coordinated net transmission capacity (NTC) calculation:

1. Splits ex-ante 1000 MW on the network element among different borders: e.g.
   - 700 MW is reserved for DE-FR NTC
   - 200 MW is reserved for BE-FR NTC
   - 100 MW is reserved for DE-AT NTC

2. Then DE-FR NTC is:

$$NP\_DE * PTDF\_FR + NP\_FR * PTDF\_FR \leq 700\ MW$$

$$NTC\ DE\text{-}FR = 700MW/PTDF\_DE\text{-}FR$$

From physical to commercial capacity

Net Transfer Capacity (NTC) and Flow-Based (FB) - differences

Coordinated Net Transfer Capacity (SEE)

- The exchange capacity between two given bidding zones is independent from the exchanges across adjacent borders.
- The maximum bilateral exchanges are fixed ex ante. The combination of possible exchanges (on a set of adjacent borders) cannot be optimised via the capacity allocation algorithm.
- Lower visibility on the location of physical congestions.
- It is an acceptable CC method for non-meshed networks (provided that a sufficient level of coordination is applied)

Flow-Based Capacity Calculation

- The actual exchange between two bidding zones is dependent on the exchanges across adjacent borders within a Capacity Calculation Region (CCR). Energy exchanges between bidding zones are limited by PTDFs and available margins on CNEs.
- The combination of possible exchanges is optimised via the FBMC algorithm.
- Higher visibility on the location of physical congestions.
- It is the most efficient CC method for meshed networks.

Source: KU Leuven Energy Institute

Introduction – Capacity calculation

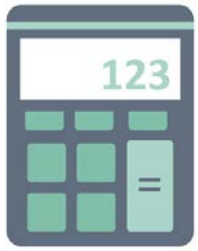
Main concepts – Overview of the relevant input parameters

Parameter	Description
PTDF – power transfer distribution factor	• Factor describing to what extent cross-zonal exchanges influence flows on CNEs.
GSK – generation shift key	• Factors describing a linear estimate of the most probable change in the generation pattern within a bidding zone in relation to the change of the net position of this bidding zone.
CNEC – critical network element and contingency	• CNE - network element either within a bidding zone or between bidding zones taken into account in the CC process, limiting the amount of power that can be exchanged. • Contingency – unplanned outage(s)
Fmax – maximum flow	• Maximum power flow that a CNE can accommodate.
RM - reliability margin	• Capacity reserved by TSOs to be able to cope with uncertainties on the relevant network elements

Introduction – Capacity calculation

Main Steps

	Common Grid Model	Inputs	Coordinated Capacity Calculation	Validation Phase
What ?	• Mathematical representation of technical characteristics of the common EU network that enables simulations of power flows	• Various factors, providing an estimate of the influence of market positions on generation and load	• Cross-border capacity calculation for each critical network element (Flow-based) or bidding zone border (Net Transfer Capacity)	• Each TSO assesses whether the outcome of capacity calculation fulfils operational security requirements
By Whom ?	• Regional Security Coordinator and TSOs	• Coordinated Capacity Calculator and TSOs	• Coordinated Capacity Calculator	• TSOs



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Capacity calculation in the SEE Region

SEE region

- Bulgaria, Greece, and Romania
- TSOs: ESO EAD (BG), ADMIE (GR), TRANSELECTRICA (RO)
- NRAs: RAE (GR), DKER (BG), ANRE (RO)

Decision process

- 1st TSO proposal by 19 January 2018
- Request for Amendment by 25 June 2018
- 2nd TSO proposal by 27 August 2018
- 2nd RfA by 26 October
- 3rd TSO proposal by 7 February 2019
- Regulatory authorities approved on 4 April 2019

Capacity calculation in the SEE Region

Main features

Inputs to the methodology

- Operational Security limits
- Reliability Margin
- GSK
- RA

Mathematical description of the methodology

- Including cross-zonal capacity validation

Back-up and fallback

- Backups and replacement process
- Fallback NTC values

Transparency

- Lists publication requirements

CNTC approach – centralised calculation delivering the main parameter for the definition of CNTC domain: Total Transmission Capacity (TTC)

The methodology defines roles, communication, inputs, computation for the establishment of TTC values at all SEE borders.

Capacity calculation in the SEE Region

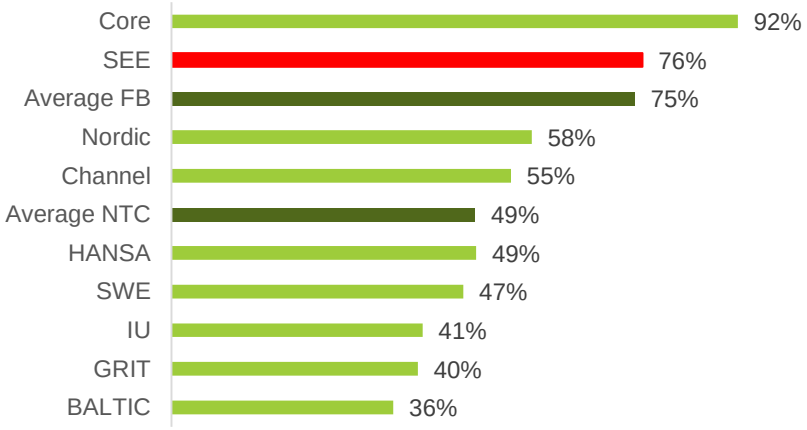
Agency assessment

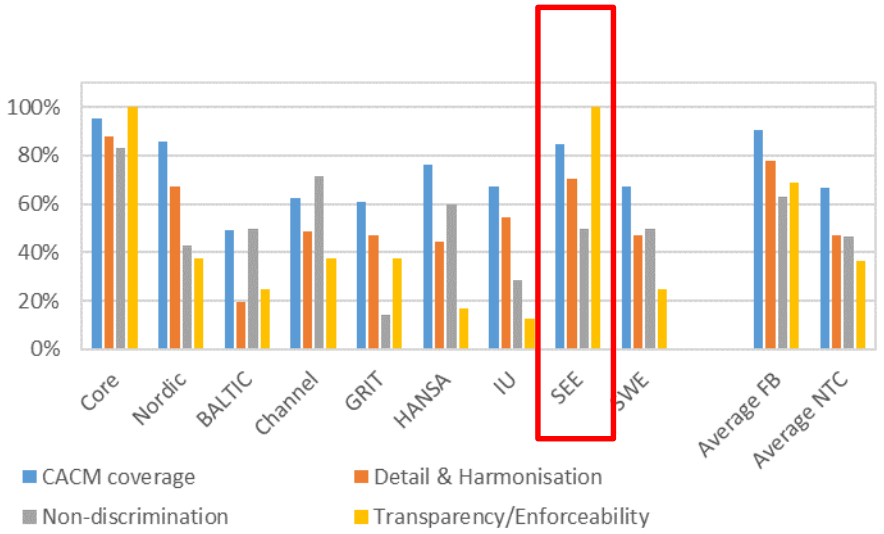
The 2018 MMR assesses how CCMs are likely to guarantee the success of general and specific objectives of the CACM Regulation, through four aspects:

- The 'CACM Regulation coverage'. This aspect assesses the explicit inclusion (or absence) of the provisions addressing the relevant requirements set by Articles 9, 20 to 27, 29 and 30 of the CACM Regulation;
- The level of 'detail and harmonisation'. This aspect assesses the content of the provisions, i.e. if they are sufficiently detailed to allow transparency and reproducibility of the calculation (e.g. possibility for third parties to replicate it), and the extent to which they result in harmonised principles, methodologies or values for a series of parameters of the CCM within a CCR;
- 'Non-discrimination'. This aspect assesses the extent to which CCMs include explicit provisions to ensure non-discrimination between internal and cross-zonal exchanges;
- 'Transparency and enforceability'. This aspect assesses: (i) the extent to which CCMs ensure that relevant information will be published timely, transparently, ensuring user-friendliness and the quality of the data, and (ii) the extent to which CCMs are drafted so as to clarify tasks, responsibilities and implementation deadlines. Non-discrimination of cross-zonal exchanges may be ensured through various means, including e.g. the design of bidding zones and CCMs.

Capacity calculation in the SEE Region

Agency assessment





Source: ACER 2018 Market Monitoring Report

Capacity calculation in the SEE Region

Conclusion

The 2016 and 2017 MMRs revealed a low fulfilment of the capacity calculation coordination requirements of the CACM Regulation, respectively for the years 2016 and 2017; in 2017, the SEE CCR showed the lowest level of fulfilment*. The analysis of loop flows in 2017 revealed that loop flows are comparatively smaller in the SEE (4.6 TWh) than the Core region.

The IMR revealed difficulties in implementing the Codes so far. The TSOs of the SEE CCR initiated the work on their capacity calculation methodology with a delay; implementation of the EU HAR was delayed because the Bulgarian TSO did not anticipate necessary adaptations of its IT system. Therefore, specific regulatory attention is needed in this CCR.

An end goal for the SEE CCR should be gradually to merge with the Core CCR and thereby properly coordinate on interdependencies already affecting both regions**.

In light of the issues highlighted above, the implementation of the CCM will be challenging; however, the approved SEE CCM offers good guarantees that it will address such issues. Nevertheless, the following aspects require specific attention:

- Non-discrimination (assessment score 50%): the methodology does not include rules for avoiding undue discrimination between internal and cross-zonal exchanges to ensure compliance with point 1.7 of Annex I to Regulation (EC) No 714/2009 - the methodology does not include sufficient provisions to guaranteed that discrimination will not arise in the future; and
- Details and harmonisation (assessment score 70%): the methodology for the establishment of GSKs must be further detailed, and deviations to the general calculation of reliability margins must be better framed.

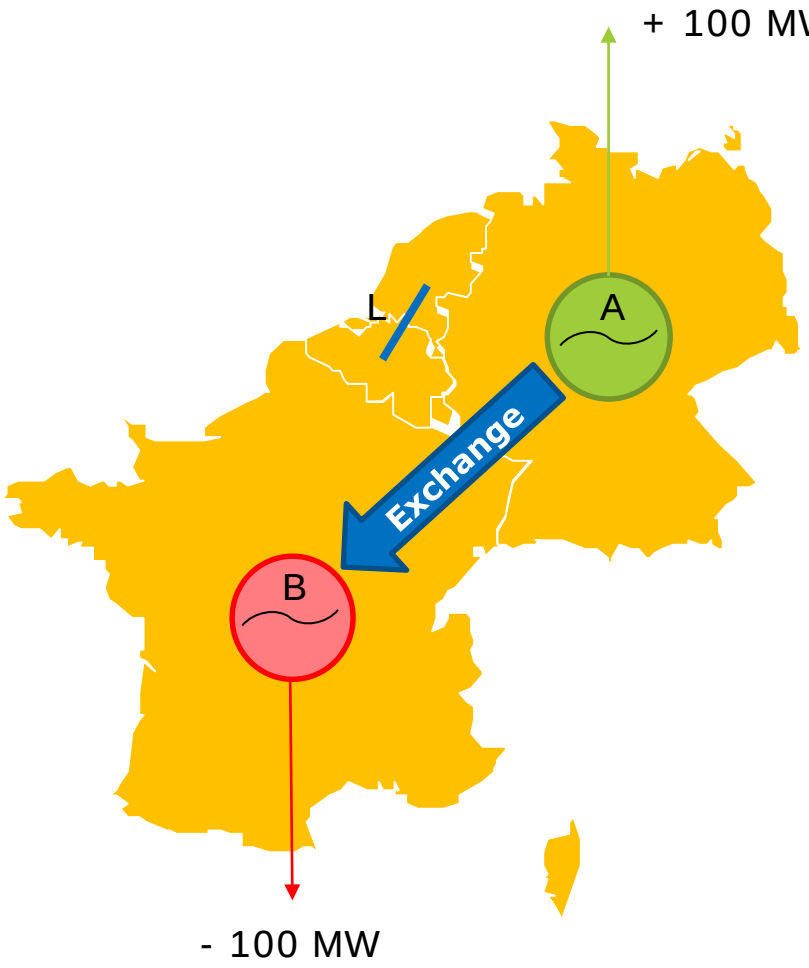
* See table ii of the 2016 MMR, revealing that the RO>BG and BG<RO borders present some of the lowest ratios between tradable capacity (NTC) and benchmark capacity in the EU. See also paragraph (272) of the 2017 MMR, explaining that regarding bidding zone efficiency, as far as cross-zonal capacity is concerned, Bulgaria and Romania are two of the three countries which performed the worst, approximately 75% below the benchmark capacity.

** See paragraph (116) of the IMR.

Thank you for your kind attention !

Introduction – Capacity calculation

Main concepts – Power Transfer Distribution Factors (PTDFs)



CNEC (« L »)

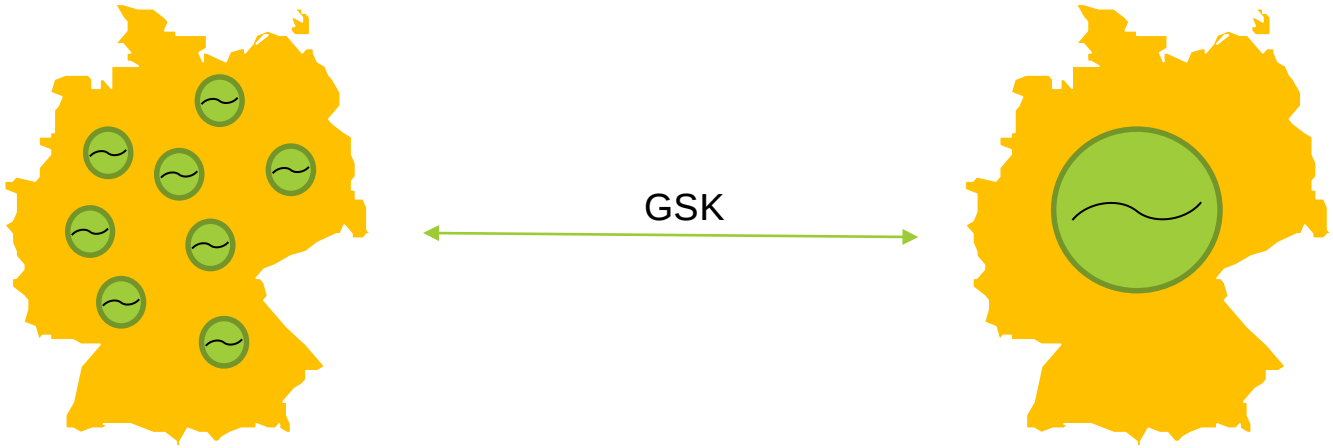
Generation (« A »)

Load (« B »)

- TSOs have limited freedom to direct electric flows
- A PTDF quantifies the impact of an exchange between two zones (A and B) on a given CNEC (L)
- A PTDF of 10% means that an exchange of 100 MW from A to B induces an increase of 100 MW * 10% = 10 MW on the network element L

Introduction – Capacity calculation

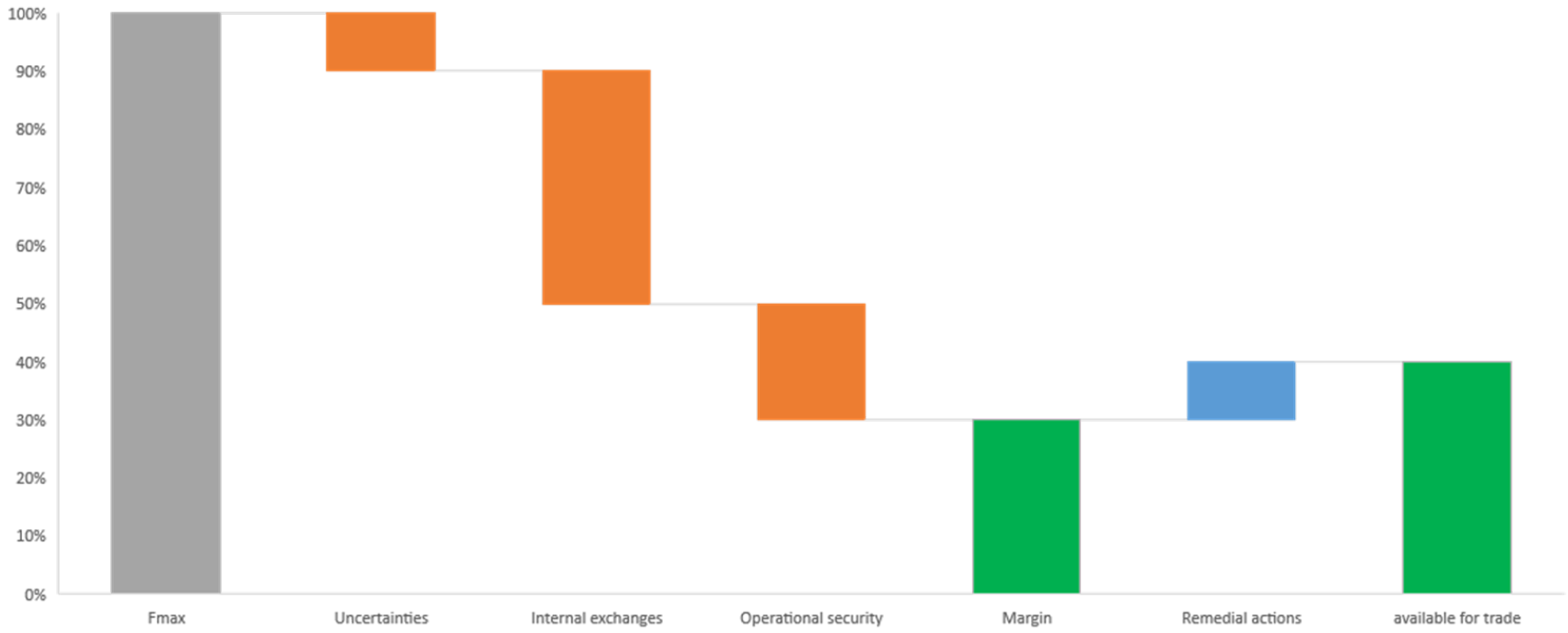
Main concepts – Generation Shift Keys (GSKs)



- GSKs denote the nodal contribution to the zonal generation balance and are needed to compile different nodes into one equivalent node.
- GSKs represent a linear estimation of the most probable change in the generation pattern within a bidding zone in relation to the change of the net position of this bidding zone.
- If for instance considering 1 generation unit in bidding zone A, a GSK_A of 40% means that an increase of 100 MW of the exchange from A to any bidding zone will be modelled as an increase of 40 MW of the generation from A.

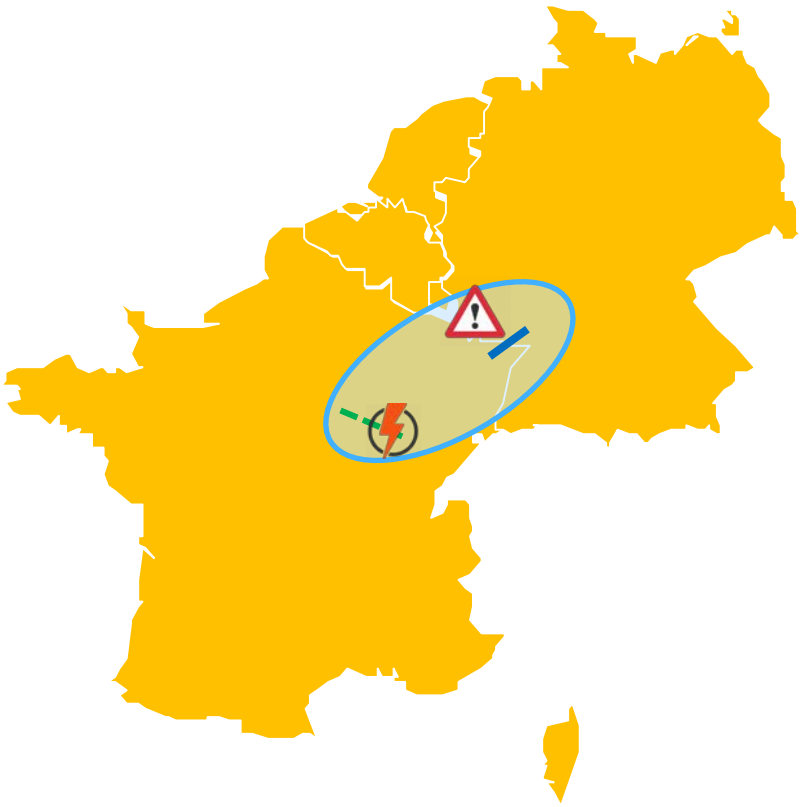
Introduction – Capacity calculation

Main concepts – Breakdown of the available capacity



Introduction – Capacity calculation

Main concepts – Critical network Elements and Contingencies (CNEC)



Critical **N**etwork **E**lement

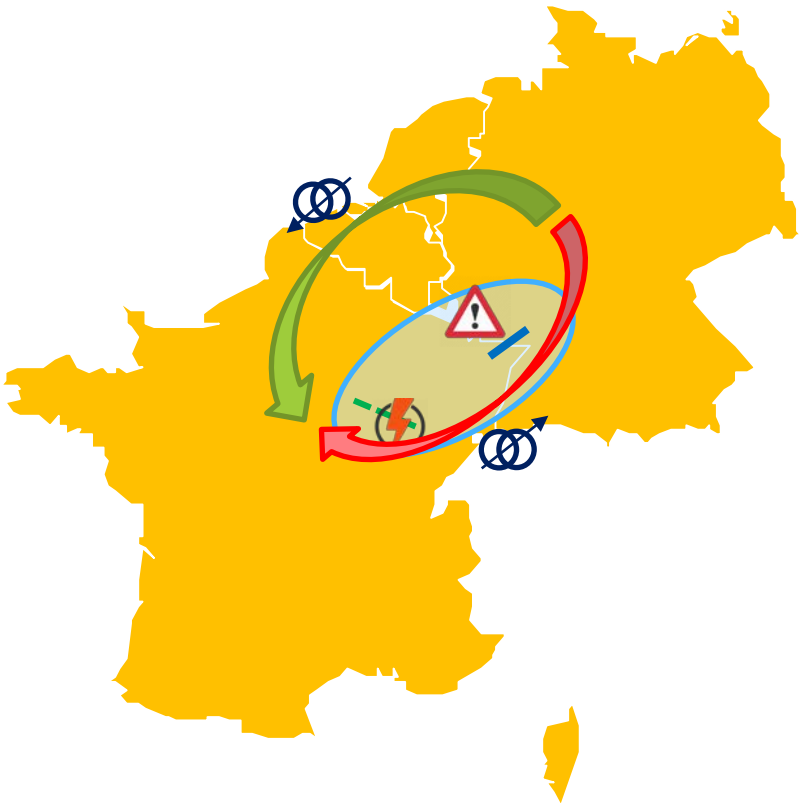
Contingency (outage)

CNEC

- Network elements impacted by cross-zonal exchanges should be monitored
- CNEs should be on the borders of bidding zones
- CNEs inside bidding-zones may only limit cross-zonal exchanges if other ways to address congestions are less efficient

Introduction – Capacity calculation

Main concepts – Remedial Actions

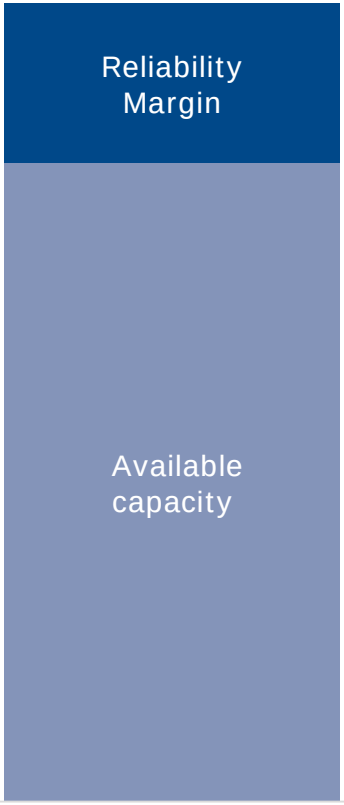


Remedial Actions redirect flows to ensure operational security

- Any measure applied by a TSO or several TSOs, manually or automatically, in order to maintain operational security
- Non costly remedial actions usually impact the network topology.
- Costly remedial actions change the generation/load patterns (include countertrading and redispatching).

Introduction – Capacity calculation

Main concepts – Reliability Margin



This security margin copes with uncertainties

- between the capacity calculation time-frame and real time
- resulting from unintentional deviations of physical flows during operation due to the physical functioning of frequency control (e.g. resulting from the operation of automated security controls)

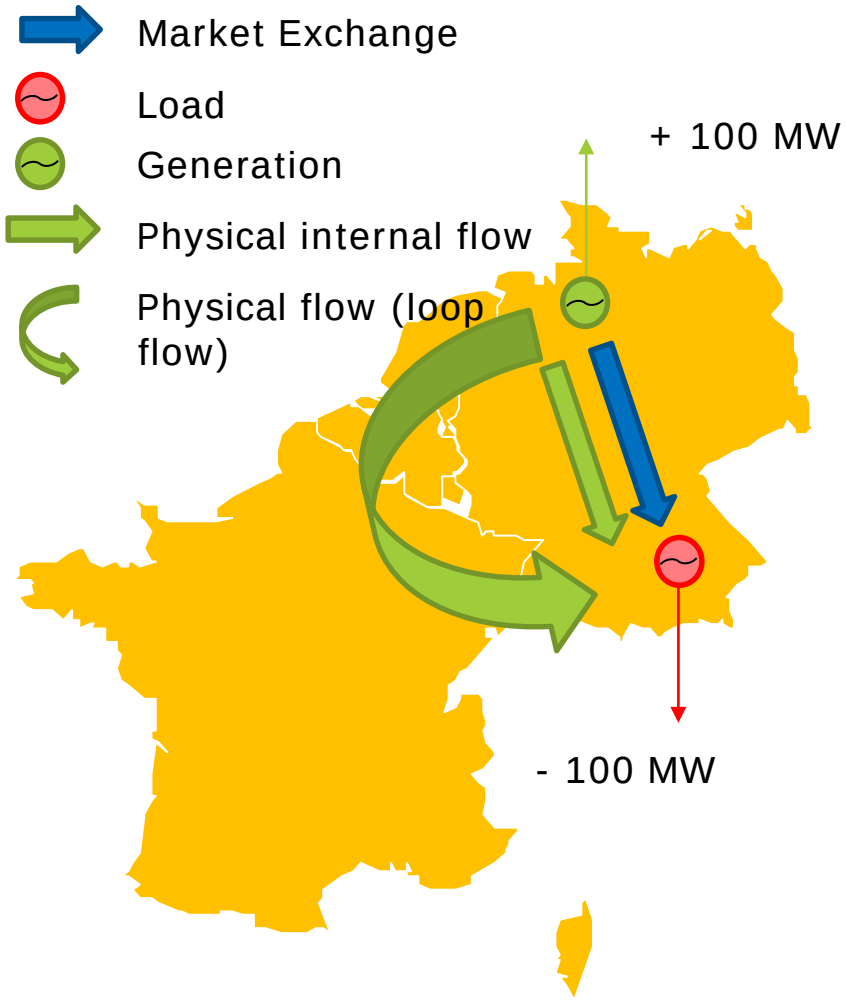
Higher margins lower the risk born by the TSOs.

Typical risk level is 10%.

Thermal capacity of the network element

Introduction – Capacity calculation

Main concepts – Loop Flows



- As the energy moves freely through the grid from generation to consumption, not only imported/exported energy will cross borders. The physical flows on these borders can be split in different flow types - flows related to import and export, transit flows and loop flows.
- A transit flow can be defined as the physical flow due to the export from one zone to another zone.
- A loop flow can be defined as the physical flow due to internal energy transfers in one bidding zone.
- Loop flows may consume available capacity and may thus limit cross zonal exchanges.