Congestion and congestion management

Per Arne Vada and Stephany Paredes

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1. Introduction
2. What is congestion?
3. Ways to handle congestion
4. Regulatory aspects

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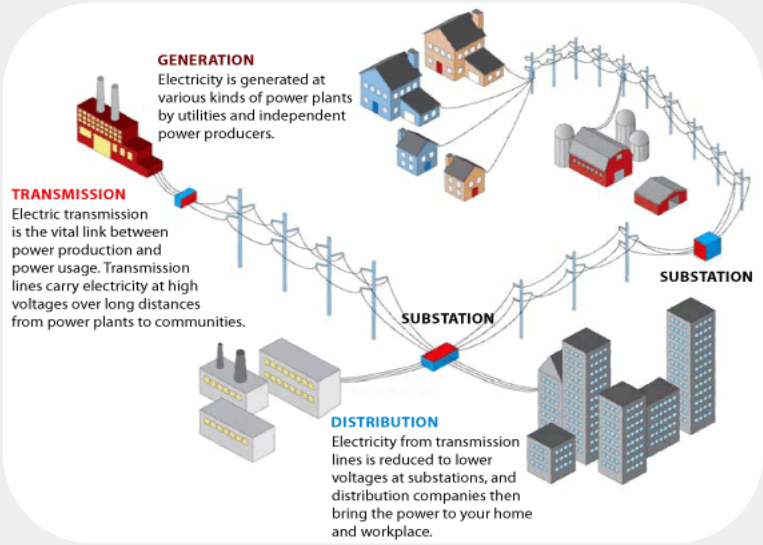
Transmission assets are needed to transfer power from production to demand centres

In several cases, these are not geographically co-located

Local grid



European Grid

1 Local generation must deliver power to demand centres via distribution grids within an area (e.g. within a city). These grids are typically managed by different distribution system operators and determine the internal power distribution capabilities ***within*** e.g. a bidding zone.

2 The European power system is interconnected. This means that generation from one country can be exported to another to cover electricity demand. This grid is made up of several transmission lines. The size of this grid determines the power transfer capabilities ***between*** bidding zones.

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   - 2.1 General definition
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3. Ways to handle congestion
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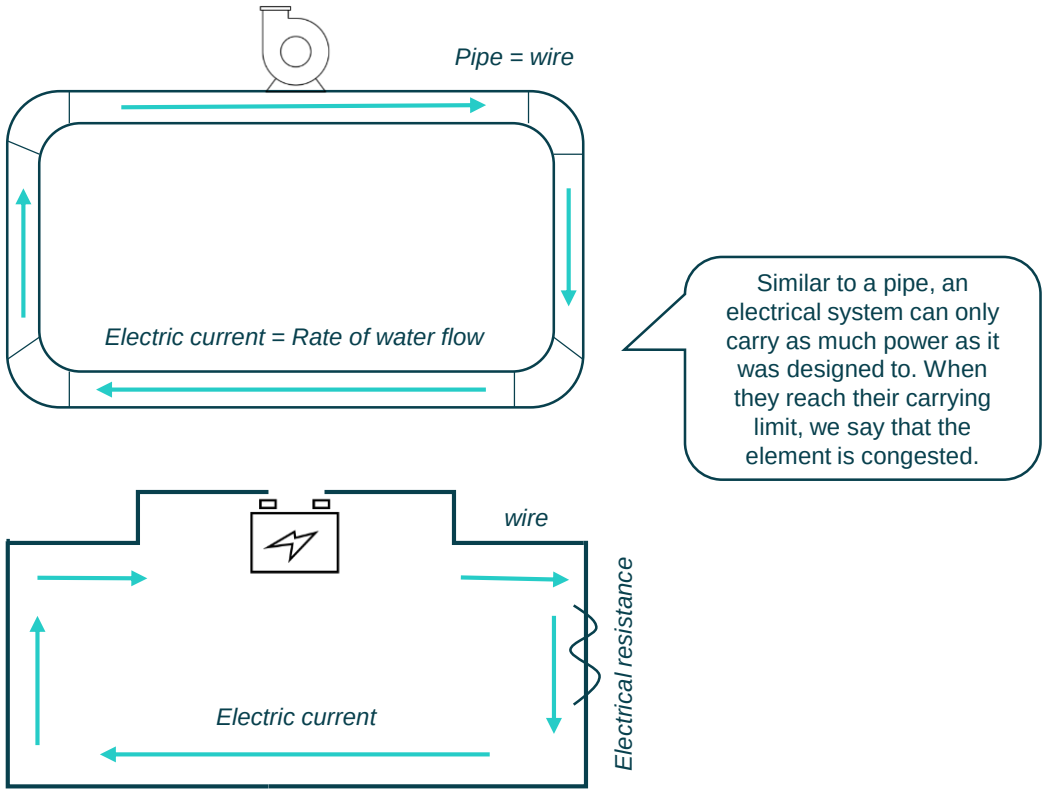
What is congestion?

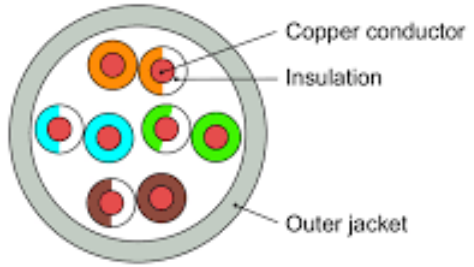
Pipes and electricity analogy



Similar to a pipe, an electrical system can only carry as much power as it was designed to. When they reach their carrying limit, we say that the element is congested.

Examples of physical limitations

- **Thermal limits**: cables are designed to withstand a certain amount of current. As current flows through a cable, this heats up. Given material properties, there is a limit to how much this temperature can be.



- When talking about an interconnected grid, we also inherently talk about element interdependency. Since a grid element is part of a larger system, its limits will likely vary in order to guarantee a safe system operation (e.g. **stability and voltage limits**). These can vary due to availability of different elements at each point in time, demand and generation patterns, etc.

A system needs redundancy to ensure safe operation in case of failure, this creates other types of limits other than the pure physical properties of an element

N-1 Principle

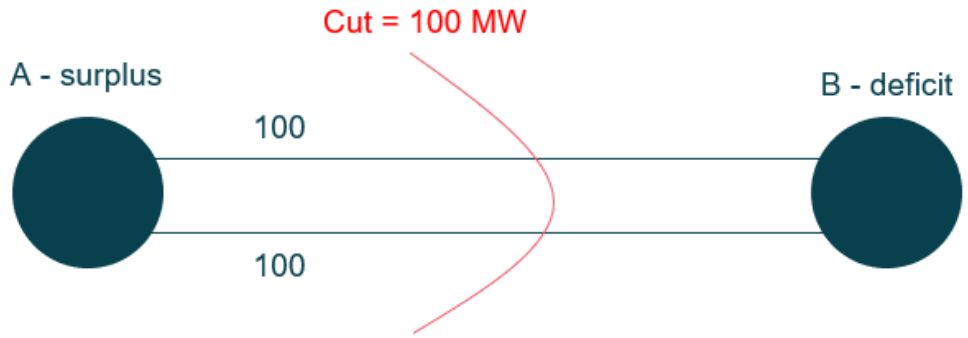
In regulation

COMMISSION REGULATION (EU) 2017/1485
of 2 August 2017
establishing a guideline on electricity transmission system operation
(Text with EEA relevance)
(OJ L 220, 25.8.2017, p. 1)

(14) '(N-1) criterion' means the rule according to which the elements remaining in operation within a TSO's control area after occurrence of a contingency are capable of accommodating the new operational situation without violating operational security limits;

(15) '(N-1) situation' means the situation in the transmission system in which one contingency from the contingency list occurred;

Example



In this situation, and in order to guarantee safe operation of the system in case of contingency on one of the lines, only a maximum 100 MW are allowed to flow from A to B.

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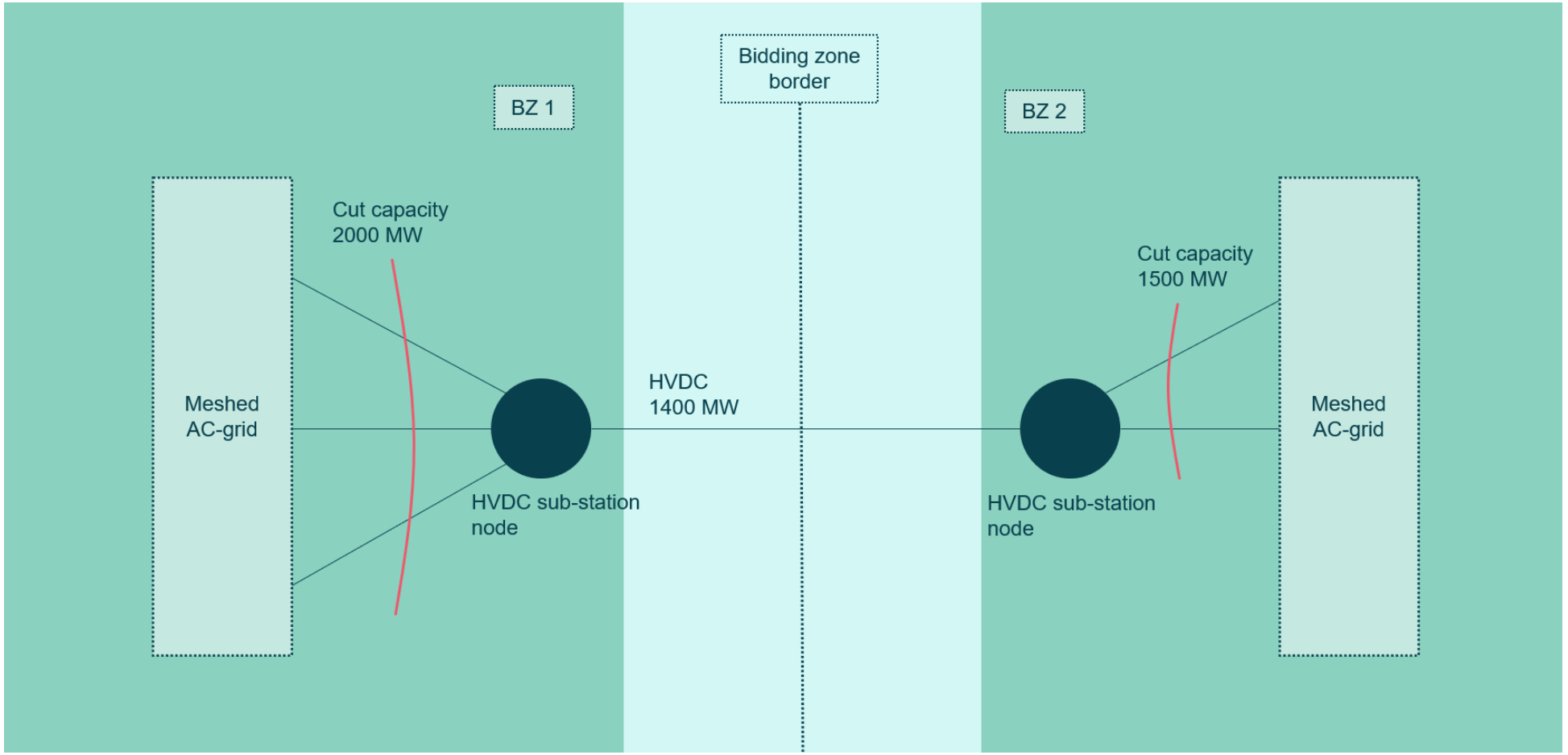
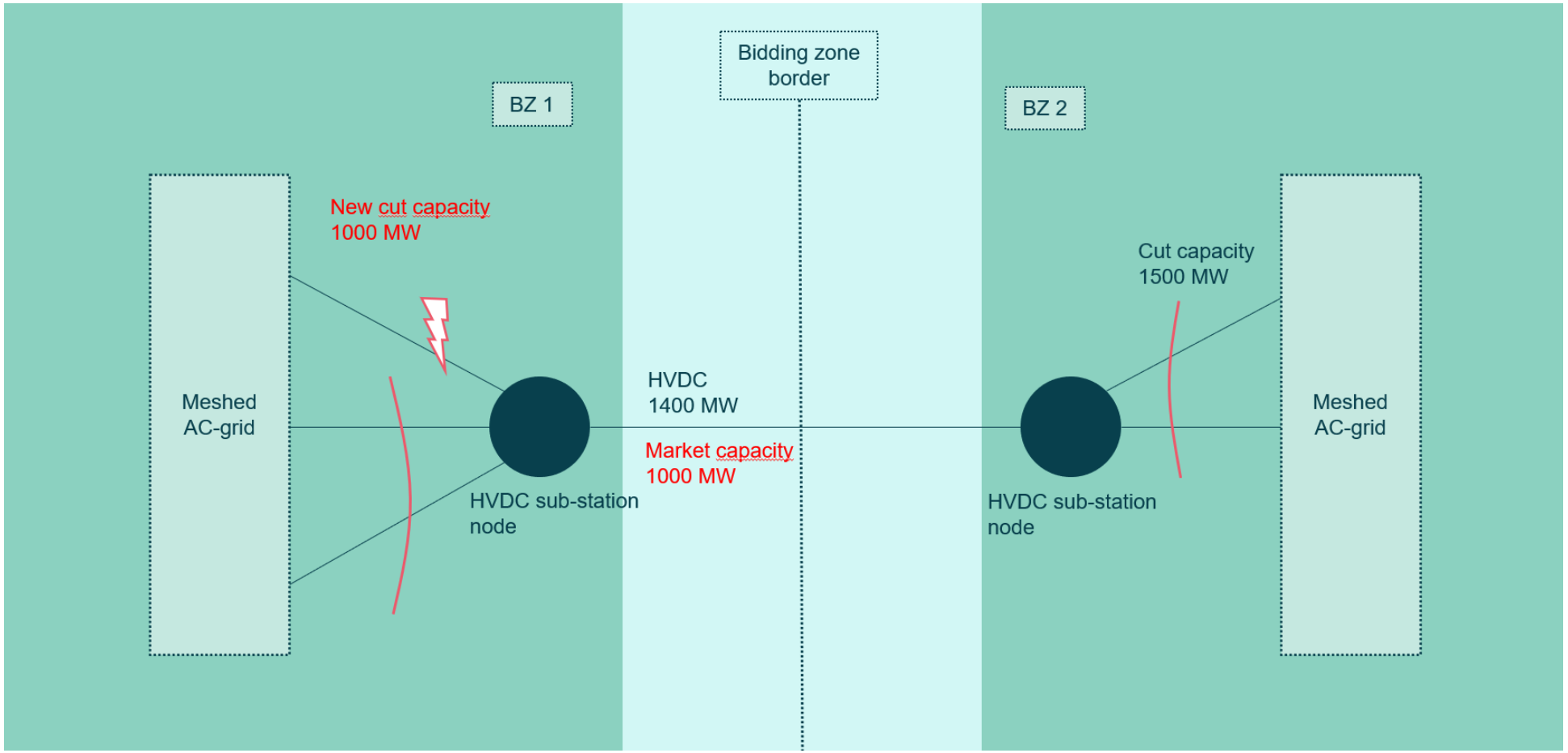
Example 1: HVDC cable is a limiting factor

Straight forward when one component is the limiting factor, in this case determines the cross-zonal capacity allocated to the market



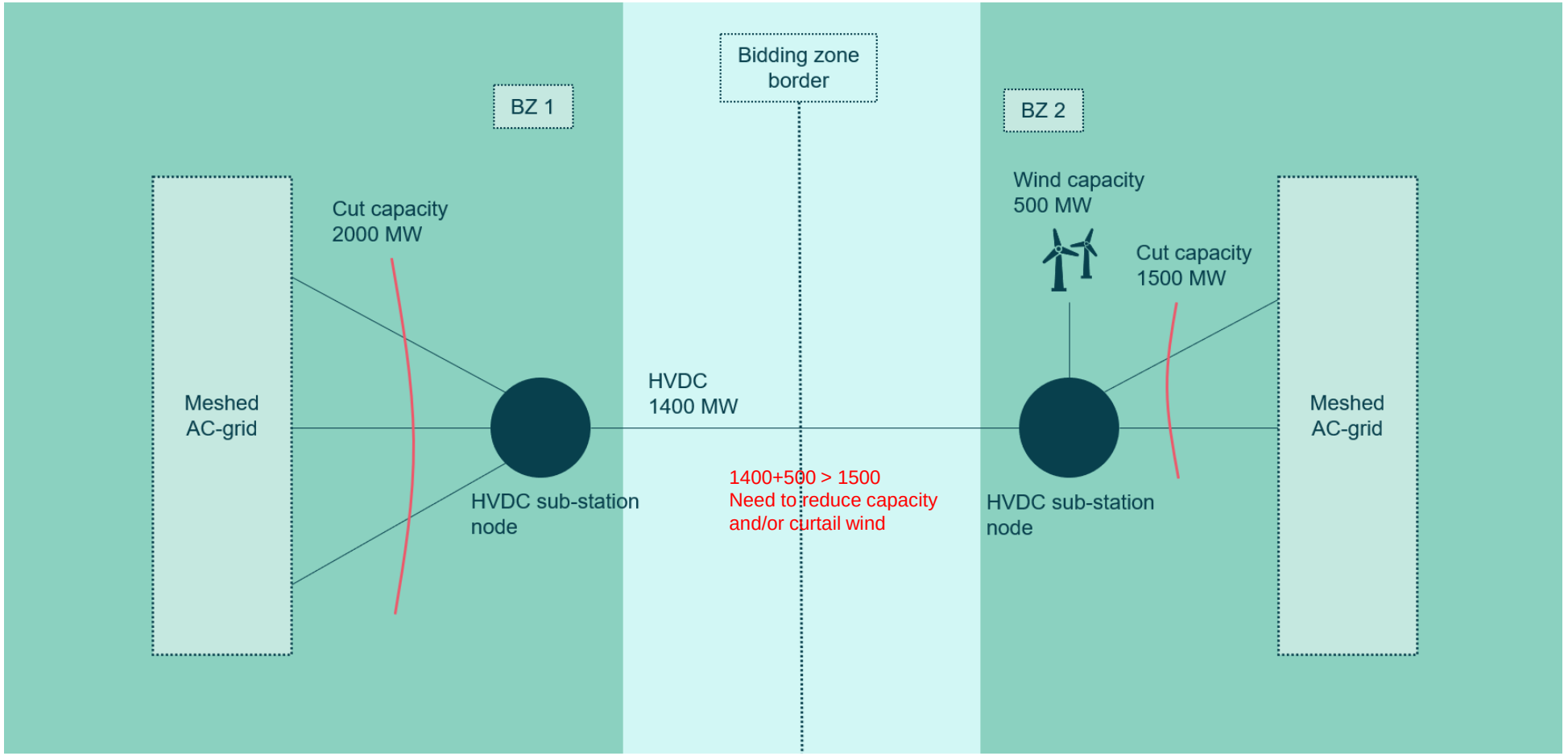
Example 2: Internal Congestion as a limiting factor

In practice, many times internal congestions might result in reduced cross-zonal capacity



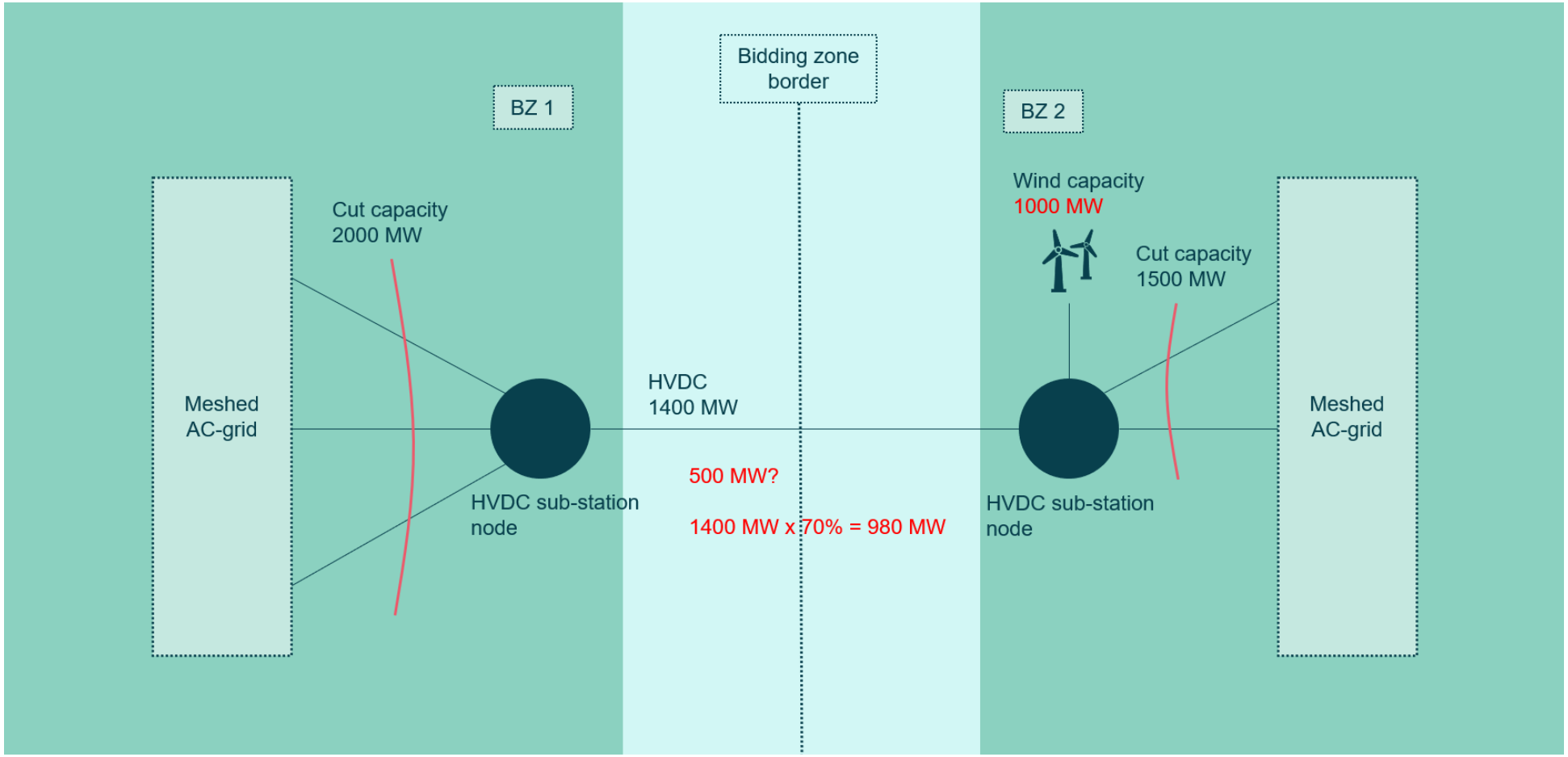
Example 3: Production as a congestion factor

Internal congestion can arise , leading to a need curtailment or reduction of available trade capacity



Example 3a: 70 % rule

If we increase the onshore wind generation to 1000 MW, is the capacity limited to 500 MW? No, probably the 70% rule requires the TSO to give 980 MW to the market. This will need to be countertraded or onshore wind to be curtailed.



Example 3a: 70 % rule

If we increase the onshore wind generation to 1000 MW in the capacity limited to 500 MW? No, probably the 70% rule requires the TSO to give 980 MW to the market. This will need to be countertraded or onshore wind to be curtailed.

In Regulation:

REGULATION (EU) 2019/943 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL

of 5 June 2019

on the internal market for electricity

(recast)

(Text with EEA relevance)

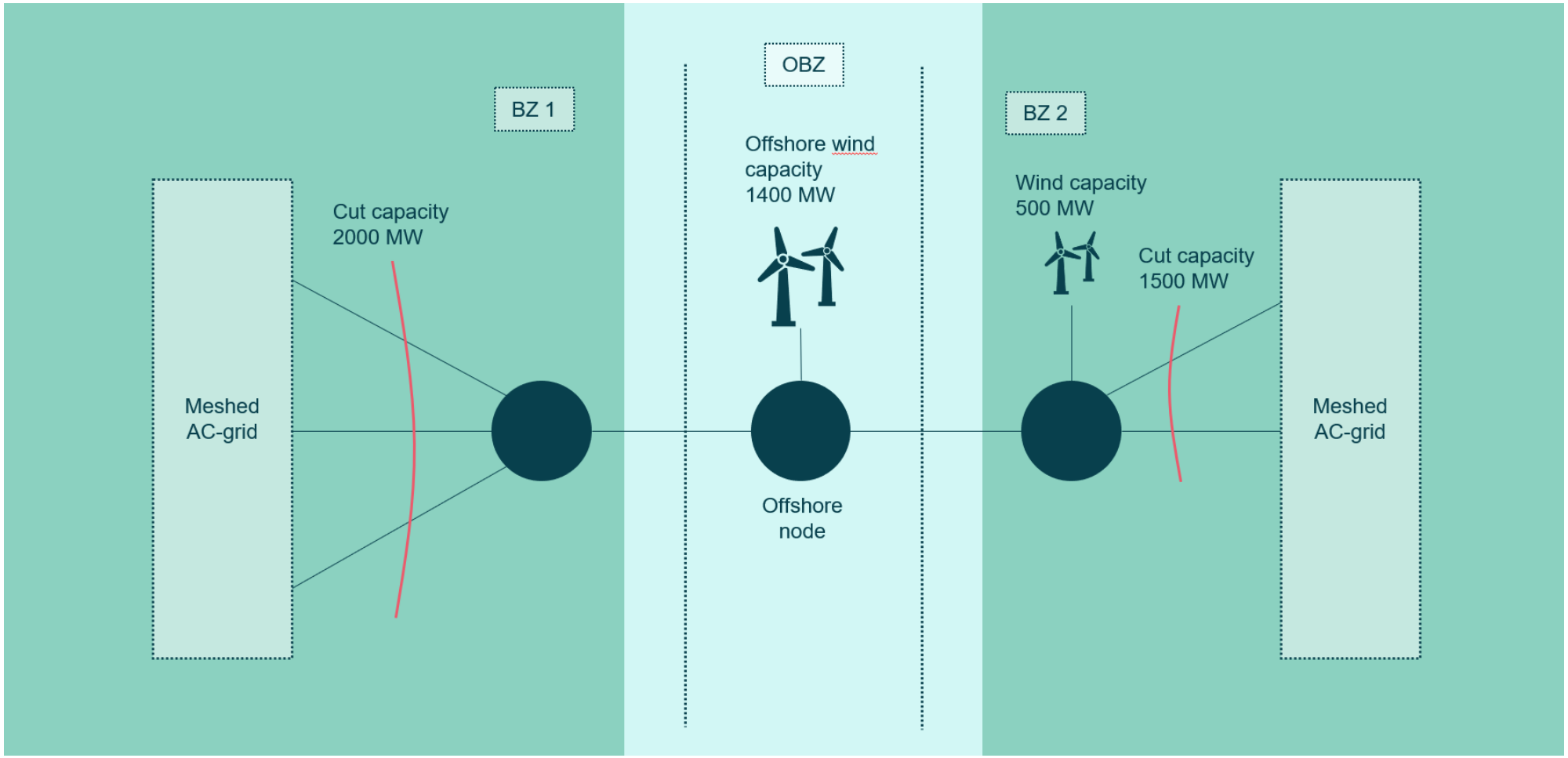
8. Transmission system operators shall not limit the volume of interconnection capacity to be made available to market participants as a means of solving congestion inside their own bidding zone or as a means of managing flows resulting from transactions internal to bidding zones. Without prejudice to the application of the derogations under paragraphs 3 and 9 of this Article and to the application of Article 15(2), this paragraph shall be considered to be complied with where the following minimum levels of available capacity for cross-zonal trade are reached:

(a) for borders using a coordinated net transmission capacity approach, the minimum capacity shall be 70 % of the transmission capacity respecting operational security limits after deduction of contingencies, as determined in accordance with the capacity allocation and congestion management guideline adopted on the basis of Article 18(5) of Regulation (EC) No 714/2009;

(b) for borders using a flow-based approach, the minimum capacity shall be a margin set in the capacity calculation process as available for flows induced by cross-zonal exchange. The margin shall be 70 % of the capacity respecting operational security limits of internal and cross-zonal critical network elements, taking into account contingencies, as determined in accordance with the capacity allocation and congestion management guideline adopted on the basis of Article 18(5) of Regulation (EC) No 714/2009.

Example 4: Hybrid assets case

For a hybrid asset, the complexity increases. The grid is not planned optimally in this case, but realistically a risk that offshore wind developers might face. Therefore, strong interest in 70% rule and compensation mechanisms.

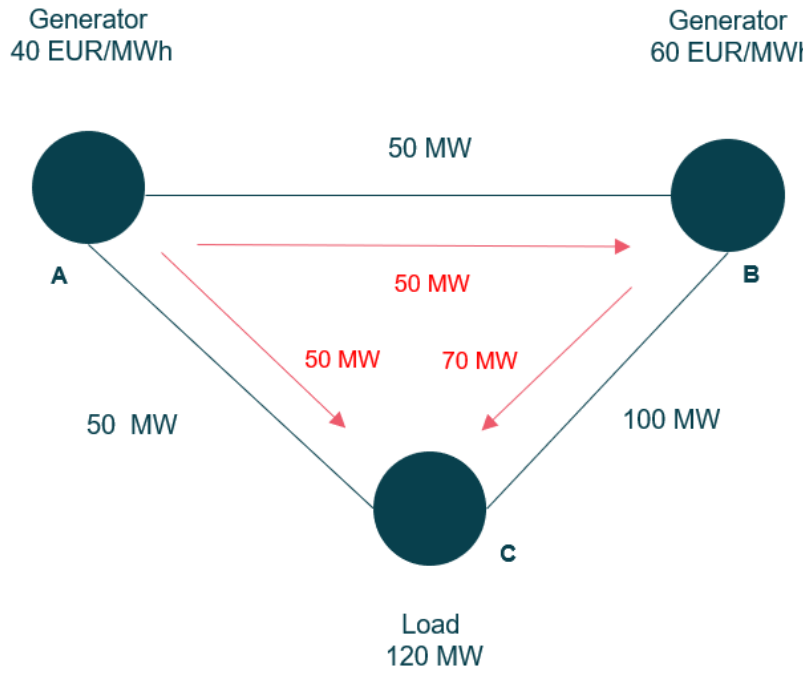


What is congestion - Consequences

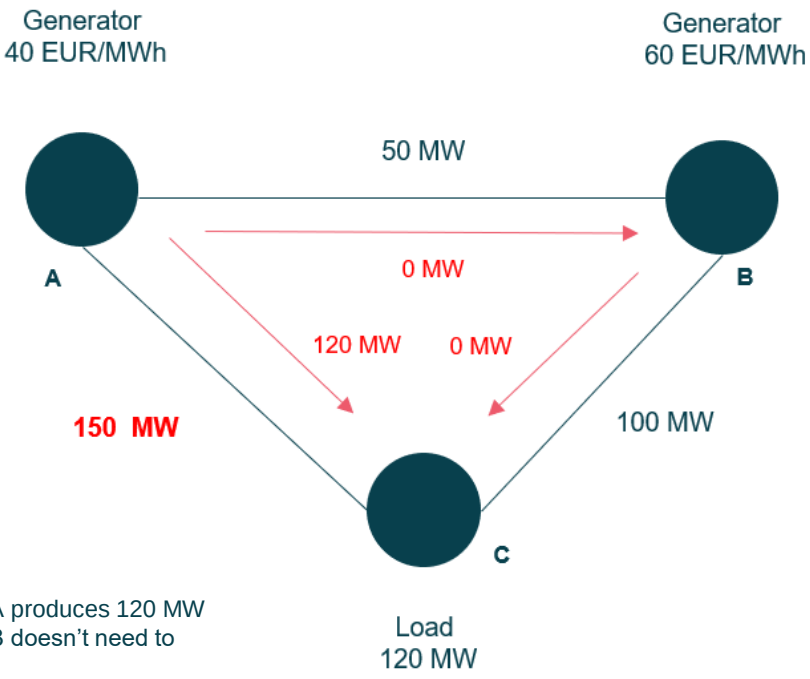
Congestion in the power grid has consequences for the different actors in the power market – either through the use of remedial actions (discussed later) or directly reflected in power prices

Example on how prices are affected due to congestions in the grid

Generator A produces 100 MW and
Generator B produces 20 MW



Price: 60 EUR/MWh



Generator A produces 120 MW
Generator B doesn't need to produce

Price:40 EUR/MWh

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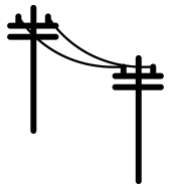
Ways to handle congestion – Technical measures

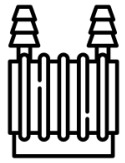
There are some technical solutions to address congestion in the power grid – some of them are listed below:

Grid planning and new connections



- Building of new transmission lines
- Connect generation and consumption appropriately in the grid to avoid congestion.
- Etc.

Transformer tap changers

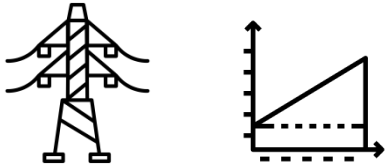


- Helps preserve voltage stability in the grid when needed.

Flexible Alternating current technologies (FACTS)

- Enhance the power transfer capability of transmission lines through the use of power electronics.

Dynamic line rating

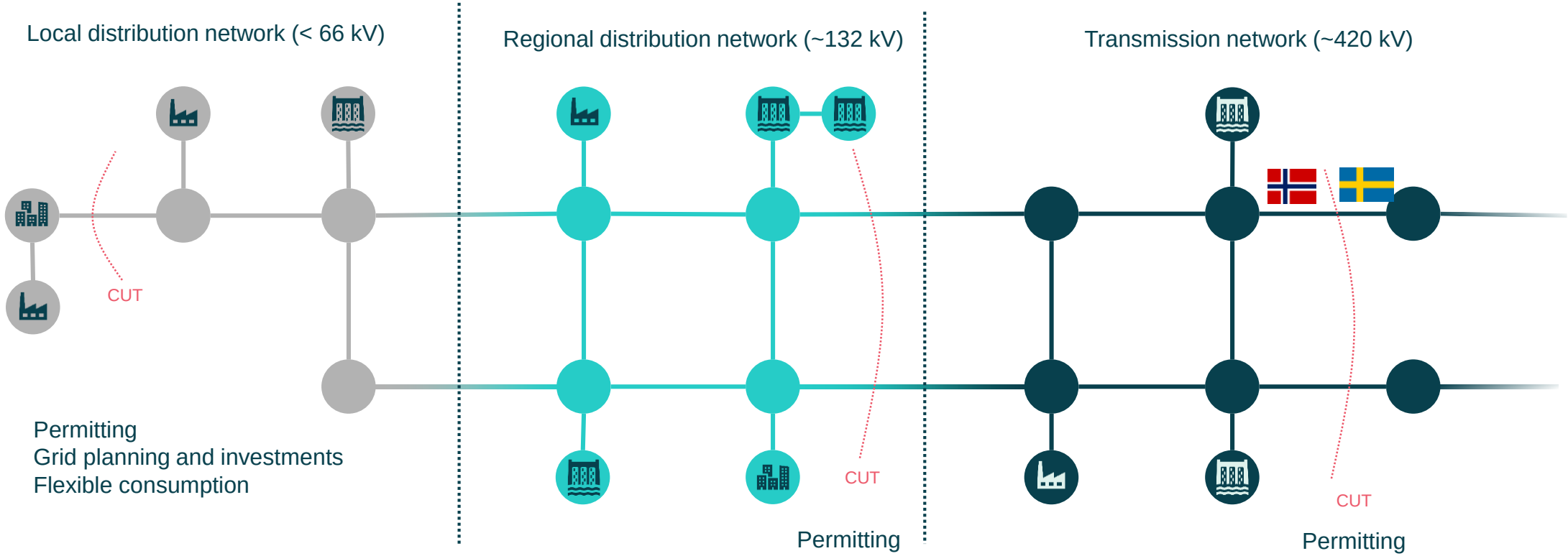


- Can increase the available capacity to the market by providing a better overview of the line actual limitations at a specific moment in time.

System protection schemes

- Can increase the pre-fault capacity of the “cuts” by changing production or consumption immediately at a specified location in case of an unexpected outage.

How to *actually* deal with congestions

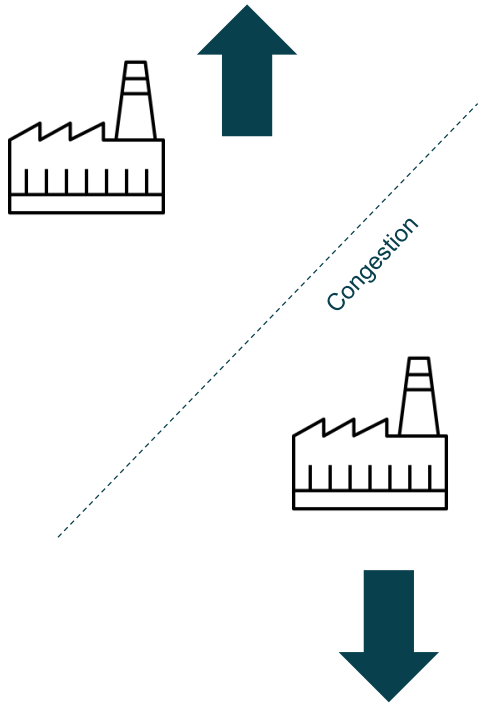


Ways to handle congestion – Market based solutions

Congestion can be handled through market mechanisms

Below we list some of the solutions available to market actors

Re – dispatch and countertrading



Load management

Curtailment

Demand response e.g. through local flexibility marketplaces

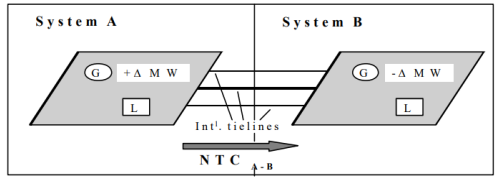
Bidding zones

Bidding Zone Review

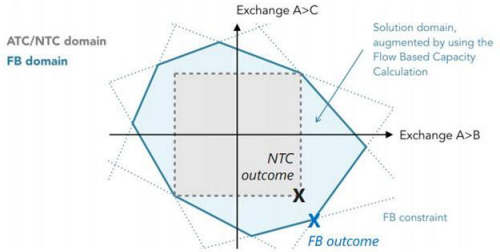
What is Bidding Zone Review (BZR)?

According to Commission Regulation (EU) 2015/1222 (CACM), bidding zones (BZs) should be defined in such a manner as to ensure efficient congestion management and overall market efficiency. In addition, according to the Commission Regulation (EU) 2019/943 (Electricity Regulation under the Clean Energy Package), bidding zone borders (BZBs) shall be based on long-term, structural congestions in the transmission network. BZs shall not contain such structural congestions unless they have no impact on neighbouring BZs, or unless as a temporary exemption, their impact on neighbouring BZs is mitigated with remedial actions and those structural congestions do not lead to reductions in cross-zonal trading capacity in accordance with the requirements of Article 16 of the Electricity Regulation.

NTC allocation



FBMC/Nodal pricing



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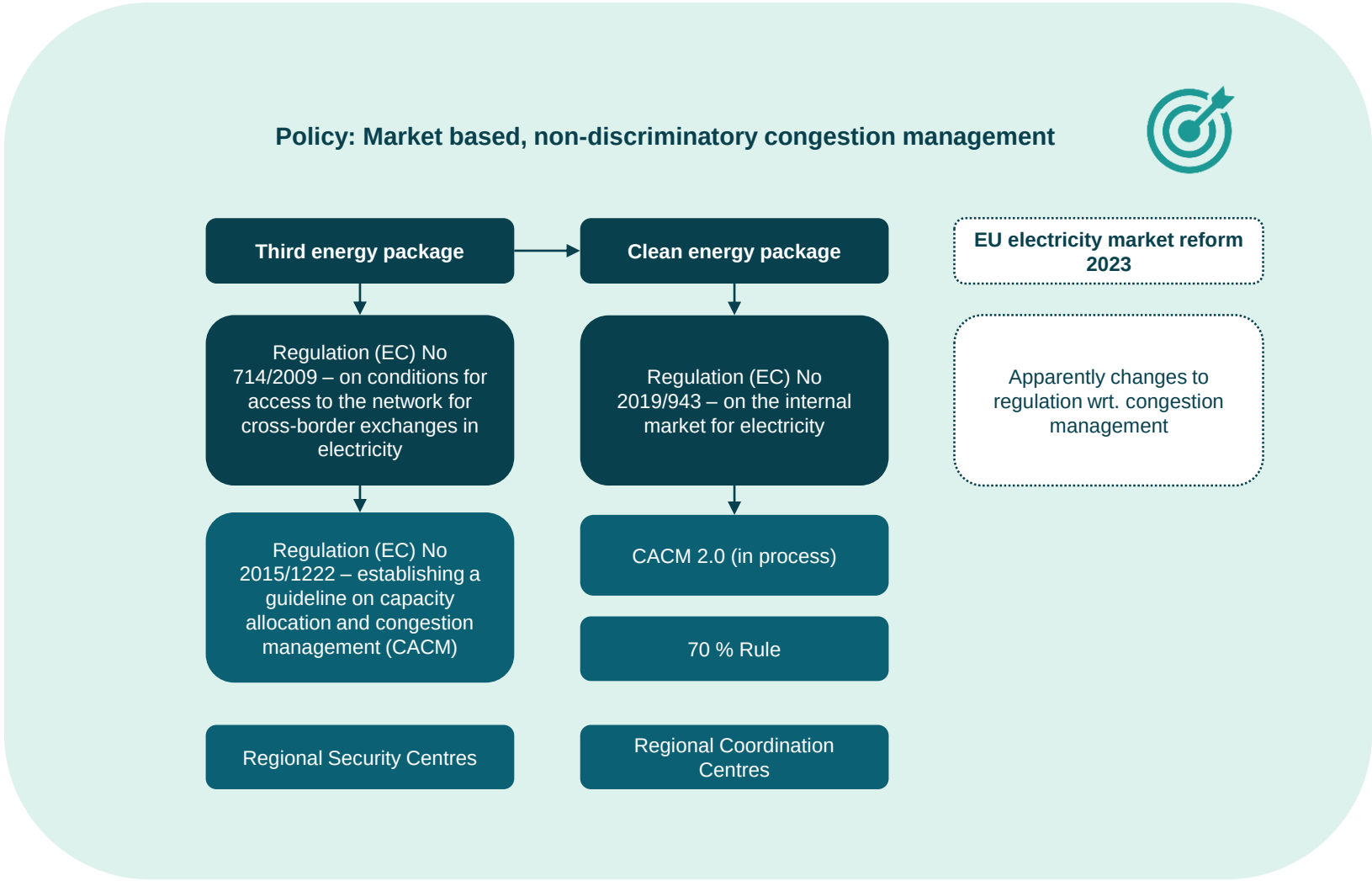
EU legal and regulatory background (includes, but not limited to)

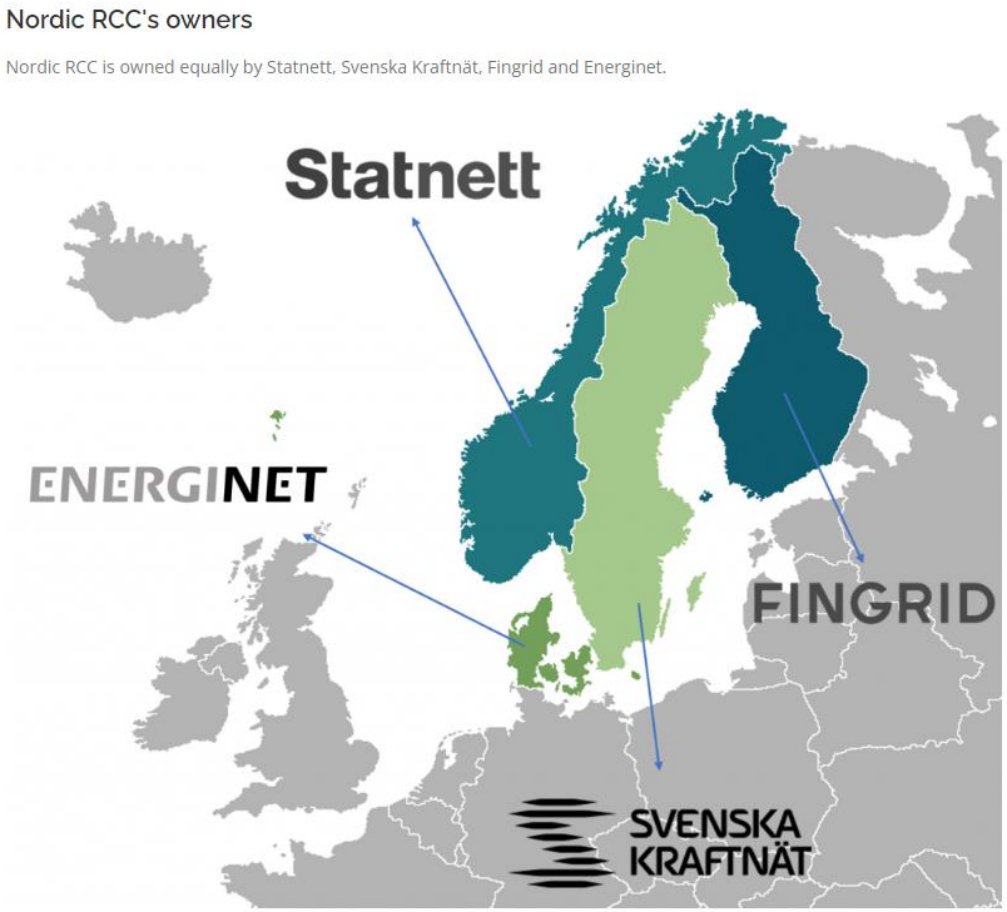


Regional Coordination Centres

- The RCCs supports the national TSOs in maintaining security of the power system, in an increasingly integrated European power system
- TSOs cooperate through the RCC to decide which remedial actions close to a national border is the most efficient
- RCC tasks are described in Annex I of the Electricity Regulation (EU) 2019/943
- Tasks mostly related to congestions and congestion management

1. Coordinated capacity calculation
2. Coordinated security analysis
3. Creation of common grid models
4. Regional outage planning coordination
5. Identification of needs for new transmission capacity, for upgrade of existing transmission capacity or their alternatives

- The Nordic RCC is located in Copenhagen, Denmark, and similar RCCs exists in Brussels, Munich, Serbia, Baltics and Greece to cover all of Europe



https://nordic-rcc.net/

Norway legal and regulatory background (includes, but not limited to)

Energiloven

Forskrift om systemansvar

Retningslinjer for utøvelsen av systemansvaret

§ 5. *Flaskehalser og budområder*

Systemansvarlig skal håndtere alle flaskehalser i regional- og transmisjonsnettet.

Systemansvarlig skal fastsette budområder for å håndtere store og langvarige flaskehalser i regional- og transmisjonsnettet.

Systemansvarlig skal normalt fastsette separate budområder ved forventet energiknapphet i et avgrenset geografisk område.

Flaskehalser i regional- og transmisjonsnettet som ikke håndteres ved bruk av budområder, skal systemansvarlig normalt håndtere ved bruk av regulerkraftmarkedet. Merkostnaden ved å fravike normal rekkefølge for effektuering av regulerkraft skal dekkes av systemansvarlig.

Systemansvarlig skal informere aktørene i kraftmarkedet om fastsatte budområder i rimelig tid før de tas i bruk. Systemansvarlig skal skriftlig informere Reguleringsmyndigheten for energi før øvrige aktører informeres.

§ 6. *Fastsettelse av handelskapasitet*

Systemansvarlig har ansvar for fastsettelse av handelskapasitet mellom budområder, per tidsenhet.

Systemansvarlig skal offentliggjøre informasjon knyttet til tilgjengelig handelskapasitet i rimelig tid før de tas i bruk.

§ 7. *Overføringsgrenser*

Konsesjonær i regional- og transmisjonsnettet skal utarbeide og skriftlig rapportere til systemansvarlig oversikt over egne anleggsdelers maksimale overføringsgrenser. Dersom systemansvarlig mener innrapporterte maksimale overføringsgrenser er satt for lave, skal systemansvarlig skriftlig rapportere dette til Reguleringsmyndigheten for energi. Systemansvarlig fastsetter innhold, format og frister for rapporteringen etter denne paragrafen.

Systemansvarlig kan fastsette driftsmessige overføringsgrenser i regional- og transmisjonsnettet. De driftsmessige overføringsgrensene skal ikke medføre overskridelse av anleggsdelenes maksimale overføringsgrenser uten etter avtale med konsesjonæren.

Questions?