ENTSO-E Public Workshop on
"NC HVDC - Call for Stakeholder Input"

General approach towards a European Network Code on HVDC connection requirements

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Reliable Sustainable Connected

What is a Network Code?

A set of rules applying to one aspect of the energy sector

Which are developed by ACER, ENTSO-E & Market Participants

And become legally binding after the Comitology process

Hence they will have the same status as any other Regulation

ENTSO-E's role in developing Network Codes

under the designation of Regulation 714/2009

Article 4: ENTSO

- Charged with working to complete the internal market.

Article 6: Creating network codes

- In line with ACER framework guidelines.
- Which become binding.
- And involve extensive consultation.

Article 8; Para 7: The scope of network codes

- Cross border & market integration issues.
- Without prejudice to Member States' right to establish codes.

Article 8: ENTSO-E's activities

- Network Codes
- Ten Year Network Development Plans.
- Generation adequacy.
- Winter and summer outlooks.
- Work programs and annual reports.

How are network codes developed?

Development of Framework Guidelines (FWGL)

Request to draft a FWGL	
EC	On a topic identified in art.8 (6) of Regulation EC 714/2009
Development of the FWGL (6 month period)	
ACER	In consultation with ENTSO-E, stakeholders and Expert Group
Request for ENTSO-E to draft a network code	
EC	According to FWGL submitted by ACER

Development of Network Code

Period in which ENTSO-E can develop a NC (12 month period)	
[redacted]	In consultation with stakeholders according to FWGL

Assessment, agreement & entry into force

Assessment of NC	
ACER	Recommendation of NC to EC
Comitology Process (where appropriate)	
EC	In consultation with all stakeholders resulting in legally binding NC

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What do Network Codes aim for?

Enabling renewables	Creating clear connection rules.	Providing harmonisation to benefit manufacturers.	Creating markets to reduce risks.
Ensuring security of supply	A coordinated approach to system operations.	Greater optimisation to enhance efficiency.	More flexible markets (e.g. balancing).
Enhancing competition	A single market design across Europe (in all timescales).	Promoting cross border trade & enhancing liquidity.	Reducing risk for all market players

Overview of set of Network Codes

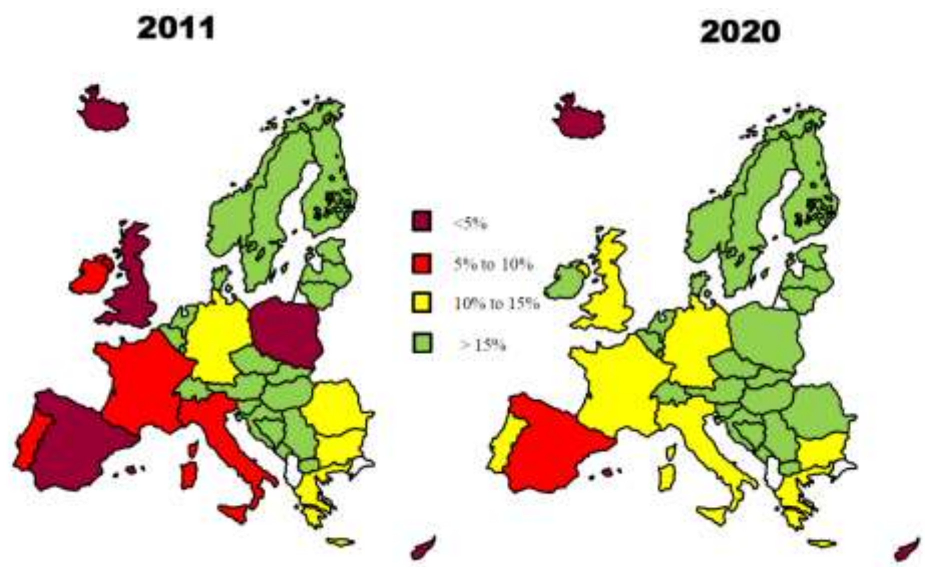
Connection Related Codes	• Requirements for Generators • Demand Connection Code • HVDC Connection Code • Connection Procedures	(RfG) (DCC) (HVDC) (CP)
System Operation Related Codes	• Operational Security Network • Operational Planning & Scheduling • Load Frequency Control & Reserves • Operational Procedures in an Emergency • Staff Training	(OS) (OPS) (LFCR) (EP) (ST)
Market Related Codes	• Capacity Allocation & Congestion Management • Forward Capacity Allocation • Balancing Network Code	(CACM) (FCA) (BAL)

NC HVDC Topics

- HVDC Systems in Europe
- General Approach
- Structure
- NC Drafting Principles
- Significant Grid Users
- Applications of HVDC AND DC connected PPMs
- Appropriate Level of Detail for HVDC
- Isolated Networks Principles
- Information Exchange
- Derogations

HVDC Solutions in Europe

Global challenges and local system needs



Interconnection Ration reflects the % interconnection capability compared to installed power capacity for each country.

The interconnection with HVDC can be realized in three different ways:

- 1. To connect two or more Synchronous Areas (SA) to each other. The HVDC link is considered a significant grid user at all connection points.
- 2. To provide a transfer capability inside a single synchronous area, called embedded HVDC. The parallel operation of the HVDC with HVAC can encompassing a single TSO control area or 2 or more control areas.
- 3. To connect remote generation to the main AC network. The HVDC connection may or may not be part of the generation facility.

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NC HVDC General Approach

- **Why are HVDC connections relevant in Network Codes on European level?**
  - Its inherent capabilities, e.g. fast active and reactive power control, supplementary control, etc…, support the EU's energy goals.
  - HVDC connected grid users complement those of generation and demand.

- **Why are DC connected Power Park Modules (PPMs) included?**
  - HVDC system in combination to PPMs could bring economic benefits
  - Coordination between capabilities of HVDC system and PPMs

- **How to cope with different technologies?**
  - Requirements should not favour a specific technology

- **How should non-mature, but potential future DC grids, be considered in this NC HVDC?**
  - Requirements for HVDC connections and DC connected PPMs should not be a barrier to future expansion into multi-terminal or meshed DC grids (either onshore or offshore)

NC HVDC General Approach

Guiding principle of the NC HVDC

- to develop requirements for high-voltage DC links and the DC connected Power Park Modules
- … from the perspective of maintaining, preserving and restoring the security of the interconnected electricity transmission and distribution systems with a high level of reliability and quality
- … in order to facilitate the functioning of the EU-internal electricity market
- … tomorrow and in the decades to come.

Present situation

- Many countries have no HVDC grid code while other countries have or are in the process of establishing national requirements either within the national code or in appendices documents.
- It is challenging but crucial to draft a NC HVDC at European level

The main principles for drafting this code

- provided in ACER's framework guidelines on electricity grid connections
- complementing other grid users (generation/demand)

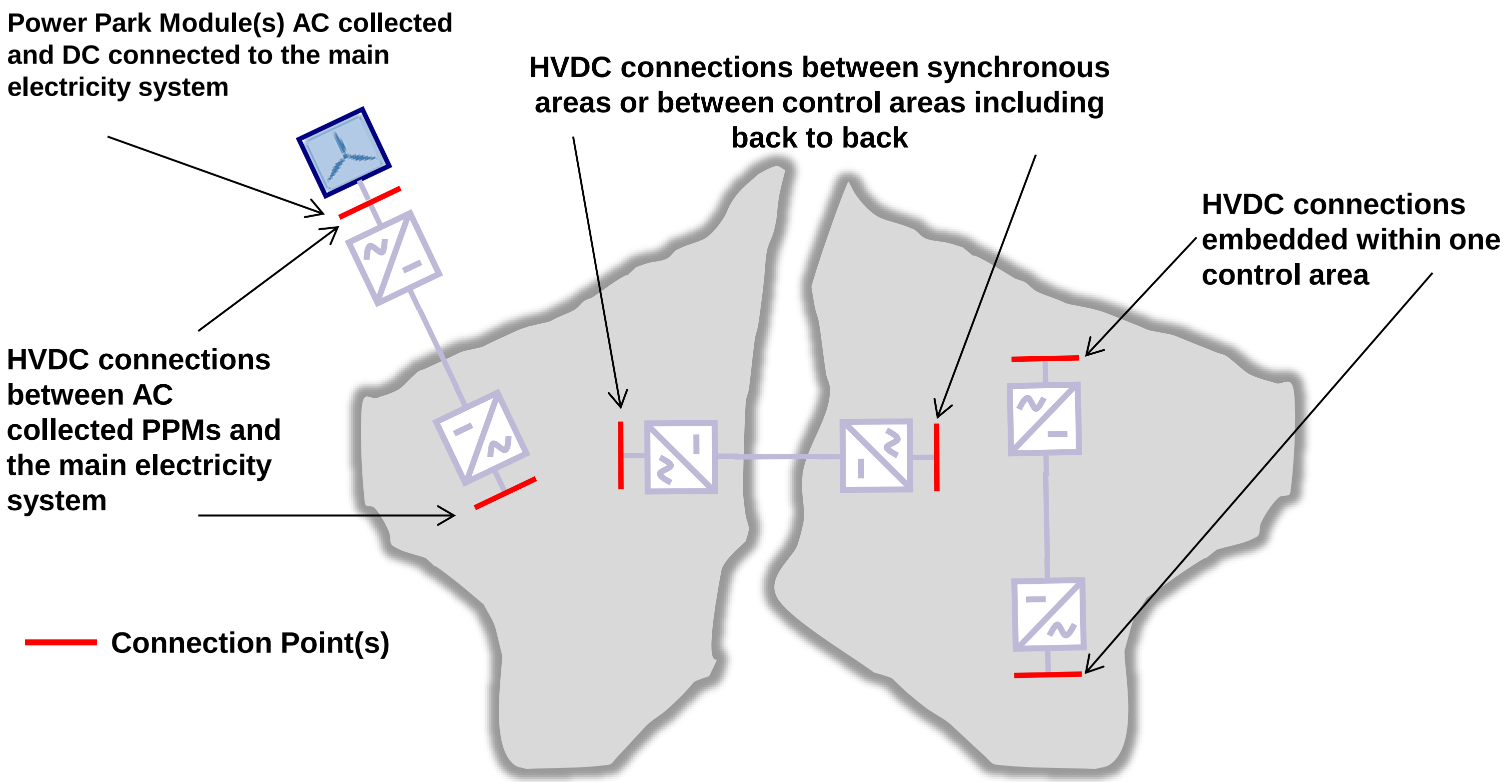
ACER‘s framework guidelines

- “The network code(s) developed according to these framework guidelines shall apply to grid connections for **all types of significant grid users**, already or to be, connected to transmission or distribution network.”

- “Any grid user **not deemed to be a significant grid user** shall not fall under the requirement of the network code(s)”

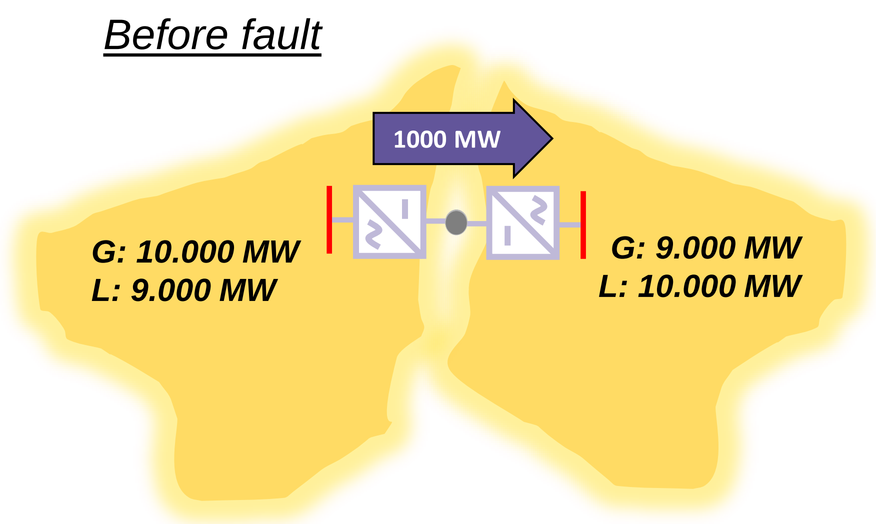
- “Significant Grid Users – pre-existing grid users and new grid users which are deemed significant **on the basis of their impact on cross border system performance** via influence on the **control area’s security of supply**, including provision of ancillary services”

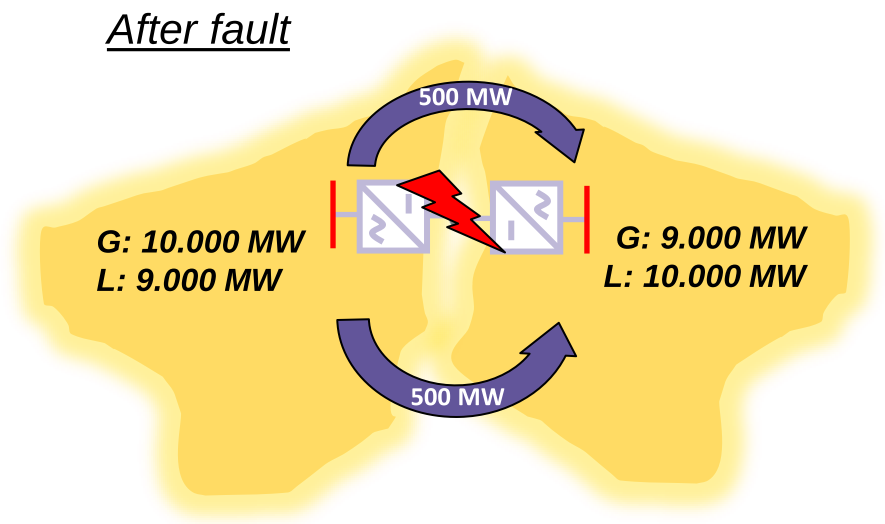
Applications of HVDC and DC connected PPMs



HVDC systems between synchronous/control areas

An HVDC transmission system with AC/DC terminals across multiple synchronous areas or control areas, has a cross border impact due to the fact that a fault on the HVDC system causes the change of flows between control areas. Therefore these schemes are deemed to be Significant Grid Users.

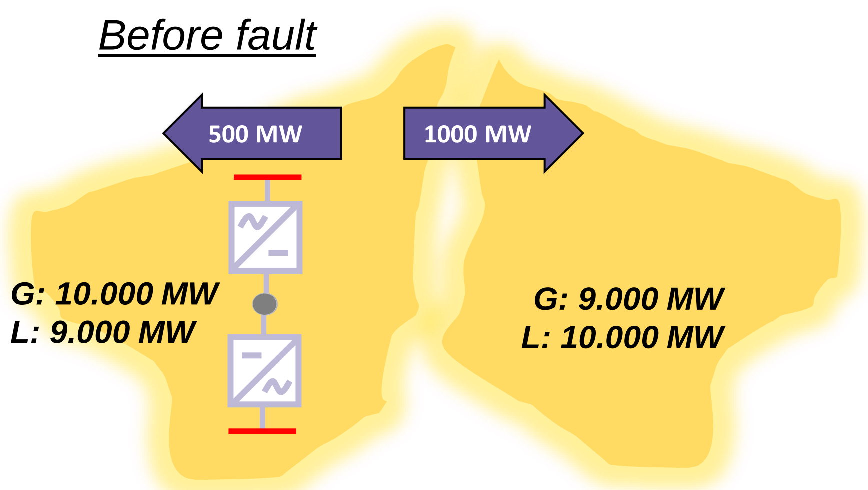


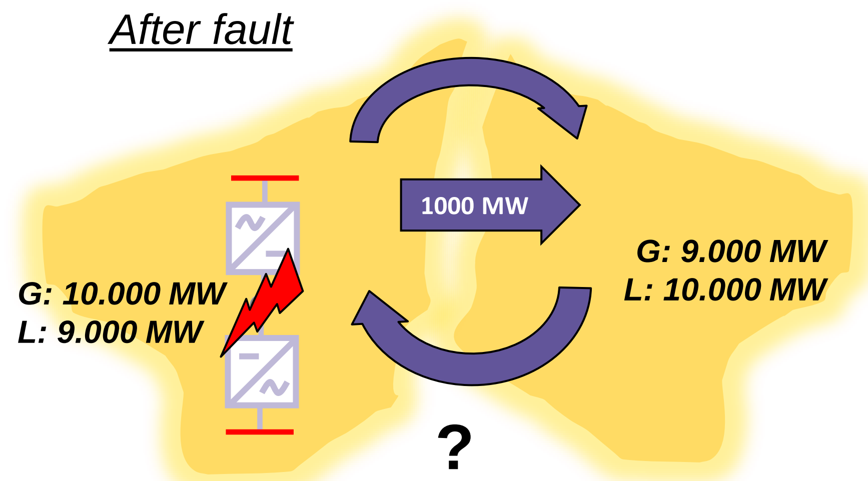


HVDC transmission system between synchronous or control areas ?

HVDC systems embedded or within one control area

Large HVDC connections embedded within one control area can also have significant cross-border impact. For instance, the loss of an internal HVDC link can modify the distribution of cross-border flows and consequently have impact on the power flow in neighbouring control areas. All HVDC connections embedded in AC transmission systems have such a potential impact on cross-border flows.

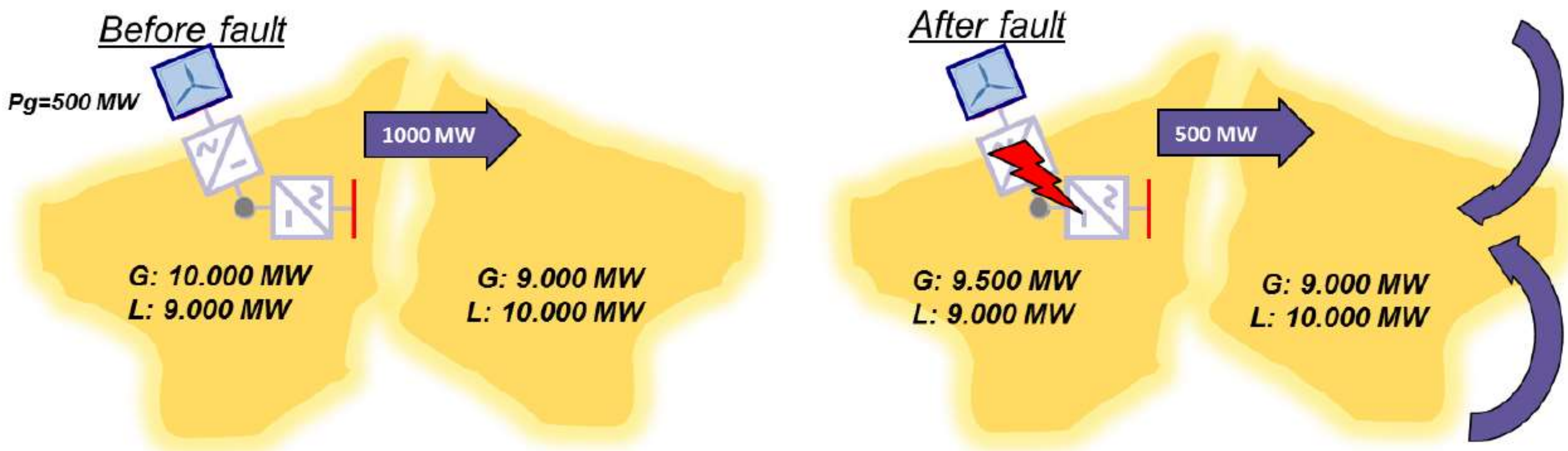




Embedded HVDC transmission system within single control area ?

HVDC generation collection systems

An HVDC generation collection system, in which all the AC/DC terminals are connected within a single control area, has a cross border impact due to the fact that a fault on the HVDC system causes the change of flows between control areas. However it is important to recall that cross-border issues are not only based on active power exchange in tie lines but are also related to the technical capabilities of all the users playing a critical part in system security. Therefore the requirements will improve robustness to face disturbances, to help to prevent any large disturbance and to facilitate restoration of the system after a collapse. Moreover, harmonization of requirements and standards at a pan-European level (although not an objective in itself) is an important factor that contributes to supply-chain cost benefits and efficient markets for equipment, placing downwards pressure on the cost of the overall system.



HVDC generation collection system within one control area ?

Which categories of requirements do we need?

- Active power control and frequency support
- Reactive power control and voltage support
- Fault ride through
- Control for system security and robustness
- Protection devices and settings
- Power system restoration

Taking into account:

- *Provisions of ACER's framework guidelines*
- *Established level of detail and drafting principles of the related NC RfG and DCC*

Principles for DC connected PPMs and remote-end DC converters

How to deal with DC connected Power Park Modules and HVDC converters at remote end ?

- Requirements as in NC RfG, with possible variation in ranges and settings, fit for 2030 challenges, e.g. offshore developments
- Additionally defining sustainable and flexible technical capability in order to meet requirements as per HVDC connections
- PPMs and HVDC connections need to have economic <u>consistent</u>, <u>coordinated</u> and <u>optimized</u> requirements so as not to impair requirements at AC onshore transmission connection point covering future extensions of the remote-end AC network

Information Exchange

POSSIBLE REQUIREMENTS FOR INFORMATION EXCHANGE AND COORDINATION ?

Adequate and coordinated information exchange between operators of HVDC and PPMs and TSOs is necessary to fulfil several objectives.

- Operational strategy ?
- Parameter setting ?
- Fault recording and dynamic performance ?
- Fault and disturbance analysis ?
- Simulation models ?

Are derogations possible and how are they granted?

ACER Framework Guideline on Electricity Grid Connection

- *“The network code(s) developed according to these Framework Guidelines shall describe the process and criteria for applying for derogation. This process is applicable to pre-existing (and in exceptional cases new) significant grid users.”*

- *“The derogation process shall be transparent, non-discriminatory, non-biased, well documented and based on the cost-benefit analysis performed by the TSO.”*

- *“The network code(s) may provide that derogation from all or some of the minimum standards and requirements may be granted to classes of pre-existing (and, in exceptional cases, new) significant grid users, non-discriminatorily, without the cost-benefit analysis being performed, if the TSO submits to the NRA a reasoned request and the exemption from the cost-benefit analysis is authorised by the NRA.”*

Taking into account established principles of NC RfG and DCC

Thank you for your attention
Questions?