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

NC HVDC – Preliminary Scope and Key Questions

Helge Urdal,
ENTSO-E Member Working Group on European Planning Standards and Connection Codes.

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Topics

- Questions and Comments at the end of each slide
- Your input to detailed drafting –pu costs & knee-points
- HVDC systems fit for purpose for 2030 challenges
- Scope limited by state of art of HVDC technologies
- Scope – 3 main elements – Significant Users
- Main parts of functional requirements in scope-costs?
- Technology neutrality-focus on system needs-impact?
- Sustainability of requirements – future HVDC Grids
- More extreme needs of systems close to 100% NSG

Your input to detailed drafting –pu costs & knee-points

The scope is preliminary: We need your views – your expertise is critical

- **TSOs** approach is from a system need point of view
  - *Aim: In view of changes & new challenges, maintain level of security of supply*
  - *Gradual sharing of services by all Users previously delivered by Synchronous Generators.*
- We need **manufacturers**' view on what can be done and the per unit incremental costs
- **Owners / Users** views on consequences in terms of incremental cost and operability

Your views will count in the detailing of the draft code

Your input to detailed drafting –pu costs & knee-points

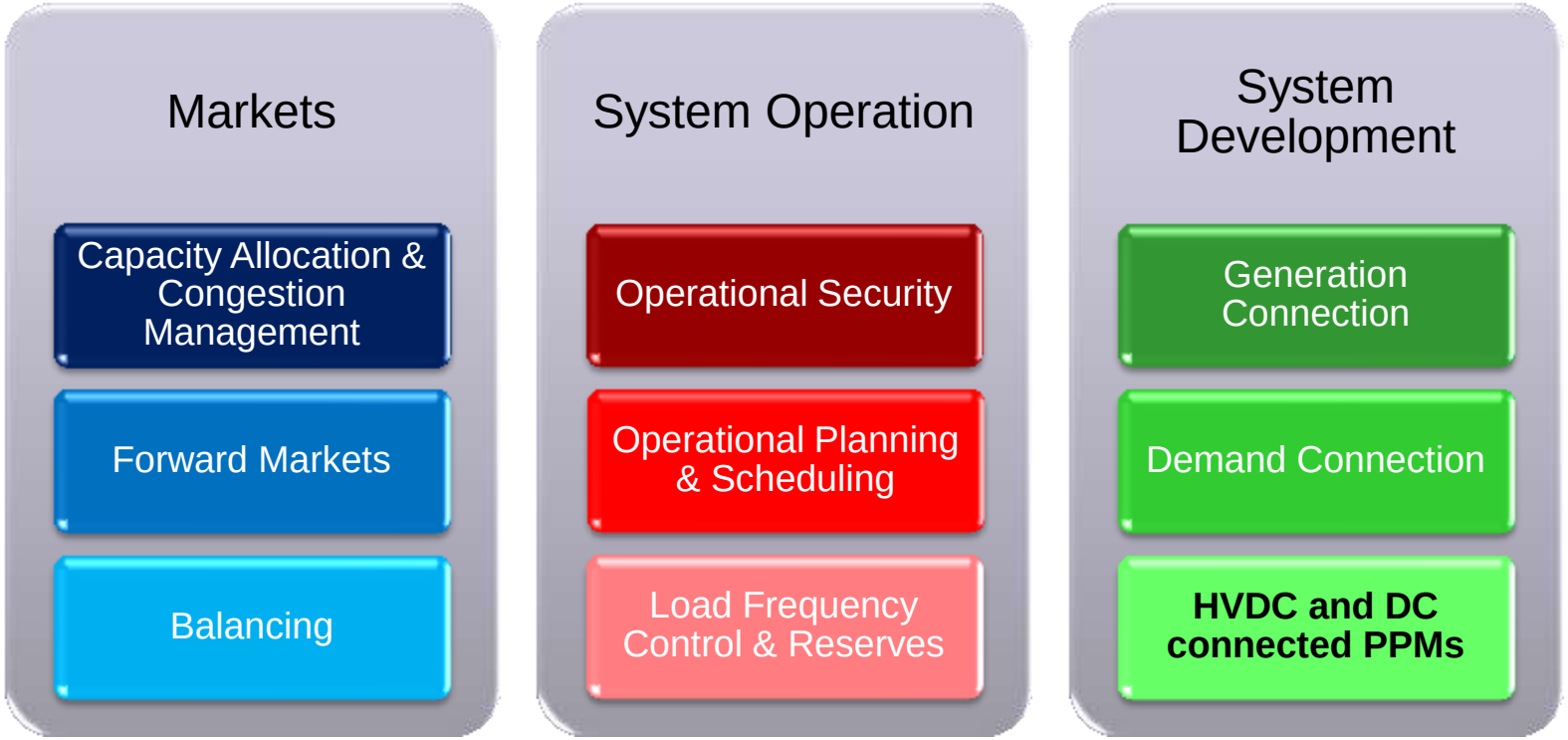
- Your input, even if related to functionality beyond the final scope, will still have value. Information will be made available for use at national & project level
  - Minimise future need for everyone to do same / similar surveys
    - Your info on what is likely to be achievable, when and at what pu incremental cost is sought
    - For non-mandatory and non-exhaustive – valuable for subsequent national process
  - Principle for “bleeding edge” functional requirements
    - First where the relevant extreme system need arrives (e.g. prospective high % Non-Synchronous Generation /NSG/)
    - Initially at project / national level
    - Bring into network code once practicalities clearer – future issue, e.g. DC Grids

HVDC systems fit for purpose for 2030 challenges

Recently, ENTSO-E views of how all the Network Codes combine was stated in:

"*European Network Code Development: The importance of network codes in delivering a secure, competitive and low carbon European electricity market"*

- Considers at a relatively high and broad level the challenges ahead
- How these relate to development of Network Codes for different fields:



HVDC systems fit for purpose for 2030 challenges

Hopefully this clarifies what you can expect from this NC HVDC and what will be found elsewhere

Connection Codes have a longer term outlook than Operation and Market Codes

- To avoid expensive retrospective actions, CCs should as far as practical be for lifetime
  - This applies particularly to the main plant
  - Some control systems may still be feasible to refine during lifetime of Converters, although best to avoid
- OCs and MCs can be refined significantly several times in the lifetime of the plant

2030 is not much beyond half time of life for the HVDC installations for which this code is to be applied

- Challenge for TSOs to define system conditions for 2030
  - Scenarios this far ahead are indicative – with large spreads – see TYNDP (10+10) and national equivalents
  - Important that technical requirements covers the best view of the future with a balance of:
    - Reasonably robust for different futures
    - Avoid excessive risks of stranded costly capabilities not needed for some futures

Scope limited by state of art of HVDC technologies

HVDC technologies are a mix of mature and emerging technologies

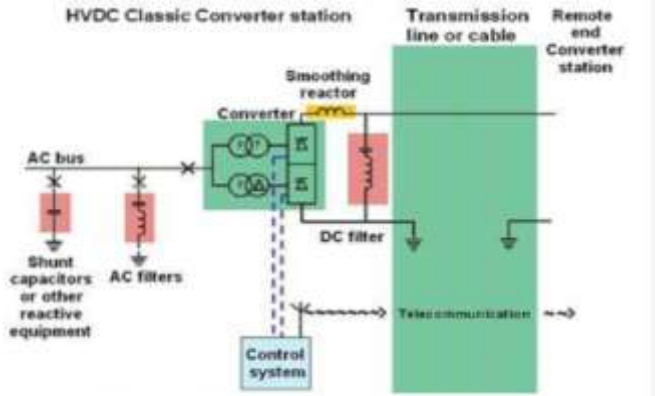
Thyristor based Line Commutated Converters (LCC) is a **mature** technology

- 100sMW Converters were commissioned in mid 70s

Transistor based Voltage Source Converters (VSC) is **less mature**

- Experience > 10 years
- Configurations still only last a couple of projects before substantial change

HVDC Grids are only about to become reality for the first time – it is **emerging**



SCHEMATIC OF A TRADITIONAL CSC HVDC SYSTEM (COURTESY OF ABB)

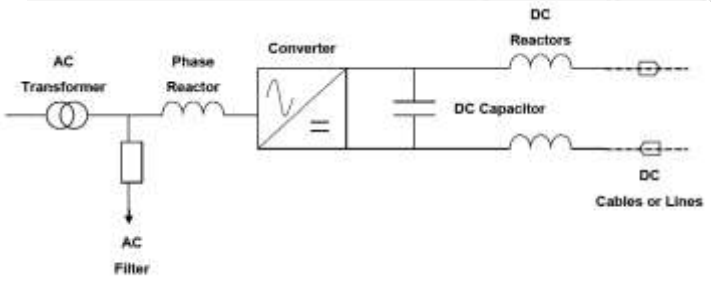


DIAGRAM OF VSC HVDC SYSTEM

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Scope limited by state of art of HVDC technologies

- This code aims at defining the requirements for ***radial LCC and VSC systems*** (two ended and multi-terminal), but intends not to include HVDC Grids (meshed HVDC)

- This does not indicate that ENTSO-E believes meshed HVDC Grids are not important or relevant to Cross Border trading, it merely indicate that ENTSO-E ***believes***
  - *it is premature to define these capabilities*
  - *to do so now may excessively stifle the freedom to innovate*

For the early projects of HVDC Grids, it is expected that the relevant TSOs will apply the principles defined in the HVDC code to the new multi-terminal context of HVDCs Grids.

Scope – 3 main elements – Significant Users

The scope sets out the 3 types of application of HVDC

- Connections between synchronous areas
- Embedded HVDC links (in parallel with HVAC links)
- DC connected Power Park Modules

Should the requirements be treated the same for all these 3 types of applications?

- If not, what are the key distinctions in terms of system related requirements?

Significant Users:

- What are your views of significance as indicated in the scope?
  - Should all 3 types be included?
  - For embedded, suggested it is limited to Transmission connected HVDC
    - Appropriate cut-off for X-border impact?

Main parts of functional requirements in scope

Focus on incremental cost expressed as per unit cost

What are the requirements with the largest cost implications?

Cost in terms of % of the total cost (e.g. of the converter valve) of the five most costly requirements.

Split the cost into R&D and production costs for each system delivered.

Any other items with cost implications greater than 0.1% of the total facility.

active power control and frequency support; possible impact of

- f range 45-55Hz?,
- df/dt withstand of 1-2Hz/s?,
- possible control & ramp rates and
- minimum inertia (H>3s?)

Reactive power control and voltage support; possible wide HVAC voltage range (low end)

Fault-ride-through

Control stability

Protection devices and setting

Power system restoration

Technology neutrality-focus on system needs-impact?

IT IS NOT EXPECTED TO HAVE SEPARATE LCC AND VSC REQUIREMENTS

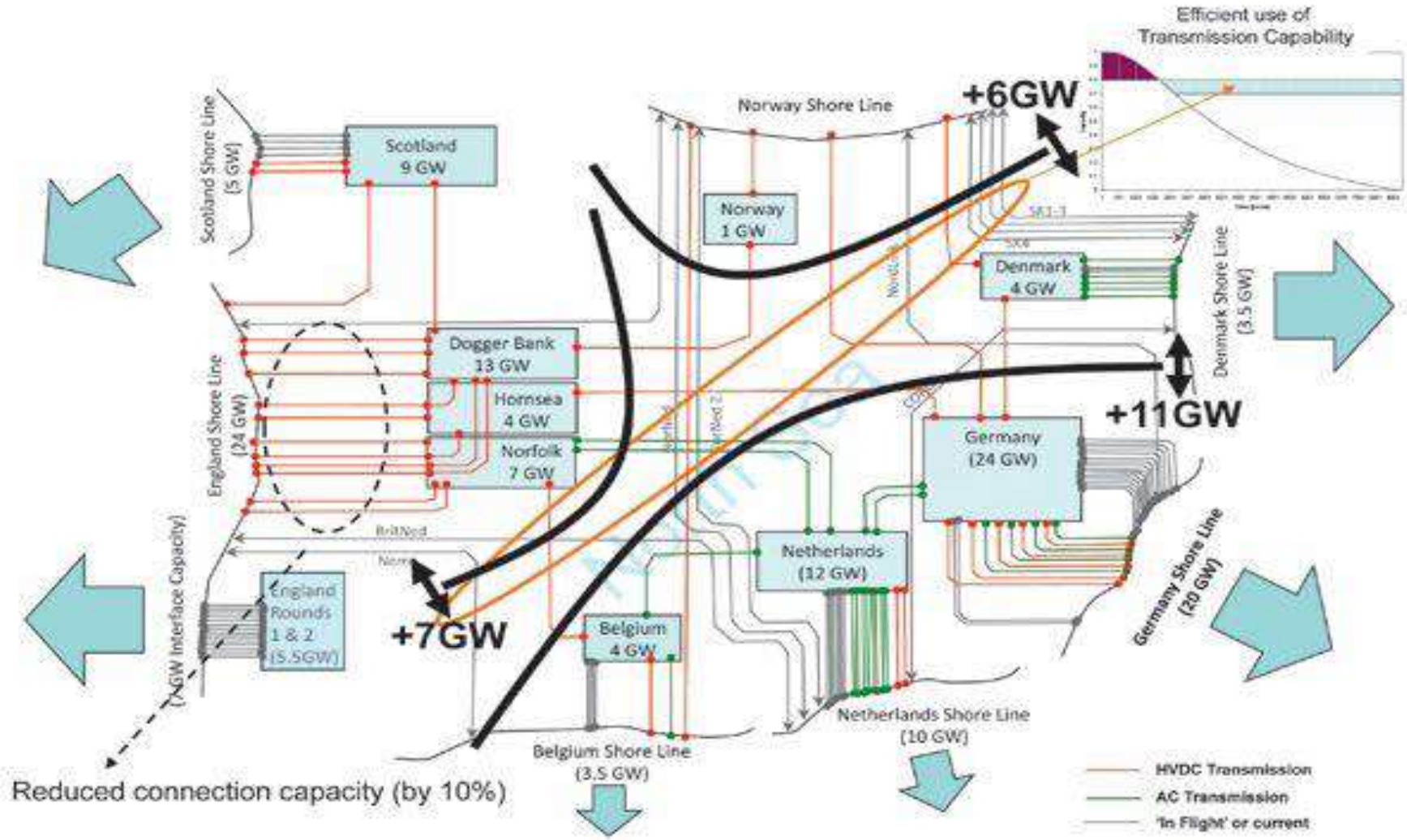
- Any problem for you?
- Do any of the requirements proposed in the preliminary scope have a major technology selection implication?
- Provide cost-related information or technical specification to support your argument. (extreme needs of systems close to 100% NSG)

MULTI-VENDOR ISSUES IN HVDC APPLICATIONS

- Need for multi-vendor arrangements to facilitate “HVDC Grid” development?
- Should this be included in the initial issue of NC HVDC?
- What level of openness is required to make multi-vendor HVDC practical, including predictable stable performance under dynamic disturbances including faults?
- What kind of possibilities do you see to establish the necessary data and model exchange needed to design any multi-vendor systems?
- Is standardisation the answer or only part of the answer?

Sustainability of requirements – future HVDC Grids

Can we wait with specifying requirements for HVDC Grids and still deliver the vision of the future?



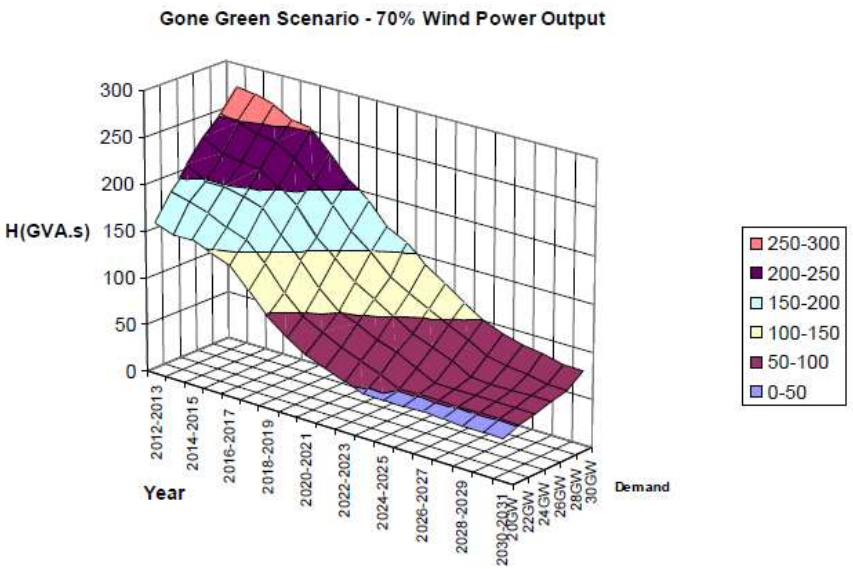
Extreme needs of future power systems with close to 100% Non Synchronous Generation – Converter Dominated PSs

We describe some future challenging requirements likely to emerge, e.g. with the large scale RES developments and HVDC developments, some control areas (CA) or even complete synchronous areas (SA) will:

- At times have very high % of demand supplied from non synchronous generation (NSG)
- Already in excess of 50% in a SA and >100% in CA have been experienced
- This trend is rapidly developing further
- Unless systems ready to cope – need to constrain off NSG for more SG support

Potentially large financial and environmental consequences (miss EU targets)

- Services provided previously by SG, if essential, has to be delivered by others



System inertia vs demand values – "Gone green" scenario

Extreme needs of future power systems with close to 100% Non Synchronous Generation – Converter Dominated PSs

HVDC IS AFFECTED:

- Contributes to NSG production – e.g. import from another SA or from offshore reduces SG
- May therefore be required to substitute more of the SG capabilities

Section 3.4 describes some of the challenges TSOs are likely to face and services that may be needed for future weak Converter dominated power systems during high RES.

- Deliver adequate fault current for continued high performance of transmission protection systems
- Help LCC commutation of HVDC when fault levels (FL) are below designed min FL
- Active controls for Quality of Supply clean up, e.g. harmonics & NPS

THESE CAPABILITIES ARE NOT IN THE SCOPE – COULD / SHOULD THEY BE?

Thank you for your attention
Questions?