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HVDC Grids – The New Era of Transmission

Large scale renewable generation is typically located remotely from the load centres. For example, Europe is planning to expand offshore wind in the range of more than 200 GW in the North Sea alone. HVDC is going to play a key role for transmitting this power to where it is needed. The transmission distance not only includes the connection to shore but often several hundreds of kilometres more to reach the loads. Combining several Point-to-Point links into Multi-terminal HVDC becomes more and more attractive, since it increases flexibility and reliability of the transmission system and can reduce the number of converter stations, saving CAPEX, OPEX (power losses) and space.

From a perspective of realization, it would be desirable to start an HVDC system with a small number of transmission lines and DC nodes and expand it step-by-step. Providing a competitive market environment in all phases of such system development, technical specifications should address all relevant aspects of interoperability of multi-vendor solutions.

Besides the aspect of multi-vendor system interoperability, expandable HVDC grids come with a number of other challenges calling for a shift of paradigms in how HVDC systems are planned, designed and operated.

Compared to the HVDC systems known today, relevant aspects include:

- **Grid architecture**: Switching stations and transmission lines form the grid, converter stations become grid users
  (today, the converter stations are largely driving the system design)
- **Capacity**: Spare transmission capacity and design margins are needed for stable and flexible grid operation
  (today, HVDC systems are optimised to their specific transmission task focussing the economical optimum of that particular application)
- **Control**: Core HVDC grid functions are independent of external communication, a central HVDC grid controller coordinates the high-level control functions
  (today, high speed communication between converter stations is typically used)
- **Faults**: Selective separation of faulty circuit(s), adequate fault behavior including backup protection
  (today: With a few examples only, fault clearing is provided by the AC side station circuit breakers)
- **Integration**: Experienced system integrators coordinate multi-vendor deliveries
  (today: DC side system integration is taken care of by the HVDC system vendor)

The development of HVDC grids has already started with single vendor systems having a small number of stations (typically less than five). Developing the fundamentals of multi-vendor interoperability is underway too, e.g. with the planning of first multi-vendor projects, still having a clearly defined final system stage. The experience gained from these projects can in the mid-term future be expected to lead to further standardization in the HVDC world providing the basis for extended HVDC grids.

In all these phases, the development of HVDC grids requires a collaborative effort of the involved parties e.g., TSOs, developers, vendors as well as politics for providing supportive frame conditions.