Study Committee C1

Power System Development and Economics

Paper 10351_2022

Compatibility & interoperability framework to facilitate the step-wise organic development of multi-terminal offshore HVDC grids

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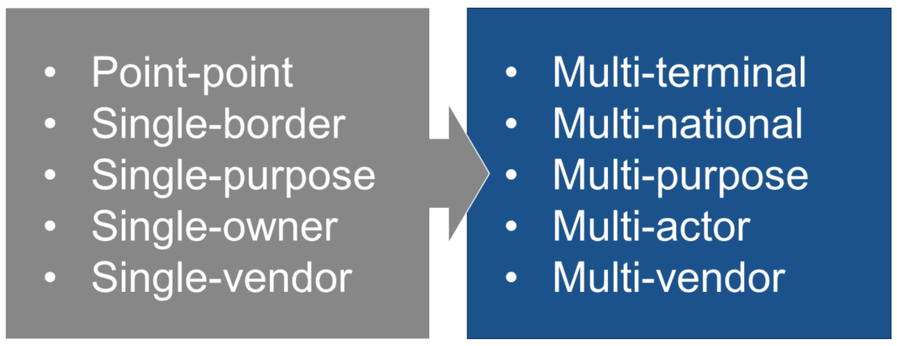
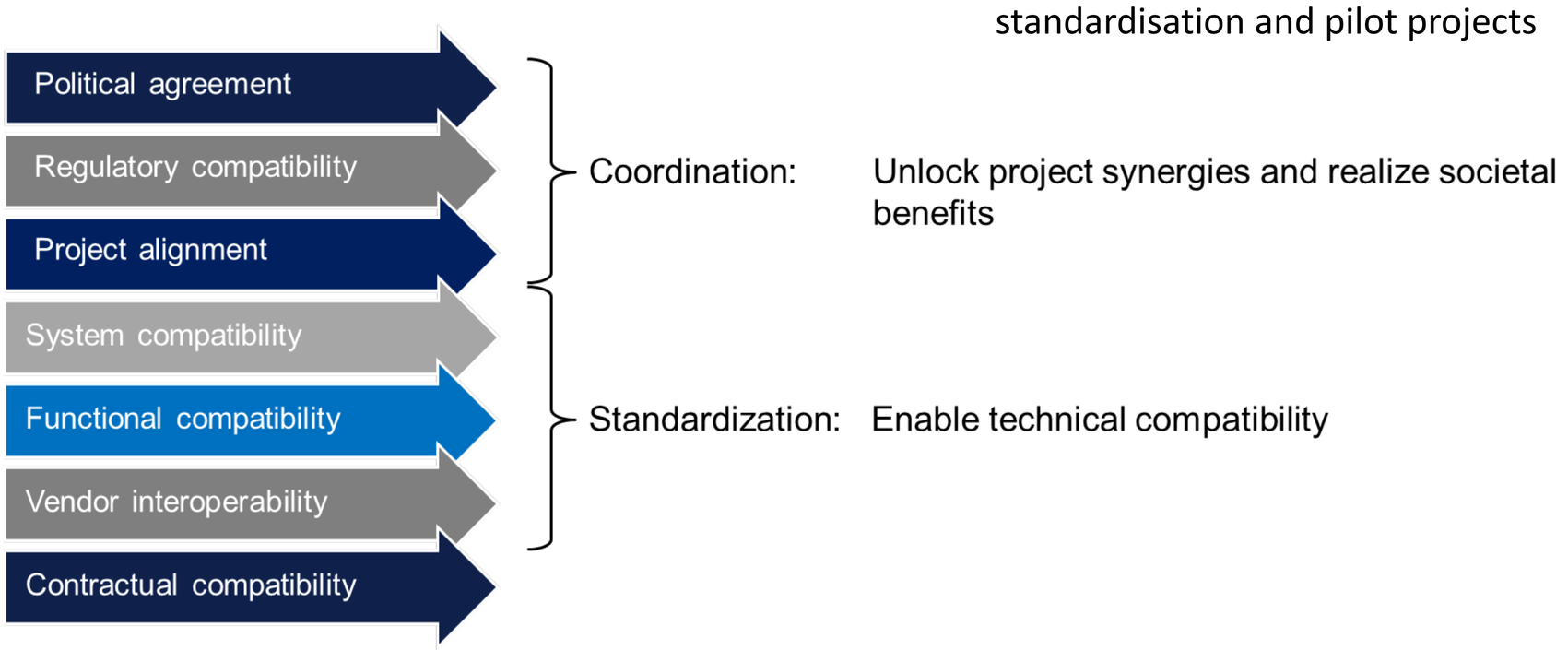
Motivation

- HVDC grids will play key role in achieving energy transition
- The HVDC grid of the future cannot be planned today. Multi-terminal readiness requires increased forward planning. Further development will be in step-wise organic fashion, adapting to an evolving transmission need
- Today's HVDC links are typically not planned, designed and procured with future extendibility in mind, resulting in systems that are often incompatible and not interoperable
- Standardization of technical characteristics and alignment of power markets and system planning is required to enable coordinated planning of HVDC projects to achieve the socio-economic benefit



Goal

- Determine the status of a minimum set of regulatory agreements, functional requirements, technical parameters and project aspects…
  …that need to be planned, agreed, coordinated, harmonized and/or standardized…
  …to enable expandability, compatibility and interoperability of HVDC equipment & systems…
  …to allow step-wise organic development…
  …of multi-purpose, cross-border, multi-owner, multi-vendor, multi-terminal HVDC grids.



Approach

- A framework of seven levels of compatibility and interoperability between power markets, HVDC projects, HVDC systems and HVDC components was developed. Each level is characterized by several aspects which are common to projects on different sides of a jurisdictional border
- For each identified commonality, the progress made within North-West Europe was assessed through a comprehensive survey of technical literature, policy documents, and press releases
- The status of each commonality is reported using a traffic light indicator

Conclusion

- It is not realistic to create a 'blueprint' for the HVDC grid of the future, albeit a strong vision may facilitate broader economic benefit
- HVDC grids will develop in step-wise organic fashion, adapting to an evolving transmission need
- A paradigm change is needed in the way HVDC systems are planned, specified, procured, and operated to ensure individual HVDC links are expandable, compatible and interoperable and avoid undue (potential) expense
- This requires extensive collaboration, coordination and standardization of project commonalities
- Significant progress is made in Europe, but is slow, seemingly uncoordinated and as yet still insufficient to realize shared HVDC grids.
- Implement a structured approach towards achieving the required coordination and standardisation through open communication, binding multi-lateral agreements, technical standardisation and pilot projects

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	Level	Aspect	Status
Coordination	Political agreement	Set ambitious international and national carbon reduction targets	
		Cooperation in or coordination of national energy plans	
		Agreement on regional resource adequacy and security of supply	
		Common CBCA method across a region	
		Comprehensive consultation process to mitigate environmental & social risks	
	Regulatory compatibility	Develop frameworks for regional cooperation and shorter term legislation for current projects	
		Create a strong regional regulator and regional coordination centres (RCCs) with legal responsibility for grid operation tasks	
		A coordinated maritime spatial planning & permitting framework	
		Clear framework for network asset ownership	
		Market models, Hybrid / multi-purpose assets	
		Anticipatory investments (and remuneration of these)	
		System operation guidelines (SOGL)	
		System balancing and ancillary services	
		Market models and support schemes	
		Decommissioning of grid assets	
	Project alignment	Develop long-term planning framework which considers both generation and transmission onshore and offshore	
		Invest in supply chain	
		Expandability: Spare bay and space	
Standardisation	System compatibility	Rated operating voltages	
		Converter technology	
		Converter configuration	
		System earthing	
	Functional compatibility	AC side control	
		DC side control	
		DC side protection	
		Coordination with and between OWFs	
	Vendor interoperability	Communication interface	
		DC Control Stability	
		Mechanical interface	
	Contractual compatibility	Procurement strategy	
		Common terminology & definitions	
		Completeness of requirements	
		System integration responsibility	
		Warrantees, Liabilities & Conflict resolution	
		Exchange of information	
		Technology qualification, testing & facilities	