Thematic WG 2

Security and Operations of tomorrow

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Convener WG 2

Role of HVDC technologies in a highly decentralised RES generation

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Part 1: Interoperability Workstream

WG 2 Innovation Milestones 2030

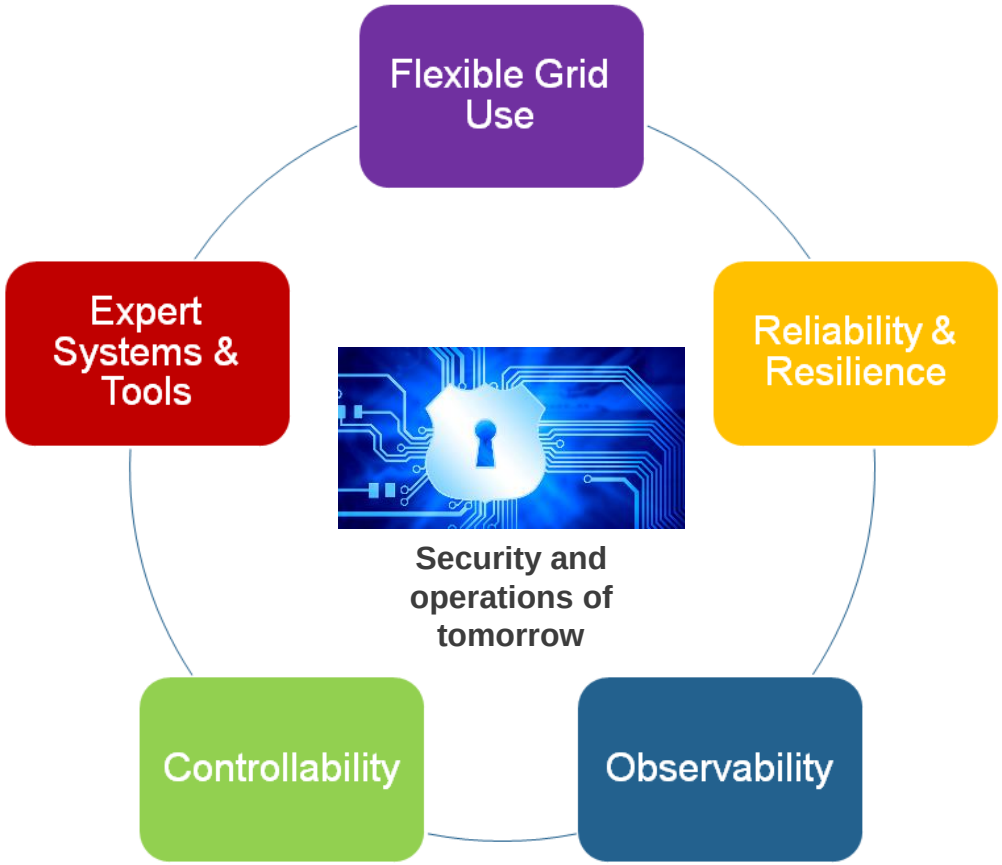
Flexible Grid Use
- **Demonstration of full scale interoperability of HVDC converter stations**

Grid Observability
- Nearly full observability of the European transmission grid based on phasor measurement linear/hybrid state estimation

Grid Controllability
- Mature technological solutions tested and proved for the provision of increased controllability and flexibility on both TSO and DSO voltage levels

Expert Systems and Tools
- Further tool development within R&D project work, implementation of close to real-time support tools, using probabilistic algorithm, enhanced forecasting of RES

Reliability and Resilience
- Integration of methodologies and tools supporting the improved transmission network reliability and resilience in day to day business.



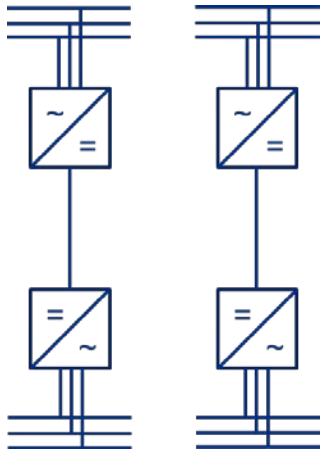
HVDC grids for improving overall AC/DC grid flexibility

Flexible Grid Use

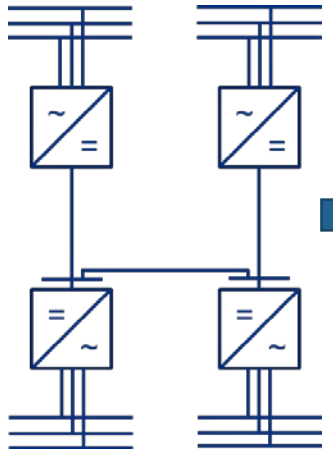
System needs: More…

- Flexibility
- Observability
- Controllability

HVDC systems offer required flexibility for large scale integration of PEIG and grid forming control



Today: Single Point-to-point connections



Multi-terminal Systems

Source: PEI, European grid vision

DC Grids as backbone system for AC?

- **Interoperability as main challenge**

Interoperability Work Stream

Flexible Grid Use

- Important task: enlargement of possible share of renewables utilizing HVDC technology
- Resulting challenges
  - Integration of HVDC systems in AC and DC grids
  - Large-scale interaction studies and compliance testing for assuring grid stability and security of supply
  - Optimized interfaces and process are a must due to system scale and complexity
- 3-step approach
  - Step 1: Build a solid foundation – model requirements and ENTSO-E standard interface for HIL/PHIL and SIL Actual step: finalization and demonstration)
  - Step 2: Prevent risks in existing grids – multi-vendor AC-grid integration
  - Step 3: Build new grids – multi-vendor DC-grid integration

Make DC as easy as AC!

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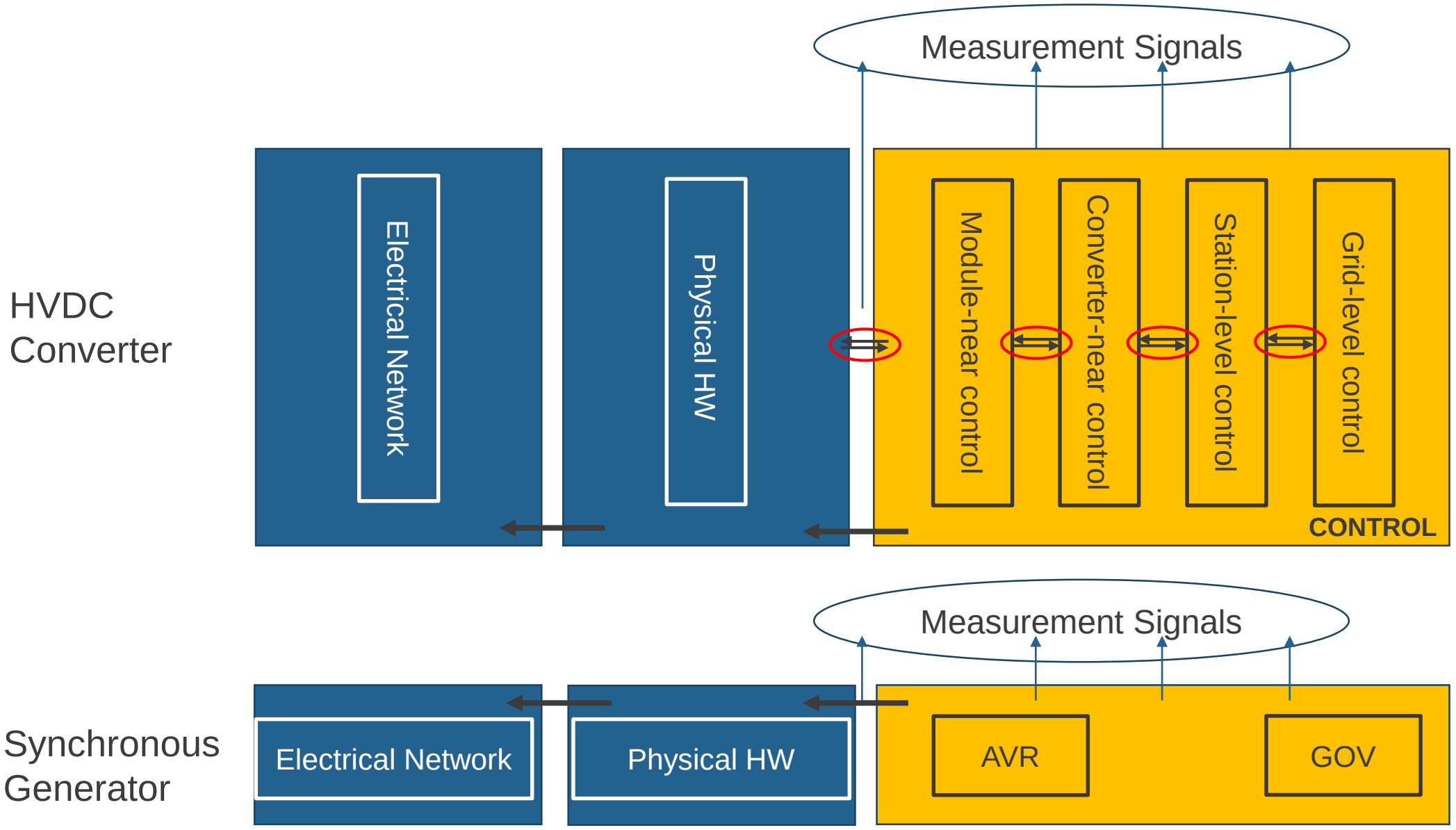
Step 1: Standard Control Interface Proposal – HIL/PHIL and SIL



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Step 1: Status and next steps

- Standard Control Interface definition & requirements proposed
  - Interface architecture hardware interface/software interface are introduced
    - Describes the technical standards for such an interface
    - Out of scope: Requirements on data provision which is already given in NC HVDC (European Regulation 2016/1447)
  - Relevant for (European) vendors to be more competitive in order to cope with the EC regulations
  - Ensure good quality interaction studies and avoid expensive actions after commissioning
  - Use cases for interaction performance studies are discussed
- System for demonstrating the Software and Hardware interface achieved
  - The operation of the interface was demonstrated on 29th of January already
  - Link to European Regulations: All parties shall contribute to the interaction studies and shall provide relevant data and models to meet the purpose of the study considering confidentiality obligations
- Next Steps
  - Drafting of the Entso-e standard control interface for HVDC converters
  - Definition of step 2 and step 3 of the interoperability Workstream

Step 2: Prevent risks in existing grids – multi-vendor AC-grid integration

- Recent challenges for assuring grid stability and security of supply
  1. Large-scale converter-converter interaction studies and compliance – North Sea CE region
- Key aims for proposed demonstration project
  - Application of ENTSO-E standard interface for HIL/PHIL and SIL for HVDC in relevant scenarios
- Additional aims for proposed demonstration project
  - Demonstration of possible usage and extension of ENTSO-E standard interface for HIL/PHIL and SIL as standard interface between grid controller and digital twins
  - Interaction study, scope, implementation, execution
- Cross Border EMT Realtime demonstrator including
  - Interoperability at the AC connection point(s)
  - SIL modelling
  - HIL P-HIL demonstration

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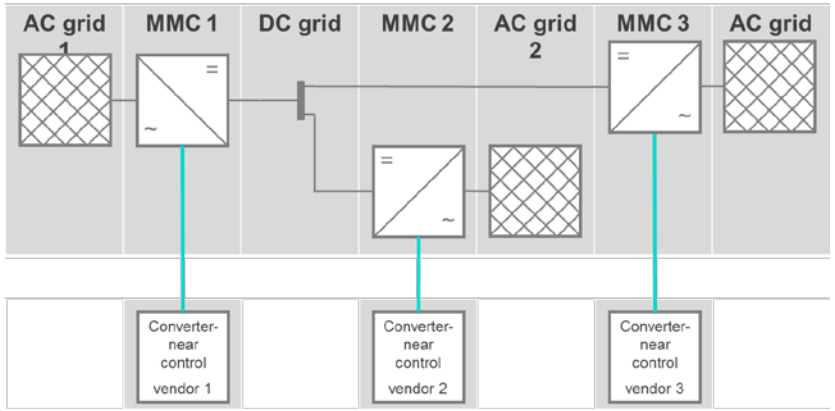
Step 3: Prevent risks in multi-vendor DC-grid integration

- Recent challenges for assuring grid stability and security of supply
  1. Large-scale converter-converter interaction studies and compliance in Multi Vendor Multi Terminal Systems
- Key aims for proposed demonstration project
  - Application of ENTSO-E standard interface for HIL/PHIL and SIL for HVDC in relevant scenarios
- Additional aims for proposed demonstration project
  - Demonstration of a Multi vendor Multi Terminal DC system with at least 3 converters of different vendors
  - Provide the standards in order to reach interoperability
  - Show interoperability at the DC connection point(s)
    - Functional specification for plug and play of converters
    - HIL P-HIL demonstration
  - Full size Demonstration project for interoperability
    - included in North Sea area



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Conclusion

- ENTSO-E standard interface for HVDC systems ready to use for large interaction studies
  - **Complete description of the control interface supporting interactions studies (NC HVDC, Art. 29)**
  - **Modular approach, supports compliance simulation and compliance testing**
  - **Allows maintenance of the HVDC model due to lifetime (NC HVDC, Art. 70)**
  - **Provision of relevant data for the standard control interface is fully in line with NC HVDC, Art. 10 and Art. 29**
- Further steps towards a successful transition to a climate-neutral energy system by 2050
  - CGMES - HVDC Standard Interface" developed demonstrated for Loadflow and RMS calculations considering Hybrid AC-DC systems
    - HVDC models comply with the modular approach of the ENTSO-E standard control interface
  - Demonstration proposed for large-scale converter-converter interaction studies and compliance
    - Multi Vendor HVDC at AC connection point, methods and contents of interaction studies, justification of relevant data
    - HVDC models comply with the modular approach of the ENTSO-E standard control interface
  - Demonstration proposed for Multi-Vendor-Multi-Terminal systems
    - HVDC models comply with the modular approach of the ENTSO-E standard control interface
    - Full size Demonstration project for interoperability

THANK YOU FOR YOUR ATTENTION

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