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Challenges in Large Offshore Wind Farms with MVDC Collection System

Introduction

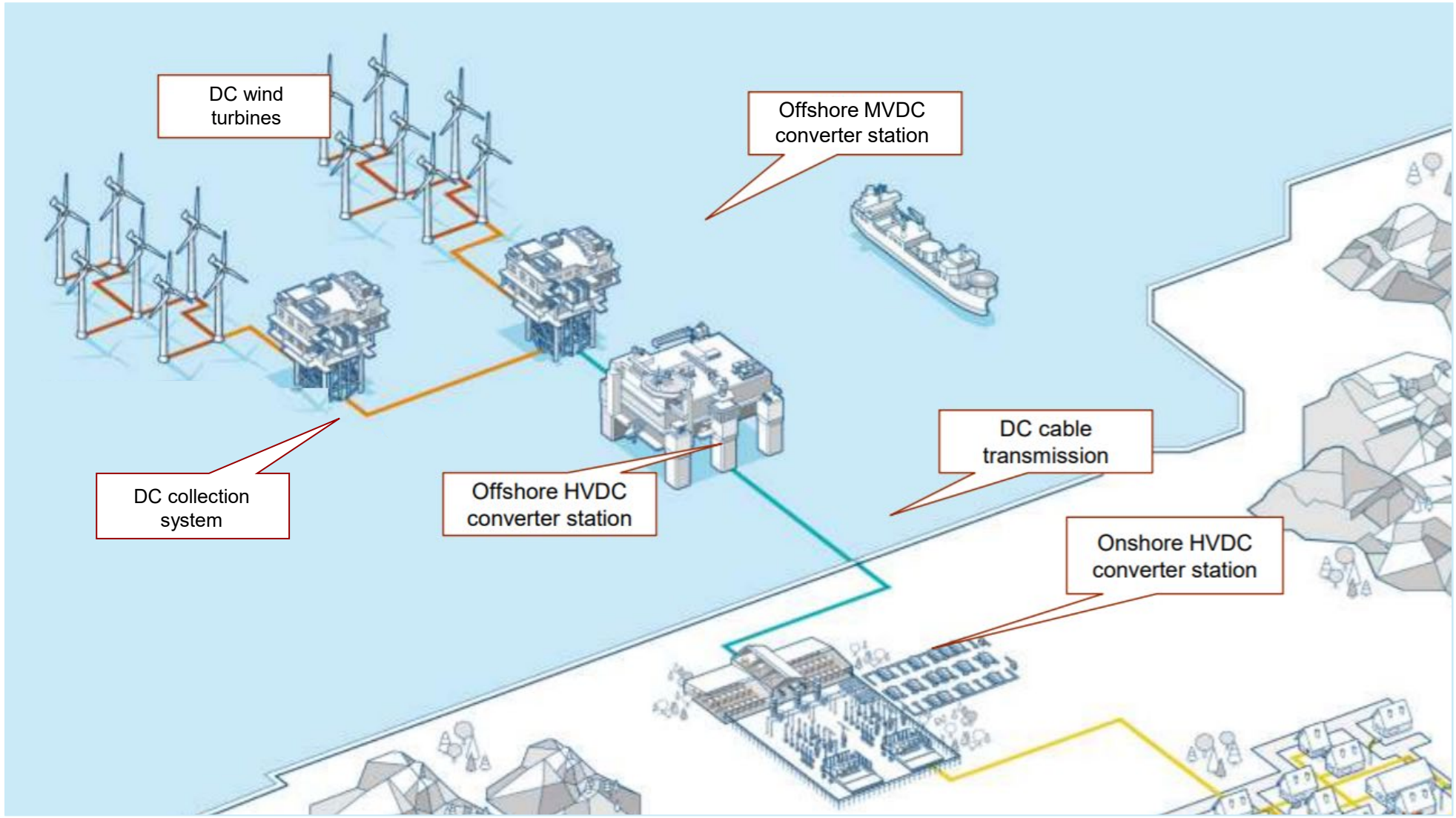

Image source: https://new.abb.com/docs/librariesprovider46/pw2016/seminars/r206-en-abb_offshore_wind_connection_by_hvdc_reformated.pdf?sfvrsn=2

Challenge I: Technological gap

- DC converters only demonstrated in computer simulations, laboratory experiments and small scale demonstrators
- Different DC converter topologies are available (e.g. resonant converter, dual active bridge, modular multilevel converter, etc…)
- Active research on optimal topology and control

Image source: https://www.offshorewind.biz/2019/10/30/abb-hvdc-gear-for-worlds-largest-offshore-wind-farm/

Challenge II: Controllability of DC collection system

- Parallel, series and series-parallel are the main layouts of DC collection systems
- Parallel layout is the most similar to AC collection system
- Series layout is attractive but the voltage in the string is difficult to control

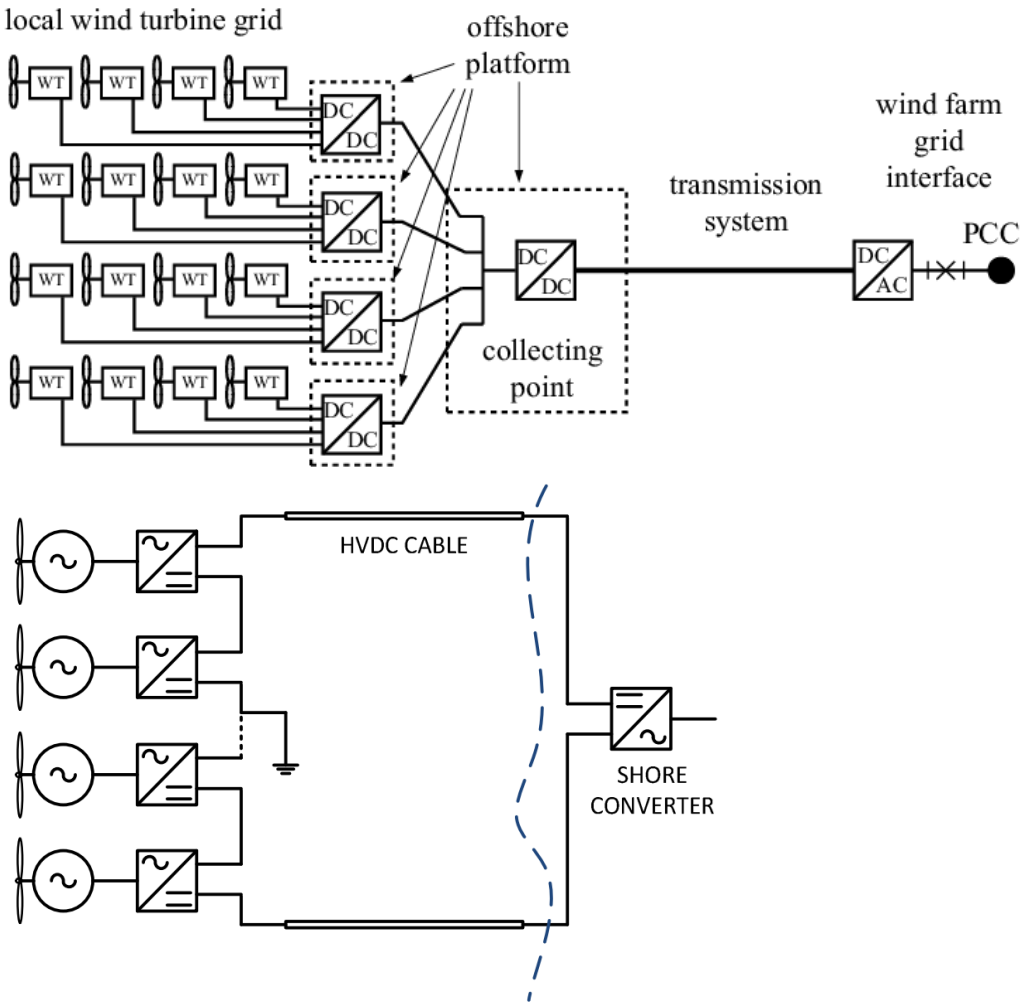

Image source: Top: Lundberg S. Evaluation of wind farm layouts. Epe journal. 2006 Feb 1;16(1):14-21.

Bottom: D'Arco, S.; Aardal, A.; Hernes, M. Efficiency analysis of non-insulated converters for DC series collection in offshore wind farms. International Symposium on Power Electronics Power Electronics, Electrical Drives, Automation and Motion. IEEE, 2012, pp. 553–558.

Challenge III: Grid code requirements

- Grid codes exist only for HVDC-connected wind farms with AC collection system
- The existing grid codes has to adapt to all-DC wind farms
- The location of the point of connection needs to be clarified

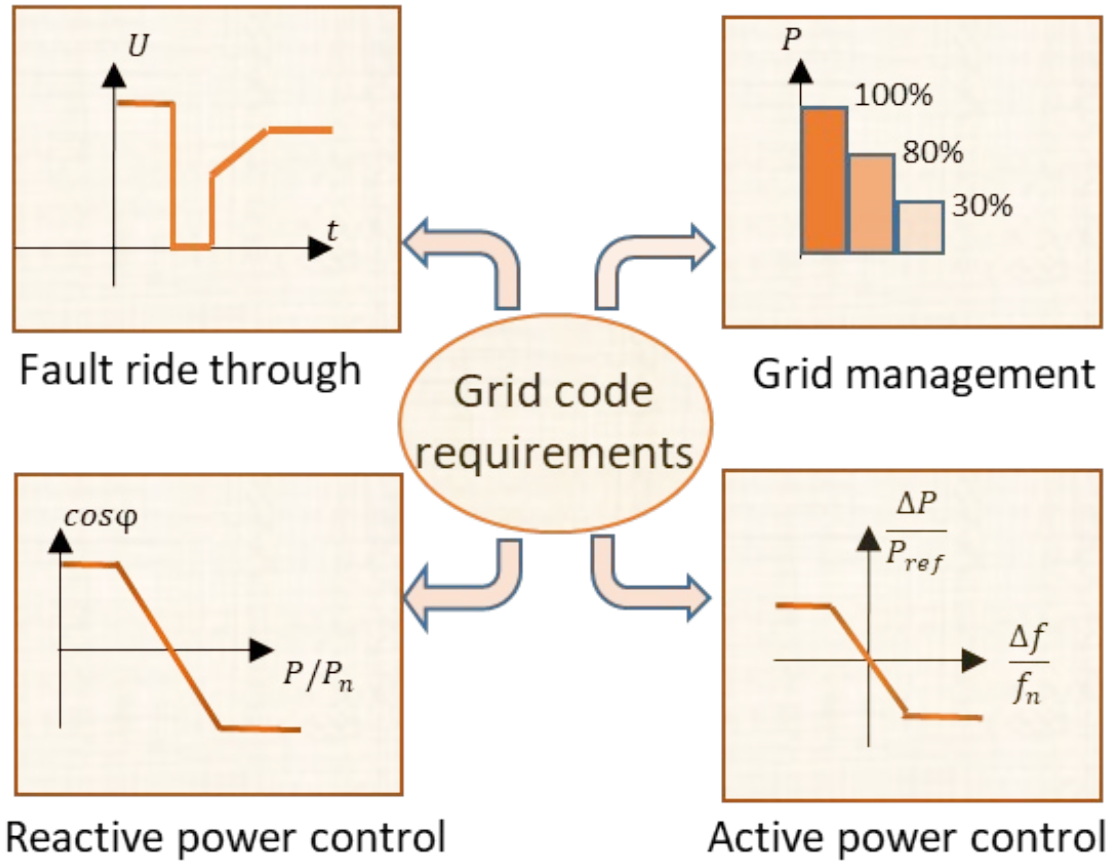

Image source: https://www.neplan.ch/description/grid-code-compliance/

Summary

- Challenge I: Technological gap
  - ➢Finding consensus on medium voltage high power DC/DC converter topologies
- Challenge II: Controllability of DC collection system
  - ➢Defining robust control algorithms for medium voltage high power DC/DC converter topologies
- Challenge III: Grid code requirements
  - ➢Adapting the existing grid codes to allow all-DC offshore wind farms to connect to and support the onshore grid


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