What role does High Voltage Direct Current play and what HVDC backbones or supergrids does Europe need?

Gianluca Fulli

European Commission
Joint Research Centre
Institute for Energy
• The European transmission grid
• HVDC features and challenges
• Developments of offshore/Mediterranean grids
• A vision for a European super grid
• Conclusions
Power system evolution

TRANSMISSION (EXTRA HIGH VOLTAGE GRID)

SUBTRANSMISSION (HIGH VOLTAGE GRID)

HIGH-MEDIUM VOLTAGE DISTRIBUTION

LOW VOLTAGE DISTRIBUTION

UTILISATION SYSTEM

Transmission (super-smarter)

Distribution (smart)
HVDC – recent trends

• Power grids traditionally based on HVAC – High Voltage Alternating Current technologies

• HVDC already used
  – to link systems with different frequencies (asynchronous) and
  – for very long lines and underground/submarine cables

• New HVDC concepts add on flexibility, responsiveness and controllability over traditional HVDC
  – also for multi-terminal applications needed for offshore wind
HVDC vs. HVAC

The breakdown distance depends on link length, voltage and power rating.
HVDC features and challenges

- Investment costs for HVDC may be sizeable
- HVDC displacing HVAC can reduce environmental/visual impact
- HVDC can act as a ‘firewall’ immunising the AC grid from wide area problems/disruptions
- Open questions for research & demonstration:
  - Meshed (i.e. multiterminal) HVDC lines
  - Interoperability of HVDC into AC grids
  - HVDC superconductors
From present European transmission grid to...
HVDC for offshore grids

Mid-long term vision of ENTSOE

2030 vision of EWEA (Wind association)
Crucial challenge for DC meshed grids:
DC breaker and new technology developments

(Source: OffshoreGrid project)
Mediterranean ring

(Source: Medring update study)
Technical, economic and political issues for this long-term project

(Source: Desertec)
European Super Grid vision

Long-term combination of offshore (HVDC/HVAC) grids, enlarged HVAC continental network, DESERTEC and MedRing as parts of the European transmission grid

(Source: ENTSO-E)
Conclusions

• HVDC favourite option for long-distance power transmission and for connection of offshore large-sized renewable plants

• Significant investment and technological demonstration needed for reinforced transmission highways leading to a super grid

• Coordination of HVDC planning and operation necessary, as well as an appropriate legislative and regulatory framework
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gianluca.fulli@ec.europa.eu

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