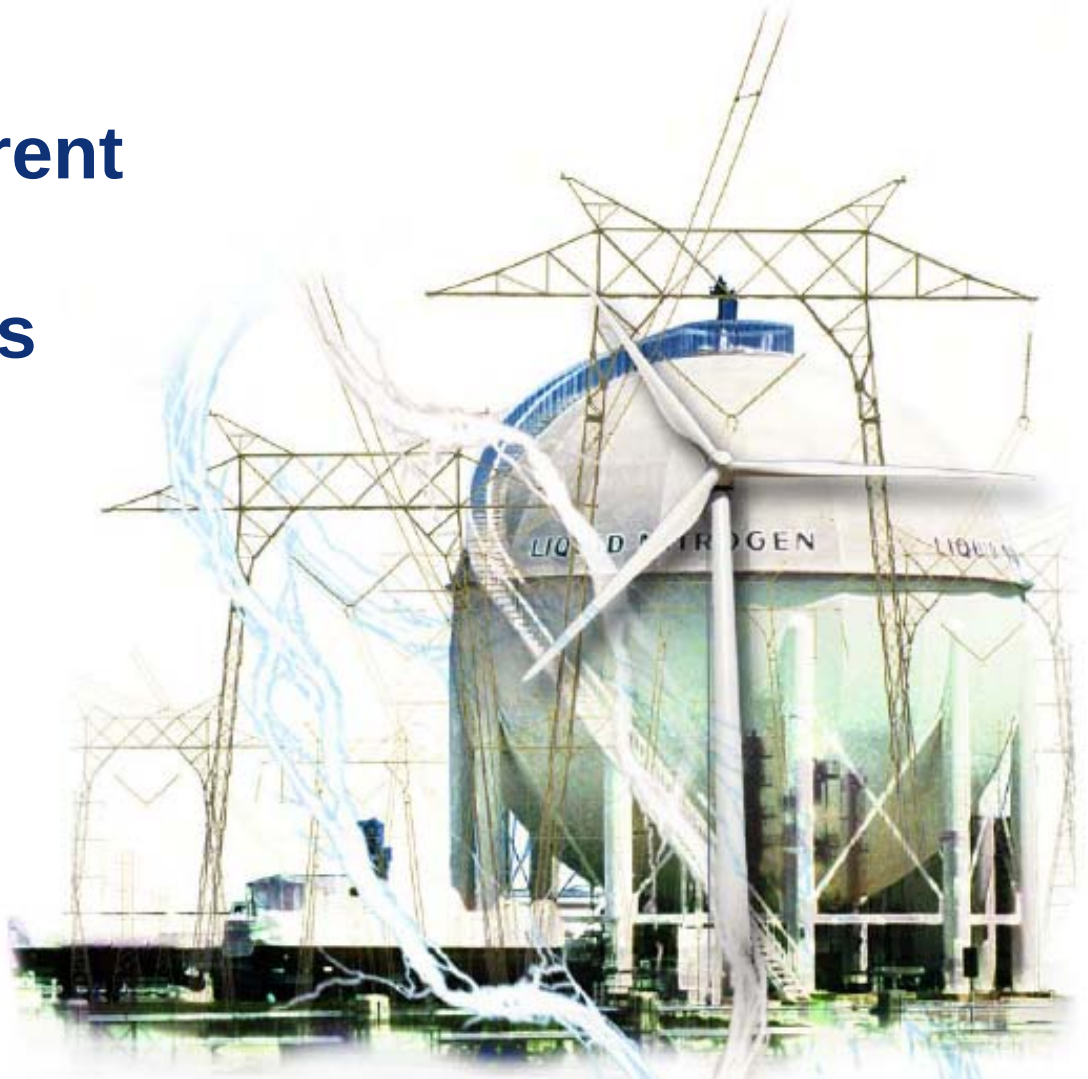
What role does High Voltage Direct Current play and what HVDC backbones or supergrids does Europe need?



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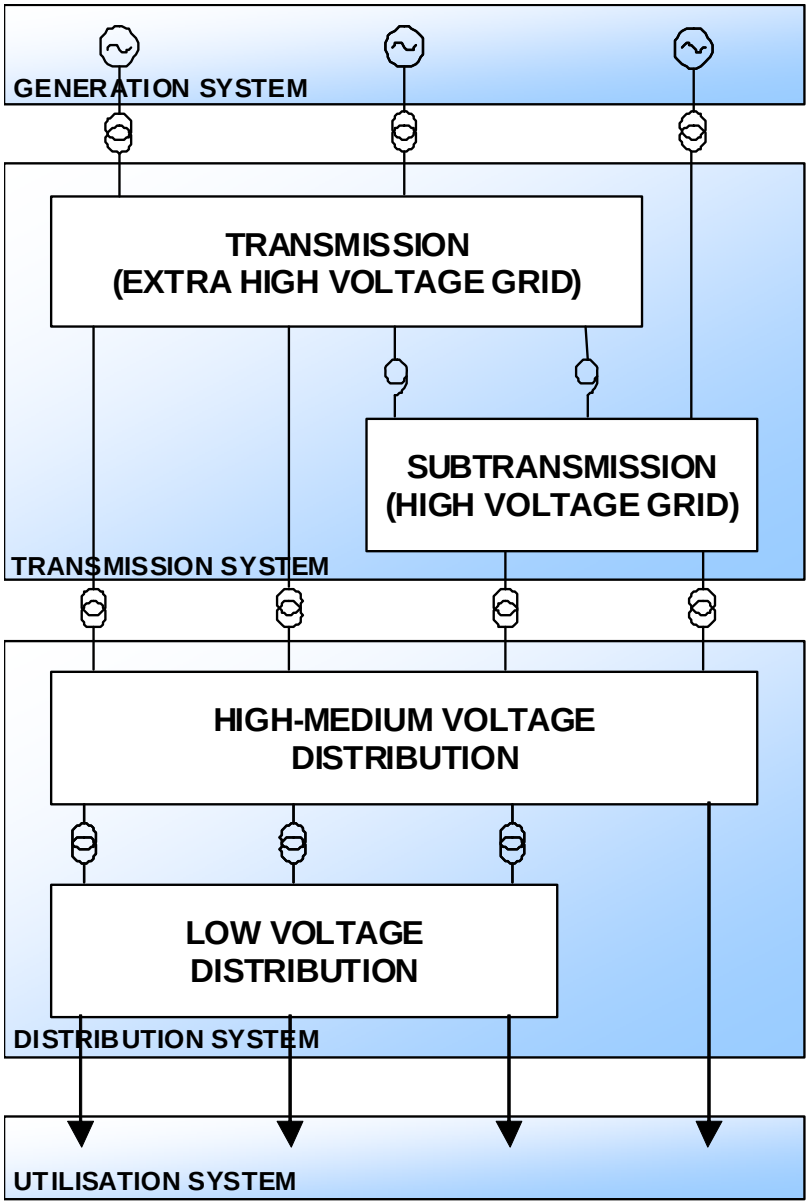
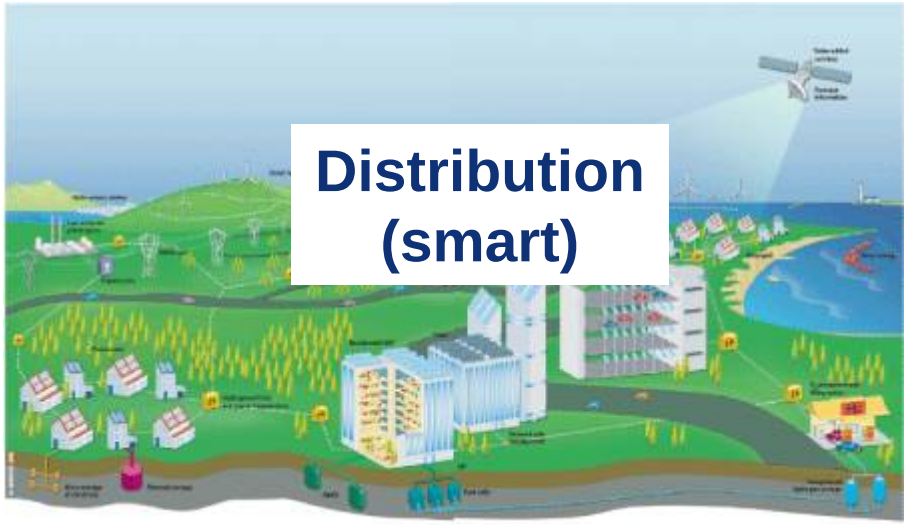
Outline

- The European transmission grid
- HVDC features and challenges
- Developments of offshore/Mediterranean grids
- A vision for a European super grid
- Conclusions

Power system evolution



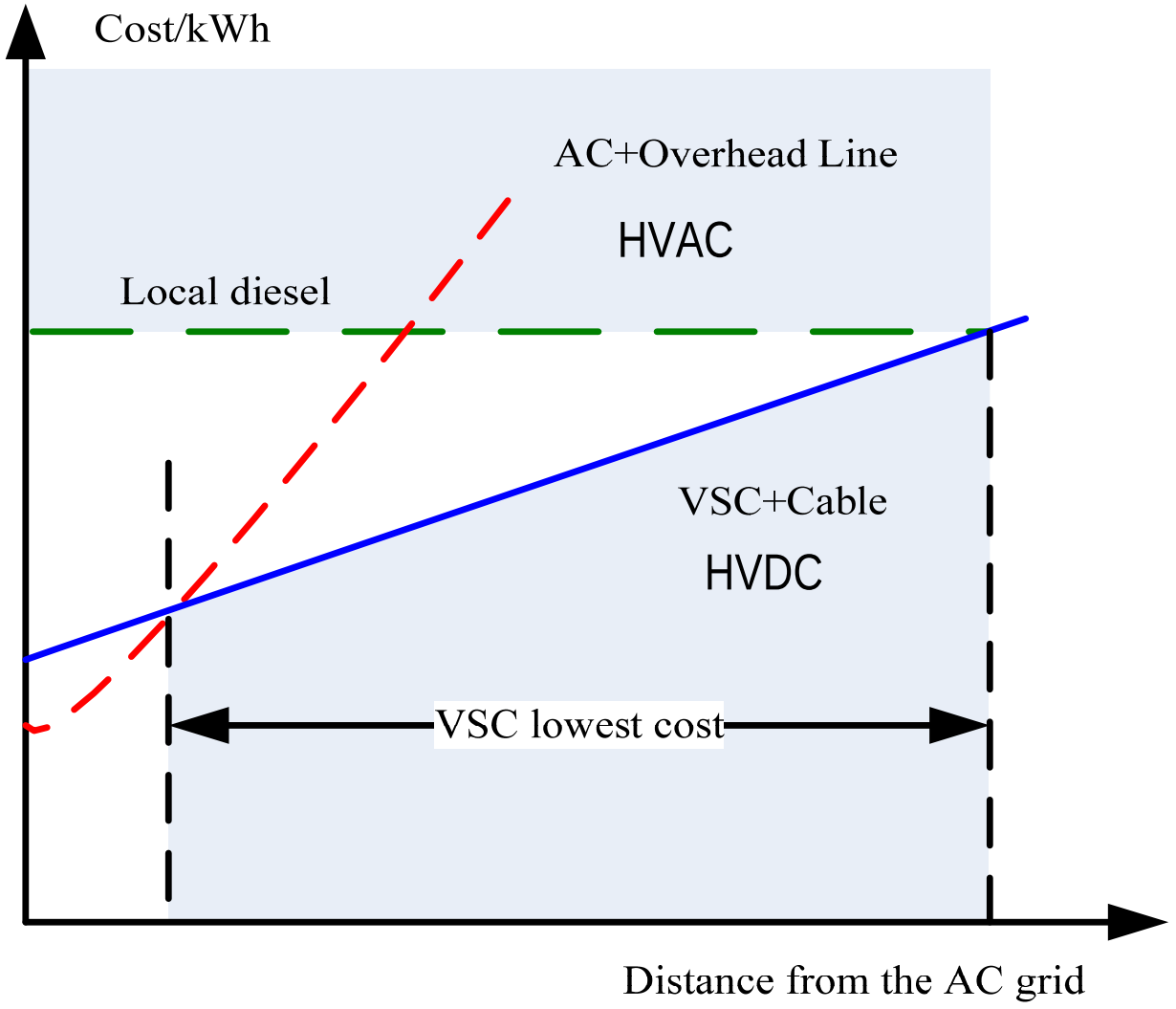


HVDC – recent trends

- 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

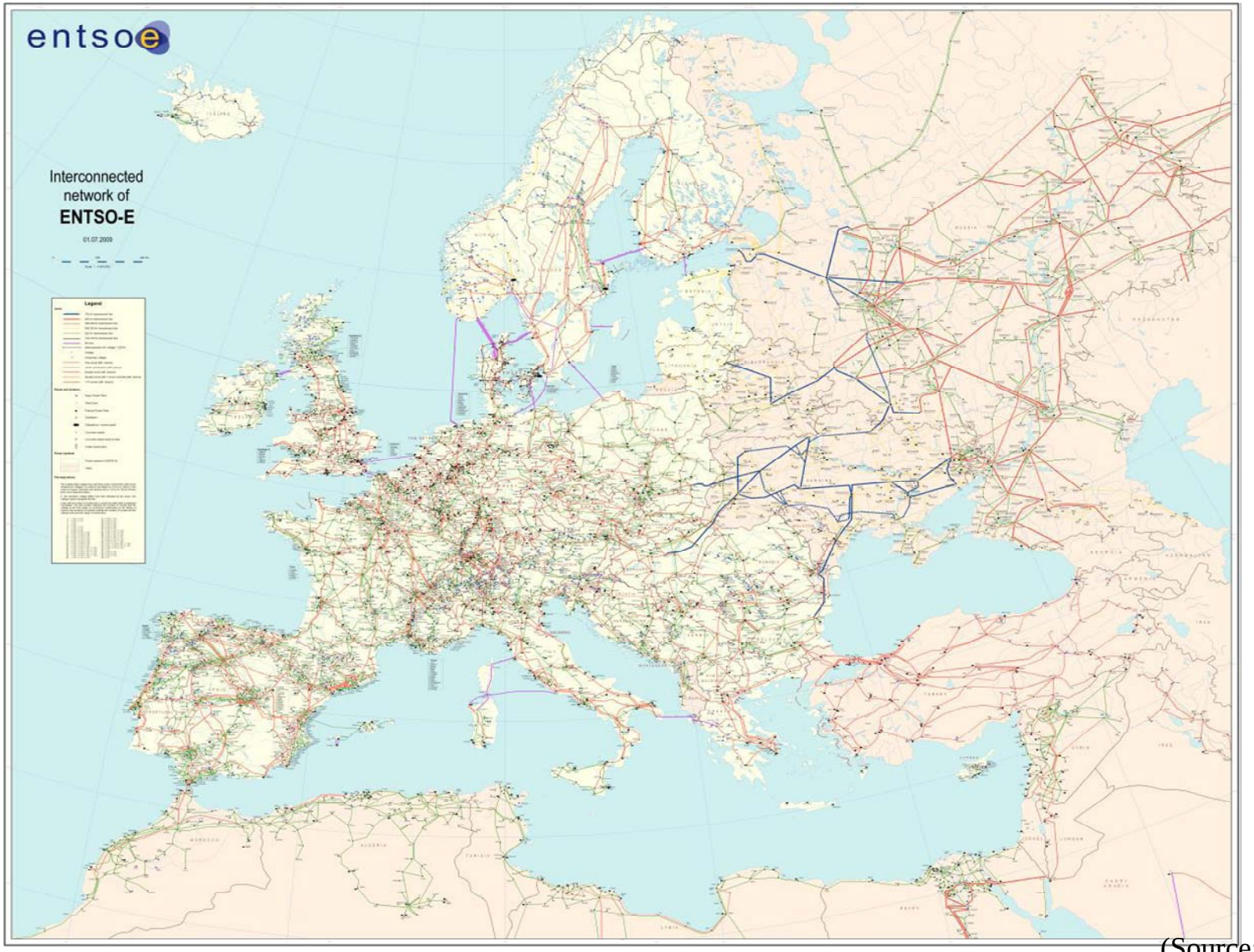
The breakdown distance depends on link length, voltage and power rating



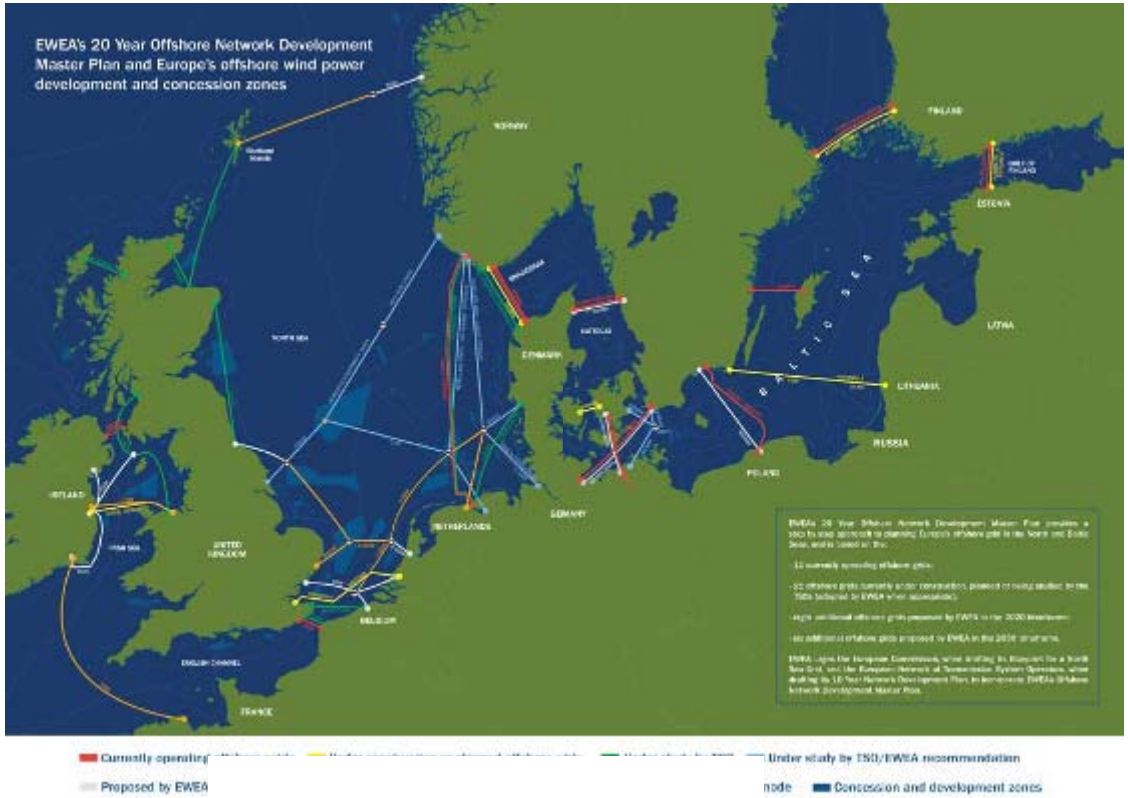
HVDC features and challenges

- 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...

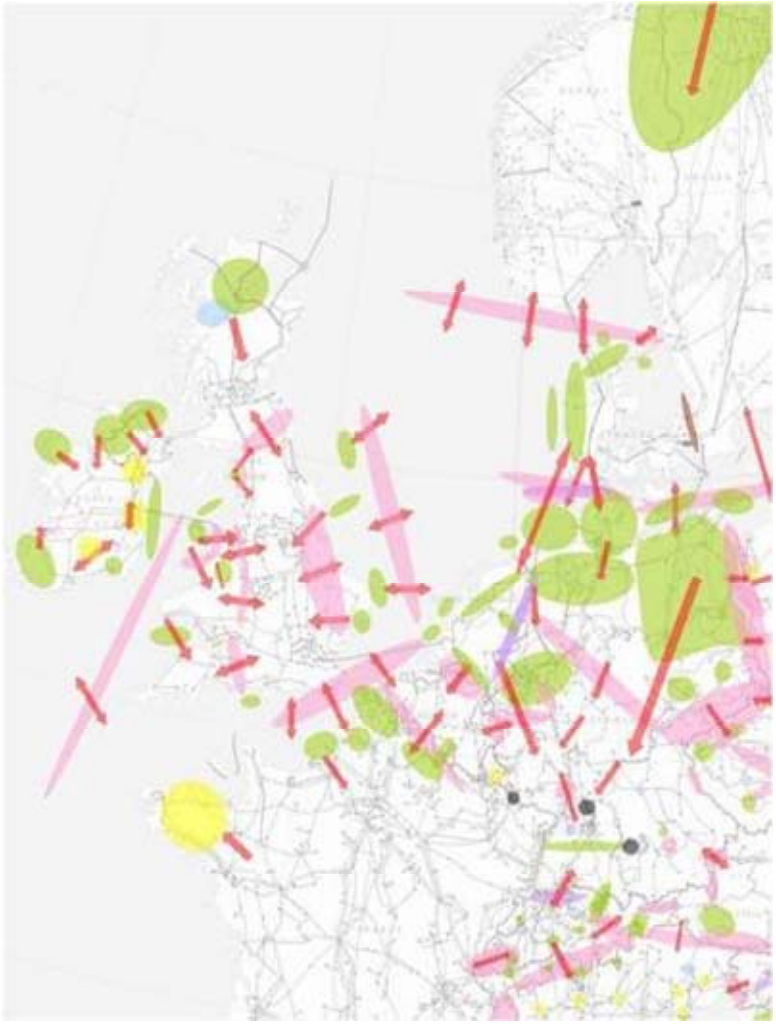


(Source: ENTSO-E)



2030 vision of EWEA (Wind association)

Mid-long term vision of ENTSOE

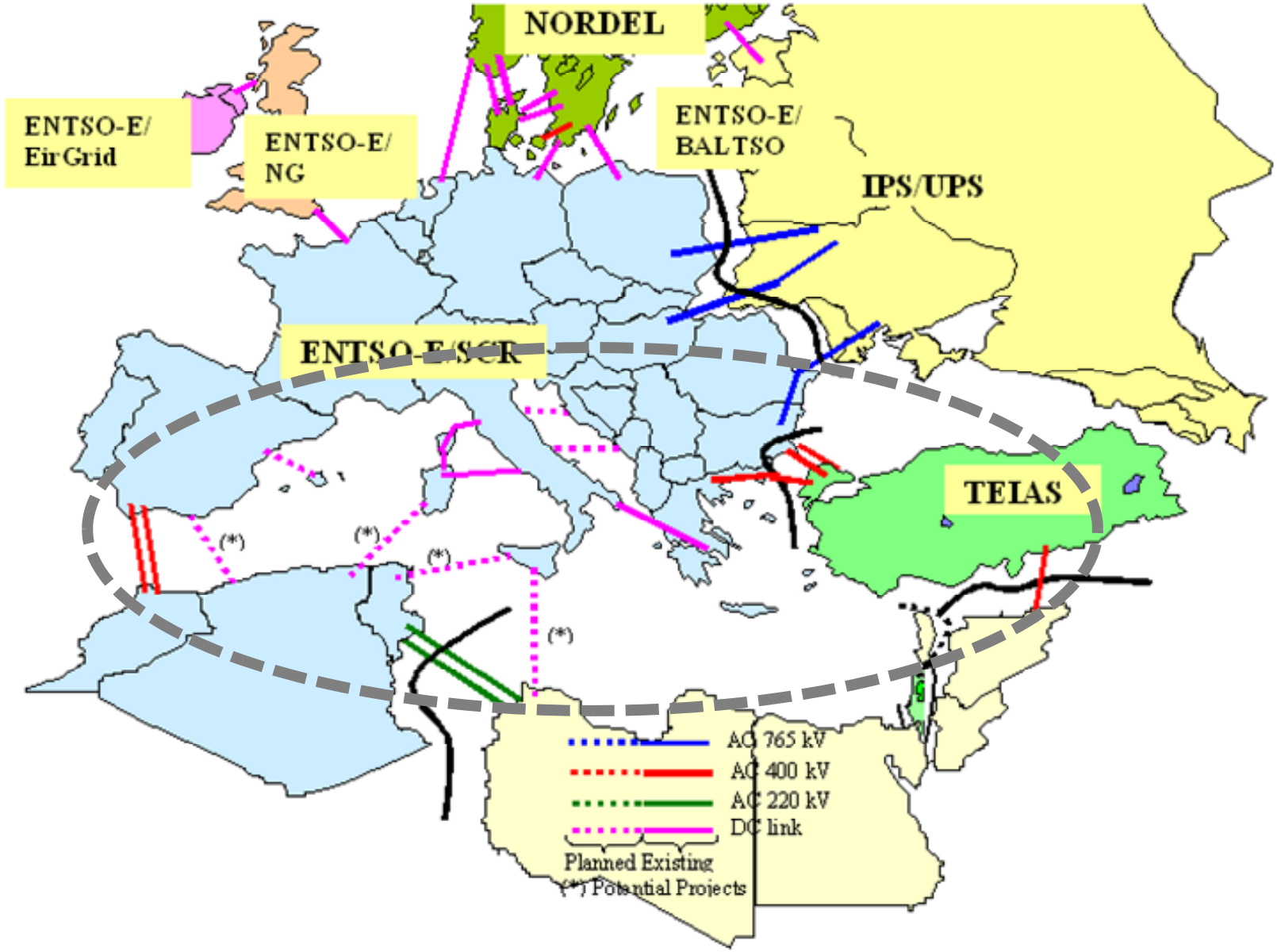


Grid developments: North Sea

Crucial challenge for DC meshed grids:
DC breaker and new technology developments

(Source: OffshoreGrid project)

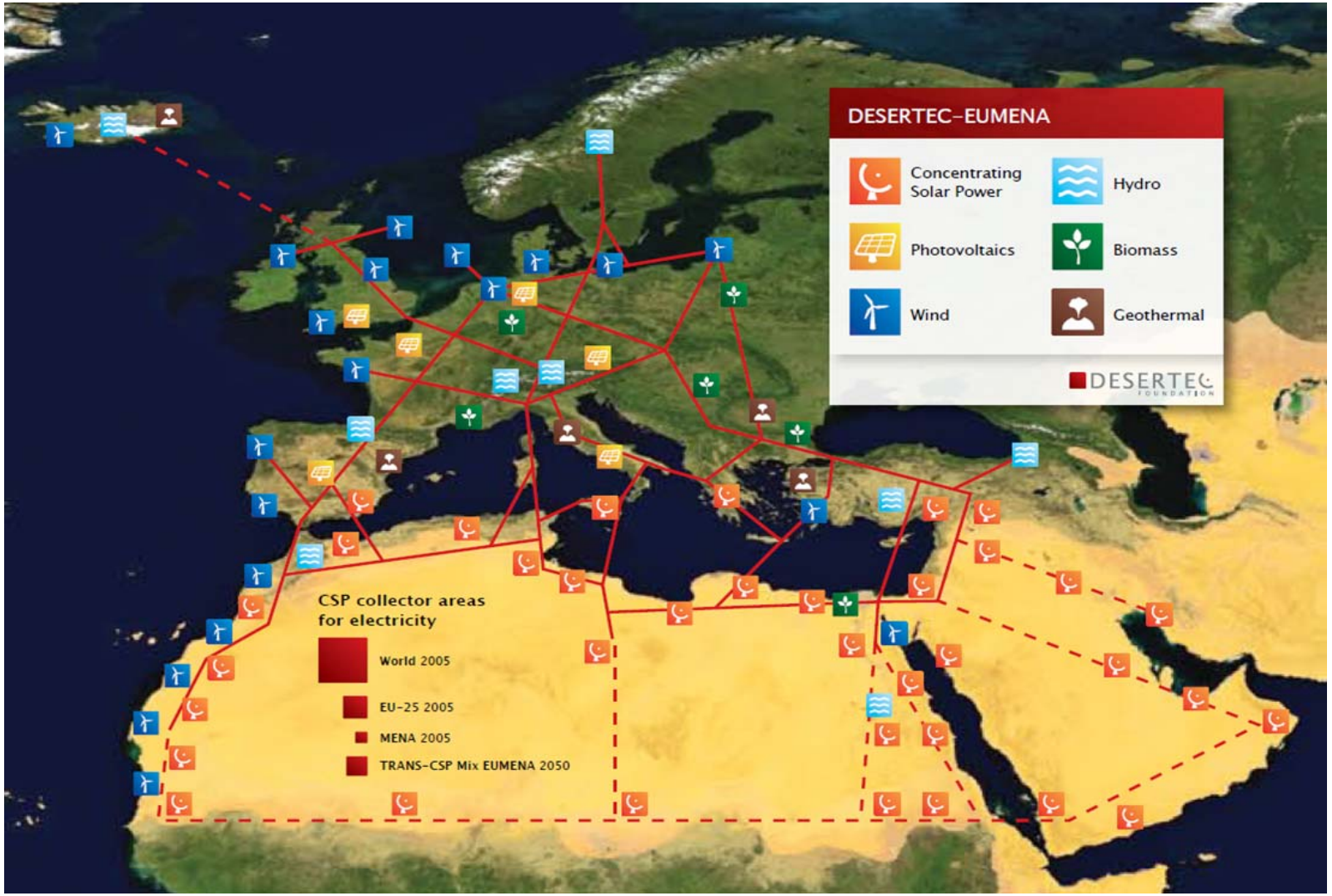
Mediterranean ring



(Source: Medring update study)

DESERTEC

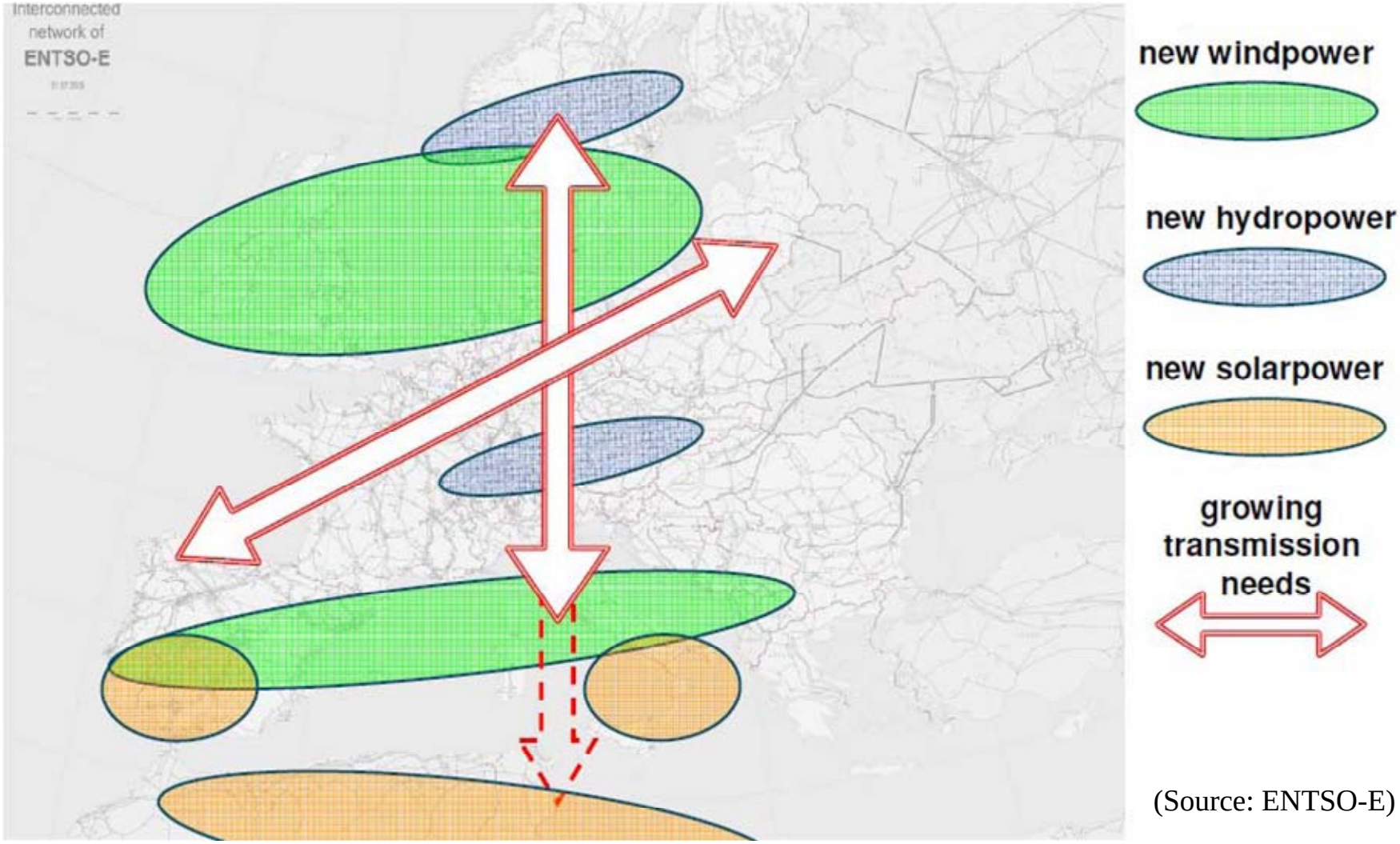
Technical, economic and political issues for this long-term project



(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

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

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