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POSTER

Challenges related to long HVAC export cables in offshore wind power plants

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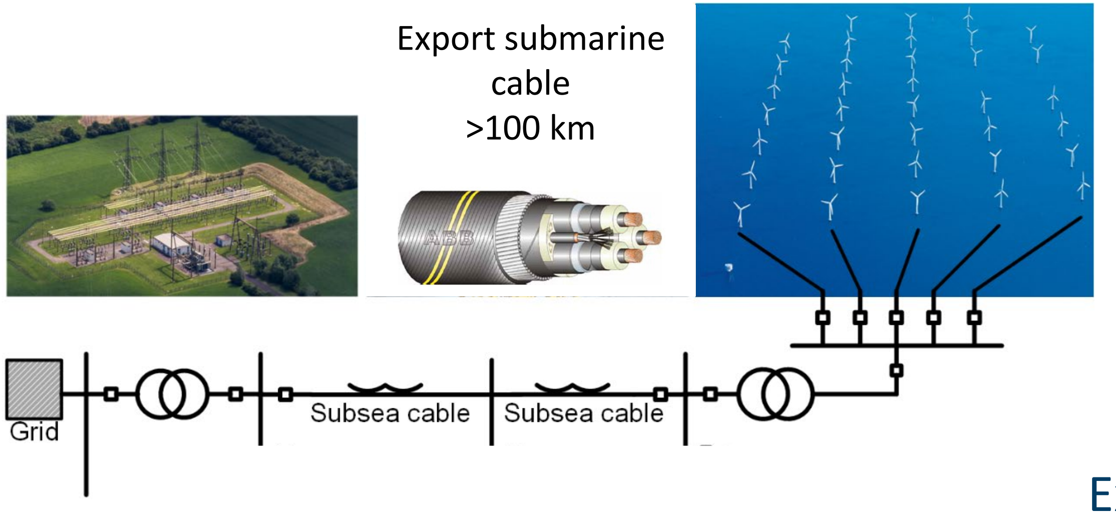
Why long HVAC and what is the challenge?



Why HVAC?

Availability

Deliverability

Developer's experience

Challenge?

Export system design

Modelling

Interaction with external grid (system), …

Influence on export system design

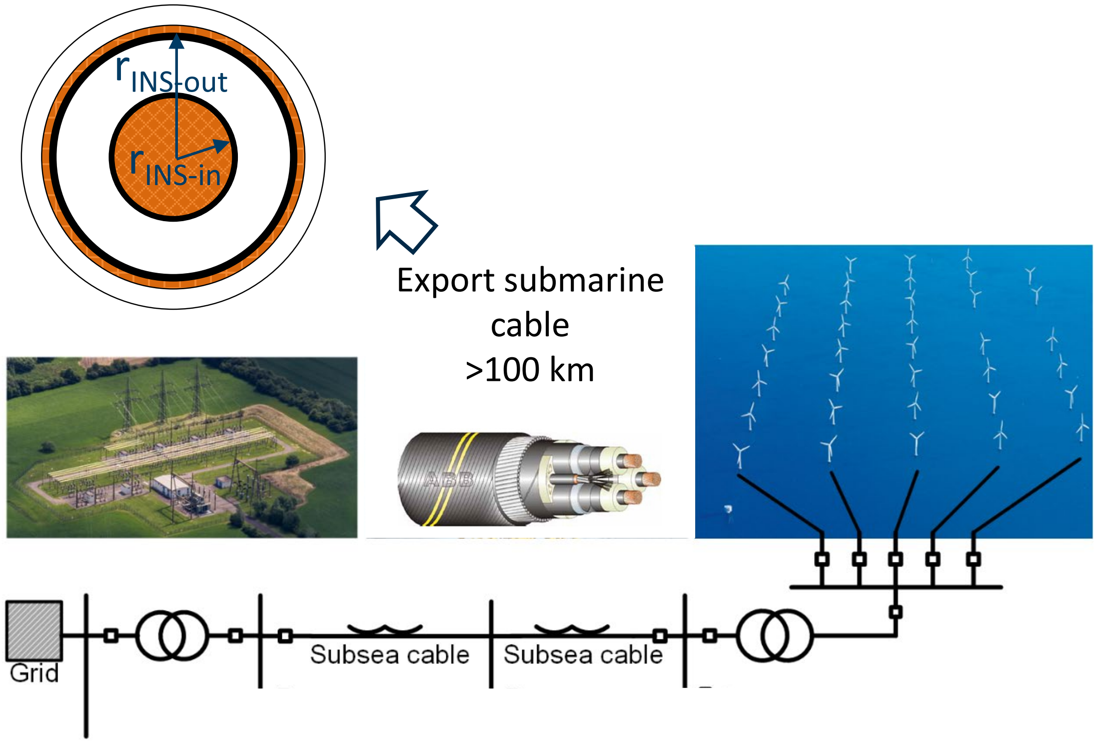
Cable capacitance

$$C = \frac{2\pi\epsilon}{\ln\frac{r_{INS-outer}}{r_{INS-inner}}}$$

Capacitive current

Decreased cable transmission capacity

Cable compensation required!



Additional platform when long cables

Challenge:

How to decrease the cost of compensation?

Subsea technologies

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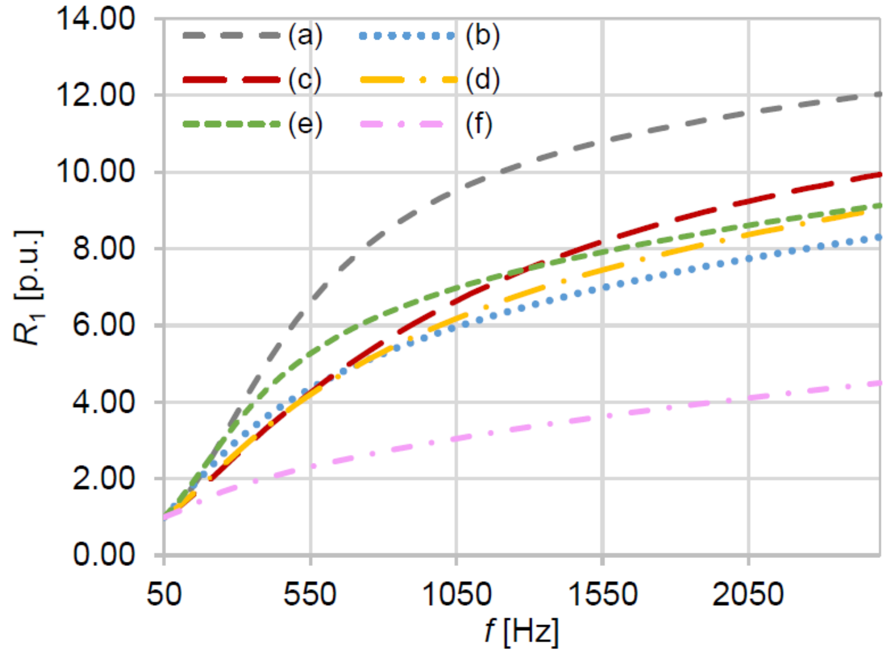
Modelling

Export system design should be supported by transients' simulations to predict representative overvoltages.

Accurate representation is essential



Submarine cable equivalent frequency-dependent positive-sequence resistance assuming:

(a) Skin effect (tubular armour) –MoM-SO

(b) Skin and proximity effects (tubular armour) –MoM-SO

(c) Skin effect (stranded armour) –MoM-SO

(d) Skin and proximity effects (stranded armour) –MoM-SO

(e) Skin, proximity and hysteresis effects (stranded armour) –MoM-SO

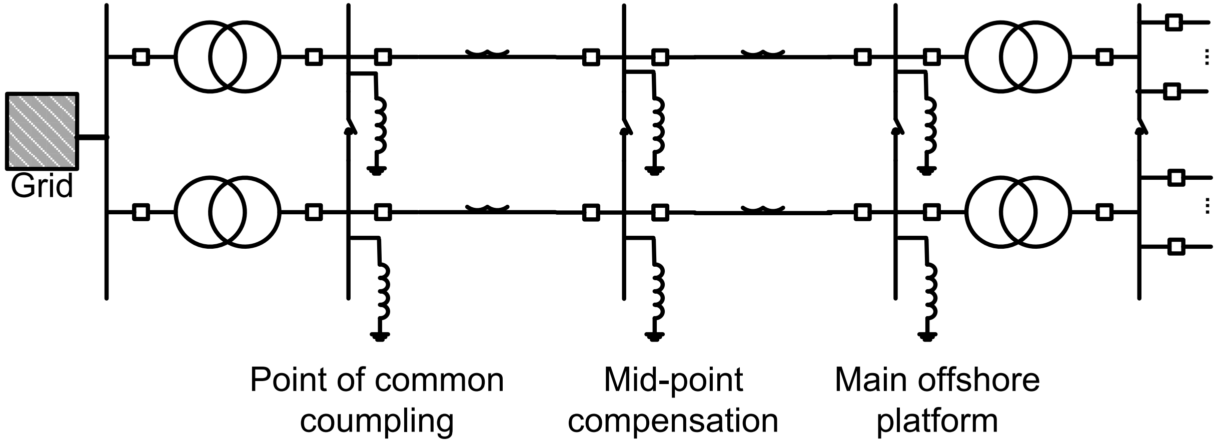
(f) Model from IEC 60287-1-1:2006.

Source: Kocewiak, Arana, Holdyk, Gustavsen; 'Modelling of Wind Power Plant Transmission System for Harmonic Propagation and Small-signal Stability Studies'

System impact

Important phenomena related to long cables:

- Zero miss
- Energization of parallel cables might result in high inrush currents
- High overvoltages during cable energization in weak grids
- Large capacitance shifts resonances to low frequencies
  - Background harmonic amplifications
  - Extended voltage oscillations during energization
- High inrush currents during ground fault



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Summary

The longer the HVAC cable connection → the more severe the presented problems will be

Developers should increase focus on the design phase, including detailed modelling and simulations

Useful reading:

- Ł. H. Kocewiak, I. A. Aristi, B. Gustavsen, and A. Hołdyk, 'Modelling of wind power plant transmission system for harmonic propagation and small-signal stability studies', IET Renewable Power Generation, vol. 13, no. 5, pp. 717–724, Jan. 2019, doi: 10.1049/iet-rpg.2018.5077.
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- B. Gustavsen, M. Høyer-Hansen, P. Triverio, U.R. Patel, "Inclusion of wire twisting effects in cable impedance calculations", IEEE Trans. Power Delivery, vol. 31, no. 6, pp. 2520-2529, Dec. 2016.
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