Paris Session 2022

cigre
For power system expertise

Increased Impact of Clean Energy Transition on Sub-station Design

SC B3 Substations

PS1 / Q1.4

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Offshore Wind in the National Electricity Market

•*Question PS1.4*

To what degree are the new environmental directives impacting on the industry's ability to respond and deliver the substation infrastructure necessary to facilitate Net Zero?

•Offshore Wind is emerging as a key component of the pathway to net zero globally and in Australia.

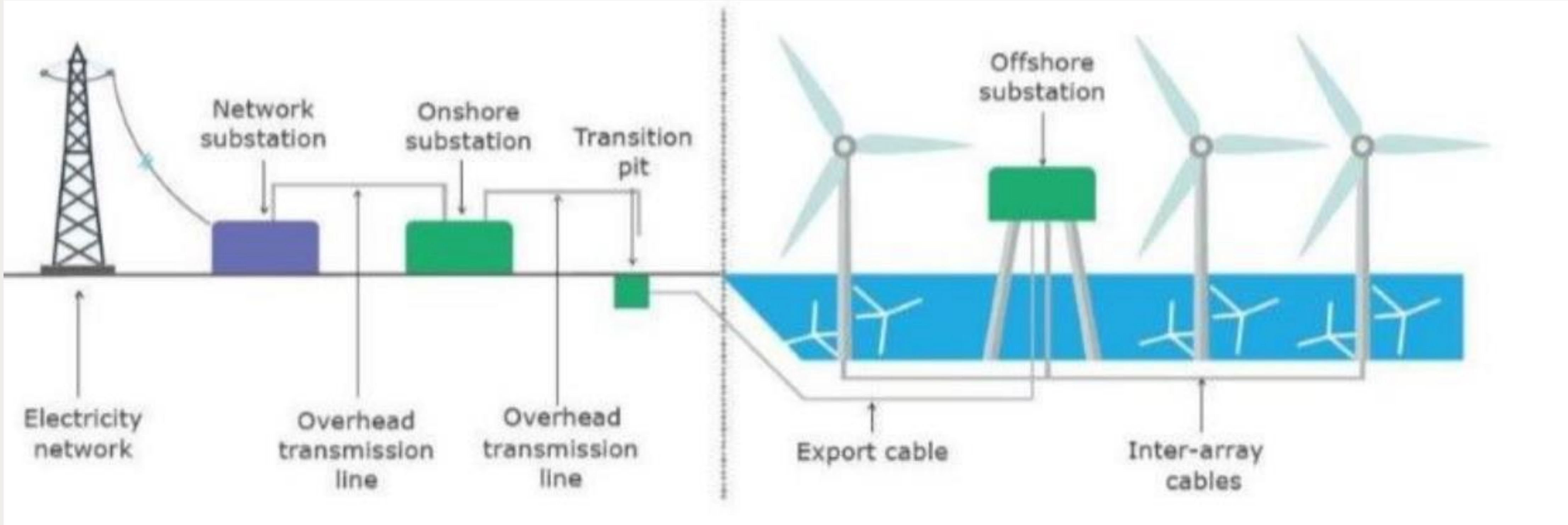
•Offshore Wind has key technical features and constraints which impact upon substation design and require special design consideration.

Offshore Wind Zones (blue)

Heightened interest in Offshore Wind in Australia requires additional transmission infrastructure

Offshore Wind - Diagram

Component selection and grid compliance requirements will influence onshore and offshore substation configuration



Offshore Wind Farm network components

Component	Notes
Offshore WTGs	Increasing size, fixed or floating (10-15MW typical)
Offshore subsea collector network	33 kV, 66 kV or 132 kV subsea UGC
Offshore substation	Heavily space-constrained.
Subsea transmission cable	HVAC 220/275kV (HVDC depending on distance).
Onshore compensation station	Shunt reactors – switched/non switched
Onshore cable or OHL	HV AC OHL or UGC, multiple circuits
Onshore grid substation	Point of connection, grid compliance

Offshore wind farm key design decisions

Component	Design Question
Offshore WTGs	WTG size selection (10-15MW)
Offshore subsea collector network	Offshore configuration and voltage based on WTG rating. Minimisation of collector network losses.
Offshore substation	One or more offshore substations depending on number of WTGs Primary switchgear configuration for reliability. Shunt reactors for transmission cable loss reduction
Subsea transmission cable	Distance of wind farm will drive HVAC//HVDC selection. EHV AC UGC voltage and cable size frequently the limiting factor for wind farm. Cable rating likely to limit Mvar transfer capability from WTGs to POC
Onshore compensation station	Shunt reactor sizing for loss minimization (switched/non switched) Primary config/ bus connection for load sharing between onshore circuits
Onshore cable or OHL	HV AC OHL or UGC depending on planning and enviro constraints Multiple circuits depending on rating and voltage selection Cyclic loading/shore transition/construction pinch points/ easement co-location
Onshore grid substation	Point of connection, primary config for RAM, shunt reactors, dynamic plant for grid compliance (STATCOM, SVC, MCSR, Cap) (grid compliance)

Design constraints

- Grid compliance – Var support from WTGs frequently not available at POC due to cable current limits (MW only). Dynamic reactive plant (DRP) at POC (STATCOM or other)
- Shunt reactor sizing location and switching subject to cable parameters (length, Ic) and voltage profile.
- Composite Short Circuit Rating may be marginal for furthest turbines. Will influence allowable cable network design impedance. Short circuit support may be required at offshore substations.
- Main grid transformers require careful design if STATCOMs connected via tertiary winding due to rating and large reactive power variation. Tertiary winding may not be possible. Impacts on substation layout to be determined ASAP.
- Harmonic filter design influenced by requirements at POC and DRP.
- Connection configuration to POC influenced by single contingency planning limits. Grid connections are frequently subject to competition from other projects